



# BAY AREA AIR QUALITY MANAGEMENT DISTRICT

**STAFF REPORT**

**PROPOSED AMENDMENTS TO  
REGULATION 9, RULE 10:**

**NITROGEN OXIDES AND CARBON MONOXIDE FROM BOILERS,  
STEAM GENERATORS AND PROCESS HEATERS IN PETROLEUM  
REFINERIES**



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# Contents

1.0 Executive Summary.....	3
2.0 Background.....	5
2.1 Current Regulation 9-10 Emission Standards.....	5
2.2 Emission Reductions Through 2002.....	6
2.2.1 Inter-Changeable Emission Reduction Credits (IERC).....	7
2.3 Emission Reductions After 2002 .....	8
3.0 Proposed Rule Amendments.....	9
3.1 Proposed Alternate Emission Standard .....	9
3.1.1 Equivalence with Current Rule Requirements .....	11
3.2 Continuous Emissions Monitoring Systems (CEMS) Use .....	12
3.3 Pre-1994 Heater Status Report.....	14
3.4 Emission Reductions and Benefits of the Proposed Amendments.....	14
4.0 Economic Impacts.....	15
4.1 Cost of Amendments.....	15
4.2 Cost Effectiveness .....	16
4.3 Incremental Cost Effectiveness .....	16
4.4 Socioeconomic Analysis .....	16
5.0 Environmental Impacts.....	17
6.0 Regulatory Impacts.....	17
8.0 Conclusion.....	20
9.0 References.....	21

## 1.0 Executive Summary

The Bay Area Air Quality Management District (“BAAQMD” or the “District”) is proposing amendments to Regulation 9, Rule 10: *Nitrogen Oxides and Carbon Monoxide from Boilers, Steam Generators and Process Heaters in Petroleum Refineries* (“Regulation 9-10” or “the regulation”) that will: (1) create a new, voluntary alternative nitrogen oxides (NO<sub>x</sub>) standard for pre-1994 heaters<sup>1</sup>; (2) increase continuous emissions monitoring systems (CEMS) coverage on pre-1994 heaters; and (3) establish a new reporting requirement. The purpose of the proposed amendments is to: (1) provide operational flexibility to refinery operators and encourage energy efficiency improvements, and thus, lower greenhouse gas emissions, while assuring that the NO<sub>x</sub> emission reductions achieved under the current rule continue; (2) improve the enforceability of the rule; and (3) gather information from which future emission reductions can be considered.

Pre-1994 heaters are currently subject to a daily, average *emission rate* limit of 0.033 pounds NO<sub>x</sub> per million BTU of heat input (0.033 lb NO<sub>x</sub>/MM BTU). This is a limit on the amount of NO<sub>x</sub> emitted relative to the amount of fuel consumed. A refinery is not bound to limit its total mass emissions to any particular amount - it will be in compliance as long as the ratio of NO<sub>x</sub> to fuel usage, averaged among all pre-1994 heaters, remains at or below 0.033 pounds NO<sub>x</sub>/MM BTU per day. By contrast, the proposed alternative NO<sub>x</sub> standard for pre-1994 heaters is a daily, total *mass emission* limit. This is a limit on the total amount of NO<sub>x</sub> emitted. The purpose of the alternative is to provide the refineries with a lower-cost compliance option while limiting pre-1994 heaters to their historic NO<sub>x</sub> mass emission levels. Under the current rule, a refinery that replaces and/or removes from service a pre-1994 heater that has a lower emission rate than its pre-1994 counterparts may be required to add controls on the remaining heaters to ensure that the remaining heaters as a group continue to comply with the 0.033 lb NO<sub>x</sub>/MM BTU daily, average emission rate limit. Some refineries have characterized this requirement as a “disincentive” to modernization since it increases the cost of heater replacement projects when the above circumstances are met. A refinery that opts for a mass limit under the proposed amendments would not be required to add controls on the remaining heaters in this situation. In return, however, that refinery would lose the ability to increase total NO<sub>x</sub> emissions beyond historical levels even if its fuel usage increases in the future.

The California Global Warming Solutions Act of 2006 (AB 32) requires major greenhouse gas-emitting facilities, like refineries, to significantly reduce greenhouse gas (GHG) emissions by 2020. It is expected that compliance with the requirements of AB 32 and subsequent regulations will ultimately require modification and replacement of pre-1994 heaters (the least energy-efficient heaters in the refineries), and result in significant further reductions of NO<sub>x</sub> and CO emissions, in addition to GHG emission reductions. As mentioned above, the proposed amendments would allow refineries to perform these modifications and replacements without incurring the additional cost of making further NO<sub>x</sub> emission reductions on remaining pre-1994 heaters. The proposal would also allow certain

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<sup>1</sup> For simplicity, the term “pre-1994 heater” will be used in this report to refer to the refinery boilers, steam generators and process heaters, not including CO boilers, that were operating prior to January 5, 1994, and that are currently subject to the 0.033 lb NO<sub>x</sub>/MM BTU emission rate limit in current Regulation 9-10. The term does not include any heaters that are exempt or were modified since 1994 and thus are not currently subject to the emission rate limit.

refineries to use emission reduction credits (ERC) to establish the mass emission limit, which would be an expansion of the use of ERC under District regulations.

Heaters subject to Regulation 9-10 must monitor emissions to allow verification of compliance with the daily, average emission rate limit. Monitoring may be performed with a CEMS, which measures the NOx emission rate directly. Alternatively, monitoring may be performed by measuring key heater operating parameters (firing rate and exhaust oxygen level) and estimating the NOx emission rate based on the results of source tests conducted at similar operating parameters. This is called “parametric monitoring”. The proposed amendments would require that each refinery operate enough CEMS on pre-1994 heaters such that at least 95% of the NOx emissions at pre-1994 heaters are monitored with a CEMS. This new criteria would require additional CEMS to be installed at four of the five Bay Area refineries, would make the level of CEMS-coverage more uniform across the refineries, and would improve enforceability of the rule. Because all significant NOx emission contributors at each refinery (collectively contributing 95% or more of NOx emissions from pre-1994 heaters) would be covered by CEMs under the proposed amendments, staff also proposes simplifying the monitoring requirements for the remaining heaters without CEMS.

Finally, the proposed amendments include a new heater status report to be submitted by each refinery with current burner information. The report would need to be updated whenever burners are changed or replaced. The purpose of this report is to provide data necessary for the District to estimate potential further emission reductions at pre-1994 heaters and the cost of these reductions.

The proposed alternative emission standard is voluntary and therefore may not produce any particular level of additional emission reduction. However, the proposed amendments contain provisions to ensure that if a refinery selects the alternative standard, equivalent emission reductions to those that would have been required by the current provisions of Regulation 9-10 will occur for any foreseeable project. Also, since the proposed alternative standard is voluntary, it imposes no mandatory additional costs on refinery operators. If a refinery operator elects to use the alternative standard, it presumably will do so because the overall cost of compliance with the alternative standard will be lower than with the existing standard.

The proposed changes to monitoring requirements would require approximately 23 new CEMS to be installed at the five Bay Area refineries and would improve the enforceability of the rule although it would not directly result in emissions reductions. Each CEMS may cost from \$100,000 up to \$500,000 to be installed and commissioned, and may have annual operating and maintenance costs of as much as \$25,000. The proposed reporting requirement is considered to have a negligible cost because the data should be readily known and available to refinery operators.

Discussion of an alternative standard for Regulation 9-10 began prior to the Board’s adoption of the 2010 amendments. At that Board hearing on December 15, 2010, staff was directed to work with refineries to explore alternative standards. Staff considered many options to provide flexibility and maintain achieved emissions reductions, and, on November 14, 2012, provided notice of draft amendments. A public workshop was conducted on December 4, 2012 in Martinez, CA. Staff received comments, made appropriate revisions to the draft and, on May 29, 2013, published a second

draft and requested further comments. Staff made further revisions based on these latest comments. A socioeconomic analysis conducted by Applied Development Economics of Walnut Creek, CA has concluded that the costs associated with the proposed amendments would not have a significant economic impact on the affected industry, and a California Environmental Quality Act (CEQA) environmental analysis conducted by Environmental Audit of Placentia, CA concluded that the proposed amendments would not have significant adverse environmental impacts. Staff has reviewed and accepted these analyses. A CEQA Negative Declaration is proposed.

## **2.0 Background**

### **2.1 Current Regulation 9-10 Emission Standards**

Nitrogen Oxides (NO<sub>x</sub>), consisting of nitric oxide and nitrogen dioxide, are a by-product of combustion processes, be they automobile engines, water heaters or industrial boilers. NO<sub>x</sub> are the result of a high temperature reaction between oxygen, necessary for the combustion of fuel, and nitrogen in the air. NO<sub>x</sub> reacts with organic compounds in the presence of sunlight to produce photochemical smog, or ozone. NO<sub>x</sub> also contributes to the formation of fine particulate matter (PM<sub>2.5</sub>). Carbon monoxide (CO) is a poisonous gas that is the product of incomplete combustion. There are federal and California ambient air quality standards for ozone, PM<sub>2.5</sub> and CO. The District is not in attainment of the federal or State standards for ozone and PM<sub>2.5</sub>, although the District does attain both federal and State standards for CO. Regulation 9-10 sets emission limits for NO<sub>x</sub> and CO from boilers, steam generators and process heaters at petroleum refineries in the San Francisco Bay Area. Petroleum refineries are complex facilities that refine crude oil into gasoline and other salable products. Numerous processes are involved in the refining process, which seeks to maximize the yield of high-value products like gasoline. Most of these processes involve heat, and most of the heat is supplied by combusting refinery fuel gas, a by-product of the refining process. There are approximately 180 boilers, steam generators and process heaters that are subject to Regulation 9, Rule 10. Regulation 9-10 was last amended in 2010 to add new CO boiler emission limits (effective 2015) that are shown in Table 1. CO boilers are a class of large heaters that produce steam and that use as fuel, at least in part, a waste gas rich in CO. CO boilers combust and eliminate much of the CO that would otherwise be emitted from the refinery.

Regulation 9-10 includes District “best available retrofit control technology” (BARCT) NO<sub>x</sub> limits and federal “reasonably achievable control technology” (RACT) NO<sub>x</sub> limits for pre-1994 heaters, and separate BARCT and RACT limits for CO boilers. BARCT limits satisfy California requirements for ozone non-attainment areas, while RACT standards satisfy less-stringent federal requirements for ozone non-attainment areas. Table 1 summarizes the current Regulation 9-10 emission limits.

<b>Table 1 – Current Regulation 9-10 NOx Emission Limits*</b>		
	<b>Federal “RACT” NOx Limit</b>	<b>BAAQMD “BARCT” NOx Limit</b>
<b>Pre-1994 Heaters (except CO boilers)</b>	Refinery-wide, daily average: 0.20 lb NOx / MM BTU input	Refinery-wide, daily average: 0.033 lb NOx / MM BTU input
<b>Pre-1994 CO Boilers</b>	<b>Current Limit:</b> Daily average, each device: 300 ppmv	<b>Current Limit:</b> Daily average, each device: 150 ppmv
		<b>Effective 1/1/2015:</b> Partial-burn boilers: 125 ppmv daily average; 85 ppmv annual average Non-partial-burn boilers: 150 ppmv daily average; 45 ppmv annual average
<b>Post-1994 Heaters (including CO boilers)</b>	Not subject to Reg. 9-10; subject to more stringent BAAQMD “BACT” limits under Regulation 2, Rule 2: New Source Review.	

\* All “parts per million by volume” (ppmv) concentration limits are standardized to a 3% exhaust oxygen concentration.

Regulation 9-10 is unusual because most of the heaters subject to the rule do not have source-specific emission limits, but instead are subject to the refinery-wide daily, average NOx limits. The rule was structured this way in order to minimize the cost of compliance with the required NOx emission reductions, and to allow operational flexibility on a day to day basis as heater demand changes.

Regulation 9-10 applies an average, daily NOx emission rate limit of 0.033 lb NOx/MM BTU to pre-1994 heaters that are not CO boilers. Pre-1994 CO boilers are subject to boiler-specific (not average), daily NOx exhaust concentration limits expressed in units of “parts per million by volume” (ppmv). The specific value of the limit depends on the design of the CO boiler. The proposed amendments to Regulation 9-10 described in this report only affect the average, daily NOx limit of 0.033 lb NOx/MM BTU that applies to pre-1994 heaters that are not CO boilers.

## **2.2 Emission Reductions Through 2002**

The NOx limits for pre-1994 heaters in Regulation 9-10 were adopted in 1994 and required that refinery operators retrofit many of these devices with a variety of NOx controls by 2002 to reduce the average, daily NOx emission rate to no more than 0.033 lb NOx/MM BTU. (Most pre-1994 heaters were in service before the District created its new source review permit program that requires “best available control technology” (“BACT”) on new sources, and therefore were not subject to any regulatory or permit condition emission limits until Regulation 9-10 was adopted.) As a result of these retrofits, Regulation 9-10 achieved a permanent NOx reduction of about 26 ton/day, which represents about a 65% emission reduction from refinery heaters from 1994 through 2002. This is the largest NOx reduction achieved from any single District rule. Since 2002, refinery heater NOx emissions have trended lower, although a sustained increase in refinery production could result in a reversal of this

trend. This is because Regulation 9-10 does not limit pre-1994 NOx emissions on a mass basis; NOx emissions are limited only in proportion to the fuel that these heaters use, i.e. an emission rate limit.

Regulation 9-10 never applied to newer refinery heaters that have been permitted by the District since 1994 (“post-1994” heaters) because these devices must comply with the BACT permit requirements under Regulation 2-2: New Source Review for new or modified heaters. BACT requirements have become stricter over time to reflect the improvement of emission-control technology. Compared to the Regulation 9-10 average limit of 0.033 lb NOx/MM BTU, which is equivalent to about 28 ppmv NOx, the current BACT requirement for a typical refinery heater would be a NOx limit of 5 ppmv (*Reference 1*) achieved with a selective catalytic reduction (SCR) system. Thus, replacing a pre-1994 heater with a new or modified heater that would be required to meet stringent BACT limits may result in a net reduction of 50% or more in the NOx emission rate. That does not necessarily mean that the replacement would also yield a reduction of 50% or more in NOx mass emissions, because the refinery operator may replace the pre-1994 heater with a larger device. However, there would likely be a net reduction in NOx mass emissions, even if the new heater is larger and would burn more fuel. This is because, in addition to being subject to BACT limits on emissions, new heaters at refineries must have their new permitted emissions fully offset by emission reductions elsewhere as required by Regulation 2, Rule 2. If the offsets are in the form of emission reduction credits (ERC), then they must be provided at a 1.15:1 ratio – meaning that the new permitted emissions must be over-offset by 15%. An ERC is a credit, stored in an emissions bank, of nitrogen oxides or organic compounds. Regulation 2, Rule 2 prevents a net increase in emissions in the Bay Area, even if one facility is able to increase emissions. ERC may be banked and traded between facilities, but are generated only from source shutdowns or other voluntary, permanent emissions reductions not required by regulations.

Further, ERC are adjusted at the time they are generated, which means that the amount of ERC granted to the facility as the result of making a permanent emission reduction is lowered to the amount that would have been emitted if the source of the emissions had emission controls that met current reasonably available control technology (RACT) requirements for similar sources. Thus, an ERC used to offset a new source may represent even greater emissions actually reduced, thus increasing further the net environmental benefit of a new heater replacement.

As an example, if a heater that is uncontrolled and that emits 100 tons NOx/year is removed from service at a refinery and replaced with a heater equipped with BACT that will emit 50 tons NOx/year, the 100 tons NOx/year emissions from the removed heater might be adjusted to a RACT level of 40 tons NOx/year ERC. Because the difference is 10 tons NOx/year, NOx ERC in the amount of 11.5 tons will be required to offset the new source (10 x 1.15 as per Reg. 2-2-302). So the net NOx emissions are reduced by 50 tons/year, plus 11.5 tons of ERC are retired - a significant net benefit to the environment.

## **2.2.1 Inter-Changeable Emission Reduction Credits (IERC)**

Although all refinery operators implemented NOx retrofits on pre-1994 heaters that are not CO boilers in order to comply with the 0.033 lb NOx/MM BTU limit by 2002, some refinery operators that had CO boilers at their refineries also added or improved NOx controls on these CO boilers in order to

comply indirectly with the 0.033 lb NO<sub>x</sub>/MM BTU limit. This is possible because BAAQMD Regulation 2-9 (“Interchangeable Emission Reduction Credits”) and California law allow the operator of a permitted source of NO<sub>x</sub> that “over-complies” with all applicable NO<sub>x</sub> limits to apply credits from that over-compliance to different NO<sub>x</sub> sources at the same facility. The generation, banking and use of ERC and IERC are among the most complex aspects of air pollution law. Table 2, below, provides a very simplified explanation of the differences between these credits.

<b>Table 2 – Emission Reduction Credits (ERC) and Interchangeable Emission Reduction Credits (IERC)</b>		
	<b>ERC</b>	<b>IERC</b>
<b>Pollutants allowed</b>	NO <sub>x</sub> , organic compounds, sulfur dioxides, particulate matter, CO	Only NO <sub>x</sub>
<b>Sources</b>	Sources shut down, permanent reductions below regulatory limits.	Permanent reductions below regulatory limits.
<b>Uses</b>	Offset emissions from new sources. May be sold or traded between facilities, or translated into IERC.	Compliance with District NO <sub>x</sub> rules.
<b>Lifespan</b>	Permanent	5 years
<b>Restrictions</b>	Can only be used to offset emissions from new sources.	Cannot be used for compliance with federal rules, District rules submitted into the SIP* or District BACT determinations for new sources. Must be used within the generating facility
<b>Surcharge for use</b>	1:1.15 (15%) for non-attainment pollutants	1:1.10 (10%)
<b>Reference</b>	Regulation 2, Rule 2: New Source Review	Regulation 2, Rule 9: Interchangeable Emission Reduction Credits

\* *State Implementation Plan. The EPA requires ozone non-attainment areas to submit District rules into the California SIP, which then become federally enforceable. Because of more stringent California ambient air quality standards, the District is also required to implement more stringent BARCT standards. IERC can be used to comply with these BARCT standards.*

As an example, if a refinery operator reduced emissions at a stationary gas turbine in a refinery to below the NO<sub>x</sub> emission limit for turbines (Regulation 9-9) the operator could apply credits from that over-compliance to pre-1994 heaters that are subject to the daily, average NO<sub>x</sub> limit of 0.033 lb NO<sub>x</sub>/MM BTU. Regulation 2-9 requires that when the IERC process is used, the over-compliance at one source be discounted by 10% when it is applied to the other source.

### **2.3 Emission Reductions After 2002**

After the NO<sub>x</sub> reductions associated with the 1994 version of Regulation 9-10 were realized by 2002, each refinery has been required to maintain compliance with the average NO<sub>x</sub> emission rate limit of 0.033 lb NO<sub>x</sub>/MM BTU for pre-1994 heaters that are not CO boilers. Over time, as heaters are retired or substantially modified, the number of heaters subject to Regulation 9-10 is reduced. As that happens, the emissions from the remaining ones still cannot exceed the 0.033 lb NO<sub>x</sub>/MM BTU

standard. The rule has no explicit requirement that additional emission reductions occur after 2002, but there are two situations where the current rule would require a refinery to add additional NO<sub>x</sub> controls to pre-1994 heaters in order to maintain compliance.

The first situation results when all of the following conditions are present:

- A heater is removed from the population of pre-1994 heaters that is subject to the average NO<sub>x</sub> emission rate limit of 0.033 lb NO<sub>x</sub>/MM BTU - because it is retired, or because it is replaced (the replacement heater would be subject to BACT NO<sub>x</sub> limits and emission offset requirements, but would not be subject to Regulation 9-10); and
- The removed heater operates below the 0.033 lb NO<sub>x</sub>/MM BTU average; and
- The removed heater is a large enough contributor to the overall average that its removal from the pre-1994 heater population results in the average NO<sub>x</sub> emission rate of the remaining heaters to exceed the 0.033 lb NO<sub>x</sub>/MM BTU standard.

In this case, one or more of the remaining pre-1994 heaters would be required to be retrofitted with additional NO<sub>x</sub> controls to bring the overall average down to no higher than 0.033 lb NO<sub>x</sub>/MM BTU.

The second situation that would require a refinery operator to make additional, permanent emission reductions to pre-1994 heaters after 2002 occurs when a refinery operator has complied indirectly with this limit by using IERC, as described above, and the source of the IERC is lost – either because the IERC-generating source is removed from service, or because it no longer generates enough IERC (because the source emission rate increases, or the source becomes subject to stricter NO<sub>x</sub> limits). In this situation, similar to the first, additional NO<sub>x</sub> emission reductions on pre-1994 heaters would be required to reduce emissions to a level no greater than 0.033 lb NO<sub>x</sub>/MM BTU.

## **3.0 Proposed Rule Amendments**

### **3.1 Proposed Alternate Emission Standard**

Each Bay Area refinery complies with the current emission standard for pre-1994 heaters in Section 9-10-301 of Regulation 9-10 by applying a variety of NO<sub>x</sub> control technologies to refinery heaters in a combination that allows compliance with the daily, average emission rate limit. These technologies range from basic, low-NO<sub>x</sub> burners that have NO<sub>x</sub> emission rates around 30 ppmv (at 3% oxygen), to more-advanced burners that achieve lower NO<sub>x</sub> emission rates through staged combustion techniques and other NO<sub>x</sub>-minimization techniques, including add-on controls such as selective catalytic reduction and non-selective catalytic reduction, a technique in which ammonia is added to a NO<sub>x</sub>-rich gas stream to reduce the NO<sub>x</sub> to nitrogen (N<sub>2</sub>) and water.

The new, voluntary alternate emission standard would be a daily NO<sub>x</sub> mass limit for pre-1994 heaters subject to Regulation 9-10. The alternative standard applies to the same population of pre-1994 heaters that are currently subject to Section 9-10-301. While Section 9-10-301 includes a *daily average emission rate* limit expressed in units of “pounds of NO<sub>x</sub> per million BTU of heat input”, the alternative limit is a *daily total mass* limit expressed in units of “pounds of NO<sub>x</sub>”.

The value of the mass limit is not set in the rule, since the value will be different for each refinery that elects to use the alternative. Instead, the proposed amendment includes a procedure for establishing the mass limit for each refinery. Under this procedure, each pre-1994 heater would have baseline NO<sub>x</sub> emissions equal to the average of its NO<sub>x</sub> emissions on any ten days during the three-year period immediately preceding the date of the refinery's application to select the alternative standard. The intent is to allow each refinery to select ten days that represent a full level of production provided, however, that the refinery must have been in compliance with the Section 9-10-301 NO<sub>x</sub> limit on all of those ten days. The APCO would have discretion to allow the baseline period to be extended farther back into the past if the refinery can demonstrate that they have not been at full production. The value of the mass limit would be the sum of the baseline emissions for all the pre-1994 heaters at each refinery that elects to use the alternative standard. Like with the current rule, the proposed amendments would not impose source-specific emissions limits on pre-1994 heaters. Rather, under the mass limit alternative, a refinery would need to comply with a daily, total mass limit. The refinery would therefore retain operational flexibility under either limit.

After the alternative limit is set, if a pre-1994 heater is modified or removed from service, such that it is no longer subject to Regulation 9-10, the value of the limit would be reduced by the amount that heater originally contributed to the alternative limit. Unlike under current Section 9-10-301, removal or modification of a heater that is lower emitting than its pre-1994 counterparts would not trigger a requirement to add additional NO<sub>x</sub> controls on the remaining heaters. This creates an incentive to modernize or replace heaters with more efficient units, enabling refiners to more easily move towards compliance with AB 32 requirements, but preserves the emissions reductions achieved by Regulation 9-10.

If a refinery operator had been relying on IERC to comply with Regulation 9-10 during the baseline period, the heaters had been emitting at a higher rate than the *daily average emission rate* standard of 0.033 lb NO<sub>x</sub>/MM BTU. The alternative mass emission limit would be set to be equivalent to the 0.033 lb NO<sub>x</sub>/MM BTU limit. A refinery with a continuing source of IERC could continue to apply IERC to comply with the new alternative limit, just as it had with the original limit. The proposed amendments also would allow the refinery to apply ERC at a 1.15:1 ratio to set the alternative mass emission limit, but only to set a NO<sub>x</sub> mass emission limit no higher than the actual emissions level that was offset by the use of IERC (to achieve compliance) during the baseline period. The equivalence of the new alternative limit to the original limit is further discussed in Section 3.1.1.

Also, if a refinery operator had submitted a permit application for a project that would have required that it achieve additional NO<sub>x</sub> emission reductions on pre-1994 heaters at the time the alternate standard is applied for, then the alternative mass emission limit would be reduced by the amount of required reductions if the project is constructed. Again, this adjustment is necessary to make the new alternative limit equivalent to the original *daily average emission rate*. And again, the refinery operator could apply ERC at a 1.15:1 ratio to set the alternative NO<sub>x</sub> mass emission limit, but only to a level no higher than the actual NO<sub>x</sub> emissions level during the baseline period.

In both cases above, the described use of ERC to establish the value of the alternative mass limit would be an expansion of the use of ERC under District regulations, which currently allow ERC to be used

for offsets for New Source Review (NSR) permitting purposes or to be exchanged for (time-limited) IERC. Importantly, however, the use of ERC in this way does not allow refinery emissions to increase above historical levels; it only allows a mass emission limit to be set that is no higher than actual historical emissions.

A refinery operating under the alternative NO<sub>x</sub> mass limit would be required to install additional NO<sub>x</sub> controls on pre-1994 heaters if it were to increase its fuel usage to the point that the NO<sub>x</sub> mass emissions limit was being exceeded. As mentioned previously, under the existing standard in Reg. 9-10, NO<sub>x</sub> mass emission increases are not limited as long as they do not exceed the 0.033 lb NO<sub>x</sub>/MM BTU emission rate.

Appendix A includes three examples that illustrate: 1) how a refinery would establish the alternative NO<sub>x</sub> mass limit; 2) how the use of IERC or a proposed project that would increase the NO<sub>x</sub> emission rate would affect this limit; and 3) how the alternate limit could be complied with, including the use of ERC to adjust the limit.

### **3.1.1 Equivalence with Current Rule Requirements**

As discussed in Section 2.3, compliance with the current daily, average *emission rate* limit was achieved at each Bay Area refinery in 2002 through permanent modifications of heaters, and the current rule does not explicitly require any additional emission reductions in the future. However, ongoing compliance with the current rule may require additional NO<sub>x</sub> controls to be installed on pre-1994 heaters as a result of projects that modify or remove other pre-1994 heaters, as explained in Section 2.3.1. Therefore, the proposed amendments may be considered to be equivalent to the current rule if emission reductions that would have been required by the current rule are not foregone by the alternative standard. The proposed amendments include requirements to ensure that if there are any foreseeable projects at a refinery that would involve pre-1994 heaters and would require additional NO<sub>x</sub> controls under the current NO<sub>x</sub> limit, equivalent reductions are factored into the NO<sub>x</sub> mass emission limit for that refinery. To see this in action, we revisit the two situations described in Section 2.3 and alluded to in Section 3.1 where a refinery would be required, under the current rule, to add NO<sub>x</sub> controls to pre-1994 heaters after 2002.

For the first situation – a heater upgrade project for which a permit application had been submitted - the permit application has the information the District needs to determine whether the current rule would require NO<sub>x</sub> emission reductions (for example, if the project involves replacing or modifying a large, low-emitting pre-1994 heater and removal of the heater would increase the average emission rate of the remaining pre-1994 heaters to above 0.033 lb NO<sub>x</sub>/MM BTU). The proposed amendments would require an equal amount of reductions as a condition of selecting the alternative standard. The refinery operator would have the option of providing Emission Reduction Credits (ERC) to make up that difference.

The second situation – losing a source of IERC – is addressed by setting the new alternative NO<sub>x</sub> mass emission limit equal to the existing 0.033 lb NO<sub>x</sub>/MM BTU emission rate standard. The difference between actual emissions and the equivalent standard is the same difference that was offset with IERC to comply during the baseline period. Then, if the refinery operator continues to have a source of

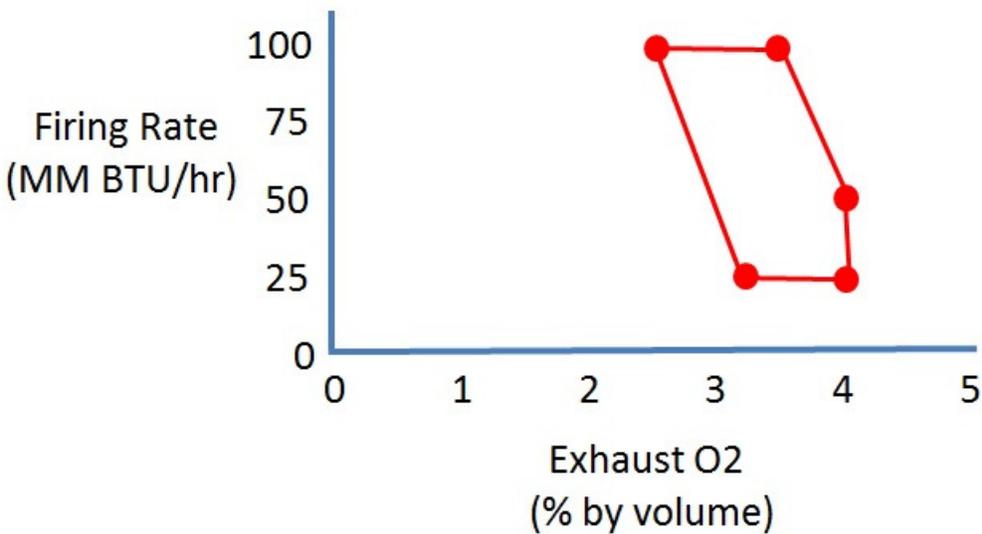
IERC, they could simply apply IERC to the new limit as they did to the original limit. If the operator loses the ability to generate all or some of the IERC necessary to comply with the original limit, they would also lose the ability to use IERC to comply with the new alternative limit. Even though, as described in Section 3.1, the refinery operator could use ERC to make up for the loss of IERC rather than applying NO<sub>x</sub> controls to comply, the use of ERC removes these emissions from the market. In neither case would emissions from pre-1994 heaters increase.

### **3.2 Continuous Emissions Monitoring Systems (CEMS) Use**

Regulation 9-10 requires the use of NO<sub>x</sub> and CO CEMS to monitor compliance with each of the emission limits in the rule, although it allows the use of an “equivalent parametric monitoring system” that is specified in a District permit. A CEMS is an automated, high-frequency analyzer that directly measures emissions while a parametric monitoring system monitors key system parameters, primarily firing rate and excess oxygen levels. Emissions are then calculated based on the emissions factors measured during source tests previously performed at the same or similar parameters. While a parametric monitoring system might over-estimate emissions to some extent, because it uses the highest emissions factor established by source test to estimate emissions during all periods of operation, a CEMS is considered the most accurate method of emissions monitoring. Most of the refineries have at least some heaters that use a parametric monitoring system rather than a CEMS, and for these heaters, the provisions of the parametric monitoring system are established in the permit conditions assigned to the heater.

The District has required the use of NO<sub>x</sub> and CO CEMS on any refinery heater that uses selective catalytic reduction (SCR) for NO<sub>x</sub> control, and also has required CEMS on any refinery heater rated 200 MM BTU/hr or more. This has resulted in a wide discrepancy in the coverage of NO<sub>x</sub> emissions with CEMS at different refineries. One refinery has less than half of its NO<sub>x</sub> emissions from pre-1994 heaters monitored by CEMS, while another has 98% coverage (based on 2011 NO<sub>x</sub> emission data).

Where a NO<sub>x</sub> CEMS is not required on a heater, the parametric monitoring system that is allowed for Regulation 9-10 requires that the heater operate with combinations of firing rates and exhaust oxygen levels where the NO<sub>x</sub> emission rates have been established by source testing. This allowed operating range is referred to as a “NO<sub>x</sub> Box”. An example of a NO<sub>x</sub> Box is shown in Figure 1:



***Figure 1 – Example of a NOx Box***

NOx Boxes are graphed as either a 4 or 5-sided polygon, with the underlying data included in the operating permit for the associated heater. In this example, a heater with a maximum firing rate of 100 MM BTU/hr has been tested at five points to form a 5-sided polygon. Each of the five data points represents a combination of firing rate and exhaust oxygen content (the two factors that most influence NOx emissions rates at a heater), and each point has an associated NOx emission rate (not shown in the graphical representation of a NOx Box) that was measured during the source test that established the point. The highest emission rate for all of the tested points becomes the NOx emission factor for that heater. Once the NOx Box is established, the heater must operate within the parameters outlined by the box, except during startup and shutdown periods. In this way, operation within the NOx Box provides near certainty that the actual heater emission rate is no higher than the emission factor that is used to estimate emissions.

Under the current rule, when a heater operates for any period of time outside of the parameters that have an established NOx emission factor, the refinery is required to perform a source test at the same operating conditions (firing rate and oxygen level), and to perform an evaluation verifying that the excursion outside of the NOx Box did not result in a violation of an emission limit in Regulation 9-10. A refinery has up to eight months to conduct the source test and then up to 45 days to submit the test results. During that time, compliance status is unknown. In some cases a refinery operator was unable to replicate the conditions of the excursion to perform a source test, so was cited for failure to perform the test, even though noncompliance with the emission limit was never established.

In order to improve the enforceability of Regulation 9-10 through more accurate NOx monitoring, to reduce the administrative burden of regulating parametric monitoring systems, to make the use of NOx CEMS much more consistent among refineries, and to simplify NOx monitoring where appropriate, the District is proposing to make two changes to NOx monitoring requirements in Regulation 9-10.

First, the regulation would require that each refinery monitor at least 95% of the NO<sub>x</sub> emissions from pre-1994 heaters, on a mass basis, with a CEMS. This would result in almost all NO<sub>x</sub> emissions being monitored with the most accurate monitoring technology, and would allow refineries to use parametric monitoring on the heaters that did not cumulatively make a significant contribution to total pre-1994 heater NO<sub>x</sub> emissions.

Second, for the remaining heaters without a CEMS, periodic source tests would continue to be required at the same frequency, but heaters would not be limited to any particular combination of firing rates and exhaust oxygen level. Each non-CEMS-equipped heater would still have one or two conservative emission factors, which would be used to estimate the emission contribution of that heater. Periodic source tests would simply be used to verify a NO<sub>x</sub> emission rate no higher than the emission factor for each heater that did not have a CEMS. If a periodic source test showed a NO<sub>x</sub> emission rate that exceeded the emissions factor assigned to that heater, the higher measured emission rate would then be the basis for a new emission factor at that heater. Since the non-CEMS-equipped heaters would make up no more than 5% of the emissions, the likelihood that a violation of the refinery-wide average would be undetected would be minimal.

### **3.3 Pre-1994 Heater Status Report**

The proposed amendments require a heater status report to be submitted by each refinery with current burner information. The report would be required to be updated whenever any burner is changed or replaced. The purpose of this report is to provide the District with data necessary to estimate potential further emission reductions at pre-1994 heaters and the cost of these reductions. Because the refineries constitute a large emission sector within the Bay Area, evaluation of potential further emission reductions will be an ongoing effort by District staff.

### **3.4 Emission Reductions and Benefits of the Proposed Amendments**

The proposed alternative standard will allow refineries to modernize and replace old heaters with newer heaters without having to retrofit older heaters to reduce emissions to meet a rate-based standard. Newer heaters emit significantly less NO<sub>x</sub> and CO and are designed to be more energy efficient, emitting less greenhouse gases and allowing the refinery to progress towards AB32 goals. The pre-1994 heaters under the alternative NO<sub>x</sub> mass standard will not be able to increase emissions. The alternative emission standard is voluntary and therefore may not produce any quantifiable emissions reductions. However, the proposed amendments contain provisions to ensure that if a refinery selects the alternative standard, equivalent emission reductions to those that would have been required by the current provisions of Regulation 9-10 will still occur for any project for which an application has been submitted prior to the selection of the alternate standard. The proposed alternative standard allows the flexibility that the averaging provision of the existing standard allows. The proposed requirement to cover at least 95% of the NO<sub>x</sub> emissions from heaters with CEMS will provide an increased certainty about NO<sub>x</sub> emissions and improve the District's ability to enforce the rule. Finally, the proposed heater status report will allow the District to investigate whether future cost effective emissions reductions can be proposed.

## 4.0 Economic Impacts

### 4.1 Cost of Amendments

#### 4.1.1 Alternative NO<sub>x</sub> Standard

The proposed alternative standard is voluntary, so it imposes no mandatory additional costs on refinery operators. If a refinery operator elects to use this alternative standard, it presumably will do so because it believes that the overall cost of compliance with the alternative standard will be lower than with the existing standard.

The current standard for pre-1994 heaters requires that they meet an average emission rate limit of 0.033 lb NO<sub>x</sub>/MM BTU. As described previously, modernization or replacement of a heater that has a lower-than-average emission rate could result in additional controls on one or more of the remaining pre-1994 heaters. In the development work that led up to the 2010 amendments, staff investigated a reduction in the emission standard through upgraded burners that produce less NO<sub>x</sub>, and through the addition of SCR systems or a variation of SCR that omits the catalytic reaction stage – “selective non-catalytic reduction” (SNCR). Each of these technologies has been implemented at the Bay Area refineries for NO<sub>x</sub> control. The cost of these NO<sub>x</sub> controls was discussed in the staff report for the 2010 amendments to Regulation 9-10 (*Reference 2*). The incremental cost effectiveness for pre-1994 heaters was estimated to be more than \$30,000 per ton of NO<sub>x</sub> emissions reduced for the lowest cost heater with most heaters exceeding \$100,000 per ton of NO<sub>x</sub> for burner upgrades and \$200,000 per ton for SCR or SNCR installation. These costs were based on refinery engineering estimates that were reviewed and validated by District staff. The cost for many heaters is related to space or structural limitations that would require significant additional modifications to install upgraded burners, SCR or SNCR. Since the alternate standard is voluntary, a refinery would only be expected to select it if it expected compliance to cost less than under the current rule.

#### 4.1.2 NO<sub>x</sub> Emissions Monitoring

The proposed amendments require the installation of CEMS on as many pre-1994 heaters as is necessary so that at least 95% of the NO<sub>x</sub> emissions from these heaters, on a mass basis, are monitored with CEMS. Based on the most current emission data for pre-1994 heaters, District staff estimates that 23 additional CEMS would be required, in order for each refinery to monitor at least 95% of the NO<sub>x</sub> emissions from pre-1994 heaters with CEMS. One Bay Area refinery is not expected to need any additional CEMS. Each of the other four Bay Area refineries would need to install between 2 and 10 additional CEMS.

The cost of CEMS varies significantly depending on installation-specific factors, such as the quality of enclosure required and the difficulty in providing electrical power and other utilities. Based on a review of recent total installation cost data for CEMS at Bay Area refineries, District staff estimates that each CEMS may cost from \$100,000 to as much as \$500,000 to install and put into service. Each CEMS is also expected to have about \$25,000 per year of operating costs, which includes maintenance and required accuracy testing.

### **4.1.3 Pre-1994 Heater Status Report and Updates**

The proposed requirement for refinery operators to provide and update heater burner information is considered to have a negligible cost because the required data should be readily known and available to refinery operators.

## **4.2 Cost Effectiveness**

The cost effectiveness of a rule is the sum of required compliance costs divided by the expected emissions reduction.

For the alternate NO<sub>x</sub> standard, there is no required compliance cost because the alternate standard is voluntary. Also, the cost effectiveness calculation cannot be made because, while the intent of this proposal is to encourage emission reductions through the modernization of pre-1994 heaters, there is no quantified expected emission reduction.

For the additional CEMS required, the cost effectiveness calculation cannot be made because there is no expected emissions reduction. The current rule establishes CEMS as the default monitoring method for the rule and only allows parametric monitoring if it is equivalent. While the use of parametric monitoring systems has previously been allowed on specific heaters in lieu of CEMS, this allowance was discretionary. Since 2002, District staff has concluded that expanded use of CEMS, as proposed in the amendments, will eliminate uncertainty about compliance status associated with excursions outside of the NO<sub>x</sub> Box parameters that constitute part of the parametric monitoring protocol currently in use. This, as well as the greater accuracy of CEMS, will improve the enforceability of the regulation.

For the proposed heater status report, the required compliance cost is considered to be negligible, although there is also no associated emissions reduction.

## **4.3 Incremental Cost Effectiveness**

Section 40920.6 of the California Health and Safety Code requires an air district to perform an incremental cost analysis for any proposed Best Available Retrofit Control Technology (BARCT) rule or for a rule that is part of an Alternative Emission Reduction Strategy as described in Section 40914 of the Health and Safety Code. This analysis is omitted here because the proposed amendments do not include either of these elements.

## **4.4 Socioeconomic Analysis**

Section 40728.5 of the California Health and Safety Code requires an air district to assess the socioeconomic impacts of the adoption, amendment or repeal of a rule if the rule is one that “will significantly affect air quality or emissions limitations.” Although the proposed amendments do not meet these criteria, Applied Development Economics of Walnut Creek, California has prepared a socioeconomic analysis of the proposed rule amendments to assess the impacts of the costs of the additional CEMS monitoring. It is attached to this report as Appendix C. The analysis concludes that the proposed regulation would have a less than significant economic impact to the affected industry.

## **5.0 Environmental Impacts**

Pursuant to the California Environmental Quality Act, the District has had an initial study for the proposed amendments prepared by Environmental Audit, Inc. of Placentia, California. The initial study concludes that there are no potential significant adverse environmental impacts associated with the proposed amendments. A negative declaration will be proposed for adoption by the Air District Board of Directors. The initial study and negative declaration will be circulated for public comment prior to the public hearing for this rule.

## **6.0 Regulatory Impacts**

Section 40727.2 of the California Health and Safety Code requires an air district, in adopting, amending, or repealing an air district regulation, to identify existing federal and air district air pollution control requirements for the equipment or source type affected by the proposed change in air district rules. The air district must then note any differences between these existing requirements and the requirements imposed by the proposed change.

BAAQMD Regulation 9 for NO<sub>x</sub> sources is structured so that no source is subject to more than one rule under Regulation 9. Therefore, the heaters that are currently subject to Regulation 9, Rule 10 and that are proposed to remain so, are not subject to any other District regulation that establishes specific emission limits or monitoring requirements, although they may be subject to other District regulations that establish permitting requirements, including heater-specific permit conditions, or fees.

U.S. EPA has established New Source Performance Standards (NSPS) in Part 60 of the Code of Federal Regulations (CFR) and National Emission Standards for Hazardous Air Pollutants (NESHAP) in Part 63 of the CFR that include NO<sub>x</sub> and CO emission limits that affect some refinery heaters as listed in Table 3.

**Table 3 – Federal Standards for Petroleum Refinery Heaters**

Federal Standard	Affected Heaters	Requirements
New Source Performance Standard (NSPS) Subpart D 60.44(a)	Steam Generator; input rating >250 MM BTU/hr; constructed after August 17, 1971	<ul style="list-style-type: none"> <li>• 0.20 lb NO<sub>x</sub>/MM BTU limit for gaseous fuel</li> <li>• 0.30 lb NO<sub>x</sub>/MM BTU limit for liquid fuel</li> </ul>
NSPS Subpart Db 60.44(b)	Steam Generator; input rating >100 MM BTU/hr; constructed after June 19, 1984	<ul style="list-style-type: none"> <li>• 0.10-0.20 lb NO<sub>x</sub>/MM BTU limit for natural gas and distillate oil fuel</li> </ul>
NSPS Subpart J 60.103	Fluid Catalytic Cracking Unit (FCCU) Catalyst Regenerators and Fuel Gas Combustion Devices constructed between June 11, 1973 and June 24, 2008	<ul style="list-style-type: none"> <li>• 500 ppmv CO limit</li> </ul>
NSPS Subpart Ja 60.103	FCCUs, Fluid Coking Units (FCUs) and Fuel Gas Combustion Devices (FGCDs) constructed after May 14, 2007	<ul style="list-style-type: none"> <li>• 80 ppmv NO<sub>x</sub> limit at 0% oxygen, 7-day rolling average</li> <li>• 500 ppmv CO limit at 0% oxygen, hourly average</li> </ul>
National Emissions Standard for Hazardous Air Pollutants Subpart UUU 63.1565(a)(1)	Catalytic Cracking Units (CCUs) constructed after September 11, 1998	<ul style="list-style-type: none"> <li>• 500 ppmv CO limit (surrogate for hazardous organic compounds)</li> </ul>

Many of the heaters subject to Regulation 9-10 are not subject to any of the NSPS because they predate the trigger dates for applicability of these rules (the rules only apply to sources constructed after the trigger dates). The Regulation 9-10 limit of .033 lb NO<sub>x</sub>/MM BTU is much more stringent than the federal standards. Regulation 9-10 also contains a more stringent CO limit of 400 ppmv.

The details of which of these federal requirements apply to specific refinery heaters are included in the major facility (Title V) permit for each refinery. In general, Regulation 9-10 already has, and is proposed to continue to have, more restrictive NO<sub>x</sub> and CO emission limits than the NSPS and NESHAPS. The only case where this is not obvious is for the 80 ppmv NO<sub>x</sub> limit in NSPS Subpart J. This limit is expressed as a daily average corrected to 0% oxygen while Regulation 9-10 has a refinery-wide daily average limit equivalent to 28 ppmv NO<sub>x</sub> at 3% oxygen. However, the NSPS standard applies to post-2007 heaters that would not be subject to Regulation 9-10, but would instead be subject to BACT standards if constructed in the Bay Area. BACT requirements would be at least as stringent as this NSPS standard.

## 7.0 Rule Development Process

District staff first considered a mass-based alternative NO<sub>x</sub> standard during the process that resulted in the 2010 amendments to Regulation 9-10. At the 2010 public hearing, a request was made by one refinery to consider the possible disincentive effect of the current rule structure to pre-1994 heater modernization and how that disincentive could be eliminated. The District Board directed staff to further consider this and these proposed amendments are the result of that direction.

Staff considered mechanisms to accomplish this task and consulted with refinery operators. District staff updated the District Board of Director's Stationary Source Committee on its rule development process on March 19, 2012. On November 14, 2012, staff posted a draft regulation and on December 4, 2012 held a public workshop in Martinez, CA to solicit public comment. A notice for this workshop was posted on the District website and individual notices were mailed to all refinery operators and other interested parties. Based on comments and a further evaluation of potential control measures, District staff prepared an amended proposal and released it for public comment in May 2013. During the public comment period on the amended proposal, District staff met and communicated with representatives from each refinery and with the Western States Petroleum Association to clarify provisions of the proposed regulation and to receive comments. The current proposed amendments are the product of this extensive process.

Staff received three written comments in response to the amended proposal:

1. Staff had previously considered eliminating a compliance monitoring provision related to heaters in curtailed operation (Section 9-10-301.4). Chevron refinery staff commented that the change would likely result in violations of the current refinery-wide NOx limit, especially when large heaters or the entire refinery is operated at a curtailed level. Because the potential exists for a refinery to operate at a reduced production rate, and emit fewer NOx emissions but still violate the rate-based standard, this draft change has been removed from the proposed amendments.
2. Valero refinery staff made a number of comments related to the alternative NOx limit and to the implementation of the new CEMS requirement. In addition, Valero has engaged staff on the details of the alternative NOx limit implementation and calculations. Most of Valero's comments have been incorporated, and example calculations to illustrate the alternative limits are provided in Appendix A.
3. Communities For a Better Environment staff commented that the draft staff report does not demonstrate a reduction in NOx emissions, and that it does not adequately illustrate the effect of adopting the alternative standard on refinery emissions, and also states that the proposed use of ERC to set the value of the alternative NOx limit represents a violation or relaxation of other District regulations, specifically Regulation 2, Rule 4 (ERC) and Regulation 2, Rule 9 (IERC). Although CBE is correct in that a reduction in NOx emissions is not mandated by the proposed amendments, the ability to use ERC in development of an alternate NOx limit is not precluded by other District rules or any State or federal laws. To better illustrate the effect of alternative NOx standard on refinery emissions, a set of quantitative examples have been added to this report.

After posting and revising the May 2013 draft, District staff continued to meet with affected parties.

The final proposed amendments and staff report were posted for public review on September 9, 2013.

## 8.0 Conclusion

The proposed amendments to Regulation 9, Rule 10 will provide an alternative, mass-based NO<sub>x</sub> emissions standard to the current, rate-based standard of 0.033 lb NO<sub>x</sub> / MM BTU. By selecting the alternative standard, refineries can more easily replace or modernize the older heaters subject to the rule. Replacement or modernization will result in significantly lower NO<sub>x</sub> emissions and enable a refinery to make progress towards compliance with the greenhouse-gas reduction mandate of AB 32. The proposed requirement to monitor at least 95% of the NO<sub>x</sub> emissions from heaters with CEMS will provide more accurate monitoring of the compliance status of refineries and reduce the administrative burden of enforcing the average standard with parametric monitoring systems. The heater status report will provide information for staff to consider future NO<sub>x</sub> reductions from refinery heaters.

Pursuant to Section 40727 of the California Health and Safety Code, the proposed rule must meet findings of necessity, authority, clarity, consistency, non-duplication, and reference. The proposed amendments to Regulation 9-10 are:

- Necessary to limit emissions of NO<sub>x</sub>, a primary precursor to ground-level ozone formation and fine particulate matter, and to provide a mechanism to allow replacement and modernization of refinery heaters to progress towards AB 32 requirements without relaxing the rule;
- Authorized under Sections 40000, 40001, 40702, and 40725 through 40728 of the California Health and Safety Code;
- Written or displayed so that its meaning can be easily understood by the persons directly affected by it;
- Consistent with other BAAQMD rules, and not in conflict with state or federal law;
- Non-duplicative of other statutes, rules or regulations; and
- Implementing, interpreting or making specific the provisions of the California Health and Safety Code Sections 40000 and 40702.

The proposed rule amendments have met all legal noticing requirements, have been discussed with the regulated community, and reflect the input and comments of many affected and interested parties.

## 9.0 References

1. Bay Area Air Quality Management District: “*BACT / TBACT Workbook*”, <http://hank.baaqmd.gov/pmt/bactworkbook/default.htm>.
2. Bay Area Air Quality Management District: Staff Report, “*Proposed Amendments to BAAQMD Regulation 9, Rule 10: Nitrogen Oxides and Carbon Monoxide from Boilers, Steam Generators and Process Heaters in Petroleum Refineries*”, December 2010.