



# BAY AREA AIR QUALITY MANAGEMENT DISTRICT

## **WORKSHOP REPORT - PROPOSED RULE AMENDMENT**

### **REGULATION 9, RULE 10: NITROGEN OXIDES AND CARBON MONOXIDE FROM BOILERS, STEAM GENERATORS AND PROCESS HEATERS IN PETROLEUM REFINERIES**



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## 1.0 Introduction

The Bay Area Air Quality Management District (“BAAQMD” or the “District”) will hold a public workshop to discuss and solicit input on proposed 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”). For simplicity, the term “heater” will be used in this report to refer to the pre-1994 refinery boilers, steam generators and process heaters that are subject to Regulation 9-10.

The District is proposing to create an optional emission standard for pre-1994 heaters that could be used in place of the current 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). The proposed alternative standard is a daily, total *mass emission* limit. The purpose of offering the optional, alternative standard is to allow refineries to perform pre-1994 heater modifications and replacements – which result in significant refinery-wide emission reductions of NO<sub>x</sub> and other pollutants – without also triggering the requirement to achieve marginal emission reductions within the population of pre-1994 heaters, which is sometimes required by the current regulation. The proposal would allow certain refineries to use emission reduction credits to comply with a mass emission limit, which would be an expansion of the use of ERCs under District regulations.

In addition, an amendment is proposed to change the parameters of emissions estimation for determining compliance for a heater that is not equipped with a continuous emissions monitoring system.

Separately from this proposed amendment to Regulation 9-10, District staff is also currently developing a proposed new rule for tracking of petroleum refinery emissions. Although NO<sub>x</sub> and CO will likely be included in the emissions to be tracked, Regulation 9-10 will not be amended for this purpose.

## 2.0 Background

### 2.1 Current Regulation 9-10 Emission Standards

Regulation 9-10 sets emission limits for nitrogen oxides (NO<sub>x</sub>) and carbon monoxide (CO) from certain combustion devices at petroleum refineries in the San Francisco Bay Area. Regulation 9-10 was last amended in 2010 to add the new CO boiler emission limits (effective 2015) that are shown in Table 1.

Regulation 9-10 includes “best available retrofit control technology” (BARCT) NO<sub>x</sub> limits and “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 NO<sub>x</sub> Emission Limits (note 1)</b>		
	<b>Federal “RACT” NO<sub>x</sub> Limit</b>	<b>BAAQMD “BARCT” NO<sub>x</sub> Limit</b>
<b>Pre-1994 Heaters (except CO boilers)</b>	Refinery-wide, daily average: 0.20 lb NO <sub>x</sub> / MM BTU input	Refinery-wide, daily average: 0.033 lb NO <sub>x</sub> / MM BTU input
<b>Pre-1994 CO Boilers (note 2)</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>  No change	<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.	

Notes:

1. All “ppmv” concentration limits are based on a 3% exhaust oxygen concentration.
2. “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 carbon monoxide (CO).

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 BARCT and RACT 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.

## 2.2 Emission Reductions Through 2002

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 ppmv (the specific value of the limit depends on the design of the CO boiler). The proposed amendment of Regulation 9-10 described in this report only affects the average, daily NOx limit of 0.033 lb NOx/MM BTU that applies to pre-1994 heaters that are not CO boilers.

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 “best available control technology” (“BACT”) program 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. 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 an absolute 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 for new or modified heaters. BACT requirements have become stricter over time to reflect the improvement of emission-control technology. Compared to the average BARCT limit of 0.033 lb NOx/MM BTU, which is equivalent to about 28 ppmv NOx at 3% oxygen, the current BACT requirement for a typical refinery heater (>50 MM BTU/hr heat input) would be a NOx limit of 5 ppmv at 3% oxygen (*Reference 1*) achieved with a selective catalytic reduction (SCR) system. Thus, replacing a pre-1994 heater with a new or modified heater that meets current BACT requirements may result in a net reduction of 50% or more in the NOx emission rate. However, a reduction in the NOx emission rate does not necessarily mean that there will be a similar reduction in mass emissions of NOx because the refinery operator may replace the original pre-1994 heater with a larger device.

Still, a new heater will, in most cases, result in a significant net reduction in NOx emissions from the facility, even if it is larger and will burn more fuel. Under District Regulation 2, Rule 2: New Source Review, a new source is subject to several requirements. First, any new source that emits more than 10 pounds per day would be required to install BACT on the source. As discussed above, this would reduce net NOx emissions even if the replacement used several times the amount of fuel. Second, when a source such as a heater is removed, it generates emission reduction credits (ERC). However,

those ERC are “RACT-adjusted” which means that the amount of credit granted to the facility is adjusted to the amount that would be generated if the source were reasonably controlled, based on other, similar controlled sources. So an uncontrolled NO<sub>x</sub>-emitting source could be RACT-adjusted to less than 50% of the NO<sub>x</sub> currently being generated. These RACT-adjusted ERC are then credited to the emissions from the new source. If the new, BACT-equipped source is projected to emit more than the amount of RACT-adjusted ERC generated from the removed heater, the facility must apply additional ERC to offset the additional emissions. For NO<sub>x</sub> emissions at a large facility like a refinery, these offsets must be applied at a 1.15:1 ratio as required by Regulation 2, Rule 2, Section 302: Offset Requirements, Precursor Organic Compounds and Nitrogen Oxides.

As an example, if a heater that is uncontrolled and that emits 100 tons NO<sub>x</sub>/year is removed from service at a refinery and replaced with a heater equipped with BACT that will emit 50 tons NO<sub>x</sub>/year, the emissions from the heater to be removed might be RACT-adjusted to 40 tons per year. Because the difference is 10 tons NO<sub>x</sub>/year, NO<sub>x</sub> ERC in the amount of 11.5 tons will be required to offset the new source (10 x 1.15 as per 2-2-302). So the net NO<sub>x</sub> emissions are reduced by 50 tons/year and 11.5 tons of ERC are retired. 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 traded between facilities, but are generated only from source shutdowns or other voluntary emissions reductions not required by regulations.

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

Although all refinery operators implemented NO<sub>x</sub> retrofits on pre-1994 heaters that are not CO boilers in order to comply with the 0.033 lb NO<sub>x</sub>/MM BTU limit by 2002, some refinery operators that had CO boilers at their refineries also added or improved NO<sub>x</sub> 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”) allows 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. For example, if a CO boiler reduced emissions to below the daily, average NO<sub>x</sub> emission concentration limit for CO boilers in Regulation 9-10, the operator could apply credits from that over-compliance to pre-1994 heaters that are not CO boilers and 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 15% 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. Although the rule has no explicit requirement that additional, permanent emission reductions occur after 2002, 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.

### **2.3.1 Emission Reductions Triggered by a Heater Removal**

The first situation results when a pre-1994 heater is removed from service and occurs 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 exceeding the 0.033 lb NO<sub>x</sub>/MM BTU standard.

In this case, one or more of the heaters remaining in the population of heaters subject to Reg. 9-10 (recall that new heaters are not subject to the rule, but more stringent standards imposed by BACT) would be required to be retrofitted with additional NO<sub>x</sub> controls to bring the overall average down to the 0.033 lb NO<sub>x</sub>/MM BTU standard.

### **2.3.2 Emission Reductions Triggered by the Loss of IERCs**

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 in Section 2.2.1, 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, the amount of the required additional NO<sub>x</sub> emission reductions on pre-1994 heaters is equal to the amount of emission reductions previously provided by the source of IERC.

## 3.0 Technical Review

### 3.1 Basis for an Alternate Standard

Refineries comply with the current emission standard for pre-1994 heaters in 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. Some heaters are controlled with SCR systems, or with a variation of SCR that omits the catalytic reaction stage – “selective non-catalytic reduction” (SNCR).

The District is proposing a new, alternate emission standard that would be a mass-based limit for pre-1994 heaters subject to Regulation 9-10. It has been argued that the current rule creates a disincentive to replace or modernize heaters that are subject to Regulation 9-10. Between the time that the rule was adopted in 1994 and the time that the standards became fully effective in 2002, each refinery examined its particular population of heaters and applied NO<sub>x</sub> controls in the most effective manner possible from the perspective of both costs and emissions reductions. And since 2002, the refineries have had to add additional controls on pre-1994 heaters whenever the circumstances described in Section 2.3 arose. As the less expensive control options are exhausted, only the more expensive control options remain. (The District examined the further costs of control of pre-1994 heaters at each refinery recently, as part of the rule development effort that led to the 2010 amendments to Regulation 9, Rule 10. Staff concluded that a further reduction in the 0.033 lb NO<sub>x</sub>/MM BTU standard was not cost effective at that time.) It may be that the cost of further control is so high that it tips the balance away from modernizing or replacing an existing heater. As stated above in Section 2.2, however, that would likely be an undesirable result, since the removal or replacement of pre-1994 heaters would be expected to result in a net NO<sub>x</sub> emissions reduction. A further benefit is that modern heaters are also much more energy efficient and emit significantly less carbon dioxide (CO<sub>2</sub>) than their pre-1994 counterparts.

Under AB32: Global Warming Solutions Act, signed by Governor Schwarzenegger in 2006, major emitters in California will have to reduce emissions of CO<sub>2</sub> and other global warming gases. Because replacing pre-1994 heaters has a co-benefit of reducing NO<sub>x</sub> emissions, replacement of older heaters is a preferred method of compliance with AB32.



## 4.0 Rule Amendments Under Consideration

### 4.1 Proposed Alternate Emission Standard

The proposed amendment creates a voluntary alternative to the refinery-wide, average NO<sub>x</sub> limit in Section 301 of Regulation 9-10. The alternative standard applies to the same, pre-1994 population of heaters that are subject to Section 9-10-301. While Section 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 alternative 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 alternative limit for each refinery. This procedure is the same procedure described in Section 605 of Regulation 2, Rule 2 for establishing historical baseline emissions at a source. This procedure is regularly used by refinery operators to establish and “bank” emission reductions (ERC) from sources that are removed from service. Thus, this procedure is familiar to both refinery operators and to District staff. The alternative limit would be the sum of the baseline emissions for all the heaters subject to Section 9-10-301 at the time of the application to use the alternative standard. In this way, the alternative limit would continue to offer flexibility in complying with the regulation, since individual heaters would not have specific emission limits. However, unlike the current limit in Section 9-10-301, the alternative limit would not be perceived as a disincentive to remove or modify any heater subject to the alternative, because removal or modification of a heater would not result in a requirement to add additional NO<sub>x</sub> controls on the remaining heaters. After the alternative limit is set, the limit would be reduced whenever a heater subject to the alternative limit is permanently removed from service by the contribution of that heater to the total.

Although adoption of the alternative standard would prevent a pre-1994 heater removal or modification from triggering new NO<sub>x</sub> control requirements on existing heaters, the alternative standard might require new NO<sub>x</sub> controls. This would occur if a refinery were to increase its fuel usage at pre-1994 heaters in the future such that the refinery would exceed its mass NO<sub>x</sub> emissions allowance.

For a refinery that relied on IERC to comply indirectly with Regulation 9-10 during the baseline period, the alternative mass emission limit would provide a mechanism to establish a mass emission limit. A refinery could use ERC at a 1.15:1 ratio in the same way as ERC can be used to offset the emissions from a new source. This would be an expansion of the use of ERCs under District regulations, which currently only allow ERCs to be used for offsets for NSR permitting purposes or to be exchanged for (time-limited) IERC. Of course, a facility also could continue to use IERC to comply with the alternate standard.

#### 4.1.1 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 that 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 amendment 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 amendment includes requirements to ensure that if there are any known projects 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 be incorporated in order to adopt the alternative standard. To see this in action, we revisit the two situations described in Section 2.3 where a heater operator would be required, by the current rule requirements, to add NO<sub>x</sub> controls to pre-1994 heaters after 2002.

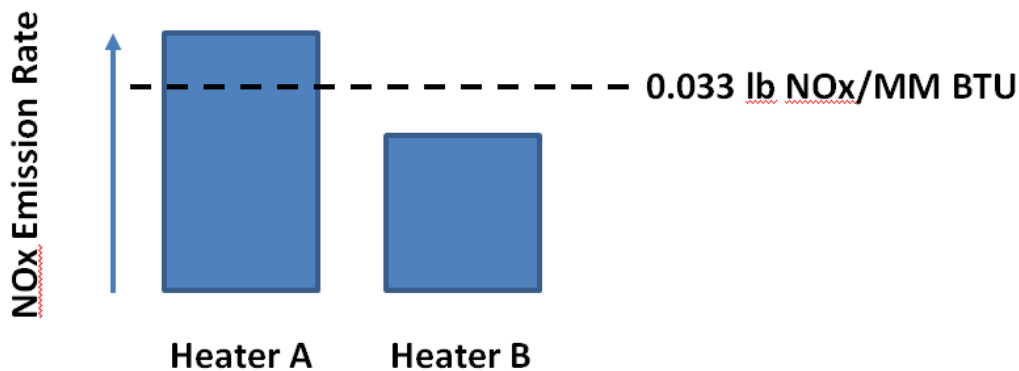
First, for any heater upgrade project for which the District has already issued an Authority to Construct, the District has the information to determine whether the current rule would require NO<sub>x</sub> emission reductions (for example, if the project involves replacing or modifying a large, low-emitting 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 amendment would require an equal amount of reductions as a condition of adopting the alternative standard. The refinery would have the option of providing Emission Reduction Credits (ERC) to make up that difference.

For the second situation – losing a source of IERC – establishing equivalent reductions is simpler because the amount of IERCs (expressed in terms of ton/year of NO<sub>x</sub>) is known exactly for every case where IERC are used to comply with the NO<sub>x</sub> emission rate limit of 0.033 lb NO<sub>x</sub>/MM BTU. Under the current rule, if the refinery were to lose its IERC sources, it would be required to add or improve NO<sub>x</sub> controls on pre-1994 heaters to compensate for that loss. To ensure an equivalent NO<sub>x</sub> emission reduction if a refinery elects to use the alternative standard, the proposed amendment provides that if a refinery used IERC to comply with the NO<sub>x</sub> emission rate limit of 0.033 lb NO<sub>x</sub>/MM BTU during the baseline period, the NO<sub>x</sub> mass limit that is calculated using data from that baseline period will be reduced by the amount of IERC used. The refinery would have the option of reducing or eliminating that reduction by providing ERC on a one-time basis.

For future projects that have not yet been proposed or permitted, however, the District does not have sufficient information to analyze whether and by how much there may be foregone emission reductions under the proposed amendment; at this time there are too many variables to predict the impact. However, because the proposed alternative limit is an absolute mass cap for pre-1994 heaters based on historical emissions, adoption of this alternative limit would assure that absolute NO<sub>x</sub> emissions (for example, expressed in terms of tons of NO<sub>x</sub> per year) could not increase above recent historical levels. Although the proposed alternative emission limit would never require additional NO<sub>x</sub> controls on pre-1994 heaters as a result of a pre-1994 heater being removed, there are circumstances under which the proposed alternative would require emissions reductions that would not be required under the current rule. Because the proposed alternative is an absolute NO<sub>x</sub> mass limit rather than a limit relative to heat input, the alternative will require the refinery to install additional NO<sub>x</sub> controls on pre-1994 heaters if the refinery exceeds its recent historical heat input at pre-1994 heaters. The amount of this required NO<sub>x</sub> reduction under the alternative depends on factors such as the amount of the increase in heat input, and cannot be calculated at this time.

Figure 1 provides a simple illustration of heater emissions averaging to meet the current standard in Reg. 9-10-301 and of how the alternate emission standard may impact emissions compared to the

existing standard. Heater A operates above the emission rate limit of 0.033 lb NO<sub>x</sub>/MM BTU, while heater B operates below this limit. Heater A and Heater B operate above and below this limit by the same margin and therefore, on average, they operate at the limit of 0.033 lb NO<sub>x</sub>/MM BTU, and therefore the refinery complies with the current rule.



**Figure 1 – Example of Heater Emissions Averaging**

Under the existing regulation, if Heater B were removed from service, then the refinery (with only Heater A operating) will have an average emission rate greater than 0.033 lb NO<sub>x</sub>/MM BTU, so additional NO<sub>x</sub> controls must be used to reduce the Heater A emission rate. On the other hand, if Heater A were removed from service, the NO<sub>x</sub> emission rate at Heater B could be increased, although to no higher than 0.033 lb NO<sub>x</sub>/MM BTU. In either case, the actual NO<sub>x</sub> mass emissions at the refinery would be reduced because any replacement would be subject to a much more stringent BACT standard and possibly require ERC as discussed previously in Section 2.2.

Under the proposed alternative, the pre-1994 heaters at the refinery would no longer be subject to an emission rate limit 0.033 lb NO<sub>x</sub>/MM BTU. Instead, they would be subject to a mass limit that was equal to the mass of NO<sub>x</sub> that had been emitted when the heaters were operating in compliance with the emission rate limit of 0.033 lb NO<sub>x</sub>/MM BTU. More precisely, Heater A and Heater B would together be subject to a mass limit that was equal to the mass of NO<sub>x</sub> emitted by both heaters when they complied with the emission rate limit of 0.033 lb NO<sub>x</sub>/MM BTU. Under the proposed alternative, if either Heater A or Heater B were removed from service, the total mass emission limit would be reduced by the mass contribution from the removed heater. Thus, if Heater B were removed, Heater A would be subject to a mass limit equal to its historic mass emissions. And if Heater A were removed, then Heater B would be subject to a mass limit equal to its historic mass emissions. But in either case, no additional NO<sub>x</sub> controls would have to be installed.

Consequently, any discussion of the relative emissions consequences of the alternate standard is only relevant in the population of heaters that remain subject to Reg. 9-10. In one case, the existing rule will require reductions that the alternate standard would not, in the other case, the existing rule will allow an increase that the alternate standard would not. In any case, because of the BACT and offset requirements in Reg. 2-2: New Source Review, overall emissions will be reduced at the facility.

District staff has concluded that an alternative emission standard for pre-1994 heaters that are not CO boilers may be established based on total NO<sub>x</sub> mass emissions at these heaters in a recent historical (baseline) period. The proposed amendment contains requirements to ensure that emissions reductions that would have been required under the current rule are still realized under the alternative standard with respect to all reasonably foreseeable projects (*e.g.*, those projects for which the District has already issued an Authority to Construct) or circumstances (*e.g.*, when a refinery that currently relies on IERC to comply with the NO<sub>x</sub> limit loses its source(s) of IERC).

### **4.1.2 Emission Reductions**

The proposed alternative emission standard is voluntary and therefore is not assured of producing any particular level of emission reduction. The proposed amendment contains requirements, however, to ensure that if a refinery elects to adopt the alternative standard, that emission reductions that would have been required by the current provisions of Regulation 9-10 will still occur for any known project. Section 4.1.1 discusses the NO<sub>x</sub> emission reductions that may be required under the proposed alternative standard.

### **4.1.3 Costs**

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, District staff assumes it will do so because it believes that the overall cost of compliance with the alternative standard will be lower than with the existing standard.

As discussed in Section 2.3.1, simply adopting the alternative standard – an absolute NO<sub>x</sub> mass cap – in lieu of the current limit of 0.033 lb NO<sub>x</sub>/MM BTU may require that a refinery operator add or improve NO<sub>x</sub> controls on pre-1994 heaters if the total heat input at pre-1994 heaters increases over recent historical levels. Because it is not possible to quantify the amount of required NO<sub>x</sub> reductions, or even to know with certainty that this requirement will be triggered, the costs for these added or improved NO<sub>x</sub> controls is not estimated here. If a refinery operator is required to add or improve NO<sub>x</sub> controls on pre-1994 heaters, this may be achieved in the same way that each refinery complied with the original NO<sub>x</sub> reduction requirements in Regulation 9-10 before 2002: with upgraded burners that produce less NO<sub>x</sub>, with SCR systems, or with 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 such NO<sub>x</sub> controls was discussed in the staff report for the 2010 amendment of Regulation 9-10 (*Reference 2*) and was estimated to cost at least \$31,000 per ton of NO<sub>x</sub> reduced. However, since the alternate standard is voluntary, a refinery operator would only be expected to adopt it if they expected the alternative standard to cost less than the current provisions of Regulation 9-10. In all likelihood, if the alternate standard removes the perceived disadvantage of replacing heaters, a refinery will probably consider modernizing or replacing heaters, which will, as discussed above, result in a lower net NO<sub>x</sub> and CO<sub>2</sub> emissions.

An application for adoption of the alternative standard would require payment of fees already included in District Regulation 3 (“Fees”).

Adoption of the alternative standard also requires the installation of CEMS on all pre-1994 heaters. The cost of CEMS varies significantly depending on installation-specific factors, such as the need to provide a climate-controlled enclosure or electrical power).

## 4.2 Other Proposed Amendments

### 4.2.1 Compliance Monitoring During Curtailed Operation

Pre-1994 heaters that are subject to the daily, average emission rate limit of 0.033 lb NO<sub>x</sub>/MM BTU are required to monitor emissions from individual heaters so as to be able to verify compliance with this average limit over a range of operating conditions. Regulation 9-10-504.1.1 requires the use of CEMS or an “equivalent parametric monitoring system”. A CEMS is a physical emissions-monitoring system while a parametric monitoring system is a monitoring plan based on the use of conservative emission factors that are established through source testing. 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 parametric monitoring systems established for refinery heaters require that a heater operate with combinations of firing rates and combustion 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”. While a heater is operating within its NO<sub>x</sub> Box, the NO<sub>x</sub> emission rate for that heater is assumed to be the highest emission rate measured during any NO<sub>x</sub> Box source test for that heater. In this way, the parametric monitoring system based on a NO<sub>x</sub> Box provides an emission estimate for any heater that does not have a CEMS that is likely higher than actual emissions. In other words, the price for not having a CEMS on a heater is likely to over-estimate the emissions at that heater, thus further limiting the emissions at other pre-1994 heaters that are collectively subject to the average emission rate limit of 0.033 lb NO<sub>x</sub>/MM BTU. Heaters with a NO<sub>x</sub> Box are also required to have periodic source tests, which is another cost that must be borne when a CEMS is not used on a pre-1994 heater. Enforcing and administering a NO<sub>x</sub> Box also represents a cost to the District.

When the Regulation 9-10 NO<sub>x</sub> Boxes were established, it was recognized that at very low firing rates, the NO<sub>x</sub> Box served little purpose because even if the NO<sub>x</sub> *emission rate* increased at low firing rates – for example, because the heater burners were not tuned to operate at such low rates, or for other reasons – the overall NO<sub>x</sub> *mass emissions* would not be higher than normal because the heater would be consuming less fuel and would have a lower volume of exhaust gas. For this reason, the NO<sub>x</sub> Box permit conditions included a uniform “curtailment” level that was defined as no more than 20% of a heater’s maximum firing rate. When a heater was operating in a curtailed condition, it was not bound by the parameters of the NO<sub>x</sub> Box – for example, it could operate at a high combustion oxygen content that had not previously been source-tested. Also, instead of using the conservative NO<sub>x</sub> emission factor that is used in the NO<sub>x</sub> Box, emissions during curtailed operation are assumed to be the same as in the previous 30 days of operation, prior to curtailment. The curtailment clause simplified the enforcement and administration of the NO<sub>x</sub> Box permit conditions for both the refineries and the District.

During the 2010 amendments of Regulation 9-10, comments were received from some refinery operators that the curtailment level could be increased from 20% to 30%, thus extending the operating range where heaters were not subject to the normal NO<sub>x</sub> Box parameters and further reducing the administrative costs associated with the NO<sub>x</sub> Boxes, with no adverse emission impact. District staff considered all the administrative actions that had occurred as a result of heaters with NO<sub>x</sub> Boxes operating between 20% and 30% of their maximum firing rate, and determined that in no case had such operation resulted in a rule violation. As a result, District staff supported the change in the curtailment range, and a curtailment definition was established in Regulation 9-10 (curtailment had previously been defined only in the NO<sub>x</sub> Box permit conditions, not the rule, and in the permit conditions was defined as operation up to 20% of a heater's maximum firing rate) such that operation up to 30% of a heater's maximum firing rate would be treated as curtailed operation.

Because refinery operators are bound by both District regulations and by the permit conditions in their District Permits to Operate, any refinery that wished to take advantage of the extended curtailment range first had to have their NO<sub>x</sub> Box permit conditions changed so that the definition of curtailment in the permit conditions was changed from a maximum firing rate of 20% to 30%. So far, two refineries have done so. When District staff was reviewing one of these applications, they examined operating data at one heater that had operated within both the 20% and 30% curtailment ranges, they considered the emissions that the refinery had assumed during curtailment (as discussed above, this is the emission estimate from the previous 30 days of operation rather than the conservative NO<sub>x</sub> Box emissions), and concluded that it would have been possible for overall emissions at the refinery to increase if the curtailment range was increased from 20% to 30%. Since only one heater was examined, District staff did not find that NO<sub>x</sub> emissions at this refinery actually would have increased as a result in the change to the curtailment range, and also did not find that the change to the curtailment range would have resulted in a violation of Regulation 9-10.

There are a number of ways to mitigate the concerns that have been raised about the current monitoring provisions for curtailed operation. One way would be to retain the definition of curtailment in the rule as operation at no more than 30% of a heater's maximum firing rate, but to require that a conservative emission factor be used whenever this monitoring option is used. Another would be to change the definition of curtailed operation so that it applies at no more than 20% of a heater's maximum firing rate, and also to limit this monitoring option for a limited period of time—in other words, to insert the historical permit definitions of curtailed operation into the rule. District staff is presenting both options in the proposal in Sections 9-10-222 and 9-10-301.4.2 of the draft rule. It is expected that only one of these options, perhaps in an amended form, will appear in the final proposal.

Option 1 retains the current rule's definition of curtailed operation as applying at no more than 30% of a heater's maximum firing rate, but requires the use of a default conservative emission factor equivalent to about 120 ppmv NO<sub>x</sub> at 3% oxygen, or another conservative factor approved by the District. The default conservative factor is the expected performance of a conventional, non-low-NO<sub>x</sub> burner and therefore would be expected to be conservative at any firing rate level for any heater.

Option 2 changes the maximum firing rate for curtailed operation from 30% of a heater's maximum firing rate to 20% of maximum firing rate, and also limits the use of this monitoring option to events no longer than 5 days in duration, and for no more than 60 days per year at any device. This is how

curtailed operation has historically been treated for purposes of Regulation 9, Rule 10, per the refineries' operating permits.

District staff solicits input on this proposal as well as alternative approaches that will ensure a conservative estimate of a heater's emissions when it is outside of the NOx Box.

## 5.0 Rule Development Process

The District has developed draft rule language that is attached to this workshop report. Staff has consulted with Bay Area refineries during the preparation of this draft rule.

A public workshop is the next step in the rule development process and will provide an opportunity for the affected Bay Area refineries and the public at large to seek clarifications and provide comments on this proposal. At the workshop, staff will seek comments on the draft amendment and will respond to questions about this report. Staff will review and consider all comments received at the public workshop and revise the proposal as appropriate.

In addition, staff will prepare an analysis of environmental impacts under the California Environmental Quality Act (CEQA), and a socioeconomic analysis of the proposal. These analyses, along with a final proposed rule and staff report will be available for public review and comment prior to a public hearing before the District Board of Directors.



## 6.0 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.