SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

Preliminary Draft Staff Report
Proposed Rule 1147.2 – NO_x Reductions from Metal Melting and Heating Furnaces

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EXECUTIVE SUMMARY

The Regional Clean Air Incentives Market (RECLAIM) program was adopted in October 1993 under Regulation XX. RECLAIM is a market-based emissions trading program designed to reduce NO_x and SO_x emissions and includes facilities with NO_x or SO_x emissions greater than four tons per year.

The 2016 Final Air Quality Management Plan (2016 AQMP) included Control Measure CMB-05: Further NO_x Reductions from RECLAIM Assessment (CMB-05) to ensure the NO_x RECLAIM program was achieving equivalency with command-and-control rules that are implementing Best Available Retrofit Control Technology (BARCT) and to generate further NO_x emission reductions at RECLAIM facilities. The adoption resolution for the 2016 AQMP directed staff to achieve five tons per day of NO_x emission reductions as soon as feasible but no later than 2025, and to transition the RECLAIM program to a command-and-control regulatory structure requiring BARCT as soon as practicable.

On July 26, 2017 the Governor approved California State Assembly Bill 617, which required air districts to develop, by January 1, 2019, an expedited schedule for the implementation of BARCT no later than December 31, 2023 for industrial facilities that are in the California greenhouse gas cap-and-trade program with priority given to older, higher polluting sources that need to install BARCT.

As facilities transition out of the NO_x RECLAIM program, a command-and-control rule that includes NO_x emission standards that reflect BARCT will be needed for all equipment categories. Proposed Rule (PR) 1147.2 – NOx Reductions from Metal Melting and Heating Furnaces is a command-and-control rule for facilities that operate furnaces used for metal melting, metal heat treating, metal heating, and metal forging. Approximately 21 facilities representing 315 combustion sources that are currently in the RECLAIM program will be subject to PR 1147.2. In addition, approximately 65 non-RECLAIM facilities that were subject to Rule 1147 – NOx Reductions from Miscellaneous Sources that operate furnaces used for metal melting, metal heat treating, metal heating, and metal forging will also be subject to PR 1147.2.

PR 1147.2 proposes NO_x and CO emission concentration limits for furnaces used for metal melting, metal heat treating, metal heating, and metal forging that were developed through a BARCT assessment process. PR 1147.2 also proposes alternative concentration limits for units that are within 10 ppmv of the BARCT-established NO_x limits. PR 1147.2 will establish implementation schedules for all impacted units taking into account the age of the burners, compliance with alternative concentration limits in PR 1147.2, and the number of impacted furnaces at a facility. In addition, PR 1147.2 will establish requirements for monitoring, record keeping, and source testing.

PR 1147.2 was developed through a public process. Nine Working Group meetings were held. Staff met with multiple stakeholders during the rule development process and conducted several site visits.

With the adoption of PR 1147.2, NO_x reductions are estimated to be 0.495 tons per day (tpd), 94% of which will be realized from units exiting the RECLAIM program. The cost-effectiveness for the rule is expected to be $12,100 per ton of NO_x reduced.

CHAPTER 1: BACKGROUND

INTRODUCTION
REGULATORY HISTORY
AFFECTED INDUSTRIES
PUBLIC PROCESS

INTRODUCTION

The RECLAIM program was adopted in October 1993 under Regulation XX. RECLAIM is a market-based emissions trading program designed to reduce NO_x and SO_x emissions and includes facilities with NO_x or SO_x emissions greater than 4 tons per year. The 2016 AQMP included CMB-05 to ensure the NO_x RECLAIM program was achieving equivalency with command-and-control rules that are implementing Best Available Retrofit Control Technology and to generate further NO_x emission reductions at RECLAIM facilities. Control Measure CMB-05 of the 2016 AQMP included a requirement for five tpd NO_x emission reductions as soon as feasible but no later than 2025, and to transition the RECLAIM program to a command-and-control regulatory structure requiring BARCT as soon as practicable. Consistent with the adoption resolution for the 2016 AQMP, staff is providing quarterly updates to the Stationary Source Committee on the status of the transition of RECLAIM facilities to command-and-control. On July 26, 2017 California State Assembly Bill (AB) 617 was approved by the Governor, which addresses stationary and mobile source air pollution. AB 398 was simultaneously approved on July 25, 2017 which extended California's cap-and-trade program for reducing greenhouse gas emissions from stationary sources.

There are nine RECLAIM facilities that are in California's cap-and-trade program and will be regulated under PR 1147.2 – NO_x Reductions from Metal Melting and Heating Furnaces. These nine facilities are subject to AB 617, which requires an expedited schedule for implementing BARCT for cap-and-trade facilities no later than December 31, 2023.

Facilities that are not in the RECLAIM program are subject to command-and-control rules. Currently, Rule 1147 – NOx Reductions from Miscellaneous Sources regulates miscellaneous combustion equipment including metal melting furnaces, metal heat treating furnaces, metal heating furnaces, and metal forging furnaces. PR 1147.2 will transition facilities out of the RECLAIM program as well as conduct an assessment to determine BARCT concentration limits for these furnace categories. These concentration limits will apply to RECLAIM facilities, former RECLAIM facilities that have exited the RECLAIM program, and non-RECLAIM facilities. Rule 1147 will no longer apply to units subject to PR 1147.2 after adoption.

REGULATORY HISTORY

Rule 1147 was adopted on December 5, 2008. Rule 1147 applies to non-RECLAIM facilities and establishes nitrogen oxide (NO_x) limits of either 30 ppmv or 60 ppmv for miscellaneous gaseous and liquid fuel-fired combustion equipment, including ovens, afterburners, calciners, and furnaces. Rule 1147 was amended on September 9, 2011 to delay compliance deadlines by one to two years, limit requirements for non-resettable fuel and time meters, and streamline source testing requirements to reduce compliance costs. Rule 1147 was amended again on July 7, 2017 to exempt units with a rated heat input of less than 325,000 Btu/hr, increase NO_x concentration limits for certain equipment categories, and change the compliance date for units with NO_x emissions of less than one pound of NO_x per day.

Under Rule 1147, new and existing metal melting furnaces, metal heat treating furnaces, metal heating furnaces, and metal forging furnaces were required to meet a NO_x concentration limit of 60 ppmv @ 3% O_2, dry, or 0.073 lb/MMBtu across all temperatures. Rule 1147 allowed emissions testing using the lb/MMBtu option as an alternative to the concentration limit. This lb/MMBtu option was used for evaluating emissions from processes that operate at high oxygen concentrations (greater than 18% O_2). Compliance for new units installed after January 1, 2010 was required at the time of permitting. The implementation schedule for in-use units operating before January 1, 2010 differed depending upon whether a unit emitted less than one pound of NO_x per day. For units with NO_x emissions greater than or equal to one pound per day, compliance was required upon unit or combustion system alteration, replacement, or the unit age reaching 15 years. For units with NO_x emissions less than one pound of per day, compliance was required upon unit or combustion system alteration, replacement, relocation, or the unit age reaching 35 years. A technology assessment was conducted by the South Coast AQMD and approved by the Governing Board in February 2018. The objective of this technology assessment was to identify available burner technologies for each equipment category. As a result of this assessment, categories were removed, limits revised, and compliance timelines modified.

AFFECTED INDUSTRIES

PR 1147.2 affects facilities in the NO_x RECLAIM program as well as facilities outside of the RECLAIM program with permitted metal melting furnaces, metal heat treating furnaces, metal heating furnaces, and metal forging furnaces. PR 1147.2 will require facilities to comply with lower concentration limits for applicable units located in the jurisdiction of the South Coast AQMD.

Out of the 246 facilities currently in the NO_x RECLAIM program as of 2019, approximately 21 facilities would be affected by PR 1147.2. There are approximately 65 non-RECLAIM facilities that are affected by PR 1147.2.

PUBLIC PROCESS

Development of PR 1147.2 was conducted through a public process. Staff has held nine Working Group meetings on May 16, 2019, August 6, 2019, November 6, 2019, February 5, 2020, June 18, 2020, September 3, 2020, February 2, 2021, July 8, 2021, and September 2, 2021. Working Group Meetings after March 2020 were held virtually via Zoom due to COVID-19. The Working Group is composed of representatives from environmental and community groups, affected businesses, burner manufacturers, trade organizations, public agencies, consultants, and other interested parties. The purpose of the Working Group meetings is to discuss proposed concepts and to work through the details of staff's proposal. A Public Workshop will be held on January 20, 2022 to discuss PR 1147.2. Determination of the applicable California Environmental Quality Act (CEQA) document is pending.

Staff has also held numerous individual meetings with stakeholders to discuss issues unique to their operations, technical details of their operations, and the proposed rule. In addition, prior to COVID-19, staff conducted 17 site visits to understand the different types of furnaces that are regulated under PR 1147.2.

Staff sent to stakeholders two surveys to collect additional equipment information. The first survey was sent to 85 facilities and collected data from permitted equipment with 31 surveys completed and returned. A second survey was sent to 64 facilities and collected data from permit-exempt equipment (i.e. units below 2 MMBtu/hr that are exempt from permitting pursuant to Rule 219) with 12 surveys completed and returned. The equipment information was used to quantity the scope and cost-effectiveness of PR 1147.2.

CHAPTER 2: BARCT ASSESSMENT

INTRODUCTION

ESTABLISHING EQUIPMENT CATEGORIES

GENERAL BARCT ASSESSMENT APPROACH

BARCT ASSESSMENT BY CATEGORY

Metal Melting Furnaces

Metal Heat Treating Furnaces: Low Temperature

Metal Heat Treating Furnaces: High Temperature

Metal Heating and Forging Furnaces: Low Temperature

Metal Heating and Forging Furnaces: High Temperature

Units with Radiant-Tube Burners

Units ≥ 40 MMBtu/hr

INTRODUCTION

As part of the rule development process, staff conducted a BARCT assessment of equipment subject to PR 1147.2. The purpose of a BARCT assessment is to identify any potential emission reductions from specific equipment or industries and to establish a concentration limit that is consistent with state law. Under California Health and Safety Code § 40406, BARCT is defined as:

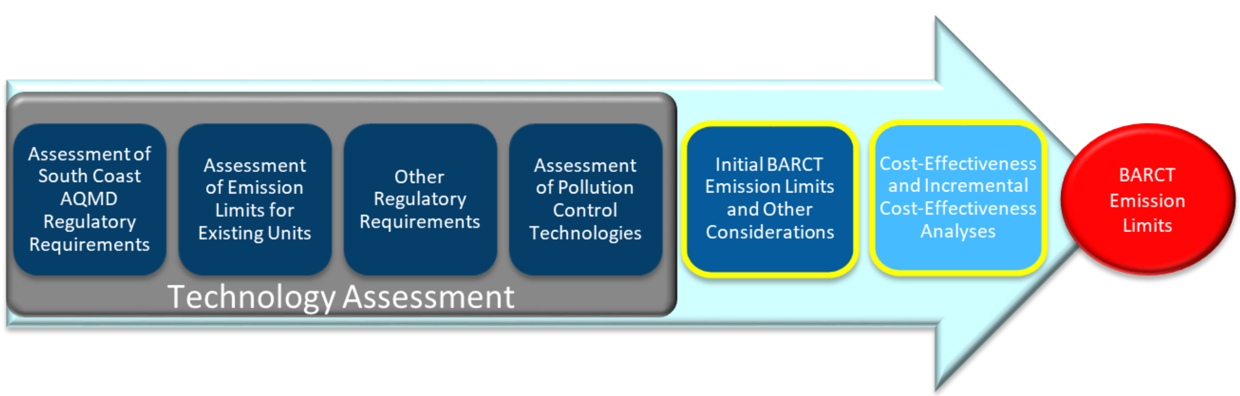
> "… an emission limitation that is based on the maximum degree of reduction achievable, taking into account environmental, energy, and economic impacts by each class or category of source."

BARCT assessments are performed periodically for specific equipment categories to determine if current concentration limits are representative of current technologies and maximum achievable NO_x reductions. The BARCT assessment is a stepwise process that includes a robust technology assessment that seeks maximum achievable cost-effective emission reductions.

The BARCT assessment begins with a technology assessment to establish initial BARCT concentration limits. A technology assessment identifies current regulatory requirements for specific equipment categories, established by either the South Coast AQMD or other regulatory agencies. Permits and source test data are analyzed to identify the emission levels being achieved with existing technology. Current and emerging technologies are evaluated to determine the feasibility of achieving lower concentration limits. Based on the technology assessment, an initial BARCT concentration limit is identified and a cost-effectiveness analysis and, if necessary, an incremental cost-effectiveness analysis, are conducted.

The cost-effectiveness analysis considers the cost to implement one or more technologies that can meet the initial BARCT concentration limit. An incremental cost-effectiveness analysis is conducted if multiple initial BARCT concentration limits are identified that vary in stringency and are each cost-effective. A final BARCT concentration limit is established that is both technologically feasible, achievable within the implementation schedule allowed in the proposed rule, cost-effective, and incrementally cost-effective.

Figure 2-1 – BARCT Assessment Process



ESTABLISHING EQUIPMENT CLASSES AND CATEGORIES

Rule 1147 originally categorized the equipment currently under the scope of PR 1147.2 as one equipment category referred to as "Metal Heat Treating, Metal Melting Furnace, Metal Pot, or Tar Pot". Through the PR 1147.2 rule development process, staff evaluated the different types of furnaces and their applications. As a result, PR 1147.2 establishes seven categories of equipment: Metal Melting Furnaces; Metal Heat Treating Furnaces: Low Temperature; Metal Heat Treating Furnaces: High Temperature; Metal Heating and Forging Furnaces: Low Temperature; Metal Heating and Forging Furnaces: High Temperature; Furnaces with Radiant-Tube Burners; and Furnaces ≥ 40 MMBtu/hr. Metal Heating Furnaces and Metal Forging Furnaces are combined into a single Metal Heating and Forging Furnaces category due to the similar processes and the interchangeability of furnace type designations on unit permits of these equipment categories.

The definitions in PR 1147.2 for each of these categories are as follows:

- "Metal Forging Furnace" means "a device which applies heat to a solid metal to allow for its further processing, forming, or shaping"

- "Metal Heat Treating Furnace" means "a device where heat is applied to a solid metal in order to alter its chemical properties, alter its microstructure to achieve desired mechanical properties (strength, hardness, toughness, ductility, and corrosion resistance), or alter its surface chemistry"

- "Metal Heating Furnace" means "a device where heat is applied to a solid metal in order to alter its physical properties"

- "Metal Melting Furnace" is "a device where metal is heated to a molten state". This definition excludes any enclosed structure in which the metal is heated but does not reach a molten state.

- "Radiant-Tube Burner" refers to units with "an indirect-fired burner where combustion takes place in a tube to prevent contact between the products of combustion and the parts being heated"

These definitions exclude any enclosure in which heating and cooling occur incidentally during other processes, such as welding or grinding, or any enclosure in which coated metal is processed, such as those processes involving resins or curing.

The distinction was made between low-temperature and high-temperature for the two categories of metal heat treating and metal heating and forging as these two categories of furnaces may operate over a wide range of operating temperatures, with higher NO_x concentration levels values being characteristic of higher operating temperatures. A temperature cutoff of 1,200 °F was determined based on permit data, burner vendors, and input from industry stakeholders.

GENERAL BARCT ASSESSMENT APPROACH

In identifying the initial universe that would be subject to PR 1147.2, staff used the South Coast AQMD's permit database. Staff identified an initial universe of 86 facilities which included 21 RECLAIM facilities with 315 units and 65 non-RECLAIM facilities with 270 units. Equipment excluded in the initial universe included: welding or grinding enclosures, ovens, afterburners, remediation units, incinerators, heated process tanks, spray booths, calciners, process heating or space heating furnaces, furnaces that process coated metals, and electrically-powered furnaces.

As part of the rule development process, staff obtained data from multiple sources which included: online articles, industry publications, scientific and vendor literature, permits and source tests, annual emission reports, inspection reports, Rule 1147 series surveys, site visits, stakeholder meetings, focus groups, Working Group meetings, a public workshop, and South Coast AQMD inter-departmental meetings.

A BARCT assessment was conducted for each equipment category. An overview of each step in the BARCT assessment is presented below, followed by the BARCT assessment for each equipment category. Each step in the BARCT process for a category will include a discussion of the development of that specific portion of the BARCT assessment. All data included in each equipment category includes only those units with NO_x emissions of greater than or equal to one pound per day. Units with NO_x emissions of less than one pound per day are expected to take the one pound of NO_x per day emission exemption provided in PR 1147.2 and would not be required to have an alteration performed at any time for the time that the unit is in compliance with the exemption. The BARCT assessment for each equipment category was conducted for the remaining units that cannot take the exemption who are most likely to require unit alteration to meet the NO_x BARCT concentration limits.

Assessment of South Coast AQMD Regulatory Requirements

Rule 1147 currently applies to all permitted gaseous and liquid fuel-fired units with a rated heat input of greater than or equal to 325,000 Btu/hr. All units subject to PR 1147.2 were subject to Rule 1147 and its 60 ppmv @ 3% O_2, dry, or 0.073 lb/MMBtu emission limits across all temperatures.

Assessment of Emission Limits for Equipment

Assessment of emission limits was conducted based on a NOx concentration measured in units of "ppmv", or parts per million on a volume basis. For RECLAIM units that had a NO_x emission factor on the unit's permit in lieu of a NO_x ppmv concentration limit, the emission factor was converted to a ppmv concentration limit.

Source test data was reviewed for all units, when available.

Other Regulatory Requirements

Staff assessed regulations at the local, state, and national levels to compare concentration limits of other air districts and air quality regulatory entities across the country. Some of these other regulations specify equipment category applicability that is general enough to be classified in multiple PR 1147.2 equipment categories, for example "combustion equipment". Additionally, these other regulations do not distinguish by temperature and, when identified and where applicable, could be included in both the low-temperature and high-temperature category of either the metal heat treating furnaces or metal heating and forging furnaces category.

Data from this review was used to assess potential BARCT NO_x concentration limits with respect to other established NO_x emission limits.

Assessment of Pollution Control Technologies

Appendix B contains the technology assessment where each potential pollution control technology is discussed in detail. Specific pollution control technology applicability will be discussed in each equipment category's BARCT assessment.

Initial BARCT Emission Limits and Other Considerations

For units permitted prior to adoption of PR 1147.2, staff determined an initial BARCT NO_x concentration limit for units in the metal melting, metal heat treating, metal heating and forging, and radiant-tube burner equipment categories using the information gathered from all previous steps. Staff reviewed source test results to determine what NO_x concentrations have been demonstrated in practice. Staff also reviewed multiple emission guarantees from burner vendors for different equipment categories and, where applicable, temperature ranges.

For new units, staff determined an initial BARCT NO_x concentration limit for units in the metal melting, metal heat treating, metal heating and forging, and radiant-tube burner equipment categories. Staff reviewed technical and cost data from burner vendors and facilities to determine initial concentration limits. Staff met with several stakeholders and burner vendors who provided information for the metal heat treating, metal heating and forging, and radiant-tube burner equipment categories that NO_x concentrations of 30 ppmv @ 3% O_2, dry, for low-temperature metal heat treating, low-temperature metal heating and forging and 40 ppmv @ 3% O_2, dry, for high-temperature metal heat treating, high-temperature metal heating and forging, and radiant-tube burner units are technologically feasible. Although these concentration limits are technologically feasible, to meet these limits would require extensive, difficult, and expensive retrofits such as refractory redesign and air/fuel system replacements. Additionally, one vendor provided information on radiant-tube burner retrofit technologies that may reduce NO_x to 40 ppmv @ 3% O_2, dry. However, the technology has not been demonstrated in practice and for units with radiant-tube burners, the lowest source test results varied between 40 ppmv @ 3% O_2, dry, and 50 ppmv @ 3% O_2, dry. Staff determined that these concerns of difficult and expensive retrofits were not applicable to the metal melting category due to the simpler operation of metal melting furnaces and the lack of temperature uniformity requirements.

Stakeholders also noted that furnaces are typically designed to account for the specific burner configuration and NO_x performance requirements and that retrofits to meet a NO_x concentration limit are inherently more difficult to install compared to purchasing a new unit that is designed to meet the NO_x concentration limit. This is due to furnace geometry, burner placement within a furnace, the number of burners, and other factors. In some cases, changes to any one of these factors as part of a retrofit to meet the BARCT limits may result in adding expensive auxiliary equipment such as air/fuel controls. Staff noted that this was a common observation for units retrofitting to meet a 30 ppmv @ 3% O_2, dry, and 40 ppmv @ 3% O_2, dry, NO_x concentration limit. However, at a 40 ppmv @ 3% O_2, dry, and 50 ppmv @ 3% O_2, dry, NO_x concentration limit units may be able to retrofit without requiring these auxiliary equipment. Additionally, staff noted that the majority of furnaces could also be considered compliant with the NO_x concentration limits or could then qualify for the alternative concentration limits in PR 1147.2 and be given an extended implementation schedule.

Staff's determination of NO_x concentration limits for new units involved a review of BACT determinations at the local, state, and national levels. Results of this review are shown in Table 2-1.

Table 2-1 – BACT Review

Facility Name	Furnace Type	Rated Heat Input (MMBtu/hr)	NO_x Concentration Limit (ppmv @ 3% O_2, Dry)
International Extrusion Corp. (Alhambra, CA)	Reverberatory Furnace (Metal Melting)	12.8	37
Sierra Aluminum Company (Riverside, CA)	Billet Furnace (Metal Heating and Forging)	5.47	25
Carlton Forge Works (Paramount, CA)	Forging Furnace (Metal Heating and Forging)	5.00	30
Vista Metals (Fontana, CA)	Billet Furnace (Metal Heating and Forging)	8.0	40
International Extrusion Corp. (Alhambra, CA)	Metal Heating Furnace (Metal Heating and Forging)	8.8	40
Superior Industries Intl. (Van Nuys, CA)	Reverberatory Furnace (Metal Melting)	12.6	43
Custom Alloy Sales (Lynwood, CA)	Reverberatory Furnace (Metal Melting)	6.0	39
International Extrusion Corp.	Reverberatory Furnace (Metal Melting)	12.8	37
Constellium – Element 13 (Colbert County, AL)	Melting/Sidewell Furnace 8 (Metal Melting)	36.0	33*
Nucor Steel – Berkeley (Berkeley County, SC)	Galvanneal Furnace 2 (Metal Heat Treating)	22.0	39*
Constellium – Alloys Plant (Colbert County, AL)	Two Heat Treat Furnaces (Metal Heat Treating)	25.0	50*
Benteler Steel Tube (Caddo County, LA)	Annealing Furnace – S10 (Metal Heat Treating)	14.0	50*
Thyssenkrup Steel USA – Mount Vernon Mill (Mobile County, AL)	Annealing Furnace (Metal Heat Treating)	120.0	50*

* Reported values were converted from lb/MMBtu to ppmv
Reference: U.S. EPA RACT/BACT/LAER Clearing House (RBLC)

For new units, based on the technological feasibility of burners for the metal heat treating, metal heating and forging, and radiant-tube burner categories, and the review of BACT determinations, NO_x concentration limits for new units were established at 30 ppmv @ 3% O_2, dry, for low-temperature metal heat treating units, low-temperature metal heating and forging units, and radiant-tube burner units and 40 ppmv @ 3% O_2, dry, for high-temperature metal heat treating units, high-temperature metal heating and forging units, and radiant-tube burner units. A NO_x concentration limit for new units with radiant-tube burners was also established at 40 ppmv @ 3% O_2, dry, after receiving feedback from stakeholders and burner vendors.

For units permitted prior to adoption of PR 1147.2, based on the technological feasibility and cost-effectiveness of burners for the metal heat treating, metal heating and forging, and radiant-tube burner categories, NO_x concentration limits for units were established at 40 ppmv @ 3% O_2, dry, for low-temperature metal heat treating, low-temperature metal heating and forging and 50 ppmv @ 3% O_2, dry, for high-temperature metal heat treating, high-temperature metal heating and forging, and radiant-tube burner units. An incremental cost-effectiveness analysis was conducted for units in the metal heat treating, metal heating and forging, and radiant-tube burner categories between the NO_x concentration limits for units and the NO_x concentration limits for new units. The results of this analysis showed that, in addition to the technological feasibility concerns, it is also not incrementally cost-effective for units to implement Low NOx Burner technology to meet the lower 30 ppmv @ 3% O_2, dry and 40 ppmv @ 3% O_2, dry NOx concentration limits. Details of this incremental cost-effectiveness are found in Appendix D.

During the BARCT assessment, staff recognized that units with a current NO_x concentration within 10 ppmv of the proposed NO_x concentration limits for units with a rated heat input of less than 40 MMBtu/hr had cost-effectiveness results of greater than or equal to $50,000 per ton NO_x reduced. Therefore, staff proposed alternative NO_x concentration limits for these units at 10 ppmv above the corresponding NO_x BARCT concentration limit. Alternative NO_x concentration limits account for the small emission reductions associated with these units compared to units that may have much higher baseline NO_x concentrations limits and greater emission reductions. An alternative implementation schedule is also established to require these units to meet the proposed NO_x BARCT concentration limits on a more extended timeline. By providing an alternative implementation schedule, staff allows for full utilization of the useful life of the burners and calculated the cost-effectiveness for these units to then be lower than $50,000 per ton NO_x reduced.

During the BARCT assessment, staff determined that a rated heat input threshold was appropriate to separately categorize larger units that may have much higher NO_x emissions than comparatively smaller units. Cost-effectiveness analyses were performed for units ranging in rated heat input from 20 MMBtu/hr to 30 MMBtu/hr, 30 MMBtu/hr to 40 MMBtu/hr, and greater than or equal to 40 MMBtu/hr. Of these various rated heat input ranges, staff determined that only the greater than or equal to 40 MMBtu/hr range had a cost-effectiveness less than $50,000 per ton NOx reduced.

Cost-Effectiveness Analysis & Incremental Cost-Effectiveness Analysis

A cost-effectiveness analysis and incremental cost-effectiveness analysis were conducted pursuant to HSC § 40920.6. A summary of the costs, emission reductions, cost-effectiveness, and incremental cost-effectiveness will be discussed for each equipment category in Chapter 2. A detailed analysis of the cost-effectiveness and incremental cost-effectiveness for each equipment category is provided in Appendix D.

For the metal melting, metal heat treating, metal heating and forging, and radiant-tube burner categories, only the Low NO_x Burner retrofit pollution control option was determined to be cost-effective and thus the only pollution control option pursued as part of each category's BARCT assessment. Details of the cost-effectiveness analyses for both remaining pollution control options – SCR installation and the combination of SCR installation and Low NO_x Burner retrofit – are provided in Appendix D.

The BARCT assessment for each equipment category is discussed next.

BARCT ASSESSMENT BY CATEGORY

Metal Melting Furnaces

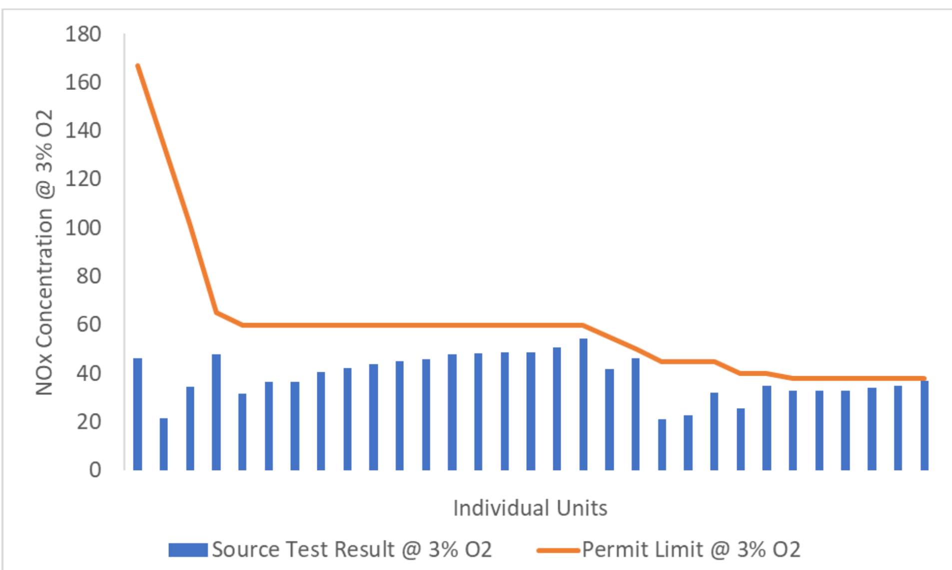
Assessment of South Coast AQMD Regulatory Requirements

Under Rule 1147, metal melting furnaces were required to meet a NO_x concentration limit of 60 ppmv @ 3% O_2, dry, or 0.073 lb/MMBtu across all temperatures.

Assessment of Emission Limits for Equipment

Staff identified 71 metal melting units. Source tests were identified and reviewed for 31 units with source test results ranging from 21-54 ppmv NO_x @ 3% O_2, dry, and an average result of 39 ppmv NO_x @ 3% O_2, dry. Staff then compared permit limits with source test results which showed that many units have source test results than can range significantly lower than their permitted limits. The median difference between a unit's permit limit and source test result for these 31 units was 13 ppmv (median of 24% lower). A graph of the source test result distribution and comparison with permit limits is shown in Graph 2-1.

Graph 2-1 – Metal Melting Source Test Result Distribution



Other Regulatory Requirements

A comparison of NO_x concentration limits with other California air districts for units in similar equipment categories as metal melting furnaces is provided in Table 2-2.

Table 2-2 – Metal Melting Other Regulatory Requirements

Air District	Rule #	Rule Date	NO_x Concentration Limit ppmv @ 3% O_2, Dry	Equipment Category
Ventura County Air Pollution Control District	Rule 74.34	12/13/2016	60	Metal Heat Treating/Metal Melting Furnace
Sacramento Metro Air Quality Management District	BACT Clearinghouse Determination #211	BACT Determination Date: 12/12/2018	60	Pot Furnace – Bronze Melting
Great Basin Unified Air Pollution Control District	Rule 404-B	9/5/1974; Amended: 5/8/1996	Natural Gas: 125	Combustion Equipment
Bay Area Air Quality Management District	Regulation 9 Rule 3	3/17/1982	Natural Gas: 125	Heat Transfer Operations
Amador Air District	SIP Rule 19	9/14/1971	140 lbs/hr	Non-Mobile Fuel Burning Equipment
San Joaquin Valley Air Pollution Control District	Rule 4301	12/17/1992	140 lbs/hr	Fuel Burning Equipment

The lowest NO_x concentration limit for this category was identified as 60 ppmv.

Assessment of Pollution Control Technologies

This section is discussed in Appendix B. SCR and Low NO_x Burners were identified as the pollution control technologies used by metal melting units. The use of flue gas recirculation (FGR) technology did not have a significant presence in the PR 1147.2 universe. The use of selective non-catalytic reduction (SNCR) was not identified on any units.

Initial BARCT Emission Limits and Other Considerations

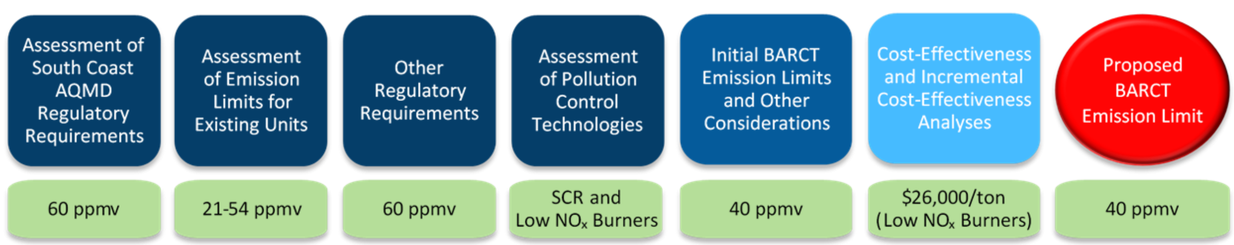
Staff reviewed source test results to determine what NO_x concentrations have been demonstrated in practice. Staff also reviewed emission guarantees from three vendors representing approximately 85% of the burners used in the metal melting category. The three vendors gave emission guarantees ranging from 30-60 ppmv @ 3% O_2, dry. Although one emission guarantee at 30 ppmv @ 3% O_2, dry, was received from one vendor, staff did not consider this emission guarantee in determining the initial BACT concentration limit as it was a conditional emission guarantee that may not be achievable for all units or would require a lowering of either operating temperature or operating capacity. As a result, an initial BARCT concentration of 40 ppmv @ 3% O_2, dry, was analyzed in the source test results and emission guarantees. This analysis showed that 16 of 31 units with source test results were less than or equal to 40 ppmv @ 3% O_2, dry. After reviewing both emission guarantee statements and source test results, staff determined that a 40 ppmv @ 3% O_2, dry, initial BARCT concentration limit was technologically feasible for metal melting units.

Cost-Effectiveness Analysis and Incremental Cost-Effectiveness Analysis

Staff conducted a cost-effectiveness analysis for metal melting units to meet a NO_x concentration limit of 40 ppmv @ 3% O_2, dry, via Low NO_x Burner retrofit. The total costs for this option was determined to be $10,909,500 and the estimated NO_x emission reductions are 419 tons. The cost-effectiveness of this category was calculated as $26,000 per ton NO_x reduced. An incremental cost-effectiveness was not conducted as only one pollution control technology was determined to be cost-effective.

Summary

Based on the BARCT assessment for metal melting units, staff determined a BARCT concentration limit of 40 ppmv @ 3% O_2, dry.



<u>Metal Heat Treating Furnaces: Low Temperature (≤ 1,200 °F)</u>

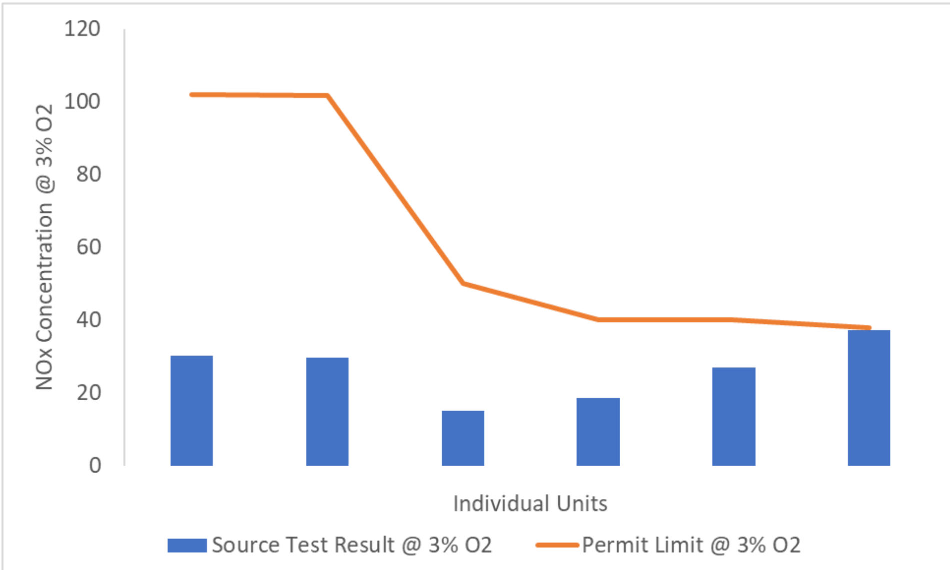
Assessment of South Coast AQMD Regulatory Requirements

Under Rule 1147, low-temperature metal heat treating furnaces were required to meet a NO_x concentration limit of 60 ppmv @ 3% O_2, dry, or 0.073 lb/MMBtu across all temperatures.

Assessment of Emission Limits for Equipment

Staff identified 26 low-temperature metal heat treating units. Source tests were identified and reviewed for six units with source test results ranging from 15-37 ppmv NO_x @ 3% O_2, dry, and an average result of 26 ppmv NO_x @ 3% O_2, dry. Staff then compared permit limits with source test results which showed that many units have source tests results that can range below their permit limits. The median difference between a unit's permit limit and source test result for these six units was 28 ppmv NO_x @ 3% O_2, dry, (median of 62% lower). A graph of the source test result distribution and comparison with permit limits is shown in Graph 2-2.

Graph 2-2 – Metal Heat Treating: Low Temperature Source Test Result Distribution



Other Regulatory Requirements

A comparison of NO_x concentration limits with other California air districts for units in similar equipment categories as low-temperature metal heat treating furnaces is provided in Table 2-3.

Table 2-3 – Metal Heat Treating: Low Temperature Other Regulatory Requirements

Air District	Rule #	Rule Date	NO_x Concentration Limit ppmv @ 3% O_2, Dry	Equipment Category
Ventura County Air Pollution Control District	Rule 74.34	12/13/2016	60	Metal Heat Treating/Metal Melting Furnace
Great Basin Unified Air Pollution Control District	Rule 404-B	9/5/1974; Amended: 5/8/1996	Natural Gas: 125	Combustion Equipment
Bay Area Air Quality Management District	Regulation 9 Rule 3	3/17/1982	Natural Gas: 125	Heat Transfer Operations
San Joaquin Valley Air Pollution Control District	Rule 4301	12/17/1992	140 lbs/hr	Fuel Burning Equipment

The lowest NO_x concentration limit for this category was identified as 60 ppmv @ 3% O_2, dry.

Assessment of Pollution Control Technologies

This section is discussed in Appendix B. SCR and Low NO_x Burners were identified as the pollution control technologies used by low-temperature metal heat treating units. The use of flue gas recirculation (FGR) technology did not have a significant presence in the PR 1147.2 universe. The use of selective non-catalytic reduction (SNCR) was not identified on any units.

Initial BARCT Emission Limits and Other Considerations

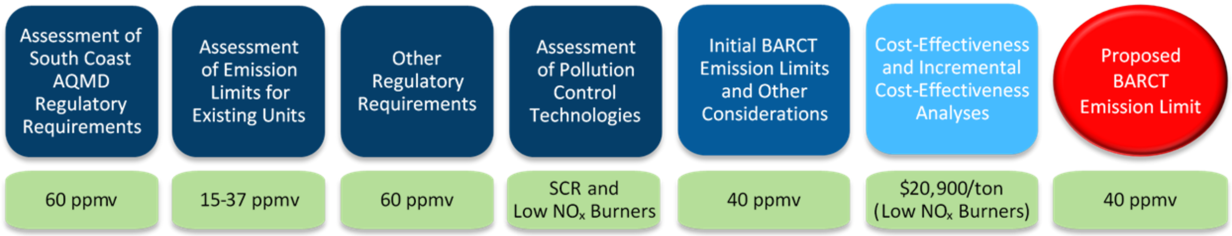
Staff reviewed source test results to determine what NO_x concentrations have been demonstrated in practice. Staff also reviewed emission guarantees from two vendors representing approximately 95% of the burners used in the low-temperature metal heat treating category. The two vendors gave emission guarantees of 30 ppmv and 42 ppmv @ 3% O_2, dry. Although one emission guarantee at 30 ppmv @ 3% O_2, dry, was received from one vendor, staff did not consider this emission guarantee in determining the initial BACT concentration limit as no units equipped with the vendor's burners had source test results less than or equal to 30 ppmv @ 3% O_2, dry. Additionally, a 30 ppmv @ 3% O2, dry, concentration limit would require additional expensive auxiliary equipment, as noted in the *General BARCT Assessment Approach* section of Chapter 2. Based on these determinations, staff analyzed an initial BARCT concentration of 40 ppmv @ 3% O_2, dry, in the source test results and emission guarantees. This analysis showed that the source test results of all six units with source test results were less than or equal to 40 ppmv @ 3% O_2, dry. After reviewing both emission guarantee statements and source test results, staff determined that a 40 ppmv @ 3% O_2, dry, initial BARCT concentration limit was technologically feasible for low-temperature metal heat treating units.

Cost-Effectiveness Analysis and Incremental Cost-Effectiveness

Staff conducted a cost-effectiveness analysis for low-temperature metal heat treating units to meet a NO_x concentration limit of 40 ppmv @ 3% O_2, dry, via Low NO_x Burner retrofit. The total costs for this option was determined to be $1,525,100 and the estimated NO_x emission reductions are 73 tons. The cost-effectiveness of this category was calculated as $20,900 per ton NO_x reduced. An incremental cost-effectiveness between a 40 ppmv @ 3% O_2, dry NO_x concentration limit and a 30 ppmv @ 3% O_2, dry NO_x concentration limit was calculated as $118,700 per ton NO_x reduced.

Summary

Based on the BARCT assessment for low-temperature metal heat treating units, staff determined a BARCT concentration limit of 40 ppmv @ 3% O_2, dry.



Metal Heat Treating Furnaces: High Temperature (> 1,200 °F)

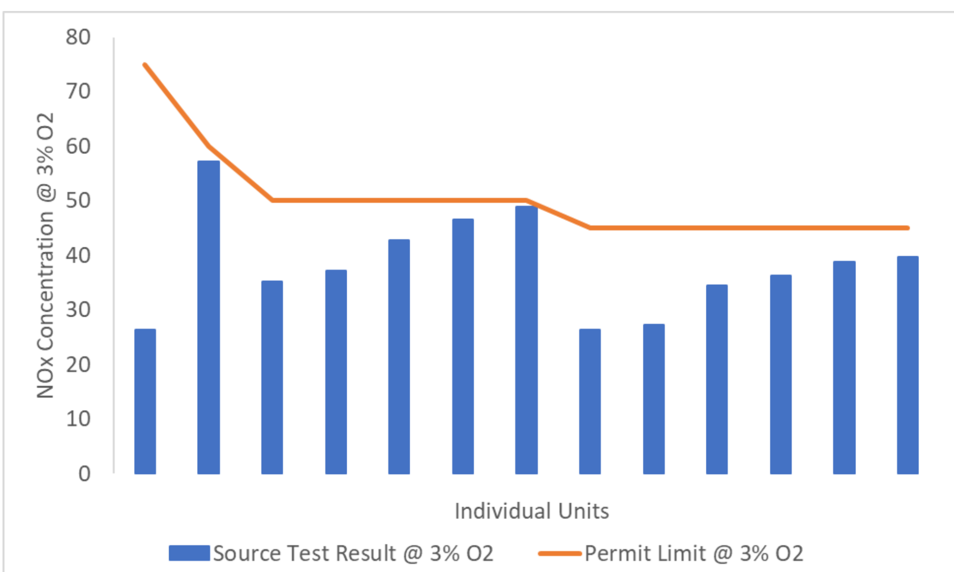
Assessment of South Coast AQMD Regulatory Requirements

Under Rule 1147, high-temperature metal heat treating furnaces were required to meet a NO_x concentration limit of 60 ppmv @ 3% O_2, dry, or 0.073 lb/MMBtu across all temperatures.

Assessment of Emission Limits for Equipment

Staff identified 59 high-temperature metal heat treating units. Source tests were identified and reviewed for 13 units with source test results ranging from 26-57 ppmv NO_x @ 3% O_2, dry, and an average result of 38 ppmv NO_x @ 3% O_2, dry. Staff then compared permit limits with source test results which showed that many units have source tests results that can range significantly below their permit limits. The median difference between a unit's permit limit and source test result for these 13 units was 9 ppmv NO_x @ 3% O_2, dry, (median of 20% lower). A graph of the source test result distribution and comparison with permit limits is shown in Graph 2-3.

Graph 2-3 – Metal Heat Treating: High Temperature Source Test Result Distribution



Other Regulatory Requirements

A comparison of NO_x concentration limits with other California air districts for units in similar equipment categories as high-temperature metal heat treating temperature furnaces is provided in Table 2-4.

Table 2-4 – Metal Heat Treating: High Temperature Other Regulatory Requirements

Air District	Rule #	Rule Date	NO_x Concentration Limit ppmv @ 3% O_2, Dry	Equipment Category
Ventura County Air Pollution Control District	Rule 74.34	12/13/2016	60	Metal Heat Treating/Metal Melting Furnace
Great Basin Unified Air Pollution Control District	Rule 404-B	9/5/1974; Amended: 5/8/1996	Natural Gas: 125	Combustion Equipment
Bay Area Air Quality Management District	Regulation 9 Rule 3	3/17/1982	Natural Gas: 125	Heat Transfer Operations
San Joaquin Valley Air Pollution Control District	Rule 4301	12/17/1992	140 lbs/hr	Fuel Burning Equipment

The lowest NO_x concentration limit for this category was identified as 60 ppmv @ 3% O_2, dry.

Assessment of Pollution Control Technologies

This section is discussed in Appendix B. SCR and Low NO_x Burners were identified as the pollution control technologies used by high-temperature metal heat treating units. The use of flue gas recirculation (FGR) technology did not have a significant presence in the PR 1147.2 universe. The use of selective non-catalytic reduction (SNCR) was not identified on any units.

Initial BARCT Emission Limits and Other Considerations

Staff reviewed source test results to determine what NO_x concentrations have been demonstrated in practice. Staff also reviewed emission guarantees from two vendors representing approximately 70% of the burners used in the high-temperature metal heat treating category. The two vendors gave emission guarantees ranging from 30-50 ppmv @ 3% O_2, dry. Although one emission guarantee at 30 ppmv @ 3% O_2, dry, was received from one vendor, staff did not consider this emission guarantee in determining the initial BACT concentration limit as no units equipped with the vendor's burners had source test results less than or equal to 30 ppmv @ 3% O_2, dry. Additionally, a 40 ppmv @ 3% O2, dry, concentration limit would require additional expensive auxiliary equipment, as noted in the *General BARCT Assessment Approach* section of Chapter 2. Based on both of these determinations, staff analyzed an initial BARCT concentration of 50 ppmv

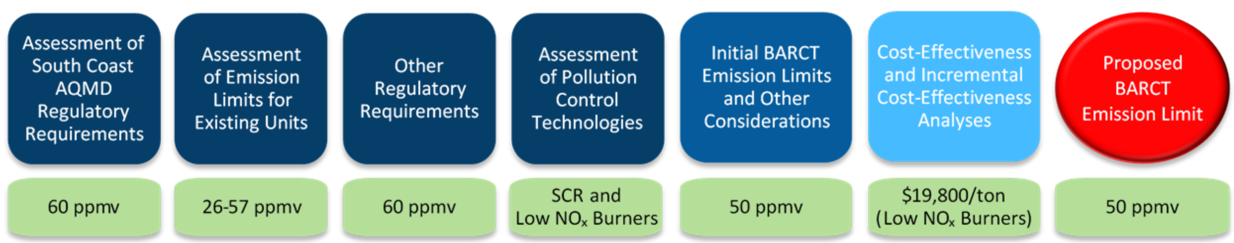
@ 3% O_2, dry, in the source test results and emission guarantees. This analysis showed that 12 of 13 units with source test results were less than or equal to 50 ppmv @ 3% O_2, dry. After reviewing both emission guarantee statements and source test results, staff determined that a 50 ppmv @ 3% O_2, dry, initial BARCT concentration limit was technologically feasible for high-temperature metal heat treating units.

Cost-Effectiveness Analysis and Incremental Cost-Effectiveness Analysis

Staff conducted a cost-effectiveness analysis for high-temperature metal heat treating units to meet a NO_x concentration limit of 50 ppmv @ 3% O_2, dry, via Low NO_x Burner retrofit. The total costs for this option was determined to be $2,643,000 and the estimated NO_x emission reductions are 133 tons. The cost-effectiveness of this category was calculated as $19,800 per ton NO_x reduced. An incremental cost-effectiveness between a 50 ppmv @ 3% O_2, dry NO_x concentration limit and a 40 ppmv @ 3% O_2, dry NO_x concentration limit was calculated as $158,700 per ton NO_x reduced.

Summary

Based on the BARCT assessment for high-temperature metal heat treating units, staff determined a BARCT concentration limit of 50 ppmv @ 3% O_2, dry.



<u>Metal Heating and Forging Furnaces: Low Temperature (≤ 1,200 °F)</u>

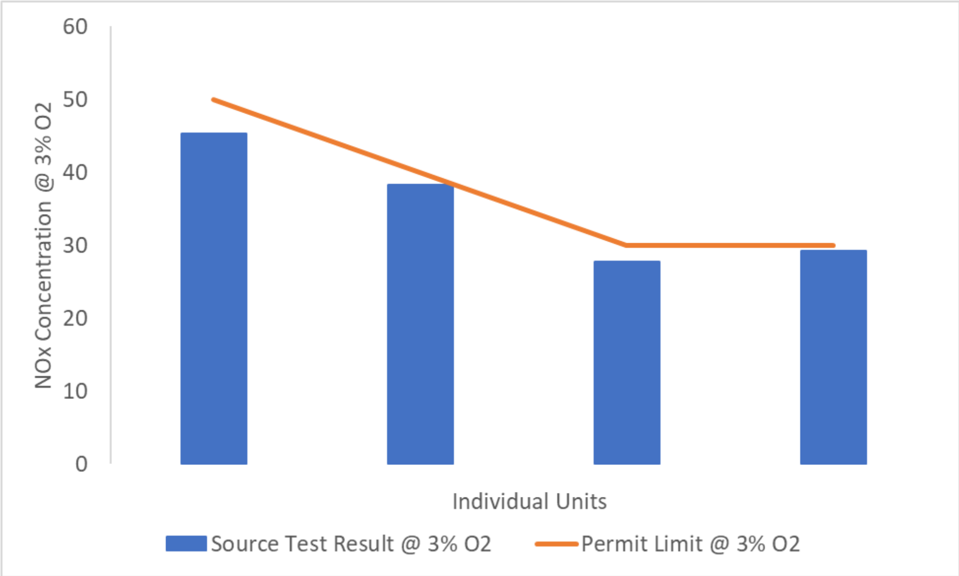
Assessment of South Coast AQMD Regulatory Requirements

Under Rule 1147, low-temperature metal heating and metal forging furnaces were required to meet a NO_x concentration limit of 60 ppmv @ 3% O_2, dry, or 0.073 lb/MMBtu across all temperatures.

Assessment of Emission Limits for Equipment

Staff identified 21 low-temperature metal heating and forging units. Source tests were identified and reviewed for four units with source test results ranging from 28-45 ppmv NO_x @ 3% O_2, dry, and an average result of 35 ppmv NO_x @ 3% O_2, dry. Staff then compared permit limits with source test results which showed that many units have source tests results that can range slightly below their permit limits. The median difference between a unit's permit limit and source test result for these four units was 2 ppmv NO_x @ 3% O_2, dry (median of 6% lower). A graph of the source test result distribution and comparison with permit limits is shown in Graph 2-4.

Graph 2-4 – Metal Heating and Forging: Low Temperature Source Test Result Distribution



Other Regulatory Requirements

A comparison of NO_x concentration limits with other California air districts for units in similar equipment categories as low-temperature metal heating and forging furnaces is provided in Table 2-5.

Table 2-5 – Metal Heating and Forging: Low Temperature Other Regulatory Requirements

Air District	Rule #	Rule Date	NO_x Concentration Limit ppmv @ 3% O_2, Dry	Equipment Category
Ventura County Air Pollution Control District	Rule 74.34	12/13/2016	60	Metal Heat Treating/Metal Melting Furnace
Great Basin Unified Air Pollution Control District	Rule 404-B	9/5/1974; Amended: 5/8/1996	Natural Gas: 125	Combustion Equipment
Bay Area Air Quality Management District	Regulation 9 Rule 3	3/17/1982	Natural Gas: 125	Heat Transfer Operations
San Joaquin Valley Air Pollution Control District	Rule 4301	12/17/1992	140 lbs/hr	Fuel Burning Equipment

The lowest NO_x concentration limit for this category was identified as 60 ppmv @ 3% O_2, dry.

Assessment of Pollution Control Technologies

This section is discussed in Appendix B. SCR and Low NO_x Burners were identified as the pollution control technologies used by low-temperature metal heating and forging units. The use of flue gas recirculation (FGR) technology did not have a significant presence in the PR 1147.2 universe. The use of selective non-catalytic reduction (SNCR) was not identified on any units.

Initial BARCT Emission Limits and Other Considerations

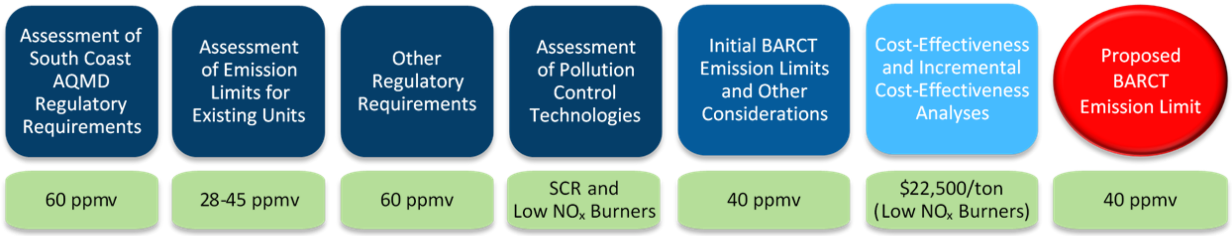
Staff reviewed source test results to determine what NO_x concentrations have been demonstrated in practice. Staff also reviewed emission guarantees from two vendors representing approximately 100% of the burners used in the low-temperature metal heating and forging category. The two vendors gave emission guarantees ranging from 30-50 ppmv @ 3% O_2, dry. Although one emission guarantee at 30 ppmv @ 3% O_2, dry, was received from one vendor, staff did not consider this emission guarantee in determining the initial BACT concentration limit as no units equipped with the vendor's burners had source test results less than or equal to 30 ppmv @ 3% O_2, dry. Additionally, a 30 ppmv @ 3% O2, dry, concentration limit would require additional expensive auxiliary equipment, as noted in the *General BARCT Assessment Approach* section of Chapter 2. Based on both of these determinations, staff analyzed an initial BARCT concentration of 40 ppmv @ 3% O_2, dry, in the source test results and emission guarantees. This analysis showed that three of four units with source test results were less than or equal to 40 ppmv @ 3% O_2, dry. After reviewing both emission guarantee statements and source test results, staff determined that a 40 ppmv @ 3% O_2, dry, initial BARCT concentration limit was technologically feasible for low-temperature metal heating and forging units.

Cost-Effectiveness Analysis and Incremental Cost-Effectiveness Analysis

Staff conducted a cost-effectiveness analysis for low-temperature metal heating and forging units to meet a NO_x concentration limit of 40 ppmv @ 3% O_2, dry, via Low NO_x Burner retrofit. The total costs for this option was determined to be $942,900 and the estimated NO_x emission reductions are 42 tons. The cost-effectiveness of this category was calculated as $22,500 per ton NO_x reduced. An incremental cost-effectiveness between a 40 ppmv @ 3% O_2, dry NO_x concentration limit and a 30 ppmv @ 3% O_2, dry NO_x concentration limit was calculated as $81,800 per ton NO_x reduced.

Summary

Based on the BARCT assessment for low-temperature metal heating and forging units, staff determined a BARCT concentration limit of 40 ppmv @ 3% O_2, dry.



Metal Heating and Forging Furnaces: High Temperature (> 1,200 °F)

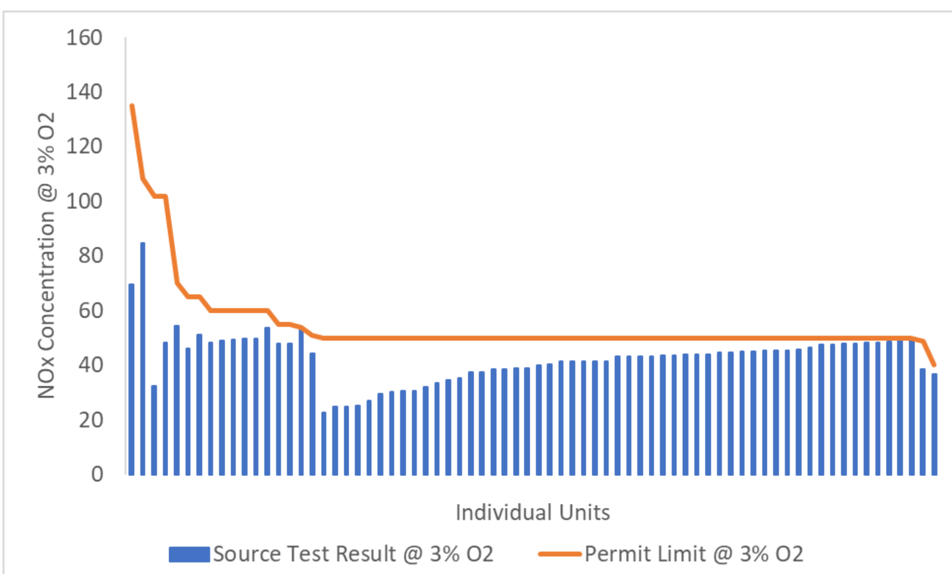
Assessment of South Coast AQMD Regulatory Requirements

Under Rule 1147, high-temperature metal heating and metal forging furnaces were required to meet a NO_x concentration limit of 60 ppmv @ 3% O_2, dry, or 0.073 lb/MMBtu across all temperatures.

Assessment of Emission Limits for Equipment

Staff identified 137 high-temperature metal heating and forging units. Source tests were identified and reviewed for 72 units with source test results ranging from 23-85 ppmv NO_x @ 3% O_2, dry, and an average result of 43 ppmv NO_x @ 3% O_2, dry. Staff then compared permit limits with source test results which showed that many units have source tests results that can range somewhat below their permit limits. The median difference between a unit's permit limit and source test result for these 72 units was 9 ppmv NO_x @ 3% O_2, dry, (median of 17% lower). A graph of the source test result distribution and comparison with permit limits is shown in Graph 2-5.

Graph 2-5 – Metal Heating and Forging: High Temperature
Source Test Result Distribution



Other Regulatory Requirements

A comparison of NO_x concentration limits with other California air districts for units in similar equipment categories as high-temperature metal heating and forging furnaces is provided in Table 2-6.

Table 2-6 – Metal Heating and Forging: High Temperature Other Regulatory Requirements

Air District	Rule #	Rule Date	NO_x Concentration Limit ppmv @ 3% O_2, Dry	Equipment Category
Ventura County Air Pollution Control District	Rule 74.34	12/13/2016	60	Metal Heat Treating/Metal Melting Furnace
Great Basin Unified Air Pollution Control District	Rule 404-B	9/5/1974; Amended: 5/8/1996	Natural Gas: 125	Combustion Equipment
Bay Area Air Quality Management District	Regulation 9 Rule 3	3/17/1982	Natural Gas: 125	Heat Transfer Operations
San Joaquin Valley Air Pollution Control District	Rule 4301	12/17/1992	140 lbs/hr	Fuel Burning Equipment

The lowest NO_x concentration limit for this category was identified as 60 ppmv @ 3% O_2, dry.

Assessment of Pollution Control Technologies

This section is discussed in Appendix B. SCR and Low NO_x Burners were identified as the pollution control technologies used by high-temperature metal heating and forging units. The use of flue gas recirculation (FGR) technology did not have a significant presence in the PR 1147.2 universe. The use of selective non-catalytic reduction (SNCR) was not identified on any units.

Initial BARCT Emission Limits and Other Considerations

Staff reviewed source test results to determine what NO_x concentrations have been demonstrated in practice. Staff also reviewed emission guarantees from three vendors representing approximately 95% of the burners used in the high-temperature metal heating and forging category. The three vendors gave emission guarantees ranging from 20-50 ppmv @ 3% O_2, dry. Although two emission guarantees at 20 ppmv @ 3% O_2, dry, and 30 ppmv @ 3% O_2, dry, were received from two vendors, staff did not consider these emission guarantees in determining the initial BACT concentration limit as no units equipped with these vendors' burners had source test results less than or equal to 20 ppmv @ 3% O_2, dry or 30 ppmv @ 3% O_2, dry, respectively. Additionally, a 40 ppmv @ 3% O2, dry, concentration limit would require additional expensive auxiliary equipment, as noted in the *General BARCT Assessment Approach* section of Chapter 2. Based on these determinations, staff analyzed an initial BARCT concentration of 50 ppmv @ 3%

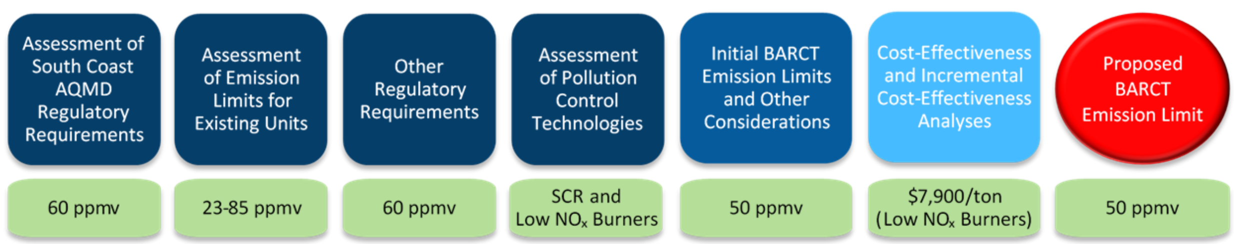
O_2, dry, in the source test results and emission guarantees. This analysis showed that 6 of 72 units with source test results were less than or equal to 50 ppmv @ 3% O_2, dry. After reviewing both emission guarantee statements and associated source test results, staff determined that a 50 ppmv @ 3% O_2, dry, initial BARCT concentration limit was technologically feasible for high-temperature metal heating and forging units.

Cost-Effectiveness Analysis and Incremental Cost-Effectiveness

Staff conducted a cost-effectiveness analysis for high-temperature metal heating and forging units to meet a NO_x concentration limit of 50 ppmv @ 3% O_2, dry, via Low NO_x Burner retrofit. The total costs for this option was determined to be $4,350,000 and the estimated NO_x emission reductions are 554 tons. The cost-effectiveness of this category was calculated as $7,900 per ton NO_x reduced. An incremental cost-effectiveness between a 50 ppmv @ 3% O_2, dry NO_x concentration limit and a 40 ppmv @ 3% O_2, dry NO_x concentration limit was calculated as $87,400 per ton NO_x reduced.

Summary

Based on the BARCT assessment for high-temperature metal heating and forging units, staff determined a BARCT concentration limit of 50 ppmv @ 3% O_2, dry.



<u>Units with Radiant-Tube Burners</u>

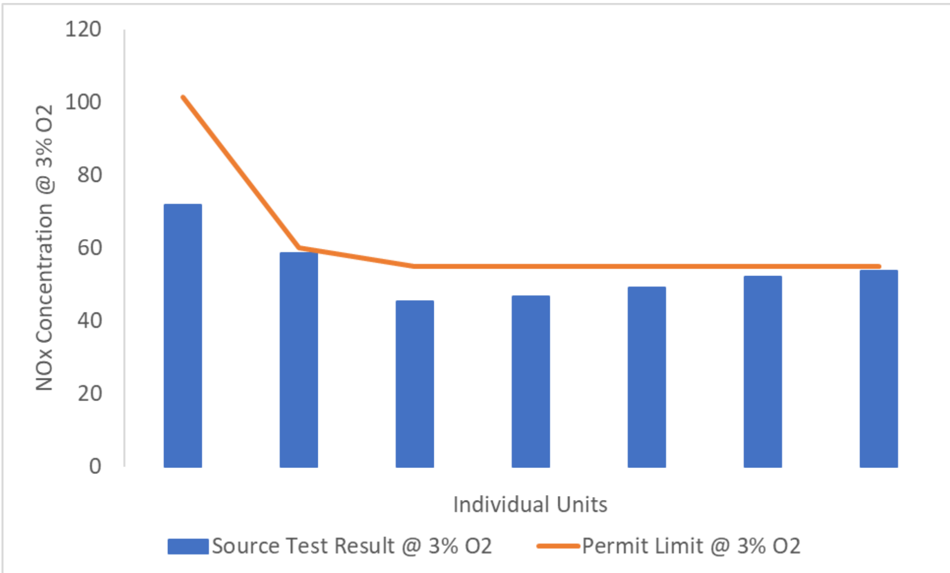
Assessment of South Coast AQMD Regulatory Requirements

Under Rule 1147, units with radiant-tube burners were required to meet a NO_x concentration limit of 60 ppmv @ 3% O_2, dry, or 0.073 lb/MMBtu across all temperatures.

Assessment of Emission Limits for Equipment

Staff identified eight units with radiant-tube burners. Although stakeholders noted to staff that approximately 20 permitted units with radiant-tube burners exist, this BARCT assessment only reviewed those units that were identified in staff's permit database. Source tests were identified and reviewed for seven units with source test results ranging from 46-72 ppmv NO_x @ 3% O_2, dry, and an average result of 54 ppmv NO_x @ 3% O_2, dry. Staff then compared permit limits with source test results which showed that many units have source tests results that can range somewhat below their permit limits. The median difference between a unit's permit limit and source test result for these units was 6 ppmv (median of 11% lower). A graph of the source test result distribution and comparison with permit limits is shown in Graph 2-6.

Graph 2-6 – Units with Radiant-Tube Burners
Source Test Result Distribution



Other Regulatory Requirements

All other regulations currently distinguish units by process type (e.g. melting, annealing, forging, etc.). As radiant-tube burners are not a process type but rather a burner type, and without burner data for these other regulations, staff was unable to determine whether the units in these other regulations are equipped with radiant-tube burners.

Assessment of Pollution Control Technologies

This section is discussed in Appendix B. These units utilize radiant-tube burners, which are a type of Low NO_x Burner. SCR and Low NO_x Burners were identified as the pollution control technologies used by units with radiant-tube burners. The use of flue gas recirculation (FGR) technology did not have a significant presence in the PR 1147.2 universe. The use of selective non-catalytic reduction (SNCR) was not identified on any units.

Initial BARCT Emission Limits and Other Considerations

Staff did not obtain emission guarantees from burner vendors for units with radiant-tube burners.

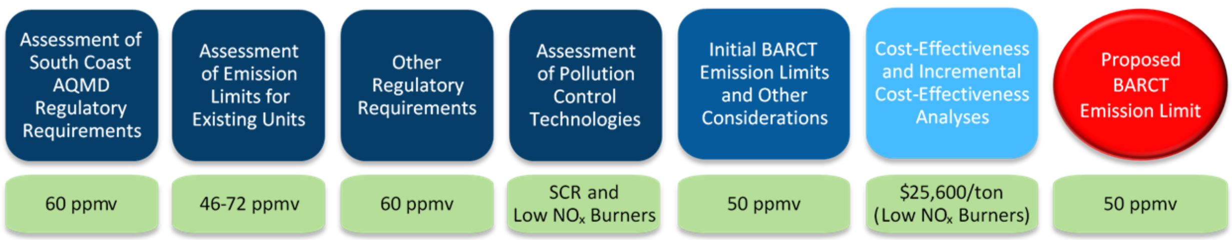
The source test results for units with radiant-tube burners confirm that 50 ppmv @ 3% O_2, dry, is achievable as three of seven units with source test results were less than or equal to 50 ppmv @ 3% O_2, dry. After reviewing source test results and meeting with stakeholders who operate units equipped with radiant-tube burners, staff determined that a 50 ppmv @ 3% O_2, dry, initial BARCT limit was technologically feasible for units with radiant-tube burners.

Cost-Effectiveness Analysis and Incremental Cost-Effectiveness

Staff conducted a cost-effectiveness analysis for units with radiant-tube burners to meet a NO_x concentration limit of 50 ppmv @ 3% O_2, dry, via Low NO_x Burner retrofit. The total costs for this option was determined to be $721,300 and the estimated NO_x emission reductions are 28 tons. The cost-effectiveness of this category was calculated as $25,600 per ton NO_x reduced. An incremental cost-effectiveness between a 50 ppmv @ 3% O_2, dry NO_x concentration limit and a 40 ppmv @ 3% O_2, dry NO_x concentration limit was calculated as $80,700 per ton NO_x reduced.

Summary

Based on the BARCT assessment for units with radiant-tube burners, staff determined a BARCT concentration limit of 50 ppmv @ 3% O_2, dry.



<u>Units ≥ 40 MMBtu/hr</u>

Assessment of South Coast AQMD Regulatory Requirements

There are no current South Coast AQMD regulatory requirements for units in this category. Identified units in this category are located at RECLAIM facilities.

Assessment of Emission Limits for Equipment

Staff identified four units with a rated heat input of ≥ 40 MMBtu/hr. Source test results were identified and reviewed for one unit with a source test result of 22 ppmv NO_x @ 3% O_2, dry. Two of the four units have an SCR installed while the remaining two units do not have any exhaust NO_x emissions control equipment installed. The one unit identified with a source test result has a permit limit of 50 ppmv NO_x @ 3% O_2, dry.

Other Regulatory Requirements

The other regulatory requirements identified by staff did not distinguish whether post-combustion emission control (such as SCR) was present. Additionally, staff performed a search for SCR installations permitted prior to adoption of PR 1147.2 and did not identify any SCR installations on any type of furnace. Therefore, staff did not include a review of other regulatory requirements for this category of equipment.

Assessment of Pollution Control Technologies

This section is discussed in Appendix B. SCR and the combination of Low NO_x Burner and SCR were identified as the pollution control technologies used by units with a rated heat input of ≥ 40 MMBtu/hr. The use of flue gas recirculation (FGR) technology did not have a significant presence in the PR 1147.2 universe. The use of selective non-catalytic reduction (SNCR) was not identified on any units.

The cost-effectiveness and incremental cost-effectiveness of adding Low NOx Burners to the two units with an SCR installation is detailed in Appendix D. Staff determined that the combination of Low NO_x Burners and SCR technology was not incrementally cost-effective. This was primarily due the SCR alone reducing NO_x emissions by more than 85% and that two of the units either currently use or would need to install regenerative burners for fuel-savings. These regenerative burners are a type of Low NO_x Burner that was determined to have an approximate 300% increase in total equipment and installation costs compared to standard Low NOx Burners. Standard Low NOx Burners represent the majority of Low NOx Burner installation as only 12 of the 239 units with identifiable burner information listed regenerative burners.

Initial BARCT Emission Limits and Other Considerations

Staff met with two SCR vendors to further understand SCR applicability and technological feasibility. While no emission guarantees were received, staff reviewed the CEMS data for one of the two units in this category with an SCR installation and determined that a 15 ppmv @ 3% O_2, dry, initial BARCT limit was technologically feasible for units with a rated heat input of ≥ 40 MMBtu/hr.

Cost-Effectiveness Analysis and Incremental Cost-Effectiveness

Staff conducted two cost-effectiveness analyses for units with a rated heat input ≥ 40 MMBtu/hr. The first analysis was to meet a NO_x concentration limit of 10 ppmv @ 3% O_2, dry, via the combination of SCR installation and Low NO_x Burner retrofit. The second analysis was to meet a NO_x concentration limit of 15 ppmv @ 3% O_2, dry, via SCR installation.

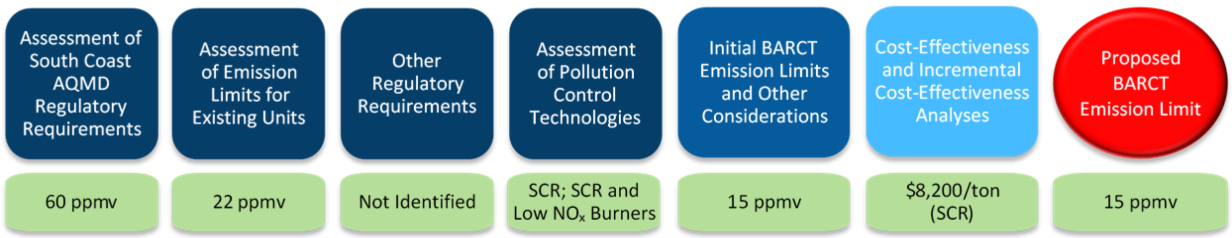
For the first analysis, the total costs was determined to be $58,561,900 and the estimated NO_x emission reductions are 2,171 tons. The cost-effectiveness of this combination of control technologies was calculated as $27,000 per ton NO_x reduced.

For the second analysis, the total costs was determined to be $13,955,100 and the estimated NO_x emission reductions are 1,695 tons. The cost-effectiveness of this category was calculated as $8,200 per ton NO_x reduced.

Staff conducted an incremental cost-effectiveness between the pollution control options of SCR alone and the combination of SCR installation and Low NO_x Burner retrofit. The total incremental costs between the two pollution control options was determined to be $44,606,800 and total incremental NO_x emission reductions between the two pollution control options was 476 tons. The incremental cost-effectiveness was then calculated as $93,700 per ton NO_x reduced and thus only the pollution control option to reach an initial BARCT limit of 15 ppmv @ 3% O_2, dry, via SCR installation alone was considered.

Summary

Based on the BARCT assessment for units with a rated heat input of ≥ 40 MMBtu/hr, staff determined a BARCT concentration limit of 15 ppmv @ 3% O_2, dry.



CHAPTER 3: PROPOSED RULE 1147.2

INTRODUCTION

PROPOSED RULE STRUCTURE

PROPOSED RULE 1147.2

INTRODUCTION

PR 1147.2 establishes NO_x limits for RECLAIM, non-RECLAIM, and former RECLAIM facilities. Non-RECLAIM facilities are currently subject to Rule 1147. Upon adoption of Proposed Rule 1147.2, non-RECLAIM facilities with metal melting, metal heat treating, and metal heating and forging furnaces will be subject to the requirements of Rule 1147.2 and no longer subject to Rule 1147.

The following information describes the structure of PR 1147.2 and explains the provisions incorporated from other source-specific rules. New provisions and any modifications to provisions that have been incorporated are also explained.

PROPOSED RULE STRUCTURE

PR 1147.2 will contain the following subdivisions:

a) Purpose
b) Applicability
c) Definitions
d) Requirements
e) Implementation Schedule
f) Determination of Burner Age
g) Demonstration of Less than One Pound NO_x Per Day
h) Monitoring and Source Testing Requirements
i) Labeling Requirements
j) Reporting and Recordkeeping Requirements
k) Exemptions

PROPOSED RULE 1147.2

Subdivision (a) – Purpose

The purpose of this rule is to limit NO_x and CO emissions from metal melting furnaces, metal heat treating furnaces, and metal heating furnaces, and metal forging furnaces.

Subdivision (b) – Applicability

PR 1147.2 applies to permitted furnaces used for metal melting, metal heat treating, and metal heating and forging.

Subdivision (c) – Definitions

Key definitions in PR 1147.2 are referenced and discussed below.

- *ALTERATION means any physical change or addition to an Existing Unit requiring an application for Permit to Construct pursuant to South Coast AQMD Rule 201 – Permit to Construct.*

This is a new definition to apply to units or their burners that have been altered in a manner that requires a permit modification. This definition includes those units that need to retrofit to meet the proposed NO_x and CO concentration limits of this rule.

- *METAL FORGING FURNACE means a device which applies heat to a solid metal to allow for its further processing, forming, or shaping.*

  This is a new definition to apply to furnaces involved in forging or drop forging operations, such as a billet furnace, drop forging furnace, or forging furnace.

- *METAL HEAT TREATING FURNACE means a device where heat is applied to a solid metal in order to alter its chemical properties, alter its microstructure to achieve desired mechanical properties (strength, hardness, toughness, ductility, and corrosion resistance), or alter its surface chemistry.*

  This is a new definition to apply to furnaces involved in heat treating operations, such as an aging furnace, annealing furnace, heat treating furnace, or homogenizing furnace.

- *METAL HEATING FURNACE means a device where heat is applied to a solid metal in order to alter its physical properties.*

  This is a new definition to apply to furnaces involved in re-heat operations and to forging furnaces that may be classified as a furnace type other than as a forging furnace (e.g. billet furnace) on the unit's permit application.

- *METAL MELTING FURNACE means a device where metal is heated to a molten state.*

  This is a new definition to apply to furnaces involved in melting operations, such as a cupola furnace, pit furnace, pot furnace, refining kettle, reverberatory furnace, or sweat furnace.

- *RADIANT-TUBE BURNER means an indirect-fired burner where combustion takes place in a tube to prevent contact between the products of combustion and the parts being heated.*

  This is a new definition to apply to those units equipped with radiant-tube type burners. Currently, the South Coast AQMD permit database only units with radiant-tube burners only present in the metal heat treating and metal heating and forging categories, but this equipment category is broadened to all units to account for units that may not be in the permit database.

- *REFRACTORY DRY-OUT means that period of time during which a Unit is either curing or drying-out refractory lining as a result of a New Unit installation, Existing Unit Alteration, or Existing Unit repair or maintenance.*

  This is a new definition to apply to units with a rated heat input greater than or equal to 40 MMBtu/hr to account for periods where a pollution control system, such as SCR, may not be in operation and during which conditions differing from normal operation may be incurred to ensure proper refractory curing and drying.

Subdivision (d) – Requirements

NO_x and CO Limits for Metal Melting, Metal Heat Treating, and Metal Heating and Forging Furnaces – Paragraphs (d)(1) through (d)(3)

Units subject to PR 1147.2 are inclusive of units that were either subject to Rule 1147 or a trading credits program (RECLAIM). Rule 1147 units are subject to a NO_x concentration limit of 60 ppmv @ 3% O_2, dry. RECLAIM units are not subject to a command-and-control rule limit and either use the default RECLAIM emission factor of 130 lbs NO_x/MMBtu (equivalent to 102 ppmv @ 3% O_2, dry) or a unit-specific permit condition.

To account for these differing emission requirements, Rule 1147 (non-RECLAIM) units are subject to paragraph (d)(1)(A) and will have an interim NO_x concentration limit of 60 ppmv @ 3% O_2, dry, and Former RECLAIM and RECLAIM units are subject to paragraph (d)(1)(B) and will have an interim NO_x concentration limit of 102 ppmv @ 3% O_2, dry. Both of these limits will apply until a unit becomes subject to the concentration limits in PR 1147.2 Table 1 or the alternative concentration limits in PR 1147.2 Table 2. All units are eventually subject to the concentration limits in PR 1147.2 Table 1, except for units that can demonstrate NO_x emissions of less than one pound per day.

Staff notes that NO_x and CO concentrations have an inverse relationship. CO is produced as a result of incomplete combustion such that the more complete the combustion, the higher the flame temperature as more input fuel is consumed. As a result of these higher flame temperatures and more complete combustion, CO is lowered but NO_x levels are raised as a result of the elevated temperatures. Thus, high CO concentrations may be produced to lower the NO_x concentration. To control higher CO levels that may be related to reduce NO_x, PR 1147.2 establishes a CO concentration limit of 1,000 ppmv @ 3% O_2, dry.

During the BARCT assessment, staff noted that the majority of non-RECLAIM units that would be subject to PR 1147.2 had a cost-effectiveness of greater than $50,000 per ton NO_x reduced in order to meet the proposed NO_x concentration limits of PR 1147.2. This was due, in part, to existing units being required to comply with a 60 ppmv @ 3% O_2, dry, NO_x concentration limit pursuant to Rule 1147. The difference between an existing unit with a 60 ppmv @ 3% O_2, dry, NO_x concentration limit and the proposed NO_x concentration limits of PR 1147.2 in paragraph (d)(2), and the cost of retrofitting a unit to meet the proposed limits, led to the cost-effectiveness of these units to be greater than $50,000 per ton NO_x reduced. As a result, staff proposed an alternative, more extended implementation schedule for these units pursuant to AB 617's prioritization to those units that have not modified their permit conditions since 2007. The alternative implementation schedule is based on an expected burner life of 35 years.

Paragraph (d)(3) allows an owner or operator of a unit with a rated heat input of less than or equal to 40 MMBtu/hr and where the burner age is less than 32 years old to meet the concentration limits in Table 1 on the extended 32-year alternative implementation schedule in paragraph (e)(2) provided that the unit either has an permit condition, or the owner or operator submits a permit application by July 1, 2023 to add a permit condition complying with the alternative concentration limits in Table 2. A South Coast AQMD-approved source test will be required to verify that the unit meets the applicable alternative NO_x concentration limit in Table 2. The source test that is submitted as part of the permit application process to add a permit condition complying with the concentration limits in Table 2 is required to have been conducted within 36 months before the date the permit application is submitted. Additionally, the source test is required to represent the equipment at the time the permit application is submitted. The objective of the alternative concentration limits is to recognize those units that are currently meeting the alternative concentration limits. It is assumed that approximately 30 months will be required for South Coast AQMD staff to review the permit application, issue the Permit to Construct or Permit to Operate, and for the operator to perform the necessary retrofits and compliance demonstration, by which time the unit's burners will be approximately 35 years old. This determination of burner useful life of 35 years is based on burner age data from the South Coast AQMD permit database and stakeholder feedback on expected burner life.

All units will eventually be subject to the concentration limits in Table 1. Permit application submissions to meet these concentration limits are required of all units; those units with a rated heat input of less than or equal 40 MMBtu/hr are required to meet either a 12-year or a 32-year implementation schedule depending on whether the unit can demonstrate compliance with the alternative concentration limits in Table 2. Effectively, compliance with the alternative concentration limits is a prerequisite condition to allow for a unit to comply with the BARCT limits in PR 1147.2 Table 1 on an extended implementation schedule of 32 years in lieu of the default 12-year implementation schedule.

Units that already have a permit condition complying with the concentration limits in PR 1147.2 Table 1 will not be required to submit a new permit application.

NO_x and CO Limits for Units ≥ 40 MMBtu/hr – Paragraph (d)(4)

Larger units are required to submit permit applications on or before July 1, 2023 to meet the concentration limits in Table 1. The implementation schedule requirements for these units is specified in paragraph (e)(3) and are given a more expedited implementation schedule due to the larger emissions from these sources and the requirements of AB 617. The averaging time for any NO_x compliance demonstration for units equipped with a certified NO_x CEMS shall use an 8-hour averaging period.

NO_x and CO Limits for New Units – Paragraph (d)(5)

NO_x and CO concentration limits for new units in the metal melting, metal heat treating, and metal heating and forging equipment categories were also established as described in the BARCT Assessment in Chapter 2, consistent with the inclusion of NO_x and CO concentration limits for new units in Rule 1147. These concentration limits are in Table 3. Any applicable BACT determination that is made after the [*Date of Adoption*] that is lower than the concentration limits for new units in PR 1147.2 will apply.

Requirement for Demonstration of Less than One Pound of NO_x per Day – Paragraph (d)(6)

An owner or operator of a unit will not be subject to the NO_x and CO concentration limit requirements subdivision (d) provided that a new unit has a permit condition that limits NO_x emissions to less than one pound per day or the owner or operator of an existing unit meets the fuel or time meter requirements of subdivision (g) for demonstration of NO_x emissions less than one pound per day.

Units that Fail to Demonstrate Less than One Pound of NO_x per Day – Paragraph (d)(7)

This provision is to capture units that are no longer considered low-emitting units with average NO_x emissions of greater than or equal to one pound of NO_x per day. While these units are subject to the concentration limits in Table 1, they are not subject to the permit application submission requirements in paragraph (e)(1), (e)(2), or (e)(3); instead, these units are required to submit permit applications within 30 days of the failure to demonstrate compliance with the less than one pound NO_x per day provision of subdivision (g). These units are also required to meet the concentration limits in Table 1 no later than 12 months after the permit issuance, similar to those units that did not opt to demonstrate NO_x emissions of less than one pound per day.

Table 1 – NO_x and CO Concentration Limits for Existing Units

Unit Size	**Furnace Type**	**Temperature**	**NO_x Limit**[1,2] (ppmv)	**CO Limit**[1] (ppmv)
< 40 MMBtu/hr	Metal Melting	All Temperatures	40	1,000
	Metal Heat Treating, Metal Heating, and Metal Forging	≤ 1,200 °F	40	
		> 1,200 °F	50	
	Units with Radiant-Tube Burners	All Temperatures	50	
≥ 40 MMBtu/hr	All Units	All Temperatures	15	

[1] Corrected to 3% O_2, dry
[2] Averaged over an 8-hour rolling interval for Units equipped with a certified NO_x CEMS

Table 2 – Alternative NO_x and CO Concentration Limits for Existing Units

Unit Size	**Furnace Type**	**Temperature**	**NO_x Limit**[1,2] (ppmv)	**CO Limit**[1] (ppmv)
< 40 MMBtu/hr	Metal Melting	All Temperatures	50	1,000
	Metal Heat Treating, Metal Heating, and Metal Forging	≤ 1,200 °F	50	
		> 1,200 °F	60	
	Units with Radiant-Tube Burners	All Temperatures	60	

[1] Corrected to 3% O_2, dry
[2] Averaged over an 8-hour rolling interval for Units equipped with a certified NO_x CEMS

Table 3 – NO_x and CO Concentration Limits for New Units

Unit Size	Furnace Type	Temperature	NO_x Limit[1,2] (ppmv)	CO Limit[1] (ppmv)
< 40 MMBtu/hr	Metal Melting	All Temperatures	40	1,000
	Metal Heat Treating, Metal Heating, and Metal Forging	≤ 1,200 °F	30	
		> 1,200 °F	40	
	Units with Radiant-Tube Burners	All Temperatures	40	
≥ 40 MMBtu/hr	All Units	All Temperatures	15	

[1] Corrected to 3% O_2, dry
[2] Averaged over an 8-hour rolling interval for Units equipped with a certified NO_x CEMS

Subdivision (e) – Implementation Schedule

12-Year Implementation Schedule – Paragraph (e)(1)

An owner or operator must submit a permit application by the July 1 after a unit's burner turns 12 years of age, determined by the burner age determination requirements of subdivision (f). Units with a burner already 12 years old as of January 1, 2023 must submit a permit application by July 1, 2023. Once the permit is issued, these units must demonstrate compliance with the applicable concentration limits in Table 1 after 12 months. A permit refers to a Permit to Construct unless a Permit to Operate is issued. The 12-month period of time is provided to allow units sufficient time to perform the necessary retrofits and conduct a source test to demonstrate compliance with the concentration limits in Table 1. An owner or operator of a unit that has both a compliance demonstration and a permit condition that meet the concentration limits in Table 1 will not be required to submit a permit application for that unit.

32-Year Implementation Schedule – Paragraph (e)(2)

An owner or operator must submit a permit application by the July 1 after a unit's burner turns 32 years of age, determined by the burner age determination requirements of subdivision (f), provided that the unit complies with the permit condition or permit application submission requirements of subparagraph (d)(3). Once the permit is issued, these units must demonstrate compliance with the applicable concentration limits in Table 1 after 12 months. A permit refers to a Permit to Construct unless a Permit to Operate is issued. The 12-month period of time is provided to allow units sufficient time to perform the necessary retrofits and conduct a source test to demonstrate compliance with the concentration limits in Table 1. An owner or operator of a unit that has both a compliance demonstration and a permit condition that meet the concentration limits in Table 1 will not be required to submit a permit application for that unit.

Implementation Schedule for Units ≥ 40 MMBtu/hr – Paragraph (e)(3)

An owner or operator of a unit with a rated heat input greater than or equal to 40 MMBtu/hr must submit permit applications by July 1, 2023. These larger units are required to meet a lower NO_x concentration limit necessitating the installation of an exhaust emission control system. A unit must not exceed the concentration limits in Table 1 on and after 18 months following the issuance of a permit. The 18-month period of time is comparatively longer than that for units with a rated heat input less than 40 MMBtu/hr due to the more extensive nature of exhaust emission control system installations and compliance demonstrations.

Units that Do Not Meet the Permit Application Submittal Deadlines – Paragraph (e)(4)

Units with a rated heat input less than or equal to 40 MMBtu/hr that do not meet the permit application submittal deadlines are still required to submit a permit application as soon as possible and also demonstrate compliance with the concentration limits in Table 1 or Table 2 by no later than 12 months after the permit is issued or 30 months after the date of the permit application submittal deadline, whichever is sooner. Additionally, these units will still be subject to the interim limits in paragraph (d)(1) despite not meeting the permit application submission requirements to meet the concentration limits in Table 1 or Table 2. Units with a rated heat input greater than or equal to 40 MMBtu/hr that do not meet the permit application submission requirements are still required to submit a permit application as soon as possible and also demonstrate compliance with the concentration limits in Table 1 by no later than 18 months after the permit is issued or 36 months after the date of the permit application submittal deadline. The requirement to meet specific concentration limits after either 30 months or 36 months is to ensure that units still reduce their emissions by a specific time, regardless of whether a permit application is submitted on time.

Permit Modifications – Paragraph (e)(5)

An owner or operator shall submit a permit application to modify the Permit to Construct or Permit to Operate if the unit can demonstrate compliance with the concentration limits in Table 1 or alternative concentration limits in Table 2 without a unit alteration. This permit application is only required to be submitted pursuant to the implementation schedule in paragraph (e)(1), (e)(2), or (e)(3). This paragraph is designed to capture units that have an existing permit condition that is not reflective of the NO_x concentrations in Table 1 or Table 2 as demonstrated in an approved source test result.

Unit Decommission – Paragraph (e)(6)

At the same time an owner or operator is required to submit a permit application, an owner or operator may submit a the appropriate South Coast AQMD form to decommission the unit no later than 30 months after the permit application submittal date in paragraph (e)(1), (e)(2), or (e)(3). A 30-month time period is chosen to proxy when the unit would be required to demonstrate compliance with the concentration limits in Table 1 or alternative concentration limits in Table 2. The unit is required to be decommissioned by a 30-month deadline after the permit application submittal deadline.

Multiple Unit Implementation Schedule – Paragraph (e)(7)

An owner or operator may have two or more units that are subject to a July 1, 2023 permit application submittal deadline in paragraph (e)(1) or (e)(2). To mitigate the impact of having multiple units meet the NO_x limits simultaneously, facilities operating multiple units at one location shall comply with the concentration limits in Table 1 following the multiple unit implementation schedule specified in Table 4 in lieu of the 12-year or 32-year implementation schedules of paragraph (e)(1) or (e)(2), respectively. Table 4 is based on the total affected rated heat input for those units required to submit permit applications by January 1, 2023. For example, if a facility has 16 units with a combined rated heat input of 20 MMBtu/hr, that facility would be on a 4-year permit application submission schedule in Table 4 and be required to begin submitting permit applications for at least 50% of the 20 MMBtu/hr by January 1, 2023 (or 8 units if the rated heat input is identical for all 16 units), followed by submitting permit applications for the remaining 50% of the 20 MMBtu/hr by January 1, 2025. Any partial number of permit applications equating to the minimum percentage of total rated heat input in Table 4 shall be rounded up to the nearest whole permit application. For example, if 50% of the total rated heat input required to be submitted by January 1, 2024 equates to 3.4 permit applications, a minimum of 4 permit applications are required to be submitted. Units that are not required to submit permit applications by July 1, 2023 would still be required to comply with the permit application submittal requirements in paragraph (e)(1) or (e)(2).

The decommissioning of a unit subject to the multiple unit implementation schedule will require the appropriate South Coast AQMD form be submitted to decommission the unit. The submission of this form or the submission of a permit application will both qualify for meeting the minimum permit application submission requirements of subparagraph (e)(7)(A). Similar to the requirements for those units that are not subject to the multiple unit implementation schedule, the unit will be required to be decommissioned 30-months after the form submittal deadline.

Staff has received comments from stakeholders who may operate equipment subject to PR 1147.2 at multiple locations. These stakeholders have expressed concern that they would be financially burdened if each of their facilities were to be considered separately. In response, staff acknowledges that there may be financial considerations incurred but the impact to specific local communities where these units operate may be disproportionately weighted. For example, a company may operate four facilities located at four different sites. Each site operates five equivalent furnaces for a total of 20 furnaces. If the company opted to upgrade the furnaces at only two of the four sites (or 50% of the total furnaces) and forego upgrading the other two sites until a later time, then two of the four communities where this company operates would be disproportionately impacted by the continuing use of higher-emitting sources. PR 1147.2 does not extend a multiple unit compliance option for equipment operated by a single owner over multiple locations.

Table 4 – Multiple Unit Implementation Schedule to Meet Concentration Limits in Table 1

<table>
<tr><th>Permit Application or Inactivation of Permit Submittal Date</th><th>2 – 9 Units (Minimum % of total Rated Heat Input)</th><th>10 – 19 Units (Minimum % of total Rated Heat Input)</th><th>20 or More Units (Minimum % of total Rated Heat Input)</th></tr>
<tr><td>January 1, 2023</td><td>50%</td><td>-</td><td>-</td></tr>
<tr><td>January 1, 2024</td><td>100%</td><td>50%</td><td>33%</td></tr>
<tr><td>January 1, 2025</td><td rowspan="4">Not Applicable</td><td>-</td><td>-</td></tr>
<tr><td>January 1, 2026</td><td>100%</td><td>67%</td></tr>
<tr><td>January 1, 2027</td><td rowspan="2">Not Applicable</td><td>-</td></tr>
<tr><td>January 1, 2028</td><td>100%</td></tr>
</table>

Subdivision (f) – Determination of Burner Age

Burner age is the criteria by which units will be subject to the limits in Table I by either a 12-year burner age timeline or a 32-year burner age timeline, corresponding to the implementation schedule in paragraph (e)(1) or (e)(2). The options to determine burner age are largely based on Rule 1147's structure. However, the hierarchy of order in these options has been removed. Other methods of determining burner age, substantiated with sufficient written information, may be approved by the Executive Officer. A default assignment has also been added to designate a burner as 32 years old as of January 1, 2023. It is anticipated that this option will be chosen only if no other records are available to otherwise determine the burner age.

The permit application submission requirements of paragraph (d)(2) and (d)(3) are based on the burner age as of January 1 of any given year. Staff recognizes that a burner's original date, determined pursuant to subdivision (f), may occur any time within the year after January 1. Only whole-year increments will be considered for determining a burner's age. For example, if a burner's original date is determined to be March 1, 2011, for purposes of determining burner age the original date will be used as January 1, 2012. As of January 1, 2023 the burner would be considered 11 years old and not 12 years old.

Subdivision (g) – Demonstration of Less than One Pound NO_x per Day

The one pound of NO_x per day emissions provision is analogous to the one pound of NO_x per day provision in Rule 1147. Units that can demonstrate NO_x emissions of less than one pound per day will only be required to comply with labelling and recordkeeping requirements in subdivisions (i) and (j), respectively, and be exempt from all other provisions of the rule. To qualify, units shall make the demonstration effective six months after [*Date of Adoption*].

Staff provides two options to determine compliance to the one pound of NO_x per day emissions provision. Each of these options uses an emission factor variable, which equates to 102 ppmv if no emission factor is on a Unit's permit. To convert a NO_x concentration value (with units of ppmv) to a NO_x emission factor (with units of lbs NO_x/MMScf), the NO_x concentration value is multiplied by 1.275.

Subparagraph (g)(1)(A) requires the installation of a non-resettable time meter and usage of no more than the minutes per day calculated using PR 1147.2 Equation 1 or as specified in PR 1147.2 Table 5.

$$\text{Daily Operating Time} = 60\ minute/hour\ \div [R\ x\ (EF\ \div HHV)] \quad \text{(Equation 1)}$$

Where,

R = Rated Heat Input (MMBtu/hr)

EF = Emission Factor (lbs NO_x/MMScf or lbs NO_x/gal)

HHV = Higher Heating Value of Natural Gas (MMBtu/MMScf or MMBtu/gal)

The following example demonstrates how a unit with a rated heat input of 1.5 MMBtu/hr equipped with an installed non-resettable time meter and using the default emission factor would determine its monthly operating time equivalent to less than an average of one pound of NO_x per day as:

$$\text{Daily Operating Time} = 60\ minutes/hour\ \div \left[1.5\frac{MMBtu}{hr}\ x\ \left(130\frac{lbs}{MMScf}\ \div 1{,}050\frac{MMBtu}{MMScf}\right)\right]$$
$$= 323.1\ minutes\ per\ day\ to\ reach\ 1\ lb\ NOx$$

Compliance with PR 1147.2 Table 5 requires a unit to operate no more than the minutes specified for each rated heat input bracket.

Table 5 – Less than One Pound per Day Daily Operating Limits

Unit Rated Heat Input (Btu/hr)	Daily Operating Limits (minutes)
< 1,000,000	480
≥ 1,000,000 to < 1,500,000	300
≥ 1,500,000 to ≤ 2,000,000	240

The minutes per day limits were calculated assuming an uncontrolled NO_x concentration of 102 ppmv, which is the ppmv equivalent value of the default RECLAIM emission factor of 130 lbs NO_x/MMScf natural gas. Additionally, these minutes per day limits assume a 90% operating capacity. This operating capacity was determined by using the maximum operating capacity identified for a unit in the South Coast AQMD permit database, determined to be 87%. The minutes per day limit decreases as a given unit's rated heat input increases due to the greater fuel usage associated with higher rated heat inputs.

The operating capacity for a given unit was determined by the ratio of actual fuel usage to the calculated theoretical maximum fuel usage based on the unit's rated heat input. Actual fuel usage was determined from the unit's reported fuel usage from the associated facility's 2017 Annual Emission Report sent to the Executive Officer. Operating capacity was then calculated using the Equation 3-1:

$$\text{Operating Capacity (\%)} = (2017\ AER\ Fuel\ Usage) \div [(R\ x\ 24\ x\ 365) \div HHV]\ x\ 100\% \quad \text{(Eq. 3-1)}$$

Where,

R	= Rated heat input (MMBtu/hr)
24 x 365	= Conversion to hours/day and days/year
HHV	= Higher heating value of natural gas (1,050 MMBtu/MMScf)

The following example demonstrates how the operating capacity for unit with a rated heat input of 1.5 MMBtu/hr and 2017 AER fuel usage of 3.0 MMScf/year is calculated:

$$\text{Operating Capacity (\%)} = \left(3.0\frac{MMScf}{yr}\right) \div \left[\left(1.5\frac{MMBtu}{hr}\ x\ 24\frac{hrs}{day}\ x\ 365\frac{days}{yr}\right) \div 1{,}050\frac{MMBtu}{MMScf}\right]\ x\ 100\%$$

$$= \left(3.0\frac{MMScf}{yr}\right) \div \left(13.797\frac{MMScf}{yr}\right)\ x\ 100\%$$

$$= 22\%$$

Subparagraph (g)(1)(B) requires the installation of a non-resettable fuel meter and monthly fuel usage of no more than the therms of fuel per day calculated using PR 1147.2 Equation 2:

$$\text{Daily Therms of Fuel} = (1 \div EF)\ x\ HHV\ x\ 10 \qquad \text{(Equation 2)}$$

Where,

EF	= Emission Factor for the Unit
HHV	= Higher Heating Value of Fuel
10	= Conversion from MMBtu to Therms

The following example demonstrates how a unit equipped with an installed non-resettable fuel meter, using natural gas as a fuel, and using the default emission factor would determine its maximum daily therms of fuel equivalent to less than an average of one pound of NO_x per day:

$$\text{Daily Therms} = \left(1\ \div 130\frac{lbs}{MMScf}\right)\ x\ 1{,}050\frac{MMBtu}{MMScf}\ x\ 10\frac{therm}{MMBtu}$$

$$= 81\ therms\ to\ reach\ 1\ lb\ NOx$$

Staff notes that the use of a non-resettable time meter to determine emissions may over-report actual emissions as compared to the use of a non-resettable fuel meter. However, which type of meter is used is a decision for an owner or operator to make based on individual circumstance and the potential costs associated with such a decision.

Subdivision (h) – Monitoring and Source Testing Requirements

Source Testing Frequency – Paragraph (h)(1)

The frequency at which a given unit is required to conduct a source test is similar to Rule 1146 and the RECLAIM program's source testing frequencies. Larger, more polluting units with a rated heat input of greater than or equal to 10 MMBtu/hr will be required to source test on a more frequent schedule of every three years to ensure compliance with the concentration limits. If the annual heat input of these units is less than 25 billion Btu per year, these units are required to source test every five years. Smaller, less polluting units with a rated heat input of less than 10 MMBtu/hr will be required to source test every five years.

Initial and Previous Source Tests – Paragraph (h)(2)

All existing units that are permitted and are operating as of [*Date of Adoption*] are required to source test within 24 months of [*Date of Adoption*]. However, a unit may use a previous South Coast AQMD-approved source test conducted before [*Date of Adoption*] as the basis for subsequent source testing frequency. This provision allows for units that recently conducted source tests to utilize the full 3- or 5-year frequency stated in paragraph (h)(1).

All new units are required to source test no later than 18 months after the issuance of the Permit to Construct as these units do not have a previous South Coast AQMD-approved source that can be used. The date of this source test will establish the basis for subsequent source testing frequency. Under South Coast AQMD Rule 205 – Expiration of Permits to Construct, a permit to construct shall expire one year from the date of issuance unless an extension of time has been approved in writing by the Executive Officer. If a permit to construct is extended, then any related source testing requirement timing would subsequently follow.

Source Test Protocol Submission – Paragraph (h)(3) and (h)(4)

A source test protocol must be submitted at least 90 days prior to a scheduled source test to allow for adequate time for protocol review and approval. A previously approved source test protocol may be submitted if no alterations requiring a permit modification were performed on the unit as the test setup and conditions can reasonably be expected to be similar to those of the previous source test. A new source test protocol is required to be submitted if the Executive Officer determines that the previously approved protocol is no longer applicable or requires modification.

Firing Range During Testing – Paragraph (h)(5)

Compliance demonstrations shall take place in the normal firing range of the unit's rated heat input. Stakeholders noted that most burner vendor emission guarantees are conditioned to a certain turndown ratio of the burners. Staff determined that the flexibility afforded by this provision is appropriate for units in the PR 1147.2 universe due to the varying nature of processes and loads experienced by the facilities and that the stipulation of maximum firing range in Rule 1147 may neither be reflective of operating conditions nor allow for safe operation. Firing rate range requirements will be required as part of an approved source test protocol.

Source Test Methods – Paragraph (h)(6)

Compliance demonstrations are required to utilize approved source test methods to provide a standard of consistency and accuracy across all source tests. These source test methods include South Coast AQMD Source Test Method 100.1 – Instrumental Analyzer Procedures for Continuous Gaseous Emission Sampling (March 1989); South Coast AQMD Source Test Method 7.1 – Determination of Nitrogen Oxide Emissions from Stationary Sources (March 1989); South Coast AQMD Source Test Method 10.1 – Carbon Monoxide and Carbon Dioxide by Gas Chromatograph/Non-Dispersive Infrared Detector (GC/NDIR) – Oxygen by Gas Chromatograph-Thermal Conductivity (GC/TCD) (March 1989); or EPA Test Method 19 – Sulfur Dioxide Removal and Particulate, Sulfur Dioxide and Nitrogen Oxides from Electric Utility Steam Generators (August 2017). Any other alternative test method submitted in writing to, and pre-approved by, the Executive Officer of the South Coast AQMD, the California Air Resources Board, and the United States Environmental Protection Agency is also required.

Source Test Report Submission – Paragraph (h)(7)

Source test reports must be submitted to the South Coast AQMD within 60 days of the completion of the source test in order to provide a record of the unit's emissions performance.

Additional Source Test Timing Requirements – Paragraph (h)(8)

Units may not be tuned subsequent to the conclusion of any compliance demonstration, unless for the purpose of tuning to maintain the settings set during the source test. This is to provide flexibility to operators to ensure that unit settings are appropriate for the workload processed while maintaining compliance with the concentration limits until the next source test for the unit is due.

Units may conduct a compliance demonstration within the month the compliance demonstration is due. For example, if a unit's source test is due on June 10th, the compliance demonstration may be conducted anytime between June 1st and June 30th. If the source test is conducted on June 30th, the date of the next source test deadline would then become June 30th; if the source test is conducted on June 1st, that date becomes the date of the next source test deadline. An owner or operator is encouraged to schedule and conduct source tests before the source test deadline to ensure source tests are conducted in a timely manner.

For units that have an active Permit to Operate that are not operating on the date a source test is required, the source test must be conducted after seven consecutive days, or 15 cumulative days, of resumed operation for a unit that is not in operation on the date the source test is due. This is to allow for units to not start up solely for the purpose of conducting a source test.

CEMS Monitoring Requirements – Paragraph (h)(9)

Units with a rated heat input of greater than or equal to 40 MMBtu/hr will be required to utilize a NO_x CEMS due to the potentially high NO_x emissions from units of this size. The CEMS shall be certified within 12 months of [*Date of Adoption*] to Rule 218.2 and Rule 218.3 if the unit is located at a non-RECLAIM or former RECLAIM facility, or to Rule 2012 if the unit is located as a RECLAIM facility. A CEMS is a continuous emissions monitoring system and thus ongoing NO_x concentration data will already be available and source tests to measure NO_x will not be necessary nor required.

Additionally, if a unit with a rated heat input of greater than or equal to 40 MMBtu/hr installs an optional CEMS to measure CO, ongoing CO concentration data will already be available and source tests to measure CO will not be necessary nor required.

All units with a rated heat input of greater than or equal to 40 MMBtu/hr will be required to conduct a relative accuracy test audit (RATA) to ensure accuracy of the CEMS reported data.

For units that utilize a certified NO_x CEMS, staff determined that a rolling 8-hour averaging time will provide sufficient operational flexibility to Units to meet NO_x emission concentration limits in the proposed rule. The determination was based on analysis of NO_x emission data from units subject to PR 1147.2 that were in operation prior to the rule adoption date and were equipped with a certified NO_x CEMS.

Ammonia Monitoring and Testing – Paragraph (h)(10)

Units that utilize ammonia in an exhaust emission control system are required to either source test for ammonia quarterly or to install and maintain a certified CEMS to measure ammonia.

If a unit does not install and operate a certified CEMS to measure ammonia, then the owner or operator would be required to source test the unit for ammonia compliance. Initially, the owner or operator shall begin source testing the unit within 12 months of a new permit being issued or as specified by the unit's permit to operate, with subsequent source tests required quarterly. Source test frequency would be allowed to increase to once every 12 months if four consecutive quarterly source tests are South Coast AQMD-approved and demonstrate compliance. If a unit which is on an annual source testing schedule then conducts a source test that does not demonstrate compliance, quarterly source tests will be required until four consecutive source tests are successful once again.

For units that are subject to quarterly testing, the use of calendar quarters is to be used. For example, January 1 to March 31, April 1 to June 30, July 1 to September 30, and October 1 to December 31 would be considered the time periods referred in the rule. Moreover, a quarterly test should be conducted in the time period represented by a quarter. Staff has included a requirement that at least 30 days be allowed between subsequent testing to avoid testing that might occur consecutively on September 30 and October 1 and then again on March 31, for example, that may lead to an almost six month period of time between testing.

For units that have installed an ammonia CEMS but that monitoring system has not received its certification, the unit would be required to conduct periodic source testing for ammonia until which time that the monitoring system is certified.

In a situation where a unit is required to conduct source testing for ammonia and the unit does not have a certified CEMS that measures NO_x or CO emissions, then the owner or operator will be required to conduct source testing for NO_x or CO concurrently with the testing for ammonia. Staff recognizes that NO_x and ammonia have a relationship such that an adjustment to one can have an adverse effect to the concentration of the other. To assure compliance for all emissions, concurrent source testing is required.

Source Test Frequency Setting – Paragraph (h)(11)

Any compliance demonstration, including those required as part of a permit, shall be used to establish the basis for subsequent source testing frequency. For example, a unit conducts a source test as part of regular source testing frequency requirements pursuant to paragraph (h)(1) on January 1, 2023 and is not required to source test until January 1, 2028. However, the unit conducts a source test on January 1, 2025 as part of a permit. This source test resets the subsequent source test frequency and the next source test would be required five years later on January 1, 2030.

Source Test Minimum Run Time – Paragraph (h)(12)

Compliance demonstrations are required to use a minimum of a continuous 15-minute block of time, unless otherwise approved in writing by the South Coast AQMD.

Units Subject to More than One NO_x Concentration Limit – Paragraph (h)(13)

Units in the metal heat treating and metal heating and forging categories may have a wide operating temperature range as part of normal operations and may be classified as both a low-temperature and a high-temperature unit. To prevent a unit needing to conduct multiple source tests to demonstrate compliance with multiple applicable NO_x concentration limits in Table 1 or Table 2, the unit will only be required to demonstrate compliance with the higher NO_x concentration limit.

In-Series Units with Common Exhaust Stack – Paragraph (h)(14)

If multiple units exhaust to the same stack, the lowest concentration limit for an individual unit will apply. For example, a metal heat treating furnace operating at both 1,000 °F and 2,000 °F that is subject to the concentration limits in Table 2 would be required to meet a 60 ppmv NO_x concentration limit, corrected to 3% O_2, dry. However, if this same unit was paired to the same exhaust with a new metal heat treating unit operating in the same temperature range, the NO_x concentration in the exhaust would be limited to 40 ppmv corrected to 3% O_2, dry.

Subdivision (i) – Labeling Requirements

All units are required to display a rating plate in order to have a permanent record of the burner(s) model and rated heat input. Altered units are required to display a permanent supplemental plate to document the updated information of the new burners.

Subdivision (j) – Reporting and Recordkeeping Requirements

Records documenting daily operating minutes or daily fuel consumption demonstrating compliance with subdivision (g), if applicable; CEMS data, if applicable; rated heat input; and source test reports, if applicable, are required to be kept on-site for at least five years to provide sufficient records of compliance with the concentration limits. Records pertaining to any alterations shall also be maintained to document the alterations performed.

If a unit is not in operation on the date a source test is due, the additional 7- or 15-day time period in subparagraph (h)(8)(C) is only allowed if operating records are maintained to demonstrate the unit's non-operation.

Subdivision (k) – Exemptions

The concentration limits in Table 1 will not be applicable to units during periods of refractory dry-out. Refractory dry-out periods occur after new refractory is installed and is a critical process to ensure the longevity of the refractory. New refractory may be installed as part of a new unit installation, a unit repair, or a unit alteration. These dry-out periods include a range of operating temperatures and other conditions that may not be reflective of normal operating conditions. As a result, emissions may be abnormal during these dry-out periods. Units are exempt from the emission concentration limits of this rule during these dry-out periods.

In the rule development for PR 1147.2, staff does not address any limits or exemptions from emission concentration limits during the startup and shutdown of units equipped with CEMS. Such limits will be deferred to and addressed in a Rule 429.

Proposed Rule 1147.2 will not be applicable to electrically-powered units as NO_x emissions from such units are negligible relative to NO_x emissions from fuel-fired units.

Units emitting less than one pound of NO_x per day pursuant to subdivision (g) will only be required to label units pursuant to subdivision (i) and maintain records pursuant to subdivision (j). This exemption is permanently revoked if a unit fails to demonstrate compliance with subdivision (g).

CHAPTER 4: IMPACT ASSESSMENT

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INTRODUCTION

Impact assessments were conducted during the PR 1147.2 rule development to assess the environmental and socioeconomic implications of PR 1147.2. These impact assessments include emission reduction calculations, cost-effectiveness and incremental cost-effectiveness analyses, a socioeconomic assessment, and a California Environmental Quality Act (CEQA) analysis. Staff prepared draft findings and a comparative analyses pursuant to California Health and Safety Code Section (H&SC) 40727 and H&SC 40727.2, respectively.

EMISSION REDUCTIONS

PR 1147.2 will establish lower concentration emission limits for equipment subject to this rule. Metal melting furnaces will be required to meet 40 ppmv NO_x at 3% O_2, dry. Metal heat treating and metal heating and forging furnaces with an operating temperature of less than or equal to 1,200 °F will be required to meet 40 ppmv NO_x at 3% O_2, dry. Metal heat treating and metal heating and forging furnaces with an operating temperature of greater than 1,200 °F will be required to meet 50 ppmv NO_x at 3% O_2, dry. Units with radiant-tube burners will be required to meet 50 ppmv NO_x at 3% O_2, dry. Units with a rated heat input of ≥ 40 MMBtu/hr will be required to meet 15 ppmv NO_x at 3% O_2, dry. Baseline fuel usage was determined using 2017 Annual Emissions Reports (AER).

For the purpose of determining emission reductions, baseline NO_x concentration was determined using the unit's NO_x permit limit at 3% O_2 or the default RECLAIM emission factor of 102 ppmv at 3% O_2 for RECLAIM units without a permit limit. For cost-effectiveness, baseline NO_x concentration is determined at a unit's source tested NO_x concentration or at a unit's average NOx concentration from CEMS data, if available.

The emission reductions profile for each equipment category are shown in Table 4-1.

Table 4-1 – Summary of Emission Reductions

Category	Baseline Emissions (tpd)	Emission Reductions (tpd)	Remaining Emissions (tpd)	Control Technology	Percent Reduction
Metal Melting	0.251	0.093	0.158	Low NO_x Burners	37%
Metal Heat Treating: Low Temperature	0.038	0.014	0.024	Low NO_x Burners	37%
Metal Heat Treating: High Temperature	0.074	0.011	0.063	Low NO_x Burners	15%
Metal Heating and Forging: Low Temperature	0.238	0.003	0.235	Low NO_x Burners	1%
Metal Heating and Forging: High Temperature	0.201	0.050	0.151	Low NO_x Burners	25%
Units with Radiant-Tube Burners	0.018	0.005	0.013	Low NO_x Burners	28%
Units ≥ 40 MMBtu/hr	0.391	0.319	0.072	SCR	82%
Total	**1.211**	**0.495**	**0.716**	**Various**	**41%**

COSTS AND COST-EFFECTIVENESS

Overview

The California Health & Safety Code (H&SC) Section 40920.6 requires a cost-effectiveness analysis when establishing BARCT requirements. The cost-effectiveness of a control technology is measured in terms of the control cost in dollars per ton of air pollutant reduced. The costs for the control technology include purchasing, installation, operation, maintenance, permitting, and compliance demonstration of the control technology. Emission reductions were based on fuel usage in 2017 AER reports submitted to the South Coast AQMD and the most recent source test data or, if no source test data was available, the permit limit. The 2016 AQMP established a cost-effectiveness threshold of $50,000 per ton of NO_x reduced. A cost-effectiveness that is greater than $50,000 per ton of NO_x reduced requires additional analysis and a hearing before the Board on costs.. The cost-effectiveness is estimated based on the present value of the retrofit cost, which was calculated according to the capital cost (initial one-time equipment, installation, and startup costs) plus the annual operating cost (recurring expenses over the useful life of the control equipment multiplied by a present worth factor).

Staff obtained costs for retrofits from a variety of sources that included facilities, vendors, and cost-estimation tools. The cost for combustion control equipment such as Low NO_x Burners considers capital costs only as staff determined that no additional annual operating costs would be incurred in retrofitting units Low NO_x Burners. The cost for post-combustion control equipment such as SCR considers capital costs and annual costs. Capital costs are one-time costs that cover the components required to assemble a project. These costs include, but are not limited to, equipment, installation, permitting, and source testing. Annual costs are any recurring costs required to operate equipment. These costs include operating and maintenance (O&M) costs such as electricity, monitoring, and costs for consumables.

Several capital costs were included in addition to equipment. A one-time permitting fee of $4,600 per unit was included and is based on the 2019-2020 Fee Schedule identified in Rule 301 Table 1B which ranges in size from Schedule B for Metal Heat Treating Furnaces to Schedule D for Metal Melting Reverberatory Furnaces. Periodic source testing costs were included and based on a source test frequency of three or five years, determined by the rated heat input and annual Btu usage of the unit, at a cost of $3,000 per source test per furnace over 35 years of assumed burner useful life, or over 25 years of assumed SCR useful life. A one-time cost of $190,000 for a NO_x CEMS was included for cost-effectiveness analyses of SCR installation for those units without a NO_x CEMS installed. A one-time cost of $60,000 for a NO_x feed-forward analyzer was included for cost-effectiveness analyses of SCR installation for units with batch processes as opposed to steady-state processes. Steady-state processes were only confirmed for two units in the category for units $\geq$ 40 MMBtu/hr.

Costs Based on Burner Useful Life

Whether costs of burner retrofits for units with a rated heat input of less than 40 MMBtu/hr are included is dependent upon the age of the unit's current burners. An operator generally replaces a unit's burners after a certain period of time once the burners have reached their useful life. This useful life is applicable to any piece of equipment with a finite life that must be replaced due to inefficiencies, safety concerns, owner or operator discretion, or a combination of these or other factors. The BARCT limit implementation pathways of PR 1147.2 are structured in such a way as to mitigate retrofitting burners sooner than they would have during the regular course of equipment maintenance while also achieving emission reductions as soon as practicable. The burner useful life was determined to be the normal burner replacement time as a regular course of equipment maintenance. The expected burner useful life was determined to be 35 years based on a review of equipment age and stakeholder feedback. The only costs included for units on the alternative implementation schedule or units equipped with burners that are over 35 years of age are permitting and source testing costs.

Low NO_x Burner Retrofit Costs for Units < 40 MMBtu/hr

Staff reviewed the nine burner quotes given to staff by facilities to establish the cost formulas for burner retrofit to meet the BARCT limits. Of the nine burner quotes received by facilities, one quote was for metal melting but was for burner equipment only and not as part of a complete burner retrofit and not included for analysis; eight quotes were for metal heat treating and metal heating and forging units as burner retrofits. Staff removed two of the nine burner retrofit quotes that were determined to be outliers as they were 43% and 225% higher in total cost than the next highest burner retrofit quote. Staff removed one of the nine burner retrofit quotes that was a replacement of the unit itself, due to the integrated nature of the burner with the unit, rather than a burner retrofit only.

Of the five remaining burner retrofit quotes, one burner retrofit quote in particular was determined by staff to be consistent across multiple units of varying geometries, burner ages, and rated heat inputs at the facility that were included in the quote. The burner equipment and installation costs of this burner retrofit quote were averaged across all units listed in the burner retrofit quote and used to establish a burner retrofit cost curve, shown in Equation 4-1:

$$\text{Retrofit Cost (\$)} = \$4{,}121 * (\text{Rated Heat Input: MMBtu/hr}) + \$96{,}921 \qquad \text{(Eq. 4-1)}$$

Of the nine burner retrofit quotes received, one burner retrofit quote was for regenerative burners for a unit with a rated heat input of 15 MMBtu/hr at a cost of $449,000. Regenerative burners are a type of burner that utilizes a heat recovery medium and pre-heated combustion air, commonly used to increase fuel efficiency. These burners are larger, more complex, and more expensive than non-regenerative, standard burners and thus a different cost basis utilizing this burner quote was used. In order to assess regenerative burner retrofit costs, the $449,000 cost stated in the quote was multiplied by the ratio of the rated heat input of a given unit to the 15 MMBtu/hr rated heat input of the unit in the burner retrofit quote. Regenerative burners were identified on nine metal melting units and one metal heating and forging unit.

Where retrofits are required that would take place sooner than the burners' useful life of 35 years, stranded asset costs are also included in overall compliance costs. Stranded asset costs are those costs associated with replacing equipment before it reaches its useful life as there is economic life remaining in the equipment. These stranded asset costs are based on a ratio of the remaining useful life of the burners to the maximum useful life of 35 years multiplied by the burner retrofit formula in Equation 4-1. For example, if the burners' age is 20 years when retrofitting with new burners, there are 15 years of remaining useful life in the burners, or 43% of remaining useful life. This 43% is multiplied by Equation 4-1 to determine the stranded asset costs that are added onto the cost of the new burners themselves.

For all units, regardless of whether burner costs are taken into account or excluded due to units' burner ages exceeding 35 years old, the administrative costs of periodic source testing and one-time permitting are included. No additional costs for ongoing maintenance are assumed relative to a unit's current burners.

SCR Installation Costs for Units ≥ 40 MMBtu/hr

In addition to analyzing cost-effectiveness for burner retrofit for each equipment category, SCR technology was also analyzed for cost-effectiveness for each category. Staff utilized the U.S. EPA's SCR Control Cost Manual[1] to determine estimated costs which include capital, ongoing maintenance, catalyst costs, and other annual costs such as electricity and reagent.

Two different cost methodologies were utilized, depending on the equipment category.

The first cost methodology was applied to the equipment category for units with a rated heat input of ≥ 40 MMBtu/hr. Staff utilized the U.S. EPA's SCR Cost Manual to estimate costs for SCR installation for units in this category. Costs that were included in the SCR Cost Manual include SCR equipment, electricity, reagent, catalyst, maintenance, and administration. The costs of a NO_x CEMS analyzer and a NO_x feed-forward analyzer were also added to those costs in the SCR Cost Manual, where applicable depending on whether the unit is already equipped with a NO_x CEMS and whether the unit uses a steady-state or batch process.

The second cost methodology was applied to all remaining equipment categories. The U.S. EPA SCR Cost Manual was used to estimate costs for SCR installation on 10 different units with rated heat inputs ranging from 3 MMBtu/hr to 533 MMBtu/hr and spanning all equipment categories. A present value cost for each unit was calculated using Equation 4-2:

$$PV = TIC + (AC * PVF) \quad \text{(Eq. 4-2)}$$

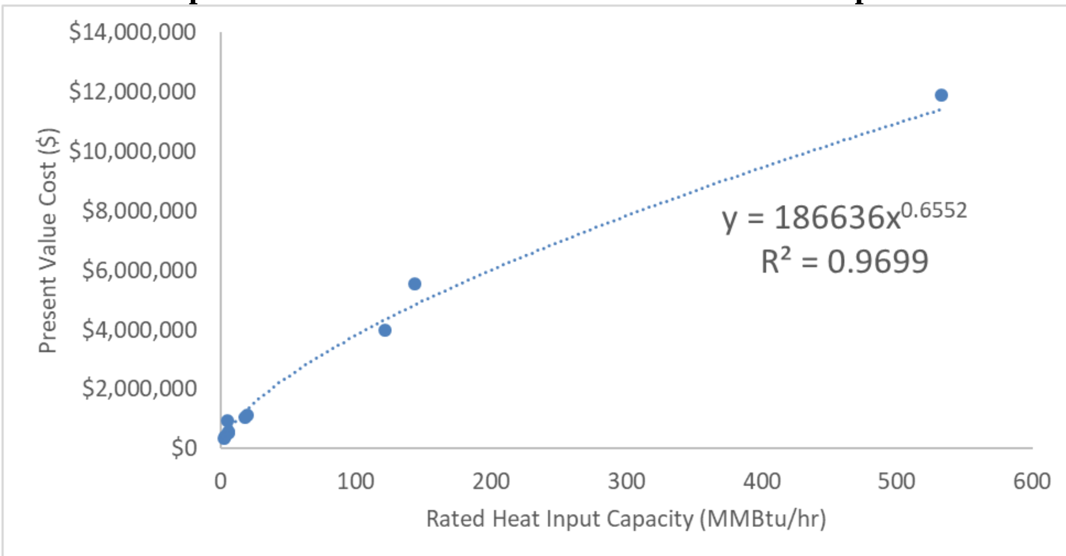
Where,

PV = Present value ($)
TIC = Total installed cost ($)
AC = Annual cost ($)
PVF = Uniform series present value factor (0.064)

The present value costs for all 10 units were then plotting on Graph 4-1 below:

[1] U.S. Environmental Protection Agency. *Cost Reports and Guidance for Air Pollution Regulations*. https://www.epa.gov/economic-and-cost-analysis-air-pollution-regulations/cost-reports-and-guidance-air-pollution#cost%20reports

Graph 4-1 – SCR Present Value Cost of 10-Unit Sample Set



The line of best fit of Graph 4-1 was used to estimate SCR installation costs for all remaining units, which combines SCR capital costs and SCR annual costs. This extrapolation was performed due to the large number of units with a rated heat input of less than 40 MMBtu/hr.

In addition to burner retrofit and SCR control technologies, staff evaluated a third pollution control option as the combination of the SCR and Low NO_x Burner technologies. In this setup, the furnace would have controlled emissions from the burner retrofit. The exhaust would then feed into the SCR equipment as the inlet stream. Effectively, the NO_x BARCT concentration limit for burner retrofits serves as the inlet NO_x ppmv concentration for the SCR equipment which would reduce NO_x emissions even further.

The first stage reduced NO_x concentration from 60 ppmv to either 40 or 50 ppmv @ 3% O_2, dry, depending on the equipment category's NO_x concentration limit for burner retrofit. The second stage reduced the NO_x concentration limit for burner retrofit from 40 or 50 ppmv @ 3% O_2, dry, to 10 ppmv @ 3% O_2, dry.

SCR annual costs for this combination control option are not included explicitly for those units with a rated heat input < 40 MMBtu/hr as the cost curve in Graph 4-1 is used to estimate total costs for units under this cost-effectiveness analysis for the combination of SCR installation and Low NO_x Burner retrofit.

Baseline emissions for the metal melting, metal heat treating, metal heating and forging, and radiant-tube burner categories utilized source test results, if available, in lieu of permit limits. Baseline emissions for units in the ≥ 40 MMBtu/hr category utilized CEMS data, which was available for all units in this category.

Summary

For the metal melting, metal heat treating, metal heating and forging, and radiant-tube burner categories, only the Low NO_x Burner retrofit pollution control option was determined to be cost-effective and incrementally cost-effective and thus only the costs associated with Low NO_x Burner retrofit to meet a 40 ppmv @ 3% O_2, dry or 50 ppmv @ 3% O_2, dry emission limit are included in this section. The costs and cost-effectiveness for the remaining two pollution control options – SCR installation and the combination of SCR installation and Low NO_x Burner retrofit – are found in Appendix D. The costs and cost-effectiveness for each category is shown below in Table 4-2 and Table 4-3.

Table 4-2 – Summary of Compliance Costs

Category	Capital Costs	Annual Costs	NO_x CEMS	NO_x Feed-Forward Analyzer	Permitting	Source Testing	Uniformity Testing	Stranded Asset Costs	Total Costs
Metal Melting	$6,971,700	-	-	-	$248,400	$1,839,000	-	$1,850,400	$10,909,500
Metal Heat Treating: Low Temperature	$637,100	-	-	-	$55,200	$552,000	$4,200	$276,700	$1,525,100
Metal Heat Treating: High Temperature	$937,900	-	-	-	$147,200	$1,278,000	$5,800	$274,100	$2,643,000
Metal Heating and Forging: Low Temperature	$364,900	-	-	-	$50,600	$414,000	$2,500	$110,900	$942,900
Metal Heating and Forging: High Temperature	$1,007,500	-	-	-	$312,800	$2,670,000	$6,600	$353,100	$4,350,000
Units with Radiant-Tube Burners	$342,100	-	-	-	$36,800	$156,000	$1,700	$184,800	$721,300
Units ≥ 40 MMBtu/hr (SCR)	$10,405,100	$216,000 per year	$0	$60,000	$18,400	$96,000	$1,700	$0	$13,955,100
Units ≥ 40 MMBtu/hr (SCR and Low NO_x Burner)	$42,486,100	$206,200 per year	$0	$60,000	$18,400	$96,000	$1,700	$12,677,900	$58,561,900

Table 4-3 – Summary of Cost-Effectiveness

Category	Total Costs	Total Lifetime Emission Reductions (tons NO_x)	Cost-Effectiveness ($/ton NO_x Reduced)
Metal Melting	$10,909,500	419	$26,000
Metal Heat Treating: Low-Temperature	$1,525,100	73	$20,900
Metal Heat Treating: High-Temperature	$2,643,000	133	$19,800
Metal Heating and Forging: Low-Temperature	$942,900	42	$22,500
Metal Heating and Forging: High-Temperature	$4,350,000	554	$7,900
Units with Radiant-Tube Burners	$721,300	28	$25,600
Units ≥ 40 MMBtu/hr (SCR)	$13,955,100	1,695	$8,200
Units ≥ 40 MMBtu/hr (SCR and Low NO_x Burner)	$58,561,900	2,171	$27,000

Two cost-effective pollution control options are identified for the units ≥ 40 MMBtu/hr category. The pollution control option ultimately pursued will be determined by the incremental cost-effectiveness analysis between the two pollution control options.

INCREMENTAL COST EFFECTIVENESS

An incremental cost-effectiveness analysis was conducted for each equipment category pursuant to California Health and Safety Code – HSC § 40920.6:

> "*To determine the incremental cost-effectiveness under this paragraph, the district shall calculate the difference in the dollar costs divided by the difference in the emission reduction potentials between each progressively more stringent potential control option as compared to the next less expensive control option.*"

This analysis is conducted for each equipment category if multiple cost-effective pollution control technologies are identified.

Equation 4-3 is used to calculate incremental cost-effectiveness.

$$\text{Incremental Cost-Effectiveness (\$/ton)} = \frac{Costs_A - Costs_B}{ER_A - ER_B} \qquad \text{(Eq. 4-3)}$$

Where,

A	=	Pollution control option A ($)
B	=	Pollution control option B ($)
ER	=	Emission reductions over lifetime of equipment (tons of NO_x)

If the incremental cost-effectiveness is substantially greater than $50,000/ton, the more stringent control technology is not pursued. Although the more stringent control technology may be cost-effective, the difference in marginal benefit in emission reductions comes with a cost per ton that is higher than the $50,000 per ton threshold set in the 2016 AQMP. The cost-effectiveness and, if applicable, incremental cost-effectiveness analyses were performed beginning at the most stringent technologically feasible initial BARCT concentration limit. The next most stringent initial BARCT concentration limit is then evaluated for cost-effectiveness and, if applicable, incremental cost-effectiveness.

More than one cost-effective pollution control technology option was identified for the low-temperature metal heat treating, low-temperature metal heating and forging, high-temperature metal heat treating, high-temperature metal heating and forging, and radiant-tube burner categories. Details of the incremental cost-effectiveness analysis are in Appendix D.

More than one cost-effective control option was identified for the units ≥ 40 MMBtu/hr category. In this category, Pollution Control Option A is the combination of both SCR installation and Low NO_x Burner retrofit; Pollution Control Option B is the installation of SCR alone. The incremental cost-effectiveness between the two options is shown below.

$$\text{Incremental Cost-Effectiveness (\$/ton)} = \frac{\$58{,}561{,}900 - \$13{,}955{,}100}{2{,}171\text{ tons} - 1{,}695\text{ tons}} = \$93{,}700/\text{ton}$$

The incremental cost-effectiveness between the two pollution control options is greater than $50,000 per ton. The pollution control option of SCR installation alone to reach a NO_x emission concentration of 15 ppmv @ 3% O_2, dry, will therefore be required.

SOCIOECONOMIC ANALYSIS

A socioeconomic impact assessment will be conducted and released for public review and comment at least 30 days prior to the South Coast AQMD Governing Board Hearing, which is anticipated to be on [*Date of Adoption*].

CALIFORNIA ENVIRONMENTAL QUALITY ACT ANALYSIS

Pursuant to the California Environmental Quality Act (CEQA) and South Coast AQMD's certified regulatory program (Public Resources Code Section 21080.5, CEQA Guidelines Section 15251(l) and South Coast AQMD Rule 110), the South Coast AQMD, as lead agency, is currently reviewing the proposed project (PR 1147.2) to determine if it will result in any potential adverse environmental impacts. Appropriate CEQA documentation will be prepared based on the analysis.

DRAFT FINDINGS UNDER CALIFORNIA HEALTH AND SAFETY CODE SECTION 40727

Requirements to Make Findings

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

Necessity

A need exists to adopt PR 1147.2 to provide NO_x and CO limits for the metal melting and heating industry to reflect current BARCT concentration limits.

Authority

The South Coast AQMD obtains its authority to adopt, amend, or repeal rules and regulations from California Health and Safety Code Sections 39002, 40000, 40001, 40440, 40506, 40510, 40702, 40725 through 40728, 41508, 41700, and 42300 et seq..

Clarity

PR 1147.2 is written or displayed so that its meaning can be easily understood by the persons directly affected by them.

Consistency

PR 1147.2 is in harmony with and not in conflict with or contradictory to, existing statutes, court decisions or state or federal regulations.

Non-Duplication

PR 1147.2 will not impose the same requirements as any existing state or federal regulations. The proposed rule is necessary and proper to execute the powers and duties granted to, and imposed upon, the South Coast AQMD.

Reference

In adopting this rule, the following statutes which the South Coast AQMD hereby implements, interprets or makes specific are referenced: AB 617, H&SC Sections 39002, 40001, 40406, 40506, 40702, 40440(a), 40725 through 40728.5, 40920.6, and 42300 et seq..

COMPARATIVE ANALYSIS

Health and Safety Code Section 40727.2 requires a comparative analysis of the proposed rule with any Federal or District rules and regulations applicable to the same source. A comparative analysis is presented below in Table 4-1.

Rule Element	Proposed Rule 1147.2	RECLAIM	Equivalent Federal Regulation
Applicability	• Metal melting, metal heat treating, and metal heating and forging furnaces • Units that have a South Coast AQMD permit to operate	Facilities regulated under the NO_x or SO_x RECLAIM program (South Coast AQMD Reg. XX)	None
Requirements	• Metal Melting (NO_x: 40 ppmv) • Metal Heat Treating: Low Temperature (NO_x: 40 ppmv) • Metal Heat Treating: High Temperature (NO_x: 50 ppmv) • Metal Heating and Forging: Low Temperature (NO_x: 40 ppmv) • Metal Heating and Forging: High Temperature (NO_x: 50 ppmv) • Units with Radiant-Tube Burners (NO_x: 50 ppmv) • Units ≥ 40 MMBtu/hr (NO_x: 15 ppmv) • All Units (CO: 1,000 ppmv)	• Major Source (NO_x/SO_x: None) • Process Unit (NO_x: 130 lb/MMScf)	None
Reporting	• Maintain data to be used for compliance determination	• Daily electronic reporting for major sources • Monthly to quarterly reporting for large sources and process units • Quarterly Certification of Emissions Report and Annual Permit Emissions Program for all units	None
Monitoring	• NO_x CEMS for units ≥ 40 MMBtu/hr • Source testing every 60 months for all units ≤ 10 MMBtu/hr; for units > 10 MMBtu/hr and < 40 MMBtu/hr, every 60	• A continuous in-stack NO_x monitor for major source	None

	months if ≤ 25 billion Btu/yr or every 36 months if > 25 billion Btu/yr	• Source testing once every 5 years for process units or every 3 years for large sources	
Recordkeeping	• All data required by this rule shall be maintained for at least five years and made available for inspection by the Executive Officer • Rating plate affixed to units specifying unit's rated heat input • Documentation identifying the unit's rated heat input and unit alteration details	• Quarterly log for process units • < 15-min. data = min. 48 hours; ≥ 15 min. data = 3 years (5 years if Title V) • Maintenance & emission records, source test reports, RATA reports, audit reports and fuel meter calibration records for Annual Permit Emissions Program = 3 years (5 years if Title V)	None

APPENDIX A: LIST OF AFFECTED FACILITIES

Table A-1: Facilities Affected by PR 1147.2

Facility ID	Facility Name
136	Press Forge
1226	Hyatt Die Cast & Engineering Corp
1824	Buddy Bar Casting
2946	Pacific Forge Inc
3277	Industrial Battery Engineering
4862	Pioneer Diecasters Inc
4906	Bucy Die Casting
6616	Chromal Plating Co
7238	Interspace Battery Corp
7411	Davis Wire Corp
8451	Hughes Bros Aircrafters Inc
8547	Quemetco Inc
9095	Mills Iron Wks Inc
9358	Semco Enter, Inc.
10132	Magnesium Alloy Prod. Co
10966	Weber Metals Inc
11847	Cast-Rite Corp
14495	Vista Metals Corporation
15110	Valley Metal Treating, Inc.
15504	Schlosser Forge Company
16149	Universal Alloy Corp
16338	Kaiser Aluminum Fabricated Products
16639	Shultz Steel Co
17325	Ace Clearwater Enterprises
18931	TAMCO
19051	California Amforge Corporation
19305	Astro Aluminum Treating Co Inc
20492	Alhambra Foundry Co Ltd
21819	Industrial Lead & Plastics Const Inc
21872	Trojan Battery Company (Ann St, Santa Fe Springs)
21972	Charter Foundry Co Inc
22092	Western Tube & Conduit Corp
22467	Lefiell Mfg Co
22632	Anaheim Extrusion Co Inc
22911	Carlton Forge Works
23752	Aerocraft Heat Treating Co Inc
23779	Luxfer Gas Cylinders
33837	Bodycote Thermal Processing (Westminster)
37507	Trojan Battery Company (Clark St, Santa Fe Springs)

Facility ID	Facility Name
43436	TST, Inc.
46268	California Steel Industries Inc
51184	International Die Casting Inc
54402	Sierra Aluminum Company
61681	The Strelitz Co Inc., California Metal-X
66323	Merit Aluminum Corp
70748	Bodycote Thermal Processing (Santa Fe Springs)
71160	U.S. Battery Manufacturing Co
71589	Artsons Mfg Co
72937	P. Kay Metal, Inc.
74086	Valley Forge Acquisition Corp
75531	Edelbrock Foundry Corp
77271	Atlas Pacific Corporation
77891	David H. Fell & Co Inc.
78030	Ontario Extrusions Inc
79682	Ramcar Batteries Inc
83102	Light Metals Inc
85943	Sierra Aluminum Company
103474	Fine Gold
104410	Ray-Bar Engineering Corp
105598	Senior Aerospace SSP
105903	Prime Wheel
109587	Craftech Metal Forming Inc
112267	Alloy Die Casting Co
113489	Universal Molding Extrusion, Co, Inc
118696	Dolphin Tackle
120526	Merit Aluminum Corporation
120697	California Die Casting Inc
123774	Heraeus Precious Metals No. America, LLC
126536	CPP - Pomona
133547	Steel Forming, Inc
138568	California Drop Forge, Inc
140871	PAC Rancho, Inc.
144293	Forged Metals Inc
145216	Universal Molding Company
145801	P.R.L. Aluminum
150496	Coast Composites Inc
150542	Edelbrock Permanent Mold, LLC
166452	Sea Shield Marine Products, Inc.
171062	American Handforge

Facility ID	Facility Name
172799	Stretch Forming Corp
172808	Thermal Solutions Manufacturing, Inc.
173302	Teledyne Battery Products
179549	Catalina Composites
181223	Sierra Alloys Company
184960	West Coast Foundry LLC
187348	Hydro Extrusion USA, LLC

APPENDIX B: ASSESSMENT OF POLLUTION CONTROL TECHNOLOGIES

ASSESSMENT OF POLLUTION CONTROL TECHNOLOGIES

Staff reviewed multiple sources to understand the available and applicable pollution control technologies for all furnace categories. This included a review of scientific literature, meetings with vendors and consultants, and site visits to permit holders. These sources were analyzed with the objective of identifying relevant combustion and post-combustion control technologies and understanding the capabilities and limitations of each technology.

Staff's initial technology assessment revealed several combustion and post-combustion control mechanisms. These included Low NO_x Burners, Radiant-Tube Burners, Recuperative & Regenerative Burners (heat recovery systems), and Flue Gas Recirculation for combustion control; for post-combustion control, these included Selective Catalytic Reduction and Selective Non-Catalytic Reduction.

A discussion of each of these technologies is below.

Low NO_x Burners

Low NO_x Burners implement a variety of combustion optimization techniques to lower NO_x emissions:

- Combustion Staging: Performing partial combustion. This can either occur in an air-rich or fuel-rich first stage, followed by a second stage with the remaining amount of the staged combustion component. For example, air-staged burners would have a first stage of full fuel but only partial air; the combustion would be completed in the second stage with the remaining volume of air necessary for complete combustion. Staged burners may have two or more stages.
- Low Excess Air: Lowers excess air to < 2% and is obtained through feedback control systems to minimize flame temperature
- Flame Enlargement: Lowers peak flame temperature but may overlap with adjacent burner flames or impinge burner components or charged materials

Regarding emissions performance and applicability, product literature from two burner vendors claim that both low and high-temperature burners can meet 30 ppmv @ 3% O_2, dry. Additionally, excess air and combustion air temperature were identified as key metrics in burner applicability.

Staff analyzed the consistency of the classification of a unit's burners as "Low NO_x" by reviewing all equipment data obtained from staff's permit database. Staff determined that, of the units with burner information listed, 86% are listed on the permit as either Low NO_x or Ultra-Low NO_x. However, the use of Low NO_x and Ultra-Low NO_x language may not necessarily correlate to a relative NO_x concentration, as 64% of units with a Low NO_x or Ultra-Low NO_x description source tested above 30 ppmv.

Radiant-Tube Burners

Radiant-tube burners are an indirect-fired burner that differ from direct-fired Low NO_x Burners as the combustion takes place in a tube to prevent contact between the products of combustion and the parts being heated. Radiant-tube burners are commonly found in "double P", "W", "U", and straight shape configurations. Units with radiant-tube burners have individual stack exhausts for each burner. Add-on control technologies are also available to retrofit onto existing radiant-tube burners, which may include inserts into the tube housing itself. These technologies may increase the fuel efficiency, reduce the NO_x concentration, or both.

Flue Gas Recirculation

Otherwise known as "FGR", flue gas recirculation involves routing a portion of exhaust gases from a furnace's combustion chamber via means of dampers, fans, and educators, to the burners. Flue gas, or exhaust gas, contains inert products of combustion products that dilute the oxygen content of fresh combustion air which leads to a lower peak flame temperature and a lower NO_x concentration.

For comparative purposes, recirculating 10-15% of total flue gas back to the burners is typical in the boiler industry. In the steel mill industry, FGR alone has been shown to reduce NO_x emissions by 10%. FGR can be combined with Low NO_x burners for even lower NO_x emissions.

Although FGR can be retrofitted onto furnaces, it may require ductwork and additional fan capacity. Additionally, it is not typically listed on a permit application's equipment description, with only one unit listing FGR of the 58 units that listed NO_x controls. Stakeholders have also commented that it is becoming less common to utilize FGR due to more advanced burner technologies staging the combustion process and effectively performing FGR's dilution effect internally (a feature also known as "Internal Flue Gas Recirculation").

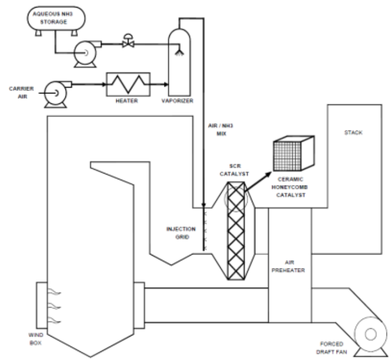
Recuperative & Regenerative Burners (Pre-heated Combustion Air)

As opposed to "standard" or "cold-air" burners, recuperative and regenerative burners are specific burner types utilizing heat exchange methods between exhaust gas and combustion air. The use of the pre-heated combustion air increases a unit's fuel efficiency but NO_x concentrations may increase due to the elevated combustion air temperatures.

Depending on the furnace design and burner, these heat recovery burners may reduce fuel usage by 30-50% over cold-air systems. Recuperative burners were not identified on staff's permit application review. Regenerative burners were listed on eight different metal melting units' permits, comprising four different models from two different burner vendors. There was one installation of regenerative burners in the metal heating and forging category. Due to the inherent size and complexity associated with regenerative burners and their heat recovery media beds, they are generally better suited for newer installs rather than retrofits.

Selective Catalytic Reduction (SCR)

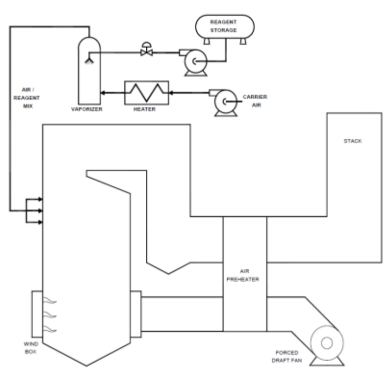
A post-combustion control technology, SCR involves the injection of ammonia (NH_3) or urea (which is vaporized into ammonia) into the flue gas stream to reduce NO_x to N_2 and H_2O via the use of catalysts. The optimal range of flue gas temperatures corresponding to the highest NO_x reductions and maximum catalyst life is 500-1,000 °F. A molar ratio of 0.9:1-1:1 NH_3:NO_x provides the maximum NO_x reductions while minimizing "ammonia slip". Ammonia slip occurs when ammonia from the ammonia injection passes through the catalyst bed without reacting with NO_x and continues outside the flue stack to the ambient air. NO_x reduction efficiencies can range from 80% to more than 85%. Currently there are no known SCR installations in the metal melting category. There is one SCR installation in the metal heat treating category and one installation in the metal heating and forging category. Catalysts are often installed in modular beds, with the first bed in the flue stream contributing to the most NO_x reductions relative to the beds subsequent in the flue gas stream. Accordingly, catalyst beds can either be rotated or replaced on a regular basis in intervals in line with their usage. Catalysts can also be regenerated instead of replaced, which can be approximately 40% less expensive that catalyst replacement.



Selective Non-Catalytic Reduction (SNCR)

A post-combustion control technology, SNCR involves the injection of ammonia or urea into the flue gas stream to reduce NO_x to N_2 and H_2O without the use of catalysts. The optimal range of flue gas temperatures corresponding to highest NO_x reductions and maximum catalyst life is comparatively higher than that for SCR, as the catalyst integrity and efficiency is no longer a concern. This temperature range is 1,500-2,200 °F. Relative to SCR, many processes may not need to install a dilution air fan nor additional duct work due to the elevated optimal temperature range capability. A molar ratio of 2:1-4:1 NH_3:NO_x with a residence time of longer than one second provides the maximum NO_x reductions. A higher molar ratio is necessary due to the absence of a catalyst facilitating the reaction between NH_3 and NO_x. Due to this, ammonia slip is more of a concern with SNCR than it is for SCR.

The lack of a catalyst leads to a lower NO_x reduction potential. While no SNCR installations were determined to exist within the proposed rule's universe, they have been demonstrated to achieve 60% NO_x reduction efficiencies in the boiler industry. However, when combined with Low NO_x Burners, NO_x reduction efficiencies can exceed that of SCR alone, at 95%+ reductions. Due to the lack of catalyst, operating costs and maintenance costs are also lower than those for SCR by approximately 20%.



APPENDIX C: SOURCE TEST RESULT SUMMARY HANDOUT

Source Test Result Summary Handout

In order to substantiate the specified initial BARCT concentration limits during the BARCT assessment process, staff provided a handout containing expanded source test data as well as equipment information for those units without source test data. This handout was prepared in response to stakeholder requests for more information regarding source test conditions. The data contained in the handout was presented during Working Group Meeting #4 held on February 26, 2020. The *Equipment Sub-Category* columns have been updated to reflect updated equipment category designations.

The handout includes several data points, when available, including: furnace rated heat input, new vs. retrofitted burners, RECLAIM vs. non-RECLAIM status, number of burners, burner manufacturer and model, firing rate, excess O_2, unit's operating temperature, and NO_x and CO concentrations.

One requested parameter staff was unable to definitively identify was whether a metal was charged to the furnace during source testing. To verify this, staff randomly selected 11 unit source tests and only four specified whether or not a metal was charged during the source test.

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Sub-30 ppm Source Test Results

Metal Heating Furnaces						
Equipment Category	Heat Input (MMBTU/HR)	Process Temperature (°F)	Control Technology	Permit Limit (ppm)	Source Test Result (ppm)	Notes
Aging	3	340 - 420	Not Listed	50	5	None
Aging	4	350	Not Listed	12	12	None
Aging	5	680 - 900	LNB	30	13	None
Aging	3	680 - 900	LNB	30	14	None
Aging	3	680 - 900	LNB	65	16	None
Aging	4	875 - 1,000	LNB	60	22	None
Aging	3	680 - 900	Not Listed	40	25	None
Aging	3	680 - 900	Not Listed	40	26	None
Aging	8	1,000	LNB	50	29	Startup Load: 29 ppm; Normal Load: 28 ppm
Annealing	2	1,220 - 1,400	Not Listed	60	20	None
Annealing	12	Not Listed	Not Listed	75	26	None
Billet & Pre-Heat	5	680 - 950	FGR; LNB	30	15	None
Billet & Pre-Heat	5	900	ULNB	50	11	High Fire: 11 ppm; Normal: 9 ppm; Low Fire: 11 ppm
Billet & Pre-Heat	5	680 - 900	FGR; LNB	30	13	None
Billet & Pre-Heat	5	680 - 950	Not Listed	25	16	None
Billet & Pre-Heat	7	900	Not Listed	50	19	None
Billet & Pre-Heat	3	880 - 1,000	LNB	50	25	None
Billet & Pre-Heat	12	Not Listed	Not Listed	40	25	None
Billet & Pre-Heat	3	800 - 850	LNB	50	25	None
Billet & Pre-Heat	5	Not Listed	Not Listed	50	27	None
Billet & Pre-Heat	4	900	LNB	30	28	None
Billet & Pre-Heat	7	680 - 950	FGR; LNB	30	29	None
Forging & Drop Forge	5	800 - 900	LNB	50	7	None
Forging & Drop Forge	6	1,600 - 2,200	LNB	50	7	None
Forging & Drop Forge	6	1,600 - 2,200	LNB	50	7	None
Forging & Drop Forge	5	800 - 900	LNB	50	10	None
Forging & Drop Forge	3	1,600 - 2,200	LNB	50	10	None
Forging & Drop Forge	3	1,600 - 2,200	LNB	50	11	Bleed Setting: 11 ppm; Ratio Setting: 5 ppm
Forging & Drop Forge	3	1,600 - 2,200	LNB	50	12	None
Forging & Drop Forge	3	1,600 - 2,200	LNB	50	14	Bleed Setting: 12 ppm; Ratio Setting: 14 ppm
Forging & Drop Forge	3	1,600 - 2,200	LNB	50	15	Bleed Setting: 15 ppm; Ratio Setting: 9 ppm
Forging & Drop Forge	5	1,900 - 2,400	Not Listed	50	18	None
Forging & Drop Forge	3	1,600 - 2,200	LNB	50	19	None
Forging & Drop Forge	6	1,600 - 2,200	LNB	50	23	Bleed Setting: 23 ppm; Ratio Setting: 20 ppm
Forging & Drop Forge	4	1,900 - 2,150	FGR; LNB; Recuperator	50	21	None

South Coast AQMD
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Sub-30 ppm Source Test Results

Metal Heating Furnaces						
Equipment Category	Heat Input (MMBTU/HR)	Process Temperature (°F)	Control Technology	Permit Limit (ppm)	Source Test Result (ppm)	Notes
Forging & Drop Forge	4	1,900 - 2,150	LNB; FGR; Recuperator	50	21	None
Forging & Drop Forge	6	1,900 - 2,400	Not Listed	50	23	None
Forging & Drop Forge	6	1,600 - 2,200	LNB	50	23	Bleed Setting: 23 ppm; Ratio Setting: 19 ppm
Forging & Drop Forge	8	2,300	LNB	50	25	None
Forging & Drop Forge	3	1,600 - 2,200	LNB	50	27	Bleed Setting: 27 ppm; Ratio Setting: 21 ppm
Forging & Drop Forge	6	1,600 - 2,200	LNB	50	27	Bleed Setting: 27 ppm; Ratio Setting: 25 ppm
Forging & Drop Forge	3	1,900 - 2,150	FGR; Recuperator	50	29	None
Homogenizing	12	843	Not Listed	45	13	None
Homogenizing	12	843	Not Listed	45	16	None
Homogenizing	24	1,000 - 1,100	LNB	40	19	None
Homogenizing	12	843	Not Listed	45	22	None
Homogenizing	12	843	Not Listed	45	26	None
Homogenizing	12	843	Not Listed	45	27	None
Re-Heat	529	1,030	LNB; Regenerative Burners; SCR	50	25	None
Other	5	1,725 - 2,150	Not Listed	50	15	None
Other	3	Not Listed	LNB	50	19	None
Other	5	970	LNB	25	21	None
Other	3	Not Listed	LNB	50	21	None
Other	7	1,700 - 2,150	LNB	50	26	None
Other	6	1,000	Not Listed	102	30	None

Note: All NOx concentrations are corrected to 3% O2, dry

Control Technology Key

FGR: Flue Gas Recirculation; LNB: Low-NOx Burner; SCR: Selective Catalytic Reduction; ULNB: Ultra-Low NOx Burner

South Coast AQMD
Proposed Rule 1147.2 – Working Group Meeting #4
Sub-30 ppm Source Test Results

Metal Melting Furnaces						
Equipment Category	**Heat Input (MMBtu/hr)**	**Process Temperature (°F)**	**Control Technology**	**Permit Limit (ppm)**	**Source Test Result (ppm)**	**Notes**
Kettle & Pot	0.30	787	Not Listed	60	13	None
Reverberatory	25	1,221	LNB	40	25	None
Reverberatory	20	1,221	LNB	45	21	None
Reverberatory	20	1,221	LNB	45	23	None

Control Technology Key
LNB: Low-NOx Burner

APPENDIX D: EMISSION REDUCTIONS AND COSTS AND COST-EFFECTIVENESS DETAILS

EMISSION REDUCTIONS

A breakdown of the emission reductions profile for each pollution control technology are shown in Table D-1.

Table D-1 – Emission Reductions

Equipment Category	Control Strategy	Baseline Emissions (tpd)	Emission Reductions (tpd)	Remaining Emissions (tpd)	Percent Reduction
Metal Melting	Low NO_x Burners	0.251	0.093	0.158	37%
	SCR		0.191	0.052	76%
	SCR and Low NO_x Burners		0.218	0.043	85%
Metal Heat Treating: Low Temperature	Low NO_x Burners	0.038	0.014	0.024	36%
	SCR		0.029	0.007	76%
	SCR and Low NOx Burners		0.032	0.006	84%
Metal Heat Treating: High Temperature	Low NO_x Burners	0.074	0.011	0.063	15%
	SCR		0.055	0.015	74%
	SCR and Low NO_x Burners		0.062	0.012	84%
Metal Heating and Forging: Low Temperature	Low NO_x Burners	0.238	0.003	0.235	1%
	SCR		0.016	0.221	7%
	SCR and Low NO_x Burner		0.019	0.219	8%
Heating and Forging: High Temperature	Low NO_x Burners	0.201	0.055	0.151	25%
	SCR		0.154	0.038	77%
	SCR and Low NO_x Burners		0.175	0.026	87%
Units with Radiant-Tube Burners	Low NO_x Burners	0.018	0.005	0.013	28%
	SCR		0.014	0.003	78%
	SCR and Low NO_x Burners		0.015	0.003	86%
Units ≥ 40 MMBtu/hr	SCR	0.391	0.319	0.063	82%
	SCR and Low NO_x Burners		0.357	0.039	91%

COSTS AND COST-EFFECTIVENESS ANALYSIS

A breakdown of the costs and cost-effectiveness for each pollution control technology is shown below for each equipment category.

Metal Melting Furnaces

- *SCR Installation and Low NO_x Burner Retrofit Cost-Effectiveness*

The costs for this combination technology control option are: SCR capital costs of $56,579,200; Low NO_x Burner retrofit costs of $10,560,300; permitting costs of $326,600; CEMS costs of $13,490,000; NO_x Feed-Forward Analyzer costs of $4,260,000; periodic source testing costs of $1,326,000; and stranded asset costs of $2,472,800.

The average cost-effectiveness for units in this category for the combination technology control option to meet a NO_x concentration limit of 10 ppmv at 3% O_2, dry, includes total costs of $89,014,900 and total NO_x emission reductions of 0.137 tpd, or a total of 1,367 tons over a 25-year useful life for the SCR component and a 35-year useful life for the burner component, and a cost-effectiveness of $65,100 per ton NO_x reduced.

- *SCR Installation Cost-Effectiveness*

The costs for this technology control option are: SCR costs of $56,579,200; permitting costs of $326,600; CEMS costs of $13,490,000; NO_x Feed-Forward Analyzer costs of $4,260,000; and periodic source testing costs of $1,326,000.

The average cost-effectiveness for units in this category for the SCR control option to meet a NO_x concentration limit of 15 ppmv at 3% O_2, dry, includes total costs of $75,981,800 and total NO_x emission reductions of 0.117 tpd, or a total of 1,064 tons over a 25-year useful life. The cost-effectiveness is $71,400 per ton NO_x reduced. No units identified have a permit limit or source test result less than or equal to 15 ppmv and costs and emission reductions for all units are included in the cost-effectiveness analysis.

- *Low NO_x Burner Retrofit*

Two burner retrofit implementation paths are provided for metal melting units.

The first implementation path is for units with a permit limit greater than 40 ppmv but less than or equal to 50 ppmv, established as of July 1, 2023 that may qualify for the alternative concentration limits. These units are required to submit permit applications to meet the 40 ppmv initial BARCT concentration limit on or before July 1 after the burner turns 32 years old. It is assumed that approximately 30 months will be required for South Coast AQMD staff to review the permit application and issue the permit, by which time the unit's burners will be approximately 35 years old. A total of 12 of the 70 metal melting units identified may qualify for the alternative concentration limits. Only permitting and periodic source testing costs are included as 35 years meets the average burner useful life of 35 years.

The second implementation path is for units that do not qualify for the alternative concentration limits and must submit permit applications to meet the 40 ppmv at 3% O_2, dry, initial BARCT concentration limit on or before July 1 after the burner turns 12 years old. It is assumed that approximately 30 months will be required for staff to review the permit application and issue the permit, by which time the unit's burners will be approximately 15 years old. Retrofit costs are accounted for as 15 years is before a unit's average burner useful life of 35 years is reached. A total of 42 of the 70 metal melting units identified do not qualify for the alternative concentration limits.

The costs for this technology control option include: burner retrofit costs of $6,971,700; permitting costs of $248,400; periodic source testing costs of $1,839,000; and stranded asset costs of $1,850,400.

The average cost-effectiveness for units in this category for the burner retrofit control option to meet a NO_x concentration limit of 40 ppmv at 3% O_2, dry, includes total costs of $10,909,500 and total NO_x emission reductions of 0.033 tpd, or a total of 419 tons over a 35-year useful life. The cost-effectiveness is $26,000 per ton NO_x reduced. A total of 16 of the 70 metal melting units identified either have a permit limit or a source test result less than or equal to the 40 ppmv initial BARCT concentration limit and the costs for these units are not included in the cost-effectiveness analysis.

Metal Heat Treating Furnaces: Low Temperature

- *SCR Installation and Low NO_x Burner Retrofit Cost-Effectiveness*

The costs for this combination technology control option are: SCR capital costs of $18,128,200; Low NO_x Burner retrofit costs of $1,090,700; permitting costs of $119,600; CEMS costs of $4,940,000; NO_x Feed-Forward Analyzer costs of $1,560,000; periodic source testing costs of $453,000; stranded asset costs of $0; and temperature uniformity testing costs of $4,200.

The average cost-effectiveness for units in this category for the combination technology control option to meet a NO_x concentration limit of 10 ppmv at 3% O_2, dry, includes total costs of $26,295,700 and total NO_x emission reductions of 0.020 tpd, or a total of 200 tons over a 25-year useful life for the SCR component and a 35-year useful life for the burner component, and a cost-effectiveness of $131,500 per ton NO_x reduced.

- *SCR Installation Cost-Effectiveness*

The costs for this technology control option are: SCR costs of $16,395,200; permitting costs of $115,000; CEMS costs of $4,750,000; NO_x Feed-Forward Analyzer costs of $1,500,000; periodic source testing costs of $429,000; and temperature uniformity testing costs of $4,200.

The average cost-effectiveness for units in this category for the SCR control option to meet a NO_x concentration limit of 15 ppmv at 3% O_2, dry, includes total costs of $23,193,300 and total NO_x emission reductions of 0.017 tpd, or a total of 151 tons over a 25-year useful life. The cost-effectiveness is $153,800 per ton NO_x reduced. One unit was identified to have a permit limit or source test result less than or equal to 15 ppmv. Costs and emission reductions for all remaining units are included in the cost-effectiveness analysis.

- *Low NO_x Burner Retrofit*

Two implementation paths are provided for existing low-temperature metal heat treating units.

The first implementation path is for units with a permit limit greater than 40 ppmv but less than or equal to 50 ppmv, established as of July 1, 2023 that may qualify for the alternative concentration limits. These units are required to submit permit applications to meet the 40 ppmv initial BARCT concentration limit on or before July 1 after the burner turns 32 years old. It is assumed that approximately 30 months will be required for staff to review the permit application and submit the permit, by which time the unit's burners will be approximately 35 years old. A total of 1 of the 26 low-temperature metal heat treating units identified may qualify for the alternative concentration limits. Only permitting and periodic source testing costs are included as 35 years meets the average burner useful life of 35 years.

The second implementation path is for units that do not qualify for the alternative concentration limits and must submit permit applications to meet the 40 ppmv initial BARCT concentration limit on or before July 1 after the burner turns 12 years old. It is assumed that approximately 30 months will be required for staff to review the permit application and issue the permit, by which time the unit's burners will be approximately 15 years old. Retrofit costs are accounted for as 15 years is before a unit's average burner useful life of 35 years is reached. A total of 8 of the 26 low-temperature metal heat treating units identified do not qualify for the alternative concentration limits.

The costs for this technology control option include: burner retrofit costs of $637,100; permitting costs of $55,200; periodic source testing costs of $552,000; temperature uniformity testing costs of $4,200; and stranded asset costs of $276,700.

The average cost-effectiveness for units in this category for the burner retrofit control option to meet a NO_x concentration limit of 40 ppmv at 3% O_2, dry, includes total costs of $1,525,100 and total NO_x emission reductions of 0.006 tpd, or a total of 73 tons over a 35-year useful life. The cost-effectiveness is $20,900 per ton NO_x reduced. A total of 17 of the 26 low-temperature metal heat treating units identified either have a permit limit or a source test result less than or equal to the 40 ppmv initial BARCT concentration limit and the costs for these units are not included in the cost-effectiveness analysis.

Metal Heat Treating Furnaces: High Temperature

- *SCR Installation and Low NO_x Burner Retrofit Cost-Effectiveness*

The costs for this combination technology control option are: SCR capital costs of $40,630,000; Low NO_x Burner retrofit costs of $3,744,400; permitting costs of $271,400; CEMS costs of $11,210,000; NO_x Feed-Forward Analyzer costs of $3,540,000; periodic source testing costs of $1,047,000; stranded asset costs of $0; and temperature uniformity testing costs of $5,800.

The average cost-effectiveness for units in this category for the combination technology control option to meet a NO_x concentration limit of 10 ppmv at 3% O_2, dry, includes total costs of $60,448,600 and total NO_x emission reductions of 0.057 tpd, or a total of 560 tons over a 25-year useful life for the SCR component and a 35-year useful life for the burner component, and a cost-effectiveness of $108,000 per ton NO_x reduced.

- *SCR Installation Cost-Effectiveness*

The costs for this technology control option are: SCR costs of $40,630,000; permitting costs of $271,400; CEMS costs of $11,210,000; NO_x Feed-Forward Analyzer costs of $3,540,000; periodic source testing costs of $1,047,000; and temperature uniformity testing costs of $5,800.

The average cost-effectiveness for units in this category for the SCR control option to meet a NO_x concentration limit of 15 ppmv at 3% O_2, dry, includes total costs of $56,704,200 and total NO_x emission reductions of 0.050 tpd, or a total of 460 tons over a 25-year useful life. The cost-effectiveness is $123,100 per ton NO_x reduced. No units identified have a permit limit or source test result less than or equal to 15 ppmv and costs and emission reductions for all units are included in the cost-effectiveness analysis.

- *Low NO_x Burner Retrofit*

Two implementation paths are provided for existing high-temperature metal heat treating units.

The first implementation path is for units with a permit limit greater than 50 ppmv but less than or equal to 60 ppmv, established as of July 1, 2023 that may qualify for the alternative concentration limits. These units are required to submit permit applications to meet the 50 ppmv initial BARCT concentration limit on or before July 1 after the burner turns 32 years old. It is assumed that approximately 30 months will be required for staff to review the permit application and submit the permit, by which time the unit's burners will be approximately 35 years old. A total of 16 of the 60 high-temperature metal heat treating units identified may qualify for the alternative concentration limits. Only permitting and periodic source testing costs are included as 35 years meets the average burner useful life of 35 years.

The second implementation path is for units that do not qualify for the alternative concentration limits and must submit permit applications to meet the 50 ppmv initial BARCT concentration limit on or before July 1 after the burner turns 12 years old. It is assumed that approximately 30 months will be required for staff to review the permit application and issue the permit, by which time the unit's burners will be approximately 15 years old. Retrofit costs are accounted for as 15 years is before a unit's average burner useful life of 35 years is reached. A total of 16 of the 60 high-temperature metal heat treating units identified do not qualify for the alternative concentration limits.

The costs for this technology control option include: burner retrofit costs of $937,900; permitting costs of $147,200; periodic source testing costs of $1,278,000; temperature uniformity testing costs of $5,800; and stranded asset costs of $274,100.

The average cost-effectiveness for units in this category for the burner retrofit control option to meet a NO_x concentration limit of 40 ppmv at 3% O_2, dry, includes total costs of $2,643,000 and total NO_x emission reductions of 0.010 tpd, or a total of 133 tons over a 35-year useful life. The cost-effectiveness is $19,800 per ton NO_x reduced. A total of 28 of the 59 high-temperature metal heat treating units identified either have a permit limit or a source test result less than or equal to the 50 ppmv initial BARCT concentration limit and the costs for these units are not included in the cost-effectiveness analysis.

Metal Heating and Forging Furnaces: Low Temperature

- *SCR Installation and Low NO_x Burner Retrofit Cost-Effectiveness*

The costs for this combination technology control option are: SCR capital costs of $13,026,300; Low NO_x Burner retrofit costs of $1,364,000; permitting costs of $96,600; CEMS costs of $3,990,000; NO_x Feed-Forward Analyzer costs of $1,260,000; periodic source testing costs of $342,000; and stranded asset costs of $235,000; and temperature uniformity testing costs of $2,500.

The average cost-effectiveness for units in this category for the combination technology control option to meet a NO_x concentration limit of 10 ppmv at 3% O_2, dry, includes total costs of $20,316,400 and total NO_x emission reductions of 0.018 tpd, or a total of 176 tons over a 25-year useful life for the SCR component and a 35-year useful life for the burner component, and a cost-effectiveness of $115,500 per ton NO_x reduced.

- *SCR Installation Cost-Effectiveness*

The costs for this technology control option are: SCR costs of $13,026,300; permitting costs of $96,600; CEMS costs of $3,990,000; NO_x Feed-Forward Analyzer costs of $1,260,000; periodic source testing costs of $342,000; and temperature uniformity testing costs of $2,500.

The average cost-effectiveness for units in this category for the SCR control option to meet a NO_x concentration limit of 15 ppmv at 3% O_2, dry, includes total costs of $18,717,400 and total NO_x emission reductions of 0.015 tpd, or a total of 140 tons over a 25-year useful life. The cost-effectiveness is $133,900 per ton NO_x reduced. No units identified have a permit limit or source test result less than or equal to 15 ppmv and costs and emission reductions for all units are included in the cost-effectiveness analysis.

- *Low NO_x Burner Retrofit*

Two implementation paths are provided for existing low-temperature metal heating and forging units.

The first implementation path is for units with a permit limit greater than 40 ppmv but less than or equal to 50 ppmv, established as of July 1, 2023 that may qualify for the alternative concentration limits. These units are required to submit permit applications to meet the 40 ppmv initial BARCT concentration limit on or before July 1 after the burner turns 32 years old. It is assumed that approximately 30 months will be required for staff to review the permit application and submit the permit, by which time the unit's burners will be approximately 35 years old. A total of 8 of the 21 low-temperature metal heating and forging units identified may qualify for the alternative concentration limits. Only permitting and periodic source testing costs are included as 35 years meets the average burner useful life of 35 years.

The second implementation path is for units that do not qualify for the alternative concentration limits and must submit permit applications to meet the 40 ppmv initial BARCT concentration limit on or before July 1 after the burner turns 12 years old. It is assumed that approximately 30 months will be required for staff to review the permit application and issue the permit, by which time the unit's burners will be approximately 15 years old. Retrofit costs are accounted for as 15 years is before a unit's average burner useful life of 35 years is reached. A total of three of the 21 low-temperature metal heating and forging units identified do not qualify for the alternative concentration limits.

The costs for this technology control option include: burner retrofit costs of $364,900; permitting costs of $50,600; periodic source testing costs of $414,000; temperature uniformity testing costs of $2,500; and stranded asset costs of $110,900.

The average cost-effectiveness for units in this category for the burner retrofit control option to meet a NO_x concentration limit of 40 ppmv at 3% O_2, dry, includes total costs of $942,900 and total NO_x emission reductions of 0.003 tpd, or a total of 42 tons over a 35-year useful life. The cost-effectiveness is $22,500 per ton NO_x reduced. A total of 10 of the 21 low-temperature metal heating and forging identified either have a permit limit or a source test result less than or equal to the 40 ppmv initial BARCT concentration limit and the costs for these units are not included in the cost-effectiveness analysis.

Metal Heating and Forging Furnaces: High Temperature

- *SCR Installation and Low NO_x Burner Retrofit Cost-Effectiveness*

The costs for this combination technology control option are: SCR capital costs of $84,337,100; Low NO_x Burner retrofit costs of $6,861,000; permitting costs of $630,200; CEMS costs of $26,030,000; NO_x Feed-Forward Analyzer costs of $8,220,000; periodic source testing costs of $2,208,000; and stranded asset costs of $0; and temperature uniformity testing costs of $6,600.

The average cost-effectiveness for units in this category for the combination technology control option to meet a NO_x concentration limit of 10 ppmv at 3% O_2, dry, includes total costs of $128,292,900 and total NO_x emission reductions of 0.151 tpd, or a total of 1,537 tons over a 25-year useful life for the SCR component and a 35-year useful life for the burner component, and a cost-effectiveness of $83,500 per ton NO_x reduced.

- *SCR Installation Cost-Effectiveness*

The costs for this technology control option are: SCR costs of $84,337,100; permitting costs of $630,200; CEMS costs of $26,030,000; NO_x Feed-Forward Analyzer costs of $8,220,000; periodic source testing costs of $2,208,000; and temperature uniformity testing costs of $6,600.

The average cost-effectiveness for units in this category for the SCR control option to meet a NO_x concentration limit of 15 ppmv at 3% O_2, dry, includes total costs of $121,431,900 and total NO_x emission reductions of 0.135 tpd, or a total of 1,232 tons over a 25-year useful life. The cost-effectiveness is $98,600 per ton NO_x reduced. No units identified have a permit limit or source test result less than or equal to 15 ppmv and costs and emission reductions for all units are included in the cost-effectiveness analysis.

- *Low NO_x Burner Retrofit*

Two implementation paths are provided for existing high-temperature metal heating and forging units.

The first implementation path is for units with a permit limit greater than 50 ppmv but less than or equal to 60 ppmv, established as of July 1, 2023 that may qualify for the alternative concentration limits. Near-limit units are required to submit permit applications to meet the 50 ppmv initial BARCT concentration limit on or before July 1 after the burner turns 32 years old. It is assumed that approximately 30 months will be required for staff to review the permit application and submit the permit, by which time the unit's burners will be approximately 35 years old. A total of 15 of the 137 high-temperature metal heating and forging units identified may qualify for the alternative concentration limits. Only permitting and periodic source testing costs are included as 35 years meets the average burner useful life of 35 years.

The second implementation path is for units that do not qualify for the alternative concentration limits and must submit permit applications to meet the 40 ppmv initial BARCT concentration limit on or before July 1 after the burner turns 12 years old. It is assumed that approximately 30 months will be required for staff to review the permit application and issue the permit, by which time the unit's burners will be approximately 15 years old. Retrofit costs are accounted for as 15 years is before a unit's average burner useful life of 35 years is reached. A total of 42 of the 137 high-temperature metal heating and forging units identified do not qualify for the alternative concentration limits.

The costs for this technology control option include: burner retrofit costs of $1,007,500; permitting costs of $312,800; periodic source testing costs of $2,670,000; temperature uniformity testing costs of $6,600; and stranded asset costs of $353,100.

The average cost-effectiveness for units in this category for the burner retrofit control option to meet a NO_x concentration limit of 40 ppmv at 3% O_2, dry, includes total costs of $4,350,000 and total NO_x emission reductions of 0.043 tpd, or a total of 554 tons over a 35-year useful life. The cost-effectiveness is $7,900 per ton NO_x reduced. A total of 80 of the 137 high-temperature metal heating and forging identified either have a permit limit or a source test result less than or equal to the 50 ppmv initial BARCT concentration limit and the costs for these units are not included in the cost-effectiveness analysis.

Units with Radiant-Tube Burners

- *SCR Installation and Low NO_x Burner Retrofit Cost-Effectiveness*

The costs for this combination technology control option are: SCR capital costs of $6,138,800; Low NO_x Burner retrofit costs of $707,200; permitting costs of $36,800; CEMS costs of $1,520,000; NO_x Feed-Forward Analyzer costs of $480,000; periodic source testing costs of $129,000; and stranded asset costs of $0; and temperature uniformity testing costs of $1,700.

The average cost-effectiveness for units in this category for the combination technology control option to meet a NO_x concentration limit of 10 ppmv at 3% O_2, dry, includes total costs of $9,013,500 and total NO_x emission reductions of 0.012 tpd, or a total of 120 tons over a 25-year useful life for the SCR component and a 35-year useful life for the burner component, and a cost-effectiveness of $74,900 per ton NO_x reduced.

- *SCR Installation Cost-Effectiveness*

The costs for this technology control option are: SCR costs of $6,138,800; permitting costs of $36,800; CEMS costs of $1,520,000; NO_x Feed-Forward Analyzer costs of $420,000; periodic source testing costs of $129,000; and temperature uniformity testing costs of $1,700.

The average cost-effectiveness for units in this category for the SCR control option to meet a NO_x concentration limit of 15 ppmv at 3% O_2, dry, includes total costs of $8,246,300 and total NO_x emission reductions of 0.011 tpd, or a total of 100 tons over a 25-year useful life. The cost-effectiveness is $82,100 per ton NO_x reduced. No units identified have a permit limit or source test result less than or equal to 15 ppmv and costs and emission reductions for all units are included in the cost-effectiveness analysis.

- *Low NO_x Burner Retrofit*

Two implementation paths are provided for existing units with radiant-tube burners.

The first implementation path is for units with a permit limit greater than 50 ppmv but less than or equal to 60 ppmv, established as of July 1, 2023 that may qualify for the alternative concentration limits. Near-limit units are required to submit permit applications to meet the 50 ppmv initial BARCT concentration limit on or before July 1 after the burner turns 32 years old. It is assumed that approximately 30 months will be required for staff to review the permit application and submit the permit, by which time the unit's burners will be approximately 35 years old. A total of three of the eight units with radiant-tube burners identified may qualify for the alternative concentration limits. Only permitting and periodic source testing costs are included as 35 years meets the average burner useful life of 35 years.

The second implementation path is for units that do not qualify for the alternative concentration limits and must submit permit applications to meet the 50 ppmv initial BARCT concentration limit on or before July 1 after the burner turns 12 years old. It is assumed that approximately 30 months will be required for staff to review the permit application and issue the permit, by which time the unit's burners will be approximately 15 years old. Retrofit costs are accounted for as 15 years is before a unit's average burner useful life of 35 years is reached. A total of 2 of the 8 units with radiant-tube burners identified do not qualify for the alternative concentration limits.

The costs for this technology control option include: burner retrofit costs of $935,500; permitting costs of $36,800; periodic source testing costs of $156,000; temperature uniformity testing costs of $1,700; and stranded asset costs of $184,800.

The average cost-effectiveness for units in this category for the burner retrofit control option to meet a NO_x concentration limit of 40 ppmv at 3% O_2, dry, includes total costs of $1,314,800 and total NO_x emission reductions of 0.002 tpd, or a total of 28 tons over a 35-year useful life. The cost-effectiveness is $46,600 per ton NO_x reduced. A total of three of the eight units with radiant-tube burners identified either have a permit limit or a source test result less than or equal to the 50 ppmv initial BARCT concentration limit and the costs for these units are not included in the cost-effectiveness.

Units ≥ 40 MMBtu/hr

A cost-effectiveness analysis was conducted for all units with a rated heat input of greater than or equal to 40 MMBtu/hr to meet several different NO_x concentration limits, all corrected to 3% O_2, dry: 15 ppmv (via the combination of both SCR installation and burner retrofit), 15 ppmv (via SCR installation), and 40 or 50 ppmv (via burner retrofit depending on whether the unit is a low-temperature or high-temperature unit).

A total of four units with a rated heat input of greater than or equal to 40 MMBtu/hr were identified, two of which have existing SCR installations.

- *SCR Installation and Low NO_x Burner Retrofit Cost-Effectiveness*

Of the four units identified in this equipment category, one unit is equipped with regenerative burners.

All costs associated with a SCR installation, including annual electricity costs, reagent costs, and catalyst costs, were included for the two units without existing SCR installations. Costs for CEMS, NO_x Feed-Forward Analyzer, periodic source testing, temperature uniformity testing, and burner retrofit costs were included.

The costs for this combination technology control option are: SCR capital costs of $10,405,100; SCR annual costs of $206,200 per year; permitting costs of $18,400; CEMS costs of $0 as each of the four units in this category are already equipped with a CEMS to measure NO_x; NO_x Feed-Forward Analyzer costs of $60,000 for the one unit in this category with a batch process and that does not have an analyzer already installed; periodic source testing costs of $96,000; temperature uniformity costs of $1,700; burner retrofit costs of $32,081,000; and stranded asset costs of $12,677,900.

The average cost-effectiveness for units in this category for the combination technology control option to meet a concentration limit of 10 ppmv at 3% O_2 includes total costs of $58,561,900 and total NO_x emission reductions of 0.199 tpd, or a total of 2,171 tons over a 25-year useful life for the SCR component and 35-year useful life for the burner component, and a cost-effectiveness of $27,000 per ton NO_x reduced.

- *SCR Installation Cost-Effectiveness*

Units in this category must submit permit applications to meet the 15 ppmv initial BARCT concentration limit on or before July 1, 2023 and full installation costs are accounted for.

The costs for this technology control option are: SCR capital costs of $10,405,100; SCR annual costs of $216,000 per year; CEMS costs of $0 as each of the four units identified in this category are already equipped with a CEMS to measure NO_x; NO_x Feed-Forward Analyzer costs of $60,000 for the 1 unit identified in this category with a batch process and that does not have an analyzer already installed; permitting costs of $18,400; periodic source testing costs of $96,000; and temperature uniformity costs of $1,700.

The average cost-effectiveness for units in this category for the SCR control option to meet a NO_x concentration limit of 15 ppmv at 3% O_2, dry, includes total costs of $13,955,100 and total NO_x emission reductions of 0.186 tpd, or a total of 1,695 tons over a 25-year useful life. The cost-effectiveness is $8,200 per ton NO_x reduced. No units identified have a permit limit or source test result less than or equal to 15 ppmv and costs and emission reductions for all units are included in the cost-effectiveness analysis.

NEW UNIT LIMIT INCREMENTAL COST-EFFECTIVENESS ANALYSIS

Chapter 2 notes staff's determinations of the technologically feasible NOx concentration limits for the metal heat treating, metal heating, metal forging, and radiant-tube burner categories. These limits were 30 ppmv @ 3% O_2, dry, for low-temperature metal heat treating, metal heating, and metal forging; 40 ppmv @ 3% O_2, dry, for high-temperature metal heat treating, metal heating, and metal forging; and 40 ppmv @ 3% O_2, dry, for radiant-tube burners. Although these NOx concentration limits are technologically feasible, they would require extensive, difficult, and expensive retrofits such as refractory redesign and air/fuel system replacements. Table D-2 shows the technologically feasible NOx concentration limit and NOx BARCT concentration limit for each category.

Table D-2 – Technologically Feasible and BARCT NOx Concentration Limits

Category	Technologically Feasible NOx Concentration Limit (ppmv @ 3% O_2, Dry)	NOx BARCT Concentration Limit (ppmv @ 3% O_2, Dry)
Metal Heat Treating: Low Temperature	30	40
Metal Heat Treating: High Temperature	40	50
Metal Heating and Forging: Low Temperature	30	40
Metal Heating and Forging: High Temperature	40	50
Units with Radiant-Tube Burners	40	40

Staff performed a cost-effectiveness analysis for units in these categories to meet these NOx concentration limits following the same methodology in Chapter 4. The cost basis used in this analysis was based on the same set of nine burner retrofit quotes received, as noted in the *COSTS AND COST-EFFECTIVENESS* section of Chapter 4. Of these nine burner retrofit quotes, three burner retrofit quotes were proposed to meet the technologically feasible NOx concentration limits of 30 ppmv @ 3% O_2, dry, or 40 ppmv @ 3% O_2, dry, as appropriate for the category. Each of these three burner retrofits was calculated as an average of retrofitting several furnaces within the quote, each furnace with different operating and equipment characteristics. The median cost of these three burner retrofit quotes was $339,000.

The costs and cost-effectiveness for each of these categories to achieve the technologically feasible NOx concentration limits is shown below in Table D-3 and Table D-4.

Table D-3 – Summary of Compliance Costs for Technologically Feasible NOx Concentration Limits

Category	Capital Costs	Permitting	Source Testing	Uniformity Testing	Stranded Asset Costs	Total Costs
Metal Heat Treating: Low Temperature	$2,034,000	$119,600	$552,000	$5,000	$1,055,700	$3,766,300
Metal Heat Treating: High Temperature	$5,085,000	$271,400	$1,278,000	$12,500	$2,518,300	$9,165,100
Metal Heating and Forging: Low Temperature	$3,051,000	$73,600	$414,000	$7,500	$1,801,500	$5,347,600
Metal Heating and Forging: High Temperature	$6,780,000	$602,600	$2,670,000	$16,600	$2,547,300	$12,616,500
Units with Radiant-Tube Burners	$1,695,000	$36,800	$156,000	$4,200	$910,500	$2,802,400

Table D-4 – Summary of Cost-Effectiveness for Technologically Feasible NOx Concentration Limits

Category	Total Costs	Total Lifetime Emission Reductions (tons NO_x)	Cost-Effectiveness ($/ton NO_x Reduced)
Metal Heat Treating: Low-Temperature	$3,766,300	116	$32,400
Metal Heat Treating: High-Temperature	$9,165,100	262	$35,000
Metal Heating and Forging: Low-Temperature	$5,347,600	95	$56,300
Metal Heating and Forging: High-Temperature	$12,616,500	785	$16,100
Units with Radiant-Tube Burners	$2,802,400	58	$48,400

While all but one of these categories showed to be cost-effective, these results include emission reductions from those units that do not have any costs attributed to their retrofit due to either having burners older than 32 years or ability to opt for the alternative implementation schedule of 32 years of burner age.

To remove the effects of these units with emission reductions but no retrofit costs, staff calculated an incremental cost-effectiveness to apply to only those units that would incur a retrofit cost in achieving emission reductions. This incremental cost-effectiveness calculates the difference in costs and emission reductions between the technologically feasible limits of 30 ppmv @ 3% O_2, dry, and 40 ppmv @ 3% O_2, dry, and the NOx BARCT emission limits of 40 ppmv @ 3% O_2, dry, and 50 ppmv @ 3% O_2, dry. The incremental costs and incremental cost-effectiveness for each of these categories between these two sets of NOx concentration limits is shown below in Table D-5 and Table D-6.

Table D-5 – Summary of Incremental Costs

Category	Capital Costs	Permitting	Source Testing	Uniformity Testing	Stranded Asset Costs	Total Costs
Metal Heat Treating: Low Temperature	$1,396,900	$4,600	$18,000	$800	$779,000	$2,199,400
Metal Heat Treating: High Temperature	$1,396,900	$36,800	$156,000	$6,600	$2,244,200	$6,590,700
Metal Heating and Forging: Low Temperature	$2,686,100	$27,600	$120,000	$5,000	$1,099,800	$3,938,500
Metal Heating and Forging: High Temperature	$5,772,500	$55,200	$240,000	$10,000	$2,194,300	$8,271,900
Units with Radiant-Tube Burners	$1,352,900	$13,800	$54,000	$2,500	$725,700	$2,148,900

The incremental cost-effectiveness is shown in Table D-6.

Table D-6 – Summary of Incremental Cost-Effectiveness

Category	Incremental Costs	Incremental Emission Reductions	Incremental Cost-Effectiveness
Metal Heat Treating: Low Temperature	$2,199,400	0.001	$118,700
Metal Heat Treating: High Temperature	$6,590,700	0.003	$158,700
Metal Heating and Forging: Low Temperature	$3,938,500	0.004	$81,800
Metal Heating and Forging: High Temperature	$8,271,900	0.007	$87,400
Units with Radiant-Tube Burners	$2,148,900	0.002	$80,700

Due to the incremental cost-effectiveness for each category for those units that incur a cost to retrofit, the technologically feasible NOx concentration limits were not economically practical to require. The NOx BARCT concentration limits are both technologically feasible and cost-effective for each of these categories.