BARCT DETERMINATIONS

New BARCT

New BARCT was recommended for some types of equipment, including:

- Rule 1146 and 1146.1 boilers and heaters;
- Rule 1109 refinery boilers and heaters;
- Fluid catalytic cracking units;
- Metal melting and heating processes; and
- Miscellaneous combustion equipment including ovens, kilns, calciners, dryers, and furnaces.

No New BARCT

No new BARCT was recommended for the following categories of equipment:

- Gas turbines;
- Cement kilns;
- Internal combustion engines;
- Glass melting furnaces; and
- Curing and drying ovens.

Rule 2009 BARCT Completed Already

BARCT for equipment at power producing facilities subject to Rule 2009 was considered separately as part of the year 2001 RECLAIM amendments and all subsequent rule implementation. Consequently, much of the analysis was done at the time these facilities filed applications for modifications of their equipment. Under Rule 2009, a case-by-case cost-effectiveness evaluation was performed for each boiler or turbine unit to determine BARCT. Permit information shows that BARCT for the majority of the equipment under Rule 2009 ranges from 5 to 9 ppm. As a result, some units were (1) taken out of service, (2) replaced by more efficient equipment, or (3) retrofit with controls. However, for the purpose of current BARCT determinations, an average concentration limit was developed for the boiler source category based on the throughput used for the year 2000 allocation.

Table 1 summarizes the BARCT analysis including, rule analysis, control technology, cost effectiveness and recommendation for new BARCT.

Table 1

Best Available Retrofit Control Technology (BARCT) Analysis Summary

Equipment	Boilers/ Heaters (non-refinery, non-utility)	Refinery Boilers/ Heaters	Utility Boilers	Gas Turbines	Fluid Catalytic Cracking Units	Cement Kilns	Internal Combustion Engines	Glass Melting Furnaces	Curing & Drying Ovens	Metal Melting & Heat Treating	Misc. Combustion Equipment
SCAQMD Rule/ Measure Subsumed	1146 1146.1	1109	1135 2009	1134	Control Measure 90P-B-2	1112	1110.2	1117	Control Measure 90P-C-6	Control Measure 90P-C-5	Control Measure 90P-C-5
Other District rule more stringent?	San Joaquin Valley Unified APCD	No	No	San Joaquin Valley Unified APCD (some units)	No	No	No	No	No	No	No
Tier I Control Technology	Low NOx burner, FGR	Low NOx burner, FGR	Facility Cap, Repower, Comb. Modifi-cations, FGR, SNCR, SCR	Various, SCR, water or steam injection	SCR	Low NOx Burner Comb. Modifi-cations	Various depending on engine use: electrification, SCR, turbocharger, aftercooler, combustion modifications	Low NOx Burner Comb. Modifi-cations	Low NOx Burner. Comb. Modifi-cations	Low NOx Burner, Comb. Modifi-cations	Low NOx Burner, Combustion Modifications
New BARCT Control Technology	Ultra low NOx burner	SCR	SCR	SCR	SCR					Ultra low NOx burner	Ultra low NOx burner
Cost Effective?	Yes	Yes	Yes	No	Yes					Yes	Yes
New BARCT	≤ 20 mmBtu/hr 0.015 lb/mmBtu 12 ppm > 20 mmBtu/hr 0.010 lb/mmBtu 9 ppm-	None for 40-110 mmBtu 5 ppm for > 110 mmBtu/hr	9 ppm	None	1.439 lb/1000 barrels of fresh feed	None[1&3]	None[3]	None[2]	None[2]	0.055 lb/mmBtu 45 ppm	0.036 lb/mmBtu 30 ppm

1. Controls not achieved in practice
2. Further reductions not technically feasible
3. Further reductions not economically feasible

Discussion

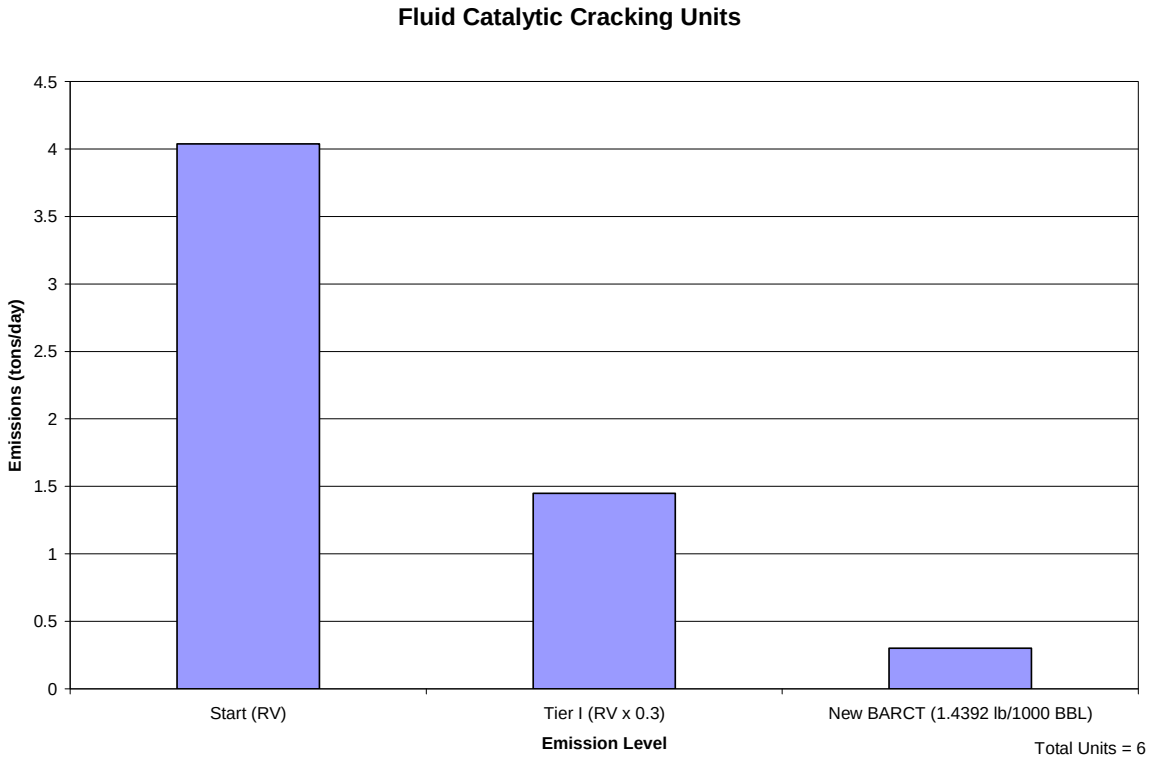
BARCT Technology Evaluation

Fluid Catalytic Cracking Units

There was a control measure for fluid catalytic cracking units (FCCUs) that was subsumed under RECLAIM. The control measure would have reduced emissions through installation of SCR. SCR technology has improved in the last decade. There are no other district rules for this type of equipment, and none were found nationwide. There are six FCCUs in the SCAQMD and two currently have been retrofit with SCR, demonstrating that this technology is achieved in practice. The new BARCT limit for this equipment category was set at 1.439 pounds of NOx per 1000 barrels of fresh feed. Two refineries in the AQMD have retrofit their FCCUs with SCR. The 1.439 pounds/1000 barrels of fresh feed is based on actual emission levels from one of the units. It has been achieved in practice and has, therefore, been determined to be the proposed BARCT.

Figure 1 is a bar chart of the total emissions based on uncontrolled, Tier 1, and new BARCT levels. There are 6 FCCUs currently in the RECLAIM program. Due to the small number of units and to protect the confidentiality of the facilities, the bar chart for the FCCUs shows total emissions for the 6 units. Charts for most other categories, where there are large numbers of equipment, are histograms. Two units have already achieved the new BARCT emission level. The other 4 units have not yet achieved Tier I levels.

Figure 1



Note: No established BACT
RV = Reported Value

Refinery Boilers and Process Heaters

Rule 1109 – Emissions of Oxides of Nitrogen from Boilers and Process Heaters in Petroleum Refineries, applies to boilers and heaters at refineries with a heat input rating of greater than 40 mmBtu/hr and was subsumed into RECLAIM. Rule 1109 limits these units to 25 ppm or approximately 0.030 pound of NOx per mmBtu. The 2000 (Tier I) Ending Emission factor for refinery boilers was based on the 25 ppm limit, so reduction to this level has already been accounted for with the 2000 allocations.

San Joaquin Valley Unified APCD has a more stringent limit than South Coast's for a subcategory of refinery boilers/heaters. Their Rule 4306 limits units with greater than 110 mmBtu/hr input rating to 5 ppm. The SJVUAPCD requirements for refinery boilers/heaters rated at < 110 mmBtu/hr are less stringent than SCAQMD Rule 1109. SJVUAPCD has not yet implemented their rule, so no units have been retrofit there.

Staff consulted with burner manufacturers and refineries in studying the technology available to reduce NOx from refinery boilers and heaters. Ultra low NOx burners are only capable of reducing NOx levels in refinery boilers/heaters to approximately 25 ppm due to the size and design of the equipment and the combustion characteristics of refinery gas. Selective catalytic reduction is capable of reaching 5 ppm NOx limits and is an achieved in practice retrofit technology. Several units in the AQMD have been retrofit with SCR and have achieved emission limits of 9 ppm and lower. This technology has improved in recent years as seen with the SCR retrofits for utility boilers which achieved limits as low as 2.5 ppm. SCR was determined to be cost effective for refinery boilers/heaters rated at greater than 110 mmBtu/hr, but not for the 40 to 110 mmBtu/hr units.

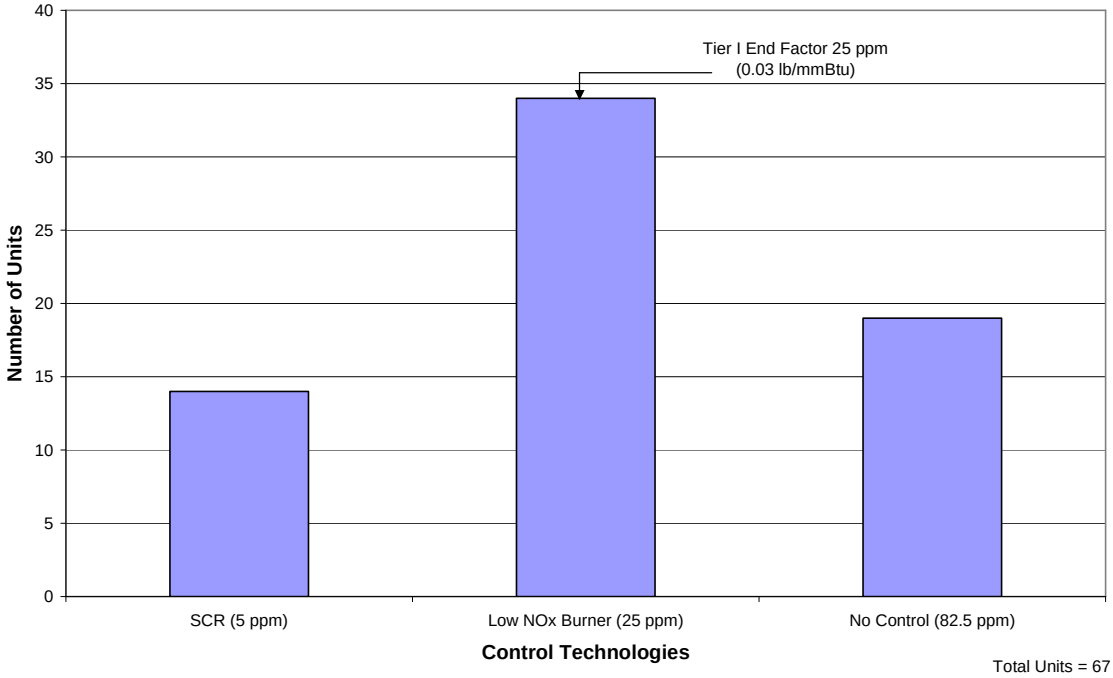
The RECLAIM inventory for refinery boilers and heaters includes approximately 140 boilers and heaters. Of those, 75 are rated at greater than 110 mmBtu/hr. Approximately a third of those 75 are already equipped with SCR. No new BARCT was set for units between 40 and 110 mmBtu/hr since SCR is not cost effective and their 2000 allocations are already based on 25 ppm, the level achievable with ultra low NOx burners. A new BARCT level of 5 ppm was determined for refinery boilers/heaters rated at greater than 110 mmBtu/hr based on the SJVUAPCD rule and the cost effectiveness and feasibility of control with SCR.

Figures 2 and 3 represent the population of Rule 1109 boilers and heaters in the RECLAIM universe and their current type of control equipment. For the purposes of these charts, boilers and heaters that are uncontrolled were assumed to be at the starting emission factor of 82.5 ppm. Those equipped with low NOx burners were assumed to be at Tier 1 ending emission factor of 25 ppm and those with SCR were assumed to meet the new BARCT level of 5 ppm. The charts are not histograms like those for the remaining categories because most of these units do not have NOx permit limits.

For Discussion Purposes Only

Figure 2

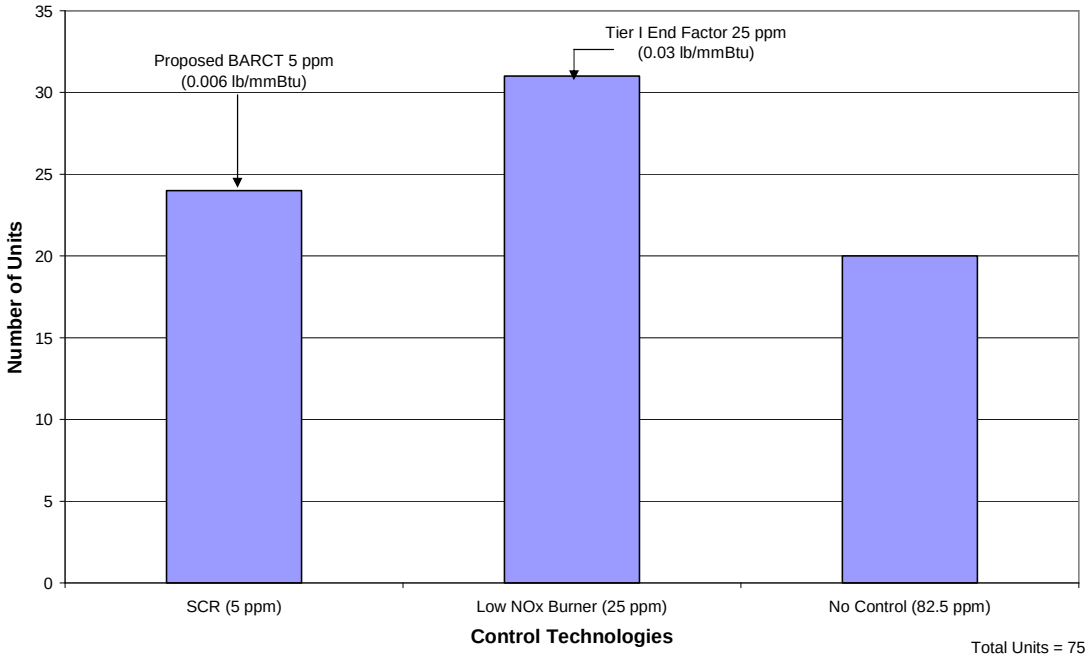
1109 Boilers/Heaters 40 - 110 mmBtu



Note: BACT is 5 ppm

Figure 3

1109 Boilers/Heaters > 110 mmBtu



Note: BACT is 5 ppm

Industrial Boilers and Process Heaters (non-Refinery)

Several factors went into determining the BARCT level for RECLAIM boilers and heaters. Current BARCT for non-RECLAIM facilities for this equipment is governed by SCAQMD Rules 1146 – Emissions of Oxides of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters and 1146.1 - Emissions of Oxides of Nitrogen from Small Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters. Rules 1146 and 1146.1 basically apply to all other boilers and heaters greater than 2 mmBtu/hr heat input rating, with the exception of those used to generate electricity and refinery boilers and heaters rated at greater than 40 mmBtu/hr which are covered by other rules and described in the next section.

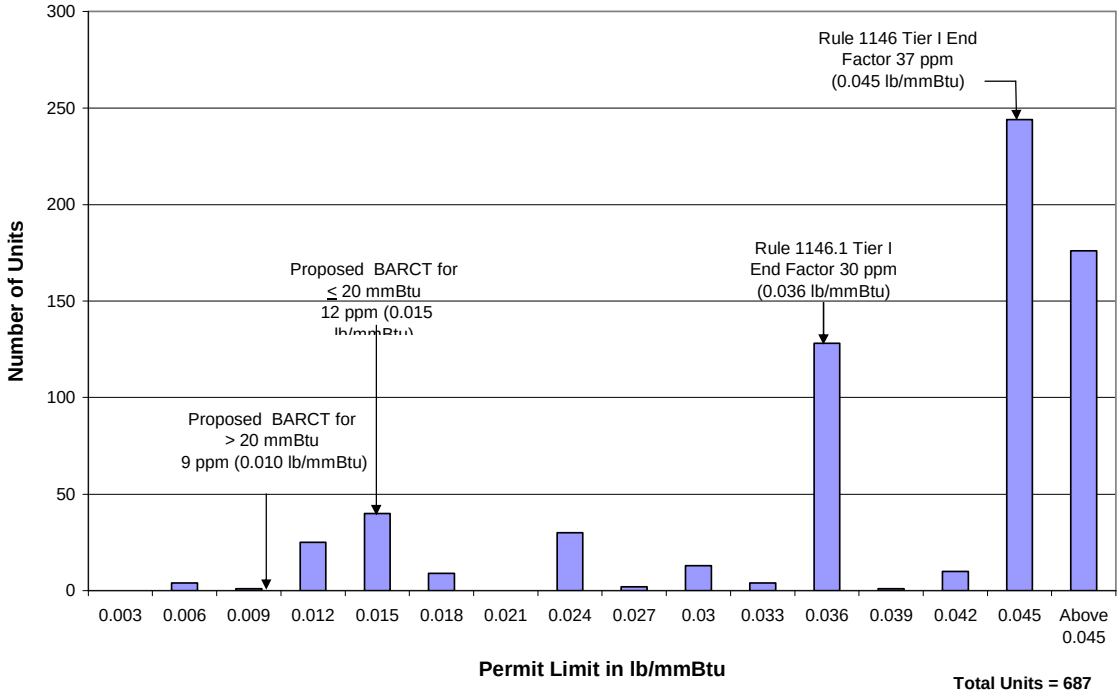
San Joaquin Valley Unified Air Pollution Control District's (SJVUAPCD) Rule 4306 – Boilers, Steam Generators, Heaters, and Process Heaters, is more stringent than the AQMD's rules for some classifications of boilers/heaters. Gaseous fueled units rated at less than or equal to 20 mmBtu/hr are limited to 15 ppm and those rated at greater than 20 mmBtu/hr are limited to 9 ppm. In addition to these two categories, the rule specifies other categories and limits. For gaseous-fueled oilfield and load following boilers/heaters, the limit is 15 ppm. For all liquid fueled units, regardless of size or usage, the limit is 40 ppm. SJVUAPCD Rule 4306 also allows a weighted average based on annual fuel usage for units that operate on both gaseous and liquid fuels. SJVUAPCD has not yet implemented their rule, so it is unknown how many units have achieved the new limits in that district.

Other considerations in the BARCT analysis were the existing technologies for NOx control. Selective catalytic reduction, while able to reach low NOx limits and achieved in practice, was determined not to be technologically feasible for this source category, particularly the smaller units. Unlike low-NOx burners, SCR installations require additional space for the controls and ammonia tanks. Due to space constraints and the toxicity issues of ammonia, SCR is typically not feasible for smaller units. Low NOx burners and ultra low NOx burners are capable of achieving NOx emission limits of 12 ppm for natural gas units rated at less than or equal to 20 mmBtu/hr and 9 ppm for units rated at greater than 20 mmBtu/hr.

The RECLAIM inventory includes approximately 700 boilers and heaters in the Rule 1146/1146.1 category. The category encompasses units from many different industries used for various processes, including approximately 100 refinery units (non-Rule 1109). Most of the boilers/heaters are fired on natural gas only, however there are some units permitted for use with other fuels, including liquid fuels, process gas, and refinery gas. A histogram of the boiler inventory was prepared based on permitted emission limits (see Figure 4). Some of the units with the lowest permit limits may be units installed at BACT. New BARCT levels of 12 ppm for units less than or equal to 20 mmBtu/hr and 9 ppm for units greater than 20 mmBtu/hr were determined for the Rule 1146 and 1146.1 boilers/heaters based on the evaluation of other district's rules, analysis of retrofit technology, and consideration of the mix of equipment types and fuels in the RECLAIM inventory. The new BARCT level is the same as the level SJVUAPCD has set for natural gas units in their Rule 4306.

Figure 4

R1146 & 1146.1 Boilers/Heaters



Notes: BACT for ≤ 20 mmBtu/hr is 12 ppm
BACT for > 20 mmBtu/hr is 9 ppm

Metal Melting and Metal Heat Treating

Current BARCT in RECLAIM for heat treating and metal melting furnaces was based on a subsumed 1991 AQMP control measure (90P-C-5). These types of equipment are subject to an end factor in Rule 2002 of approximately 50 ppm or 0.062 pounds of NOx per mmBtu of heat input.

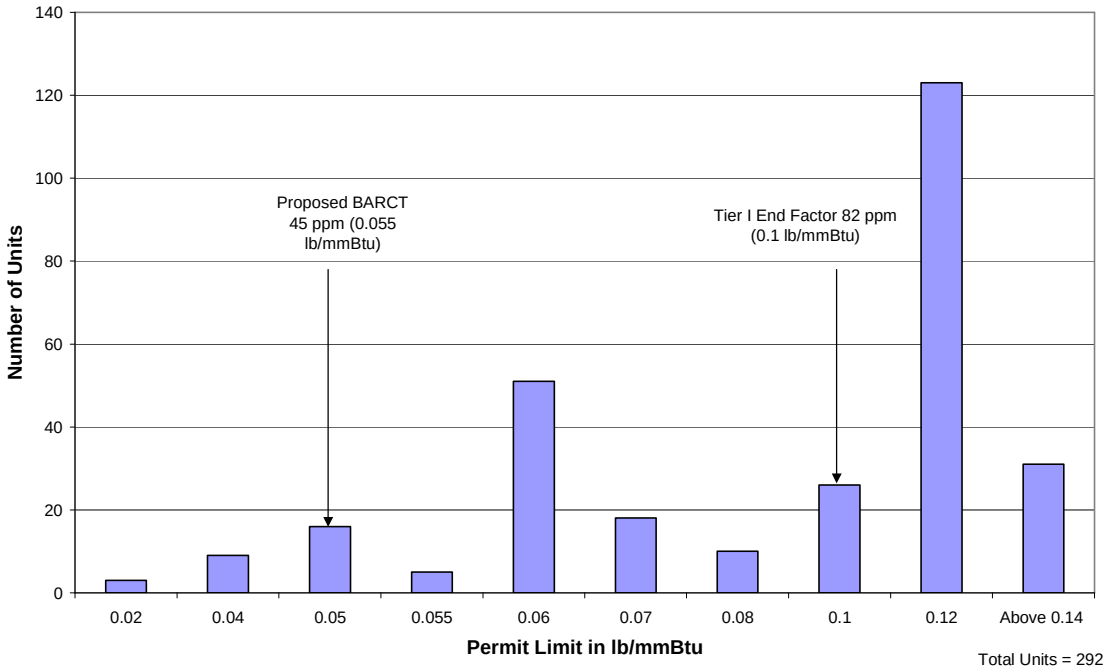
A review of South Coast and other districts' rules showed no specific rules for these two types of equipment other than rules regarding toxic emissions. Based on discussions with and information provided by equipment vendors, burner and combustion technology has improved since RECLAIM was initiated (1993/1994). Low NOx burners and ultra low NOx burners have been used to achieve NOx limits at or below 45 ppm for this type of equipment in retrofit applications. Due to the wide variety of equipment designs, the attainable NOx emission level varies on a case-by-case basis.

The RECLAIM inventory includes approximately 300 heat treating furnaces. Based on permit limits for NOx, more than 30 of the units are at or below 45 ppm. A histogram of the heat treating equipment is shown in Figure 5 based on the permitted NOx limits for the units. Some of the units with the lowest permit limits may be units installed at BACT. There are approximately 90 metal melting furnaces in the RECLAIM inventory with over one-fourth of the units currently at or below 45 ppm based on permit limits (see Figure 6). Many of the heat treating and metal melting furnaces are uncontrolled, however a review of units with burner

retrofits showed that NOx levels at or below 45 ppm are achievable. Based on improvements in burner and combustion technology, discussions with burner manufacturers, and a review of existing retrofits, a new average BARCT level of 45 ppm or 0.055 pounds of NOx per mmBtu of heat input was determined to be feasible for this equipment.

Figure 5

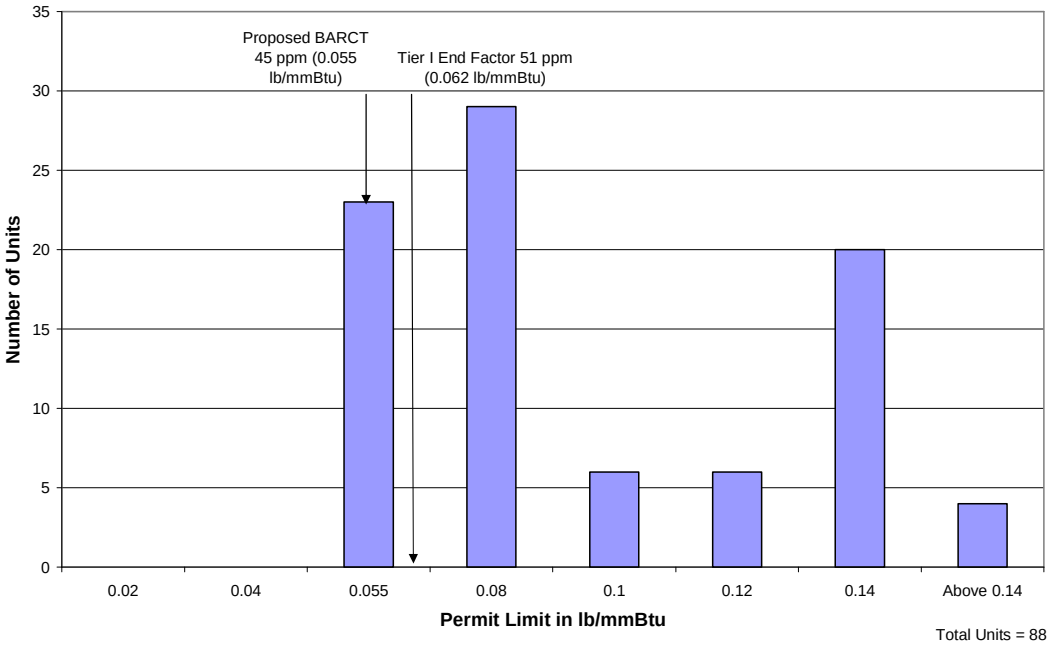
Heat Treating



Note: BACT is natural gas with low NOx burner

Figure 6

Metal Melting



Note: BACT is natural gas with low NOx burner

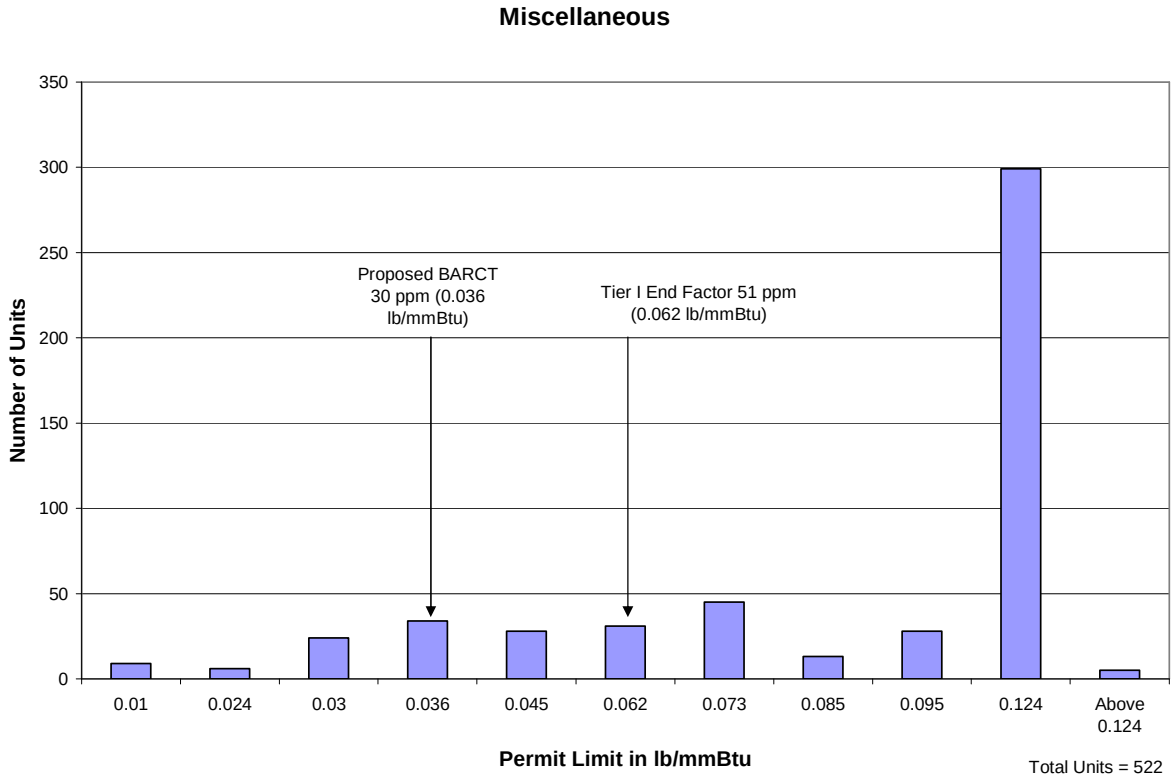
Miscellaneous Combustion Equipment

The miscellaneous equipment category includes ovens, kilns, calciners, dryers, and furnaces. It does not, however, include ceramic, clay, cement, or brick kilns or metal melting, heat treating, or glass melting furnaces. Current BARCT in RECLAIM for miscellaneous combustion equipment was based on a subsumed 1991 AQMP control measure (90A-C-5). These types of equipment are subject to an end factor in Rule 2002 of approximately 50 ppm or 0.062 pounds of NOx per mmBtu of heat input.

A review of South Coast and other districts' rules showed no specific rules for this type of equipment. However, burner and combustion technology has improved and ultra low NOx burners have been used to achieve NOx limits at or below 30 ppm for all these types of equipment in retrofit applications. There is a wide variety of equipment designs so NOx emission levels are typically determined on a case-by-case basis.

The RECLAIM inventory includes approximately 500 miscellaneous combustion sources in this category. Figure 7 is a histogram showing the distribution of the miscellaneous combustion units based on permit limits. Some of the units with the lowest permit limits may be units installed at BACT. More than 70 units are currently permitted for NOx levels at or below 30 ppm. A review of units with burner retrofits showed that NOx levels at or below 30 ppm are achievable. Based on improvements in burner and combustion technology, discussions with burner manufacturers, and a review of existing retrofits, a new average BARCT level of 30 ppm or 0.036 pounds of NOx per mmBtu of heat input was determined to be feasible for this equipment.

Figure 7



Note: BACT is natural gas with low NOx burner

Equipment Categories with No Proposed BARCT

Other categories of equipment in RECLAIM were evaluated to determine if new BARCT is feasible. Among the criteria considered when evaluating whether there was a need for new BARCT or not were:

- Does another air pollution control district or agency have a more stringent BARCT level than the SCAQMD?
- Is the proposed BARCT level achieved in practice with retrofits?
- Is technology available and feasible for retrofits?
- Do manufacturers offer guarantees for achieving proposed emission levels?
- Is retrofit technology cost effective?
- Based on the above criteria, could a command and control BARCT rule have been proposed in the absence of the RECLAIM program?

Other categories of equipment evaluated for new BARCT included afterburners, curing and drying ovens, glass melting furnaces, cement kilns, gas turbines, non-emergency internal combustion engines, and refinery boilers and heaters rated between 40 and 110 mmBtu per hour. We have not identified new, more stringent, BARCT for this equipment to date. New BARCT was not established for these categories for various reasons. In some cases, current BARCT NOx emission levels are already the most stringent. In other cases, the available retrofit technology was not cost effective. Appendix A contains a detailed listing of the BARCT

findings for each of these categories. RECLAIM facilities have the option of choosing to retrofit some of these sources in lieu of the sources where new BARCT is proposed. Although retrofits were deemed not cost effective for a category, retrofits on individual pieces of equipment may be cost effective. This allows RECLAIM participants other possibilities for flexibility to decide the best way to meet their reduced NOx RTC allocations.

Of the aforementioned categories evaluated for BARCT, only gas turbines were found to have a control level more stringent than that previously subsumed under the RECLAIM program. However, upon review of the cost associated with the use of SCR, the controls were not found to be cost effective based on the activity levels used for estimating the year 2000 allocations.

Staff Recommendation

The following categories of equipment have been identified as capable of further emission reductions beyond the Tier I emission factors (i.e., Rule 2002 Table 1 factors): industrial and refinery boilers and heaters; metal melting furnaces; metal heat treating; fluid catalytic cracking units (FCCU); and miscellaneous combustion sources (i.e., ovens, kilns, calciners, dryers, and furnaces). Utility boilers can also achieve further reductions beyond Tier I controls; however, since they have previously installed BARCT pursuant to Rule 2009, these reductions have already been achieved and need to be reflected in program allocations.

Table 1 contains a summary of the BARCT determinations for each of the equipment categories that were found to have technically and economically feasible emission reductions. Review of rules and regulations of other agencies is a key component of examining all feasible measures relative to defining technically and economically feasible BARCT levels.