Proposed Amended Rules 1146 & 1146.1 Emissions of Oxides of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters

Working Group Meeting #2
April 24, 2025

Zoom Meeting Information

URL: https://scaqmd.zoom.us/j/91820448856
Meeting ID: 918 2044 8856
Dial-In: +1 (669) 900-6833

Agenda

- Summary of Working Group Meeting #1
- Equipment Universe Update
- BARCT Assessment – Assessment of Emission Limits
- BARCT Assessment – Other Regulatory Requirements
- Next Steps

Summary of Working Group Meeting #1

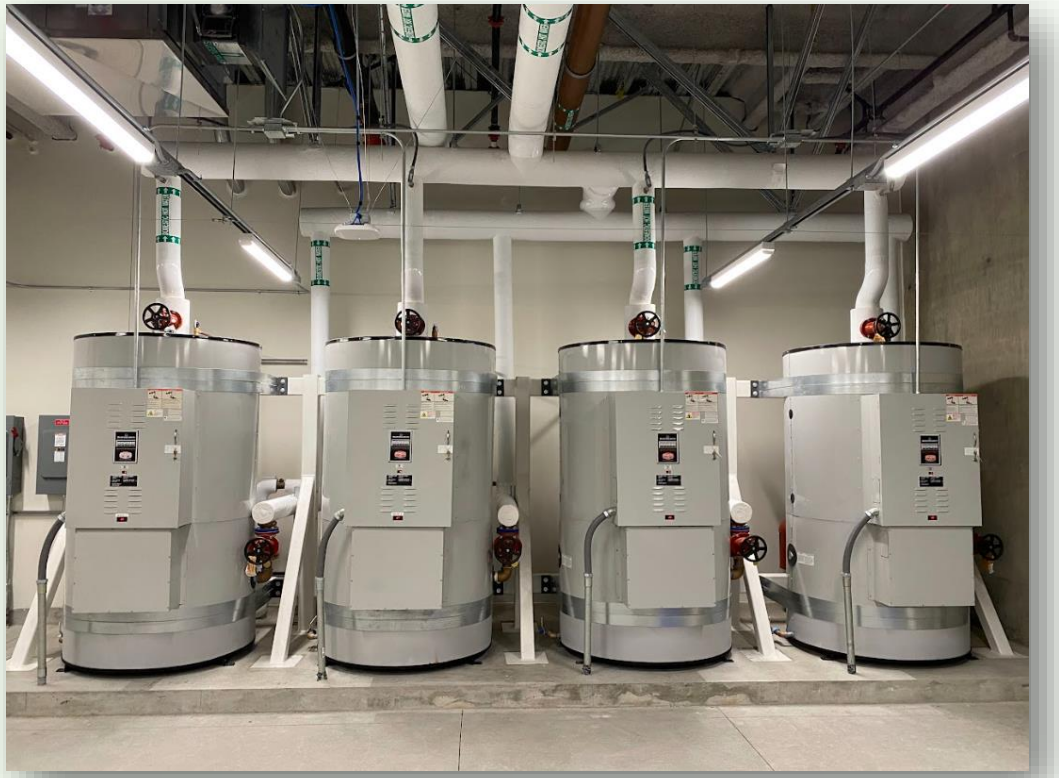
Summary of Working Group Meeting #1

- Background on South Coast AQMD and objective to meet National Ambient Air Quality Standards
  - South Coast Air Basin is in non-attainment for ozone standard
- Rule development for Proposed Amended Rules (PARs) 1146 and 1146.1 was initiated to implement Control Measure L-CMB-02 in the South Coast AQMD's 2022 Air Quality Management Plan (AQMP)
- Updated cost-effectiveness threshold in 2022 AQMP prompts an updated cost-effectiveness analysis for PARs 1146 and 1146.1
- Overview of the rule development process and importance of Working Group meetings

Equipment Universe Update

Initial Equipment Database

- Staff previously presented an initial review of the equipment subject to PAR 1146
- Categorized equipment by:
  - **Size**: Group I, Group II, Group III, and Rule 1146.1
  - **Fuel Type**: gas-fired, liquid-fired, mixed-fired, or other fuel
- Staff further refined the equipment database and removed units that are subject to other Regulation XI rules



Units Removed From Initial Database

- Rules 1146 and 1146.1 encompasses boilers, process heaters, and steam generators
- "Heater" classification on some permits were found to overlap with processes regulated by other Regulation XI rules
  - Units removed from updated PARs 1146 and 1146.1 equipment database

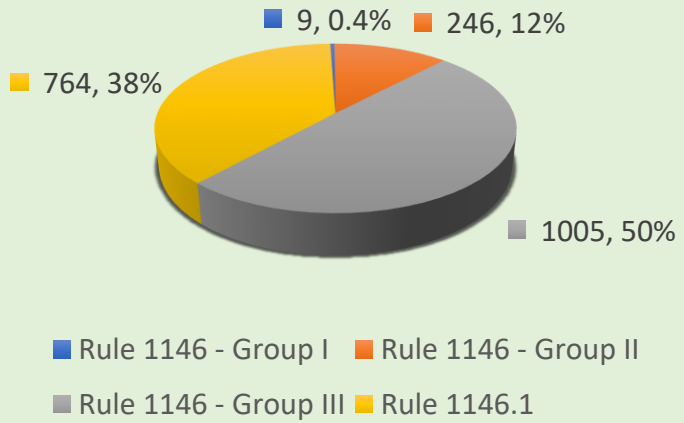
Units Removed from Initial Database

Unit Type	Regulation XI Rule	Rule Title
Used for Electrical Production	Rule 1135	Emissions of Oxides of Nitrogen from Electricity Generating Facilities
Located at Petroleum Refineries	Rule 1109.1	Emissions of Oxides of Nitrogen from Petroleum Refineries and Related Operations
Located at Sewage Treatment Plants	Rule 1179.1	Emission Reductions from Combustion Equipment at Publicly Owned Treatment Works Facilities
Located at Landfills	Rule 1150.3	Emissions of Oxides of Nitrogen from Combustion Equipment at Landfills
Used for Incineration or Drying	Rule 1147	NOx Reductions from Miscellaneous Sources
Used for Asphalt Processing	Rule 1147.1	NOx Reductions from Aggregate Dryers
Used for Metal Processing	Rule 1147.2	NOx Reductions from Metal Melting and Heating Furnaces

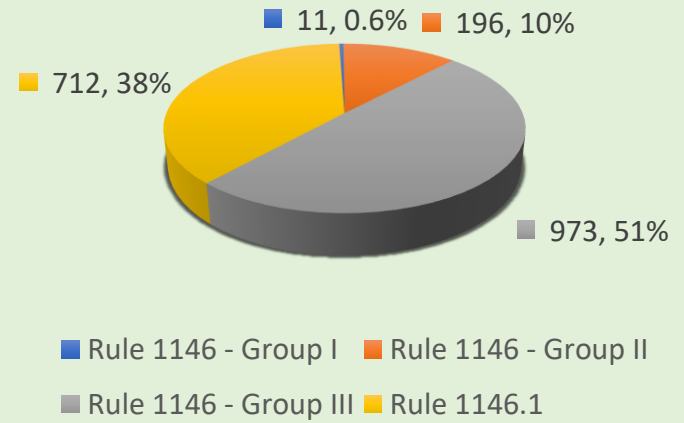
Revised Equipment Database

- PARs 1146 and 1146.1 total unit count revised from 2,024 units to 1,892 units
- Updated PAR 1146 Group I unit count
  - Original nine PAR 1146 Group I units identified as utility boilers (Rule 1135 applicability)
  - Identified 11 units from original PAR 1146 Group II as ≥ 75 MMBtu/hr (Group I eligibility)

Original PAR 1146/1146.1 Size Distribution (Unit Count, % of Total)



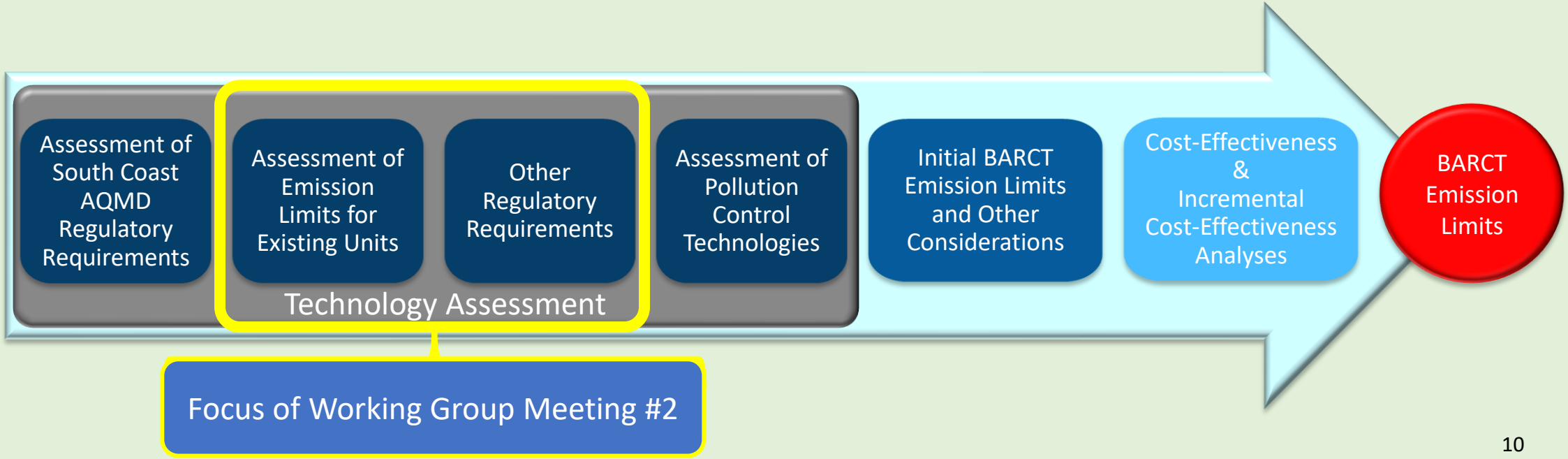
Revised PAR 1146/1146.1 Size Distribution (Unit Count, % of Total)



BARCT Assessment – Assessment of Emission Limits

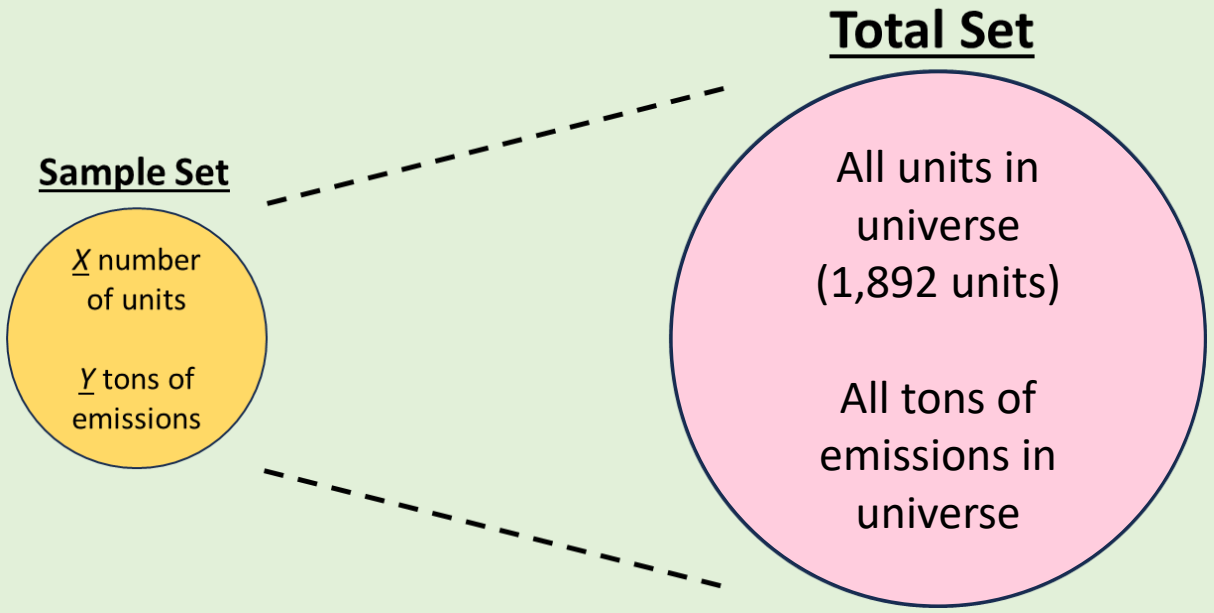
BARCT Assessment Next Steps

- BARCT assessment will be conducted for each class and category of equipment in PARs 1146 and 1146.1
- Working Group Meeting #1 discussed current South Coast AQMD regulatory requirements for the equipment categories in PARs 1146 and 1146.1
- Working Group Meeting #2 will both assess current emission limits and review regulations outside of the South Coast AQMD for industrial and commercial boilers and process heaters



Need and Process for Sample Set of Units

- PARs 1146 and 1146.1 equipment universe is large (1,892 total units)
  - Evaluating each unit individually would take over 6 months
- Staff selected a sample of units to assess emission inventory and emission reductions efficiently
- A statistically significant sample (*Sample Set*) was analyzed in order to estimate total equipment universe (*Total Set*) emissions



Process for Sample Set of Units

The unit sampling process involved the following steps

1. Establish statistical criteria to define “statistically significant” for the Sample Set
2. Utilize randomization to select which units are included in Sample Set
3. Research emissions for each individual unit in Sample Set
4. Aggregate Sample Set unit-level emissions and extrapolate to Total Set
5. Utilize results for emissions inventory and potential emission reductions

Sample Set Process: Step 1 (Statistical Significance – Background)

1 Establish statistical criteria to define "statistically significant" for the Sample Set

- **Objective**: Determine the quantity of units necessary to be confident that the unit emissions in the Sample Set approximate unit emissions in the 1,892-unit Total Set
- **Relevant statistical parameters**: *Confidence Level* and *Margin of Error*

Confidence Level

A measure of certainty that a particular parameter lies within a specific range of values

"The percentage of likelihood that a different random sample set will contain a value within the range"

E.g. **95% Confidence Level** that the Total Set emissions are between 0.13 – 0.17 tons NOx per day

Margin of Error

The range within which the true value of a Total Set parameter lies

"The degree of uncertainty of the sample set value, which sets the range"

E.g. The Total Set emissions are 0.15 tons **± 10% tons** NOx per day (range is 0.135 – 0.165 tons NOx per day)

Sample Set Process: Step 1 (Statistical Significance – Results)

1 Establish statistical criteria to define "statistically significant" for the Sample Set

- Staff selected criteria for a confidence level and margin of error generally accepted in statistical analyses
  - Confidence Level: 95%
  - Margin of Error: 10%
- Calculated the quantity of units of the Sample Set necessary to satisfy these criteria
- Calculation was performed per equipment category to minimize skewing of results
  - All 11 Group I units were analyzed to capture the largest units

Equipment Category	Total Set Unit Count	Sample Set Unit Count Confidence Level: 95% Margin of Error: 10%
Rule 1146 – Group I	11	11
Rule 1146 – Group II	196	65
Rule 1146 – Group III	973	88
Rule 1146.1	712	85
Total	1,892	**249**

Sample Set Process: Step 2 (Unit Randomization)

2 Utilize randomization to select which units are included in Sample Set

- Staff initially sought to randomly select 249 units for a Sample Set
- For each equipment category, the target Sample Set unit counts were randomly selected by:
  - Assigning each unit a number
  - Using a random number generator to select the Sample Set
- Units located at facilities that did not have emission reports were removed from the Sample Set
  - Final Sample Set count was 138 units
  - Margin of error increased from 10% to 16% but determined to still be a representative sample

Sample Set Process: Step 2 (Revised Sample Set Count)

2 Utilize randomization to select which units are included in Sample Set

Equipment Category	Total Set Unit Count	Initial Sample Set Unit Count *Confidence Level: 95% Margin of Error: 10%*	Final Sample Set Unit Count *Confidence Level: 95% Margin of Error: 16%*
Rule 1146 – Group I	11	11	8
Rule 1146 – Group II	196	65	51
Rule 1146 – Group III	973	88	48
Rule 1146.1	712	85	31
Total		**249**	**138**

Number of units randomly selected from each equipment category

Sample Set Process: Step 3 (Annual Emissions Report)

3 Research emissions for each individual unit in Sample Set

- Unit emissions data can be obtained from Annual Emission Reports (AER)
- Rule 301 Paragraph (e)(2) specifies that AERs are required to be submitted by any facility that exceeds an estimated annual emission threshold, including a threshold of 4 tons NOx per year

Sample Set Process: Step 3 (Sample Annual Emission Report)

3 Research emissions for each individual unit in Sample Set

South Coast AQMD

Annual Emission Report

(2)

(1) *Reporting Year:* **2023**

Print Date: **02/20/2024**

Facility Id: [redacted]
Facility Name [redacted]
Facility Type: [redacted]

(5)

External Combustion Process List Overview

AER Device ID	Permit Device ID	A/N	Process ID	Equipment	Fuel	Fuel Usage	Units		Criteria Pollutant Units	ROG	SPOG	NOx	SOx	CO	PM
ES11		378759	P1	Charbroiler	Natural Gas	0.151200	mmscf	EF	lbs/ mmscf	7.000000		130.000000	0.600000	35.000000	7.500000
								Emissions	lbs	1.06		19.66	0.09	5.29	1.13
ES25		631448	P1	Boiler 10-100 MMBTU/HR	Natural Gas	3.479000	mmscf	EF	lbs/ mmscf	5.500000		11.310000	0.600000	84.000000	7.600000
								Emissions	lbs	19.13		39.35	2.09	292.24	26.44
ES26		631449	P1	Boiler 10-100 MMBTU/HR	Natural Gas	3.967000	mmscf	EF	lbs/ mmscf	5.500000		11.310000	0.600000	84.000000	7.600000
								Emissions	lbs	21.82		44.87	2.38	333.23	30.15
ES27		631450	P1	Boiler 10-100 MMBTU/HR	Natural Gas	2.795000	mmscf	EF	lbs/ mmscf	5.500000		11.310000	0.600000	84.000000	7.600000
								Emissions	lbs	15.37		31.61	1.68	234.78	21.24
								Total Emissions	lbs	57.38		135.48	6.24	865.54	78.97
								Total Emissions	tons	0.03	0.00	0.07	0.00	0.43	0.04

(3) (4)

1. Calendar year for which emissions are calculated
2. Facility identification
3. Unit identification
4. Fuel usage
5. Emission factor and mass emissions

Sample Set Process: Step 4 (Extrapolation Equations)

4 Aggregate Sample Set unit-level emissions and extrapolate to Total Set

Aggregate NOx emissions for **Sample Set Unit Count** totals **Sample Set Emissions**
Aggregate NOx emissions for **Total Set Unit Count** totals **Total Set Emissions**

Extrapolation of emissions based on ratio of unit counts

$$\frac{\textit{Total Set Unit Count}}{\textit{Sample Set Unit Count}} = \textit{Unit Ratio}$$

$$\textit{Unit Ratio} * \textit{Sample Set Emissions} = \textit{Total Set Emissions}$$

Sample/Total Sets and extrapolation conducted for each equipment class and category

Sample Set Process: Step 4 (Total Set Emission Calculation)

4 Aggregate Sample Set unit-level emissions and extrapolate to Total Set

$$\frac{\textit{Total Set Unit Count}}{\textit{Sample Set Unit Count}} = \textit{Unit Ratio}$$

$$\textit{Unit Ratio} * \textit{Sample Set Emissions} = \textit{Total Set Emissions}$$

Equipment Category	Total Set – Unit Count	Sample Set – Unit Count	Unit Ratio
PAR 1146 – Group I	11	8	1.38
PAR 1146 – Group II	196	51	3.84
PAR 1146 – Group III	973	48	20.3
PAR 1146.1	712	31	23.0

Unit Ratio	Sample Set – NOx Emissions (tpd)	Total Set – NOx Emissions (tpd)
1.38	0.02	0.02
3.84	0.10	0.40
20.3	0.05	0.98
23.0	0.01	0.24
Totals	**0.18**	**1.64**

Aggregated together, the total universe NOx emissions are estimated to be 1.64 tons per day[1]

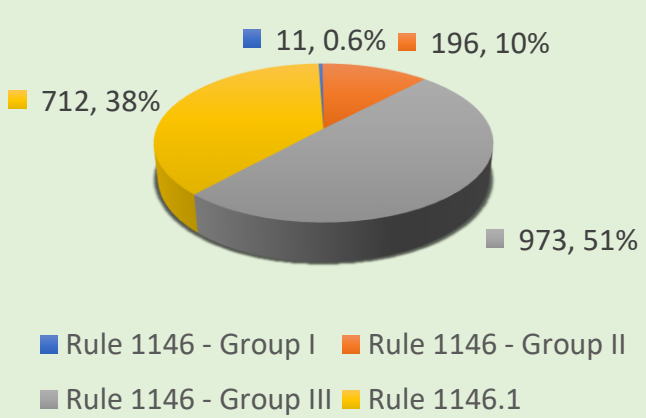
[1] Calculated result of 1.64 tons NOx per day has a margin of error of 16% with a confidence level of 95%

Sample Set Process: Step 5 (Emissions Inventory Summary)

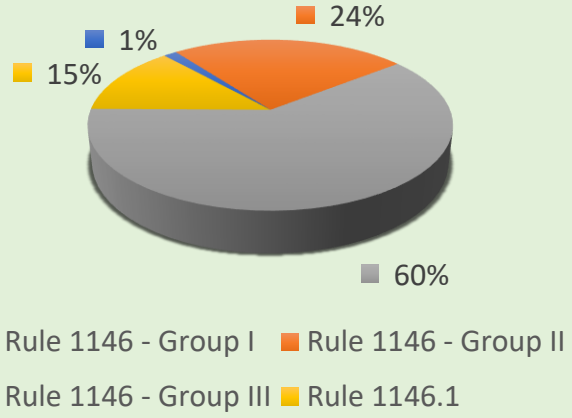
5 Utilize results for emissions inventory and potential emission reductions

Category Size Distribution vs. Emission Distribution

Revised PAR 1146/1146.1 Size Distribution (Unit Count, % of Total)



PAR 1146/1146.1 Emissions Distribution



Largest units (Group I) make up only 1% of emissions
Mid-size units (Group III) estimated to contribute the most emissions (two-thirds of universe)

Sample Set Process: Step 5 (Emissions Inventory Insights)

5 Utilize results for emissions inventory and potential emission reductions

Large difference in quantity of units across categories required an equalization of emissions

Group	Category Unit Count	Median Fuel Usage (MMScf/yr)	Median Emission Factor (lbs/MMScf)	NOx Emissions (tpd)	% of Rule 1146/1146.1 Universe Emissions
Rule 1146 - Group I	11	238	4.43	0.02	1%
Rule 1146 - Group II	196	61.7	11.5	0.40	24%
Rule 1146 - Group III	973	15.2	18.4	0.98	60%
Rule 1146.1	712	1.94	100	0.24	15%

1. Group I units have the lowest emission factor, but high fuel usage increases calculated emissions
   Rule 1146.1 emissions likely overestimated due to most units using default emission factor of 100 lbs/MMScf
2. At the category-level, Group I and Group II are only 25% of estimated universe emissions due to smaller quantity of units

Group III units likely to have the greatest potential for emission reductions due to higher unit-level emissions and larger quantity of units

Rule Limit Emission Estimate

5 Utilize results for emissions inventory and potential emission reductions

- AER reported emission factors are estimates and may not reflect actual or permitted emission limits
  - Default emission factors (e.g. 100 lbs/MMScf) may be used, which overestimate emissions
- Staff calculated emission results using the category-specific rule limit in-place of the AER emission factor (Rule Limit Approach)[1]

AER Emissions = AER Fuel Usage * **AER Emission Factor**

Existing Rule Limit Emissions = AER Fuel Usage * **Rule Limit**

Unit Category[1]	Median Emission Factor (lbs NOx/MMScf)	Median Emission Factor (ppm NOx equivalent)	Existing Rule Limit (ppm NOx @ 3% O2)[2,3]	NOx Emissions Using AER Emission Factors (tpd)	% of Universe Emissions	NOx Emissions Using Existing Rule Limit (tpd)	% of Rule 1146/1146.1 Universe Emissions
Rule 1146 - Group I	4.43	3.5	5	0.02	1%	0.04	7%
Rule 1146 - Group II	11.5	9.1	9	0.40	24%	0.22	38%
Rule 1146 - Group III	18.4	15	9	0.98	60%	0.27	48%
Rule 1146.1	100	79	9	0.24	15%	0.04	7%
				1.64		**0.57**	

[1] Groupings shown are by unit rated heat input capacity; additional rule subcategories exist for recently retrofitted units and thermal fluid heaters

[2] Due to AER reports only designating unit size, the highest NOx limit was chosen for each possible Group to balance some units operating as thermal fluid heaters with a 12 ppm NOx limit

[3] Of the 138 Sample Set units, 42 units were reviewed for permit data. All units have current permit limits that reflect the rule category limit.

NOx Emission Baseline

5 Utilize results for emissions inventory and potential emission reductions

- Previous Rule 1146 series amendment in 2018 estimates
  - Previous NOx inventory: 0.844 tons per day[1]
  - Total NOx reductions: 0.270 tons per day[2]
  - New NOx inventory: **0.574 tons per day**
- Rule Limit Approach to NOx emission inventory calculation reasonably approximates the current NOx emission baseline calculated from 2018 amendment

0.57 tons per day will serve as NOx emission inventory for PAR 1146/1146.1

Group[1]	NOx Emissions Using AER Emission Factors (tpd)	NOx Emissions Using Rule Limit Approach (tpd)
Rule 1146 - Group I	0.02	0.04
Rule 1146 - Group II	0.40	0.22
Rule 1146 - Group III	0.98	0.27
Rule 1146.1	0.24	0.04
	1.64	**0.57**

[1] Estimate of 0.404 tpd NOx from assessed RECLAIM units and 0.44 tpd NOx from Non-RECLAIM units

[2] Most NOx emission limits in 2018 amendment effective as of January 1, 2023 (0.27 tpd NOx reductions); certain sub-categories have until December 7, 2033 to meet the rule limit (additional 0.04 tpd NOx reductions)

BARCT Assessment – Other Regulatory Requirements

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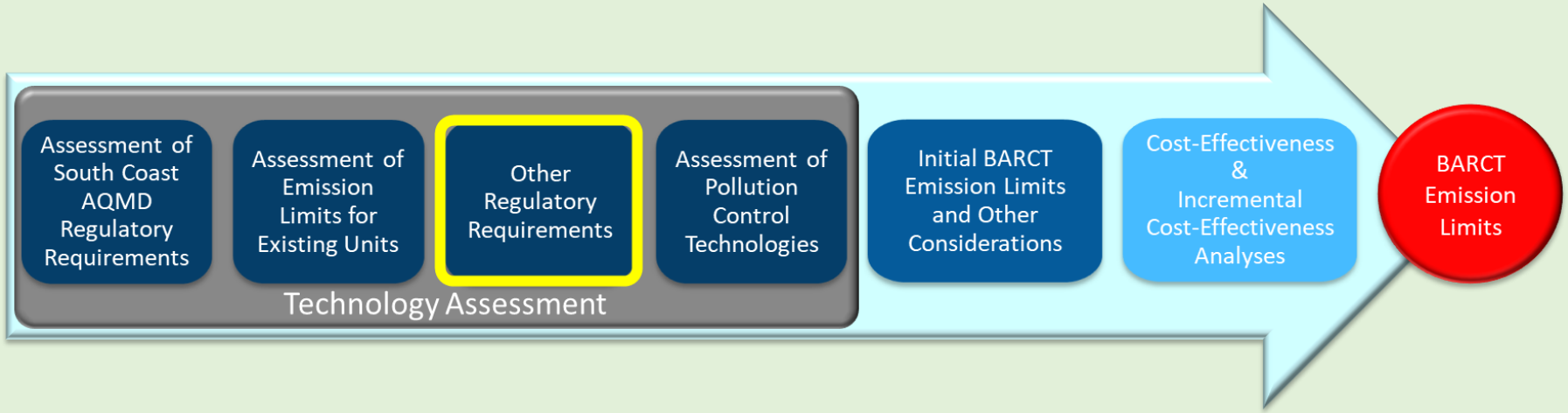


- Other NOx regulations for commercial and industrial boilers reviewed for comparative purposes
- Comparison illustrates the existing NOx limits in other jurisdictions and how South Coast AQMD limits may decrease

Staff consulted state, national, and international sources for NOx regulation information

- California
- Other States
- Federal & International

BARCT Assessment – Other NOx Regulations (California)

Other Regulatory Requirements

Staff reviewed regulations in all 33 California air districts and summarized most stringent NOx limits in table below

Air District	Rule Number	Units > 2 to ≤ 5 MMBtu/hr	Units > 5 to ≤ 20 MMBtu/hr	Units > 20 to ≤ 75 MMBtu/hr	Units > 75 MMBtu/hr
South Coast AQMD	Rule 1146 Rule 1146.1	Fire-tube Boilers: 7 ppm Other Units: 12 ppm	9 ppm	5 ppm	5 ppm
San Joaquin Valley APCD	Rule 4306 Rule 4307	Existing Unit: 30 ppm New Unit: 12 ppm	7-9 ppm	7 ppm	5 ppm
Bay Area AQMD	Regulation 9 Rule 7	30 ppm	15 ppm	9 ppm	5 ppm
Monterey Bay Air Resources District	Rule 441	30 ppm	15 ppm	9 ppm	
Sacramento Metropolitan AQMD	Rule 411	30 ppm	15 ppm	9 ppm	
Ventura County APCD	Rule 74.15 Rule 74.15.1	Gas: 9-12 ppm LPG: 20 ppm	Existing Units: 40 ppm, New Unit (Boilers): 9 ppm, New Units (Process Heaters): 12 ppm		

* All NOx ppm values corrected to 3% O2; lbs/MMBtu figures converted to 3% O2 ppm figures
** All listed NOx ppm values are applicable to gaseous fuel, unless otherwise specified
*** All listed Air Districts require a 40 ppm NOx @ 3% O2 emission limit for units fired on non-gaseous fuels

BARCT Assessment – Other NOx Regulations (Other States)

Other Regulatory Requirements

Majority of other state regulatory entities reviewed for comparative commercial and industrial boiler regulations

Sample of lowest NOx limits included below

Regulatory Agency	Rule Number	Emission Limits
South Coast AQMD	Rule 1146 Rule 1146.1	**Units > 2 to ≤ 5 MMBtu/hr**: 7-12 ppm, **Units > 5 to ≤ 20 MMBtu/hr**: 9 ppm, **Units > 20 MMBtu/hr**: 5 ppm, **All Liquid-Fired Units**: 40 ppm
Arizona	Rule 323	**Units > 10 MMBtu/hr**: 30 ppm (gas), 40 ppm (liquid)
Michigan	General Permit Criteria	**General Permit for Units ≤ 100 MMBtu/hr**: 41 ppm (gas)
Texas	Rule 117.2010	**All Minor Source Units:** 30 ppm (gas); 60 ppm (liquid)
Utah	Rule 307-315 Rule 307-316	**Units ≥ 2 MMBtu/hr**: 9 ppm (gas)
Wisconsin	Chapter NR 428	**Unit ≥ 25 MMBtu/hr**: 41 ppm (gas), 70 ppm (distillate oil), 117 ppm (residual oil)

* All NOx ppm values corrected to 3% O2; lbs/MMBtu figures converted to 3% O2 ppm figures

BARCT Assessment – Other NOx Regulations (Federal & International)

Other Regulatory Requirements

Federal and other countries reviewed for comparative commercial and industrial boiler regulations

Sample of lowest NOx limits included below

Regulatory Agency	Rule Number	Emission Limits
South Coast AQMD	Rule 1146 Rule 1146.1	**Units > 2 to ≤ 5 MMBtu/hr**: 7-12 ppm, **Units > 5 to ≤ 20 MMBtu/hr**: 9 ppm **Units > 20 MMBtu/hr**: 5 ppm, **All Liquid-Fired Units**: 40 ppm
Federal	40 CFR Part 60 Subparts D, Db	**> 100 to ≤ 250 MMBtu/hr:** 83-165 ppm (gas), 234-312 ppm (residual oil) **> 250 MMBtu/hr:** 165 ppm (gas), 234 ppm (liquid)
Japan	Regulatory Measures against Air Pollutants	**All Units**: 60 ppm (gas), 130 ppm (dual-fire), 200 ppm (liquid)
European Union	Medium Combustion Plant 2017 Regulations	**All Units**: 53 ppm (gas), 106 ppm (liquid)
Switzerland	Ordinance on Air Pollution Control	**All Units**: 80 ppm (liquid)

* All NOx ppm values corrected to 3% O2; lbs/MMBtu and mg/M^3 figures converted to 3% O2 ppm figures

BARCT Assessment – Other NOx Regulations (Summary)

Other Regulatory Requirements

Summary of Lowest NOx Limits at each Regulatory Tier

Regulatory Tier	Regulatory Agency	Emission Limits
Local	South Coast AQMD	**Units > 2 to ≤ 5 MMBtu/hr**: 7-12 ppm, **Units > 5 to ≤ 20 MMBtu/hr**: 9 ppm **Units > 20 MMBtu/hr**: 5 ppm, **All Liquid-Fired Units**: 40 ppm
California	San Joaquin Valley APCD	**All Units**: 5-12 ppm (gas; depending on size), 40 ppm (liquid)
Other States	Utah	**Units ≥ 2 MMBtu/hr**: 9 ppm (gas)
Federal & International	European Union	**All Units**: 53 ppm (gas), 106 ppm (liquid)

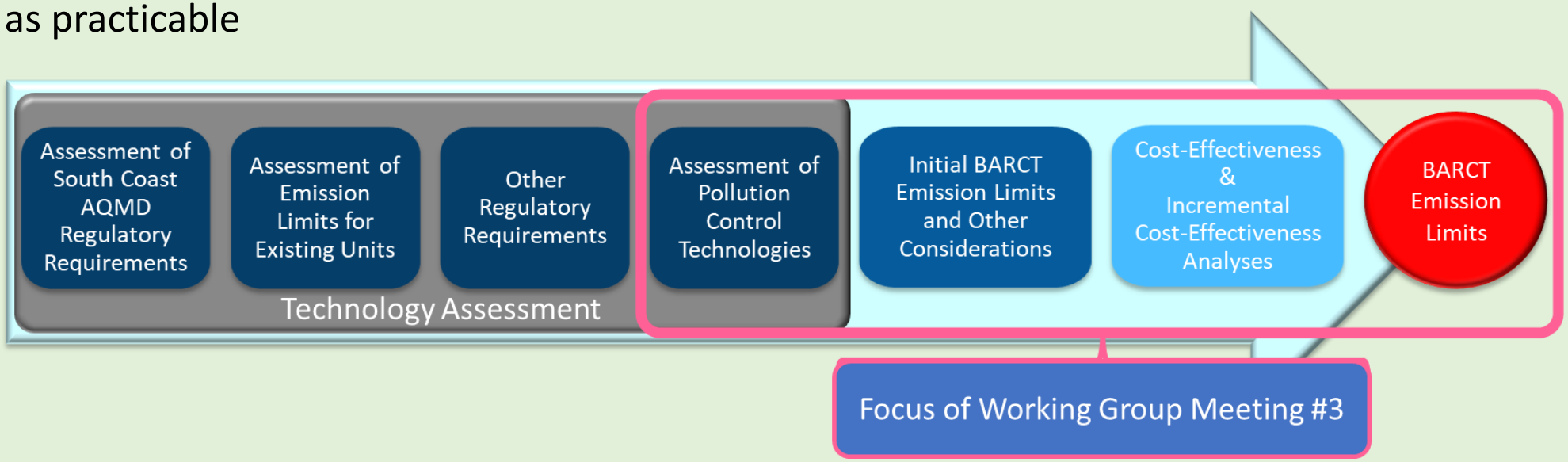
South Coast AQMD has some of the lowest NOx emission limits in the world for boilers
The South Coast Air Basin is still in extreme ozone non-attainment and requires further emission reductions

* All NOx ppm values corrected to 3% oxygen; lbs/MMBtu and mg/M^3 figures converted to 3% O2 ppm figures

Next Steps

Next Steps – Pollution Control Technologies and Cost-Effectiveness

- Staff will present its review of pollution control technologies to reduce NOx emissions
  - Will include zero-emission technology and near-zero emission technology
  - Will determine what initial NOx limits may be proposed in PAR 1146/1146.1
- Analyses will be conducted to determine whether control options are both technologically feasible and cost-effective in reducing NOx emissions (inclusive of both capital and operating costs)
- Objective is to implement Control Measure L-CMB-02 and achieve the BARCT emission limits as soon as practicable



Next Steps

Assess Zero- and Near-Zero Emission Technologies	Conduct Cost-Effectiveness Analyses	Hold Additional Working Groups	Public Process Timeline
• Meet with facilities and technology manufacturers • Conduct technology assessment for NOx control technology	• Assess emission benefit and cost of implementation of each control technology • Compare incremental benefits and costs between technologies	• Open to the public • Designed to provide forum for discussion, questions, and next steps	• Public Hearing: Q4 2025 (tentative)

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Proposed Rules Page

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