Proposed Rule (PR) 1147.2

NOx Reductions from Metal Melting and Heating Furnaces

Working Group Meeting #6

September 3, 2020

Zoom URL:
https://scaqmd.zoom.us/j/98725450149?pwd=eVhjY3Jzb3FpNjdDOVRwbjY0UmFWdz09
Dial-In: (669)-900-6833
Meeting ID: 987 2545 0149

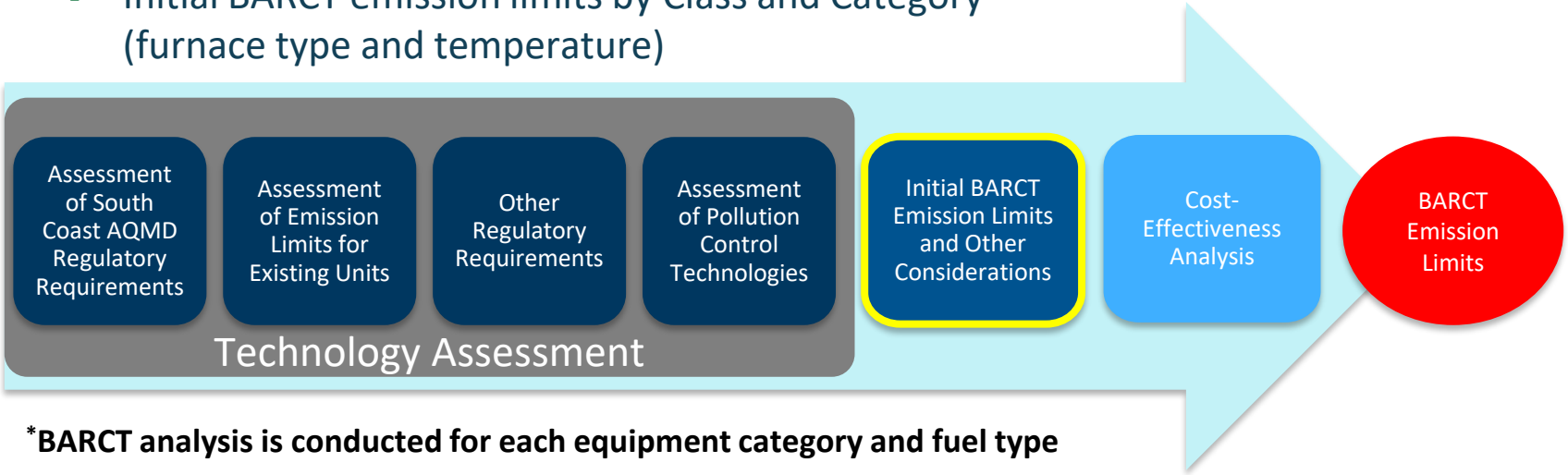
Agenda

- Summary of Previous Working Group Meeting
- Stakeholder Comments
- Re-Evaluation of BARCT Analysis for Metal Melting
- Cost-Effectiveness Methodology and Assumptions
- Cost-Effectiveness Analysis for Metal Melting

Summary of Previous Working Group Meeting

Summary of Previous Working Group Meeting

- Provided Sub-30 ppm Source Test Results Handout
  - The source test data handout presented during Working Group Meeting #5 has been further updated and has been added to the Proposed Rule 1147.2 webpage.
- Continued BARCT Analysis
  - Initial BARCT emission limits by Class and Category (furnace type and temperature)



*BARCT analysis is conducted for each equipment category and fuel type

Stakeholder Comments

Stakeholder Comments

Stakeholder Comment

Stakeholders commented on the feasibility of burners to comply with the initial BARCT emission limits presented during previous working group meeting

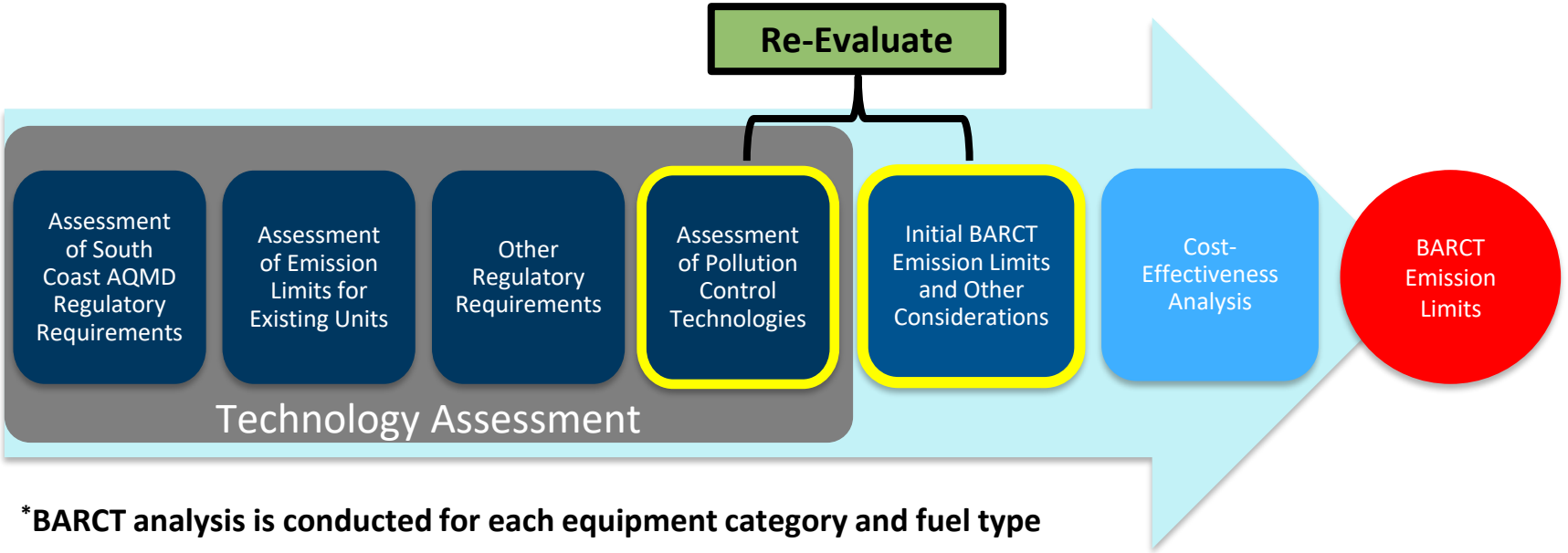
Staff Response

- Staff held additional meetings with burner vendors and facilities regarding burner emissions and other considerations
- Today's meeting will focus on re-evaluating technology assessment and initial BARCT emission limits for metal melting
- Next working group meeting will re-evaluate technology assessment and initial BARCT emission limits for metal heating
  - Will allow for staff to have further meetings with metal heating facilities

Re-Evaluation of Technology Assessment for Metal Melting

Re-Evaluation of Technology Assessment for Metal Melting

- Due to comments received regarding feasibility of burners to comply with the initial BARCT emission limits, staff re-evaluated the technical assessment and initial BARCT emission limits



*BARCT analysis is conducted for each equipment category and fuel type

Initial BARCT Emission Limits for Metal Melting from Previous Working Group Meeting

Metal Melting

Temp.	Crucible & Pit	Kettle & Pot	Holding	Reverb-eratory	Rotary	Other
≤ 1,230 °F	30 ppm	30 ppm	30 ppm	30 ppm 15 ppm* (SCR)	30 ppm	30 ppm
> 1,230 °F	30 ppm	30 ppm	30 ppm	30 ppm	30 ppm	30 ppm

* Initial BARCT emission limit based on SCR will only apply to units ≥ 20 MMBtu/hr

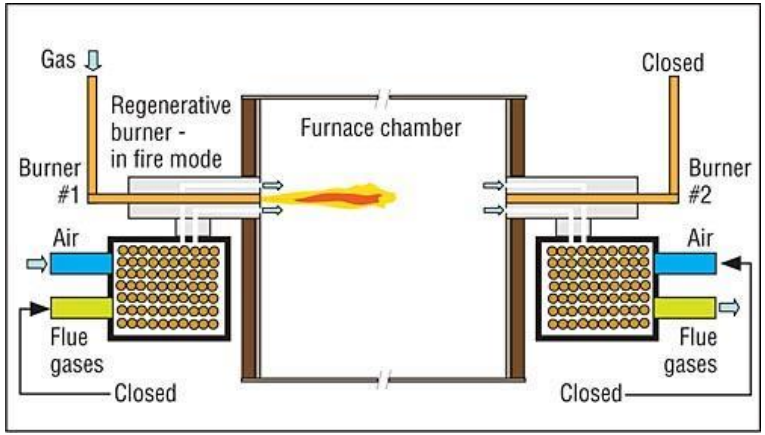
Overview

- All initial BARCT emission limits for burners were based on emissions performance stated in vendor literature
- During last working group meeting, stakeholders suggested staff have additional discussions with vendors
- Feedback from vendors and facilities suggested that staff categorize not by furnace type, but instead by burner type:
  - Cold-air burners
  - Regenerative (heat recovery) burners
- Staff re-evaluated technology assessment by burner type

Regenerative Burners

- Previous working group meetings have treated all burners as one type
  - Literature shows that regenerative burners are distinct in operations from cold-air burners and may warrant a separate categorization
- Dual-burner system that utilizes waste heat from one burner to pre-heat incoming combustion air for the other burner
- While NOx concentration may be relatively higher due to elevated combustion air temperature, less fuel is needed leading to lower overall NOx mass emissions
- The greater the process temperature, the greater the fuel savings when using regenerative burners*

Regenerative Burner Schematic



Source: Kaufman, Jared and Josh Marino. Regenerative Burners or Oxy-Fuel Burners for Your Furnace Upgrade?. Industrial Heating. June 2, 2011.

* Morris, Art. Industrial Heating. Sept 10, 2015. https://www.industrialheating.com/articles/92444-improving-energy-efficiency-with-recuperative-and-regenerative-burners

Technology Assessment by Burner Type

Previous Technology Assessment

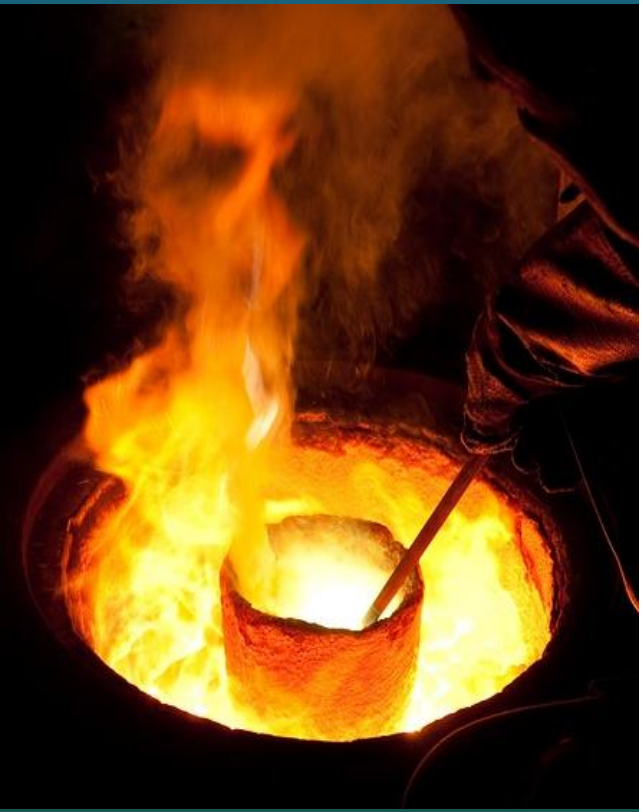
Technology portion of BARCT analysis presented at previous working group meetings was based on furnace types such as crucible & pit, kettle & pot, etc.

Stakeholder Input and Burner Literature

- Stakeholder input suggested looking at burner type
- Burner literature lists applications by material processed or burner type

Technology Assessment Re-Evaluation

- Staff conducted technology portion of the BARCT analysis based on two burner types
  - Cold-air burners
  - Regenerative burners
- Presenting results at today's working group meeting



Re-Evaluating Technology Assessment

Cold-Air Burners

Re-Evaluation of Technology Assessment

Cold-Air

- Reached out to vendors and obtained emission guarantees from 3 vendors for cold-air burners
- Compared source test results of units equipped with burners from vendors or models specified in the emission guarantees
  - Source test results of all other units also compared

Re-Evaluation of Technology Assessment

Cold-Air

Vendor	Emission Guarantee (ppm)	Source Test Results (ppm)
Vendor A (No Model Specified)	30-40 (No Conditions Specified)	**13 units: 21-51** (800-2,100 °F) 2 units: ≤ 30 7 units: 30-40
Vendor B (No Model Specified)	40-42 (No Conditions Specified)	**No Units**
Vendor C (Model Specified)	60 (No Conditions Specified)	**5 units: 38-53** (600-1,200 °F) 1 unit: 30-40
Remaining Units		**20 units: 34-59** (600-2,000 °F) 3 units: 30-40

* All ppm figures corrected to 3% O2

Re-Evaluation of Technology Assessment

- Vendor guarantees range from 30 to 60 ppm
  - Lower of the guarantees range from 30 to 42 ppm
- Source tests confirm 40 ppm achievable (13 of 38 units)

Initial BARCT Emission Limit: 40 ppm

Updated BARCT Analysis

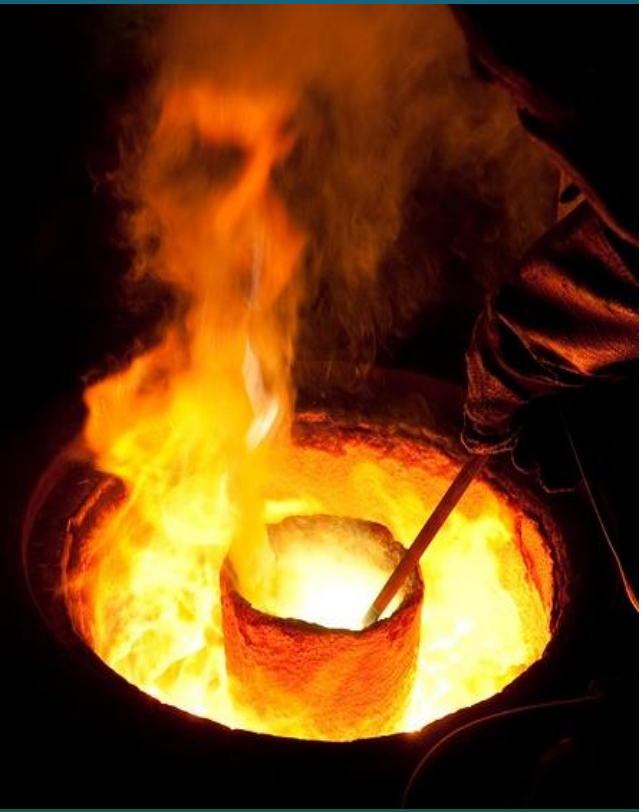
Cold-Air

South Coast AQMD Regulatory Requirements → Existing Units (Source Testing) → Other California Air Districts → Technology Assessment → Initial BARCT Emission Limit

	South Coast AQMD Regulatory Requirements	Existing Units (Source Testing)	Other California Air Districts	Technology Assessment	Initial BARCT Emission Limit
Previous Metal Melting BARCT Analysis	60 ppm	9-59 ppm 13 (26%) ≤ 30 ppm 7 (14%) ≤ 20 ppm	60 ppm	15 ppm (SCR) 30 ppm (Burner)	15 ppm (SCR) 30 ppm (Burner)
Revised Cold-Air BARCT Analysis	60 ppm	**38 Units:** **21-59 ppm*** 10 (26%) 30-40 ppm 2 (5%) ≤ 30 ppm	60 ppm	15 ppm (SCR) 40 ppm (Burner)	15 ppm (SCR) 40 ppm (Burner)

Cost-Effectiveness Analysis is Needed

* Source test data has been updated since Technology Assessment originally presented during Working Group Meeting #3



Re-Evaluating Technology Assessment

Regenerative Burners

Technology Assessment Using Vendor NOx Emission Guarantees

Regenerative

- Reached out to vendors and obtained emission guarantee from 1 vendor for regenerative burners
- Compared source test results of units equipped with burners from vendor providing the emission guarantee
  - Source test results of all other units also compared

Re-Evaluation of Technology Assessment

Regenerative

Emission Guarantee (ppm)	Source Test Results (ppm)
50-57 (No Conditions Specified)	**4 units: 32-46** (1,350-2,000 °F) 2 units: ≤ 40
Remaining Units	**4 units: 25-48** (1,400-2,000 °F) 3 units: ≤ 40

Re-Evaluation of Technology Assessment

- Vendor guarantee of 50-57 ppm
- Source tests confirm 40 ppm achievable (5 of 8 units)
- For burner replacement, technology assessment determines 50 ppm

Initial BARCT Emission Limit: 40 ppm

* All ppm figures corrected to 3% O2

Updated BARCT Analysis

Regenerative

	South Coast AQMD Regulatory Requirements	Existing Units (Source Testing)	Other California Air Districts	Technology Assessment	Initial BARCT Emission Limit
Previous Metal Melting BARCT Analysis	60 ppm	9-59 ppm 13 (26%) ≤ 30 ppm 7 (14%) ≤ 20 ppm	60 ppm	15 ppm (SCR) 30 ppm (Burner)	15 ppm (SCR) 30 ppm (Burner)
Revised Regenerative BARCT Analysis	60 ppm	**8 Units:** **25-48 ppm*** 4 (50%) 30-40 ppm 1 (13%) ≤ 30 ppm	60 ppm	15 ppm (SCR) 50 ppm (Burner)	15 ppm (SCR) 40 ppm (Burner)

Cost-Effectiveness Analysis is Needed

* Source test data has been updated since Technology Assessment originally presented during Working Group Meeting #3

Summary

Metal Melting
Revised Initial BARCT Emission Limits

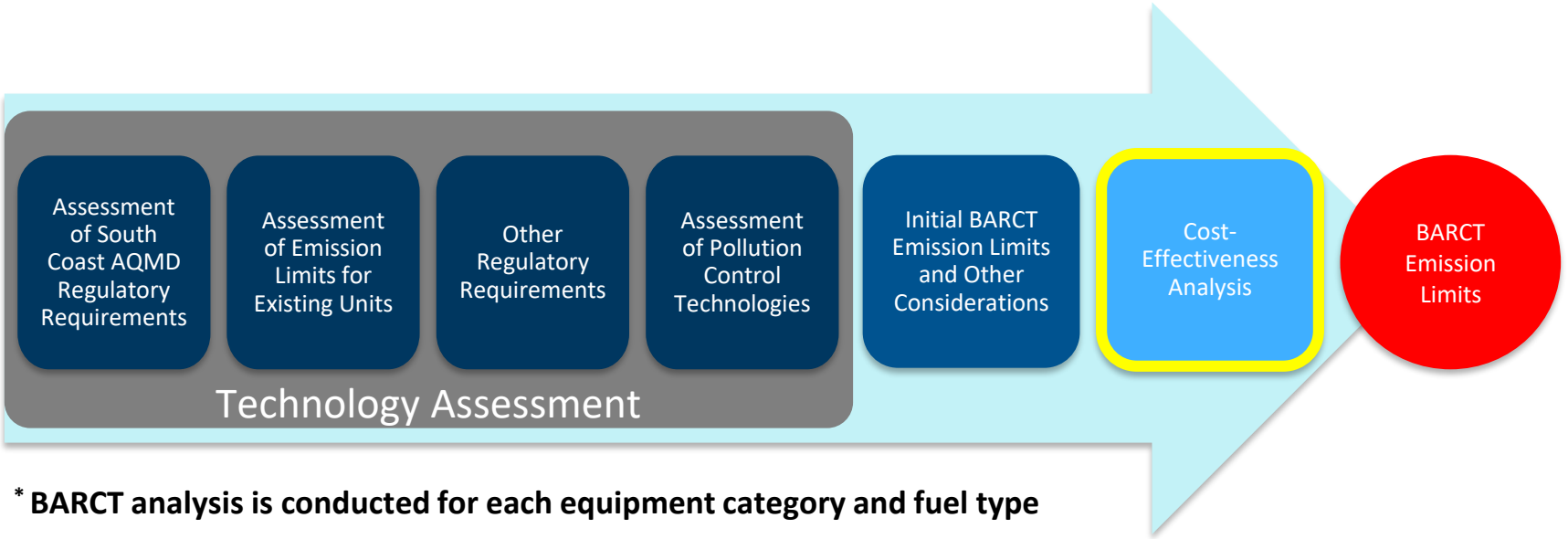
Cold-Air Burner	
40 ppm (Burner Replacement)	15 ppm (SCR*)
Cost-Effectiveness Analysis is Needed	

Regenerative Burner	
40 ppm (Burner Replacement)	15 ppm (SCR*)
Cost-Effectiveness Analysis is Needed	

* Analysis will be conducted to identify the applicable unit size for 15 ppm NOx emission limit. Some units may need SCR and burner replacements to achieve the 15 ppm NOx limit.

Cost-Effectiveness Analysis:
Methodology and Assumptions

Cost-Effectiveness Analysis

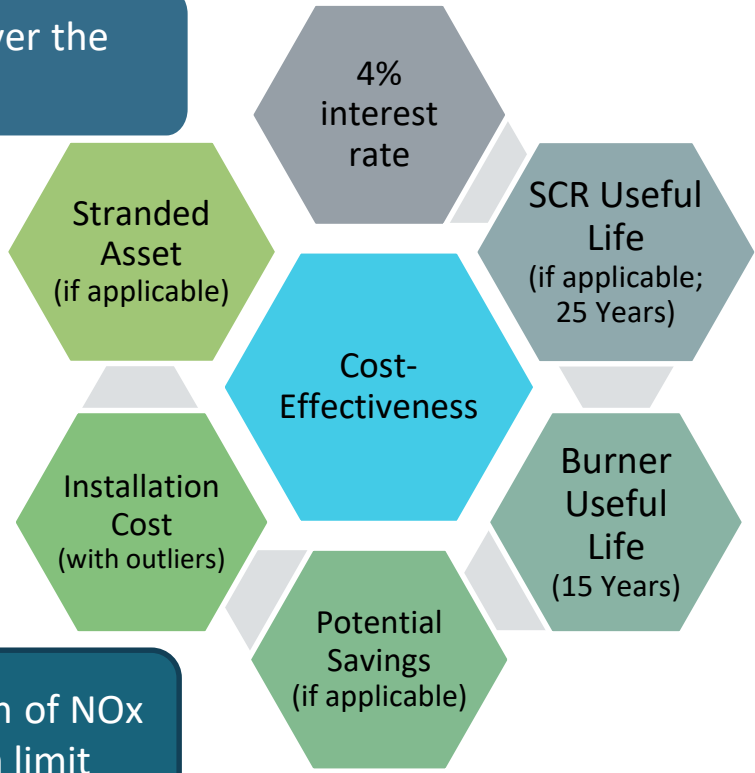


* **BARCT analysis is conducted for each equipment category and fuel type**

Overview of Cost-Effectiveness

Cost-effectiveness is the cost (capital and annual costs) over the emission reductions for the life of the equipment

- Cost-effectiveness is expressed in dollars per ton of pollutant reduced
- Two major cost elements
  - Capital costs
  - Annual costs
- Emission reductions are based on current emission levels (baseline) compared to the initial BARCT emission limit



Staff uses the 2016 AQMP cost-effectiveness of $50,000/ton of NOx reduced as guidance for establishing the BARCT emission limit

Cost-Effectiveness Calculations

Discounted Cash Flow (DCF) Method

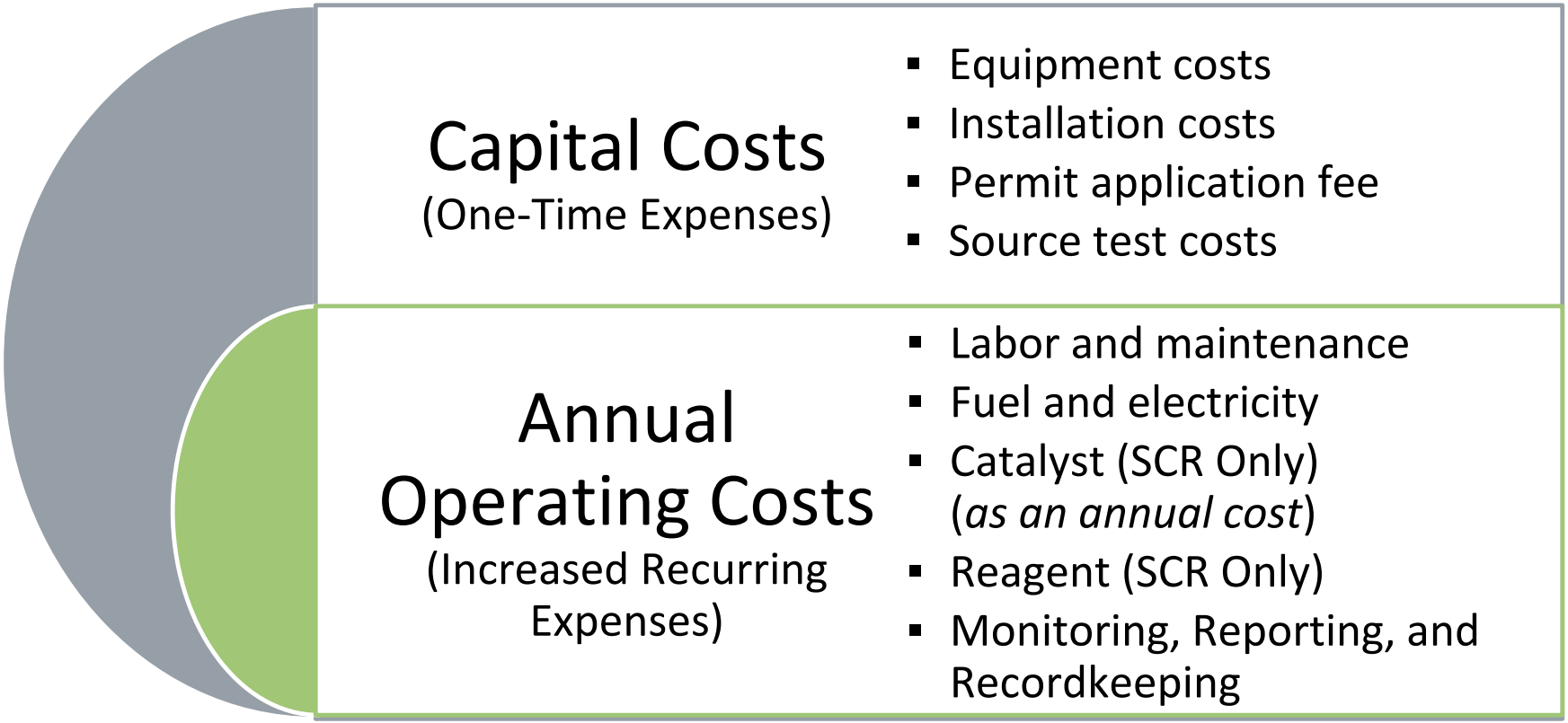
Cost-Effectiveness Calculation

$$\frac{\textit{Capital Costs} + (\textit{Increased Annual Operating Costs} * \textit{Present Value Factor})}{\textit{Emissions Reduced Over Equipment Life}}$$

Present Value Factor for annualizing equipment cost = $1/[\frac{i*(1+i)^n}{(1+i)^n-1}]$

- i = nominal interest rate
- n = equipment useful life

Capital and Annual Operating Costs



Other Cost Assumptions

Interest Rate

- 4% nominal interest rate

Permitting

- Rule 301[1] Schedule B-D specifies a one-time modification permit processing fee of between $3,000-$8,000
- Assume no change in annual renewal costs

[1] Rule 301. http://www.aqmd.gov/docs/default-source/rule-book/reg-iii/rule-301-July-2019.pdf

Emission Reduction Calculation Methodology

Step 1 Obtain **FUEL USAGE**

- Use Annual Emissions Reporting (AER) data for **FUEL USAGE**
- If AER data is not available, proportionately scale the average fuel usage by the burner size*

Step 2 Determine **BASELINE EMISSIONS (lbs/yr)**

BASELINE EMISSIONS = **Current NOx Level** * **FUEL USAGE**

Current NOx Level (lb/MMBtu) is RECLAIM default emission factor, source test result, or permit limit *[whichever is lower]*

Step 3 Calculate **EMISSION REDUCTIONS (lbs/yr)**

EMISSION REDUCTIONS = **BASELINE EMISSIONS** – **Proposed Emissions**

Proposed Emissions (lbs/yr) = Initial BARCT Limit * **FUEL USAGE**

* Example: Scaled average fuel usage throughput for cold-air burner units with AER data = 2.78 MMScf/MMBtu

Emission Reduction Calculation Assumptions

- Emission reductions calculated for the assumed useful life of the specific control technology that can achieve the initial BARCT emission limit
  - Burner useful life of 15 years
  - SCR useful life of 25 years
- Reductions only calculated for units with source test results or permit limits above the initial BARCT emission limits

Cost-Effectiveness Approach

Based on a “bottom up approach” using actual emissions data for each unit to calculate the cost-effectiveness for each unit

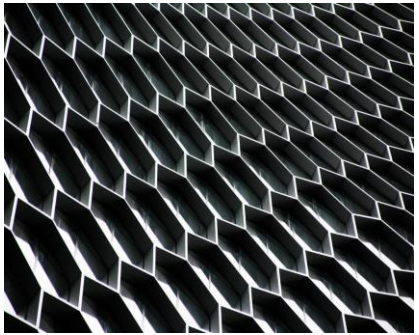
Calculated the average cost-effectiveness for each class and category of equipment, based on the data from each unit

Removed outliers that had baseline emissions of < 1 lb/day NOx

Outliers to be addressed through a different implementation approach or possible exemption

Emission Control Technologies Evaluated

- Cost-effectiveness will be conducted based on anticipated technologies available to achieve the initial BARCT emission limits
- Staff is proposing two initial BARCT emission limits
- Initial BARCT limit of 40 ppm will be based on costs associated with burner replacement
- Initial BARCT limit for 15 ppm will be based on costs associated with SCR (some units may need SCR and burner replacement)
  - Cost-effectiveness will be evaluated for use of SCR to establish the applicable equipment size for units to meet the 15 ppm limit based on SCR



Cost-Effectiveness Analysis:

Initial BARCT Limit of 15 ppm (SCR Installation)

Cost Assumptions for 15 ppm (Selective Catalytic Reduction)

- Costs for SCR systems and installation are obtained through the U.S. EPA SCR Cost Manual[1] and the 2018 Rule 1146 Staff Report[2]
- Analysis assumes 25 year useful life of the SCR system
- Costs associated with this technology includes operating and maintenance as well as consumables such as reagent and catalyst

[1] EPA SCR Cost Manual. https://www3.epa.gov/ttn/ecas/docs/SCRCostManualchapter7thEdition_2016.pdf
[2] Board Package for 2018 Amendment of Rule 1146 dated December 7, 2018. http://www.aqmd.gov/docs/default-source/Agendas/Governing-Board/2018/2018-dec7-028.pdf?sfvrsn=6

Approach to Determine Applicable Unit Size for 15 ppm NOx Limit

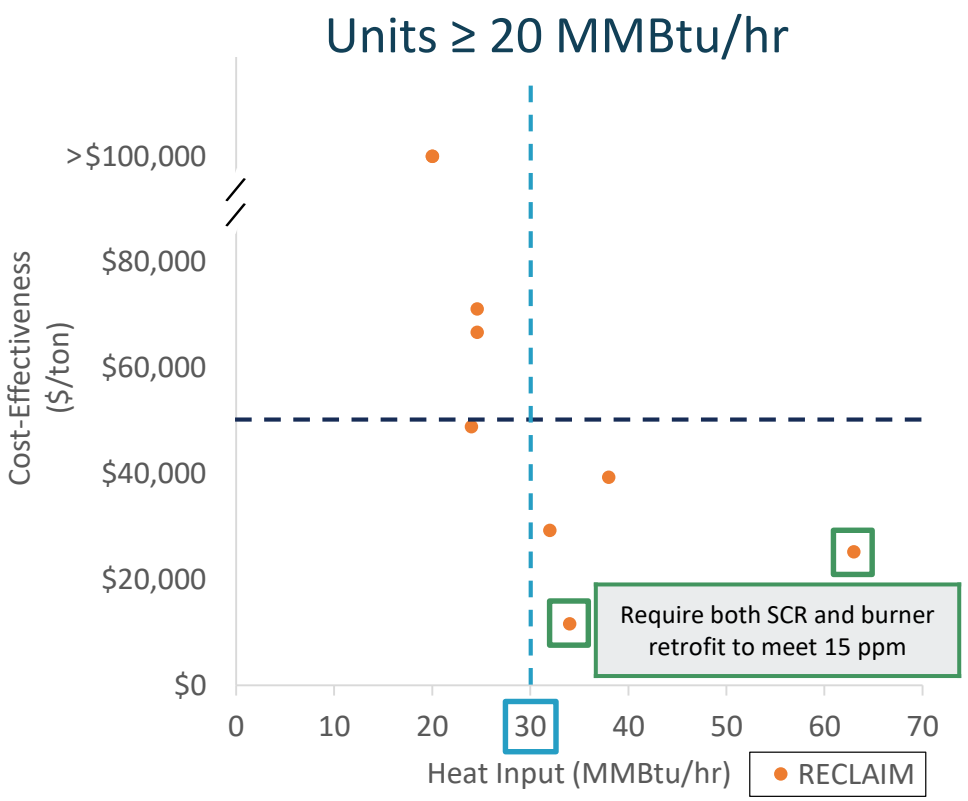
- Last Working Group Meeting discussed applicability of 15 ppm NOx limit for units ≥ 20 MMBtu/hr
- Staff evaluated the cost-effectiveness of all units ≥ 20 MMBtu/hr to identify a natural size cut-off for achieving the 15 ppm NOx emission limit
- Staff used a cost-effectiveness threshold of $50,000 per ton of NOx reduced as a guide to evaluate a “natural break”
- Some units with current high NOx levels will require SCR and burner replacements to achieve a 15 ppm NOx limit
- Any units that are not found to be cost-effective to meet the 15 ppm NOx limit will be evaluated to meet the 40 ppm NOx limit
- Analysis conducted for units with cold-air burners and regenerative burners

Determining Applicable Unit Size for 15 ppm Limit for Cold-Air Units

- Units < 30 MMBtu/hr have a cost-effectiveness generally at or above $50,000/ton
- Units ≥ 30 MMBtu/hr have a cost-effectiveness below $50,000/ton
- Average cost-effectiveness for units ≥ 30 MMBtu/hr is $21,700/ton

Recommendation

NOx BARCT limit of 15 ppm will apply to units with cold-air burners that are ≥ 30 MMBtu/hr

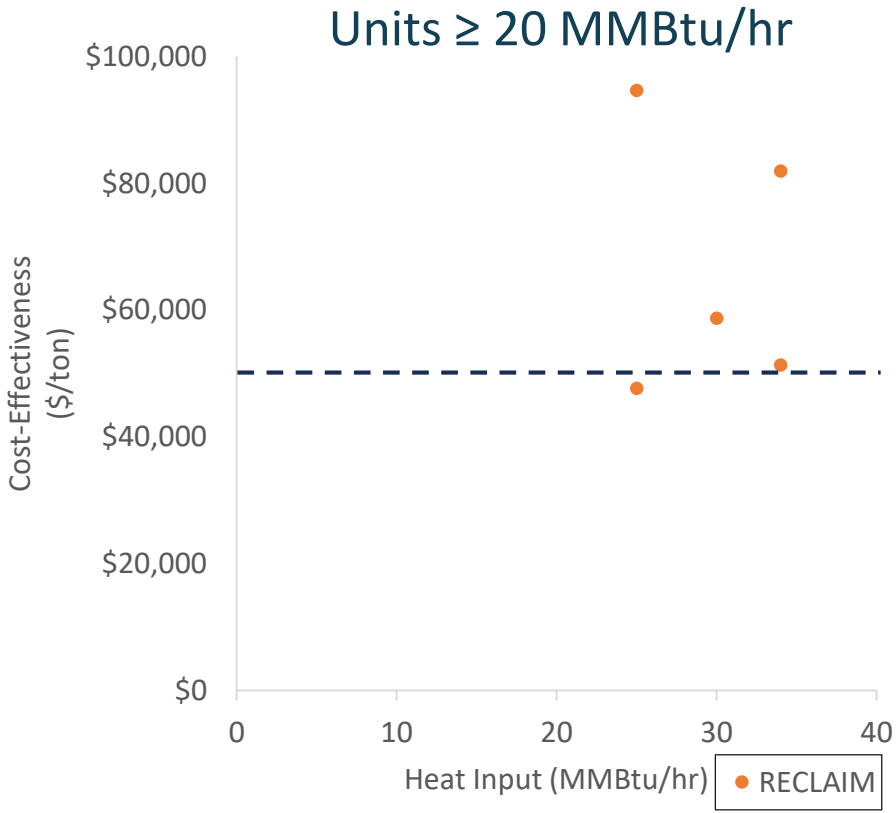


Determining Applicable Unit Size for 15 ppm Limit for Regenerative Units

- All five units have a cost-effectiveness that is near or above $50,000/ton
- Average cost-effectiveness for all units is $62,000/ton

Recommendation

NOx BARCT limit of 15 ppm will not apply to units with regenerative burners



* Units will be evaluated for regenerative burner retrofit

Implementation Schedule for Units with Cold-Air Burners ≥ 30 MMBtu/hr

- For units with cold-air burners ≥ 30 MM Btu/hr, recommending the following compliance schedule:
  - Submit permit applications by January 1, 2022
  - Meet NOx emission limit 12 months after permit application is approved

Source: Pixabay. Kepinator.

Cost-Effectiveness Analysis:

Initial BARCT Limit of 40 ppm (Burner Replacement)

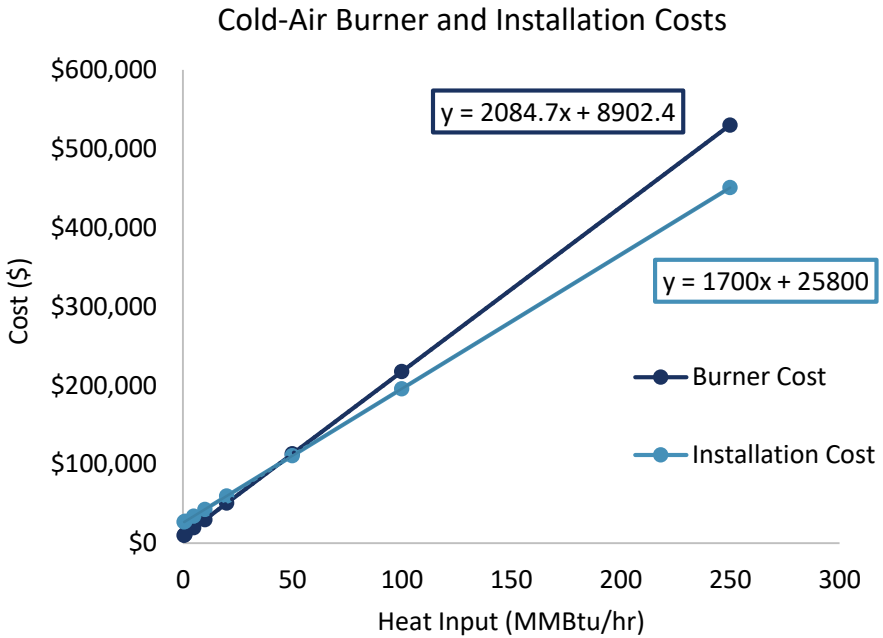
Cost-Effectiveness Analysis for 40 ppm NOx Emission Limit

Updated Slide

- Assumes that units will meet the 40 ppm NOx limit when the burner reaches 15 years
  - Concept will be incorporated into the implementation approach (discussed later in presentation)
- Units that are currently meeting the 40 ppm NOx emission limit are excluded, regardless of the burner age
- No additional operating and maintenance costs for replacing burners (same as existing burner)
- Includes cold-air units < 30 MMBtu/hr and all regenerative units
- Burner and installation costs to be evaluated based on the two burner types

Basis for Cold-Air and Regenerative Burner Costs

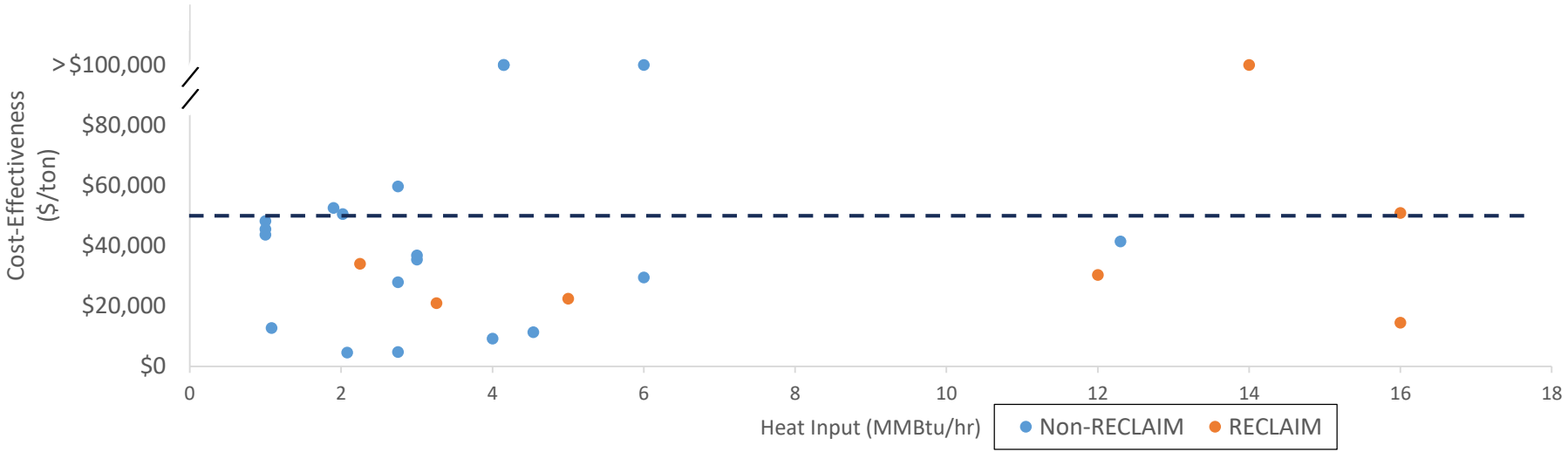
- Burner costs
  - Obtained from vendor
  - Used a 3x multiple of cold-air burners for regenerative burner (vendor estimated 2-3x multiple of cost for cold-air burners)
  - Extrapolated costs for larger equipment
- Installation costs
  - Same installation costs for both burner types
  - Based on Rule 1146 installation costs



Cost-Effectiveness Analysis

Cold-Air Burners (< 30 MMBtu/hr)

Updated Slide



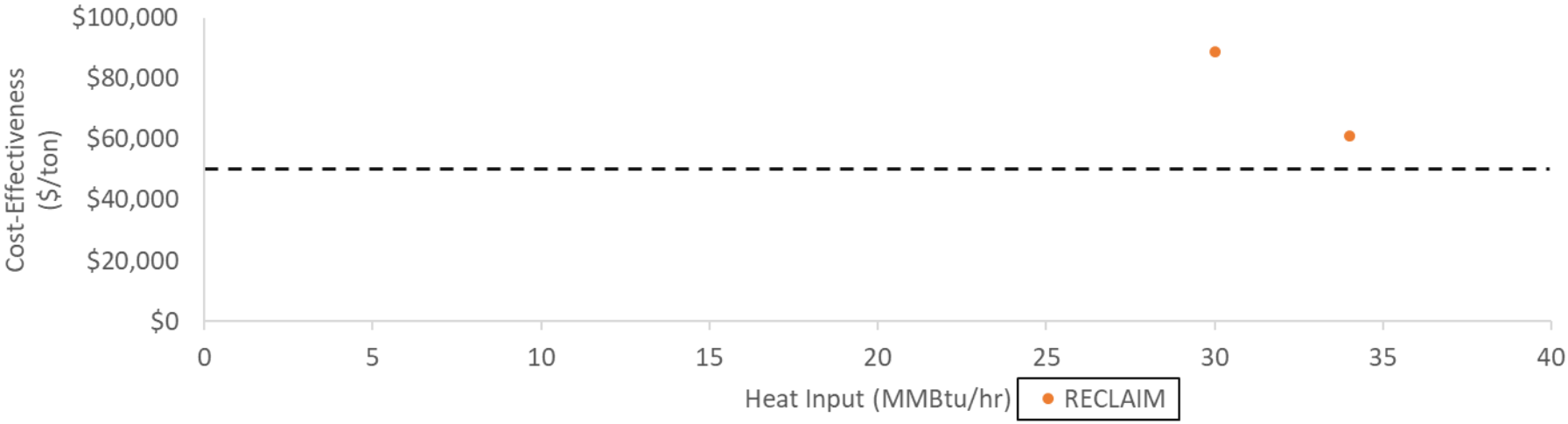
- Average cost-effectiveness for all units is $21,800/ton
- 4 units with cost-effectiveness > $100,000/ton
  - Additional analysis needed – will address at next Working Group Meeting

Recommendation

NOx BARCT limit of 40 ppm for cold-air burners < 30 MMBtu/hr for burners 15 years or older

Cost-Effectiveness Analysis

Regenerative Burners (All Sizes)



- Average cost-effectiveness for all units is $72,100/ton
- Since not cost-effective at 15 years, proposing that 40 ppm be met at burner replacement

Recommendation

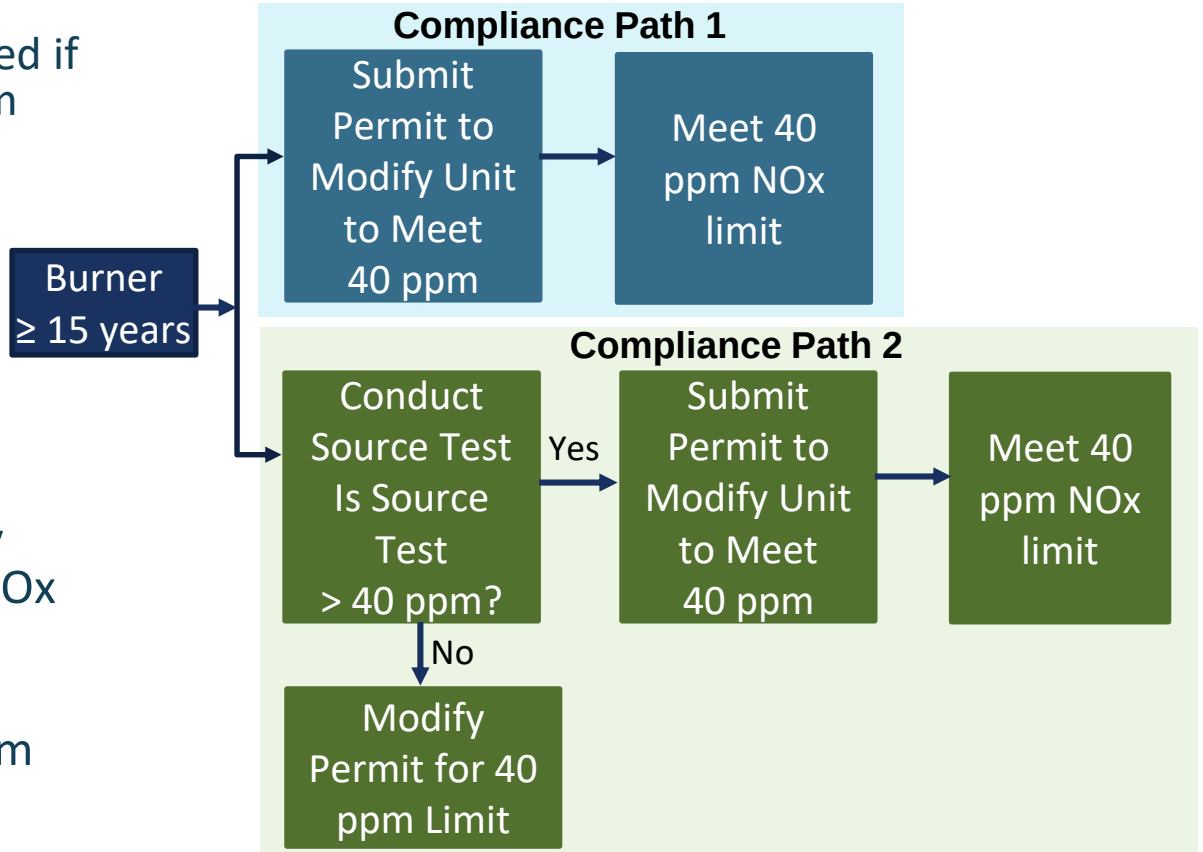
NOx BARCT limit of 40 ppm for regenerative burners upon burner replacement

Implementation Approach for Cold-Air Units < 30 MMBtu/hr

- Operators will be required to meet the 40 ppm NOx limit for units when the burner reaches 15 years
- Operators can either:
  - Demonstrate that unit meets the 40 ppm NOx emission limit through a source test; or
  - Meet the 40 ppm NOx emission limit through burner replacement
- Staff is considering a staggered implementation schedule based on unit size
  - Phase I: Units > 5 MMBtu/hr
  - Phase II: Units > 2 MMBtu/hr and ≤ 5 MMBtu/hr
  - Phase III: Units ≤ 2 MMBtu/hr
- Implementation will begin when the first group of burners are ≥ 15 years, and every year thereafter

Two Compliance Paths to Meet 40 ppm NOx Limit

- No permit modification needed if unit has permit limit ≤ 40 ppm
- Two compliance Paths
- Path 1: Submit permit to modify unit and meet 40 ppm NOx limit
- Path 2: Conduct source test
  - If Source test > 40 ppm: Submit permit to modify unit and meet 40 ppm NOx limit
  - If Source test ≤ 40 ppm: Modify permit for 40 ppm limit



Initial Compliance Dates for 40 ppm Limit for Cold-Air Burners ≥ 15 Years

Implementation Phase (Unit Size)	Compliance Path 1		Compliance Path 2			
	Permit Submittal to Meet 40 ppm	Meet 40 ppm NOx Limit	Conduct Source Test	Source Test ≤ 40 ppm Permit Modification	Source Test > 40 ppm Permit Submittal to Meet 40 ppm	Meet 40 ppm NOx Limit
Phase I: Units > 5 MMBtu/hr	Jan 1, 2022	12 months after Permit to Construct	Jan 1, 2022	6 months after source test required	6 months after source test required	12 months after Permit to Construct
Phase II: Units > 2 and ≤ 5 MMBtu/hr	July 1, 2022	12 months after Permit to Construct	July 1, 2022	6 months after source test required	6 months after source test required	12 months after Permit to Construct
Phase III: Units ≤ 2 MMBtu/hr	Jan 1, 2023	12 months after Permit to Construct	Jan 1, 2023	6 months after source test required	6 months after source test required	12 months after Permit to Construct

Subsequent Compliance Dates for 40 ppm Limit for Cold-Air Burners ≥ 15 Years

Implementation Phase (Unit Size)	Compliance Path 1	Compliance Path 2
	Permit Submittal to Meet 40 ppm	Conduct Source Test
Phase I: Units > 5 MMBtu/hr	Burners ≥ 15 years on Jan 1, 2022, and every Jan 1 thereafter burner is ≥ 15 years	Burners ≥ 15 years on Jan 1, 2022, and every Jan 1 thereafter burner is ≥ 15 years
Phase II: Units > 2 and ≤ 5 MMBtu/hr	Burners ≥ 15 years on July 1, 2022, and every July 1 thereafter burner is ≥ 15 years	Burners ≥ 15 years on July 1, 2022, and every July 1 thereafter burner is ≥ 15 years
Phase III: Units ≤ 2 MMBtu/hr	Burners ≥ 15 years on Jan 1, 2023, and every Jan 1 thereafter burner is ≥ 15 years	Burners ≥ 15 years on Jan 1, 2023, and every Jan 1 thereafter burner is ≥ 15 years

Summary of Proposed BARCT Limit for Metal Melting Cold-Air and Regenerative Burners

Burner Type	Equipment Size	Rule 1147 Limit^	Initial BARCT Limit^	Proposed BARCT Limit^	Cost-Effectiveness+	Implementation Approach
Cold-Air	≥ 30* MMBtu/hr	60 ppm	15 ppm	**15 ppm (via SCR[1])**	**$21,700**	**≥ 15 years old: Beginning 2022**
	< 30* MMBtu/hr	60 ppm	40 ppm	**40 ppm (via Burner[2])**	**$21,800**	**≥ 15 years old: Beginning 2022**
Regenerative Burners	All Units	60 ppm	40 ppm	**40 ppm (via Burner[2])**	**$72,100**	**Phase-In** ***(Upon Replacement)***

^ NOx concentrations are corrected to 3% O_2 dry
[1] Selective Catalytic Reduction (SCR) initial BARCT emission limit is based off of NOx concentrations of operating SCR units.
[2] Burner initial BARCT emission limit is based off of vendor guarantees. Source test results analyzed demonstrate burners can achieve lower concentrations
* Cold-Air SCR cutoff revised from 20 to 30 MMBtu/hr
+ Excludes low-emitting (< 1 lb NOx/day) units

Next Steps

Next Steps

- Conduct cost-effectiveness on initial BARCT emission limit
- Develop Proposed Rule Language and Preliminary Draft Staff Report

Rule Development Activity	Tentative Schedule
Next Working Group Meeting	September 2020
Public Workshop	Fourth Quarter 2020
Set Hearing	First Quarter 2021
Public Hearing	First Quarter 2021

Contacts

PR 1147.2	PAR 1147	RECLAIM Questions	General Questions
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