Proposed Rule 1109.1 – NOx Emission Reduction for Refinery Equipment and Related Operations

Working Group Meeting #22

June 30, 2021

Join Zoom Webinar
https://scaqmd.zoom.us/j/92213416923
Webinar ID: 922 1341 6923
Teleconference Dial-In: +1 669 900 6833

Agenda

- Progress and Status Since Working Group Meeting #21
- WSPA Proposal and Staff Response
- Updated Costs and Analysis
- BARCT Reassessment for Boilers and Heaters ≥40 MMBtu/hr
- BARCT Reassessment for FCCU
- Initial Concepts for Mass Emissions Approach
- Next Steps

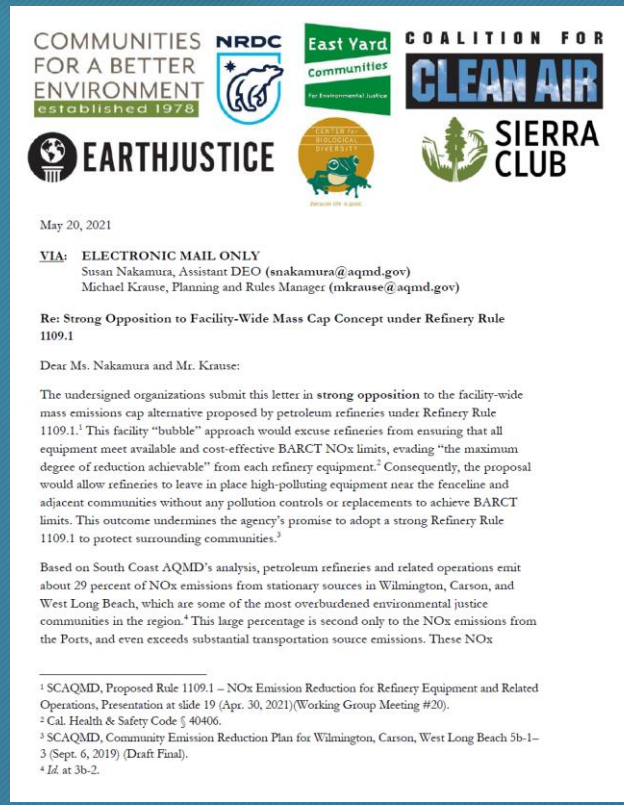
Progress and Status Since WGM #21

Status and Progress Since Last WGM

- Norton's final review of the facility-provided cost has been posted
- Completed BARCT reassessment, including cost-effectiveness, incremental cost-effectiveness, and near limit assessment for units with high cost-effectiveness,
  - Large boilers and heaters
  - FCCUs
- Continued meetings with stakeholders, WSPA, CCEEB, and environmental representatives
- Meeting with Ramboll to discuss WSPA's cost estimates
- Public hearing moved from September to November 2021

Comment Letters from Environmental and Community Groups

- Received two comment letters from seven environmental and community groups
- First letter received on May 20, 2021, requested that any proposal to create a facility-wide mass caps be rejected
  - PR 1109.1 should transition refineries to a command-and-control regulatory framework with equipment-specific limits
  - Facility-wide mass cap undermines the rule's objectives by:
    - Recreating the NOx RECLAIM program at the facility level, which conflicts with CMB-05's mandate to transition facilities to command-and-control
    - Allowing refineries to "trade" emission allowances between various sources to meet the "cap" and avoid installing lifesaving pollution controls on a range of equipment
  - A mass cap is difficult to enforce
  - Concerns regarding uncertainties associated with calculating facility-wide mass caps for each refinery, including equipment concentration and flow uncertainties, and emissions monitoring calibration and downtime issues



COMMUNITIES FOR A BETTER ENVIRONMENT established 1978 · NRDC · East Yard Communities for Environmental Justice · COALITION FOR CLEAN AIR · EARTHJUSTICE · CENTER FOR BIOLOGICAL DIVERSITY · SIERRA CLUB

May 20, 2021

VIA: ELECTRONIC MAIL ONLY
Susan Nakamura, Assistant DEO (snakamura@aqmd.gov)
Michael Krause, Planning and Rules Manager (mkrause@aqmd.gov)

Re: Strong Opposition to Facility-Wide Mass Cap Concept under Refinery Rule 1109.1

Dear Ms. Nakamura and Mr. Krause:

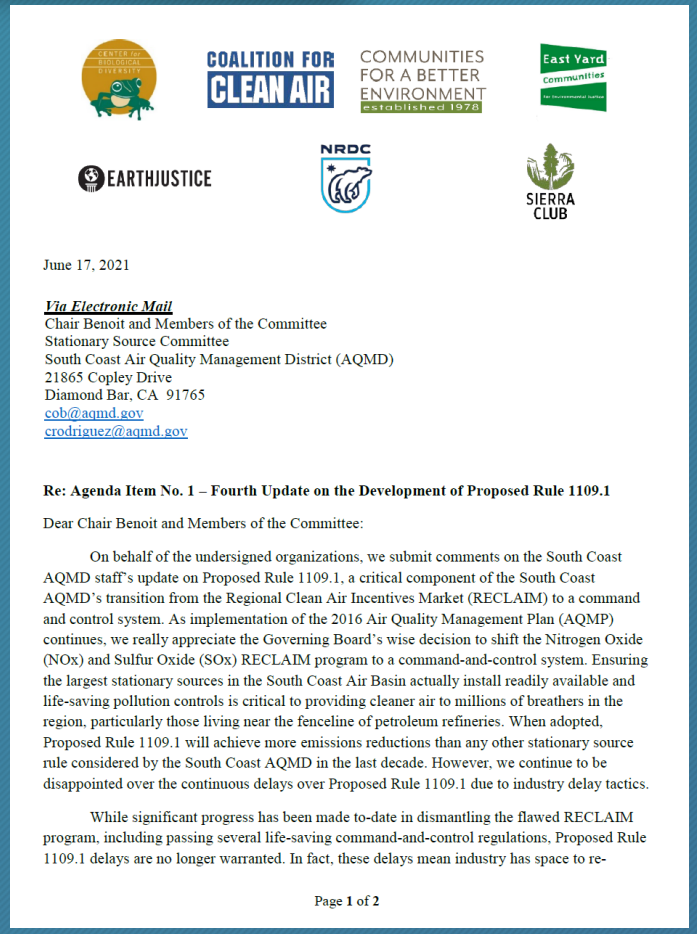
The undersigned organizations submit this letter in **strong opposition** to the facility-wide mass emissions cap alternative proposed by petroleum refineries under Refinery Rule 1109.1.[1] This facility "bubble" approach would excuse refineries from ensuring that all equipment meet available and cost-effective BARCT NOx limits, evading "the maximum degree of reduction achievable" from each refinery equipment.[2] Consequently, the proposal would allow refineries to leave in place high-polluting equipment near the fenceline and adjacent communities without any pollution controls or replacements to achieve BARCT limits. This outcome undermines the agency's promise to adopt a strong Refinery Rule 1109.1 to protect surrounding communities.[3]

Based on South Coast AQMD's analysis, petroleum refineries and related operations emit about 29 percent of NOx emissions from stationary sources in Wilmington, Carson, and West Long Beach, which are some of the most overburdened environmental justice communities in the region.[4] This large percentage is second only to the NOx emissions from the Ports, and even exceeds substantial transportation source emissions. These NOx

[1] SCAQMD, Proposed Rule 1109.1 – NOx Emission Reduction for Refinery Equipment and Related Operations, Presentation at slide 19 (Apr. 30, 2021)(Working Group Meeting #20).
[2] Cal. Health & Safety Code § 40406.
[3] SCAQMD, Community Emission Reduction Plan for Wilmington, Carson, West Long Beach 5b-1–3 (Sept. 6, 2019) (Draft Final).
[4] *Id.* at 3b-2.

Received Two Comment Letters (*cont.*)

- Second comment letter submitted on June 17, 2021 to the South Coast AQMD Board:
  - Requested the South Coast AQMD transition refineries from RECLAIM to a command-and-control system
  - Concerned that Western States Petroleum Association (WSPA) has a proposal to continue RECLAIM
  - Demanded that refineries install pollution control technologies that have been available for decades
  - Requested the Board to direct staff to finalize Rule 1109.1 and bring it to the Board as soon as possible but no later than September 2021



June 17, 2021

Via Electronic Mail
Chair Benoit and Members of the Committee
Stationary Source Committee
South Coast Air Quality Management District (AQMD)
21865 Copley Drive
Diamond Bar, CA 91765
cob@aqmd.gov
crodriguez@aqmd.gov

Re: Agenda Item No. 1 – Fourth Update on the Development of Proposed Rule 1109.1

Dear Chair Benoit and Members of the Committee:

On behalf of the undersigned organizations, we submit comments on the South Coast AQMD staff's update on Proposed Rule 1109.1, a critical component of the South Coast AQMD's transition from the Regional Clean Air Incentives Market (RECLAIM) to a command and control system. As implementation of the 2016 Air Quality Management Plan (AQMP) continues, we really appreciate the Governing Board's wise decision to shift the Nitrogen Oxide (NOx) and Sulfur Oxide (SOx) RECLAIM program to a command-and-control system. Ensuring the largest stationary sources in the South Coast Air Basin actually install readily available and life-saving pollution controls is critical to providing cleaner air to millions of breathers in the region, particularly those living near the fenceline of petroleum refineries. When adopted, Proposed Rule 1109.1 will achieve more emissions reductions than any other stationary source rule considered by the South Coast AQMD in the last decade. However, we continue to be disappointed over the continuous delays over Proposed Rule 1109.1 due to industry delay tactics.

While significant progress has been made to-date in dismantling the flawed RECLAIM program, including passing several life-saving command-and-control regulations, Proposed Rule 1109.1 delays are no longer warranted. In fact, these delays mean industry has space to re-

Page **1** of **2**

Socioeconomic Assessment Update

- Staff is currently preparing Draft Socioeconomic Impact Assessment (SIA)
  - Including estimated public health benefits and projected emission reductions
- Separate third-party reviews will be conducted for:
  - Draft SIA (Kleinhenz Economics)
  - Public Health Benefits (Industrial Economics/IEc)
- To address Governing Board Member comments, staff will estimate pass-through of PR 1109.1 compliance costs onto gasoline prices
  - Cost pass-through is the increase in retail price arising due to an increase in operating costs
  - Staff working with third-party contractor
    - Dr. Erich Muehlegger, Associate Professor, UC Davis
      - Research focus in environmental and energy policy
      - Recent publication record on cost pass-through in the U.S. oil refinery sector

CEQA Assessment Update

- Staff is preparing a Draft Subsequent Environmental Assessment to the December 2015 Program Environmental Assessment for NOx RECLAIM and the March 2017 Program Environmental Impact Report for the 2016 AQMP
  - Will include PR 429.1, PAR 1304, rescind Rule 1109, and pending rule development
  - Will be released for a 45-day public review and comment period
- Staff has met with stakeholders who provided updated data which is being incorporated into the Draft Subsequent Environmental Assessment

WSPA Proposal and Staff's Response

WSPA Bridge Concept

- On June 2nd WSPA presented an option for a bridge that would generally retain the RECLAIM structure with the PR 1109.1 endpoints
- WSPA Concept Summary
  - Use Regulation XX as the "bridge" to deliver BARCT-equivalent NO_X emissions reductions
  - Complete remaining BARCT assessments
  - Adjusted BARCT-equivalent facility allocations are met through installation of control equipment at a facility level
  - Adjust (i.e., shave) facility allocations to start in 2023-2025 timeframe
  - Restrict new purchases of IYB NO_X RTCs starting 2023
  - Voluntary exit option to Regulation XX
  - At the end of the last compliance year fully sunset RECLAIM

Staff's Response to WSPA Proposal

RECLAIM is Not Needed for Bridge

- NOx emission limits that will not require reductions can be the bridge until units fully implement landing rules
- Concerned about unnecessarily prolonging RECLAIM
- Industry comments in the past have focused on disproportionate impacts

Amendments to Regulation XX are Challenging

- Establishing "shave" will be resource intensive
- Must determine the amount of RTCs that would be retired upon exiting RECLAIM
- Analysis of market impacts as facilities exit RECLAIM is needed

Equity to Non-Refinery Facilities

- Some non-refinery facilities have compliance dates after refineries
- Refineries had information to purchase infinite year block RTCs before non-refineries
- New facilities that did not receive an initial allocation

State and Federal Approvability

- Revisions need approval by CARB and U.S. EPA
- Concerns about use of RTCs in lieu of BARCT – Health and Safety Code Section 40920.6
- U.S. EPA is concerned about prolonging RECLAIM

Staff's Proposal for Bridge Limits

- Industry concerns for the bridge can be addressed without retaining RECLAIM
- Staff presented bridge concepts during Working Group Meeting #21
- Interim limits would reflect current operating conditions until BARCT emission limits are achieved and ensure enforceable emission limits are in place
- Staff included potential bridge limits for most categories in last working group meeting
- The proposed limits that are based on current NOx levels will be based on annual average CEMS data

Table from Working Group Meeting #21

Unit	NOx (ppmv)	CO (ppmv)	Percent O2	Averaging Time (Rolling Average)	Comment
Boilers and Heaters <40 MMBtu/hour	40	400	3	2 hour	Required permit limit
Boilers and Heaters ≥40 MMBtu/hour	Discussed on following slide				
FCCU	40	500	3	365 day	Consent decree or permit limits
Gas Turbines	20	130	15	24 hour	
Petroleum Coke Calciner	70	2,000	3	365 day	Current NOx levels
SRU/TG Incinerators	100	400	3	24 hour	
SMR Heaters	60 without SCR 20 with SCR	400	3	24 hour	
SMR Heaters with Gas Turbine	5	130	15	24 hour	May not need interim limits, permit limit required prior to existing RECLAIM
Sulfuric Acid Furnaces	30	400	3	365 day	
Vapor Incinerators	130 lb/MMscf	400	3	3	Default emission factor

Staff's Proposed Bridge Concept for Boilers and Heaters ≥40 MMBtu/hr

- Large boilers and heaters have wide variation and most units do not have existing permit limits
- Considering establishing a 0.03 lb/MMBtu facility-wide bridge limit for boilers and heaters ≥40 MMBtu/hr
  - Mirrors the requirement in the original Rule 1109
  - Consistent with BAAQMD's Regulation 9 which establishes 0.033 lb/MMBtu for boilers and heaters at petroleum refineries

Staff Recommendation:

Establish facility-wide interim limit for boilers and heater ≥40MMBtu/hr at 0.03 lb/MMBtu

Facility-Revised Cost Data

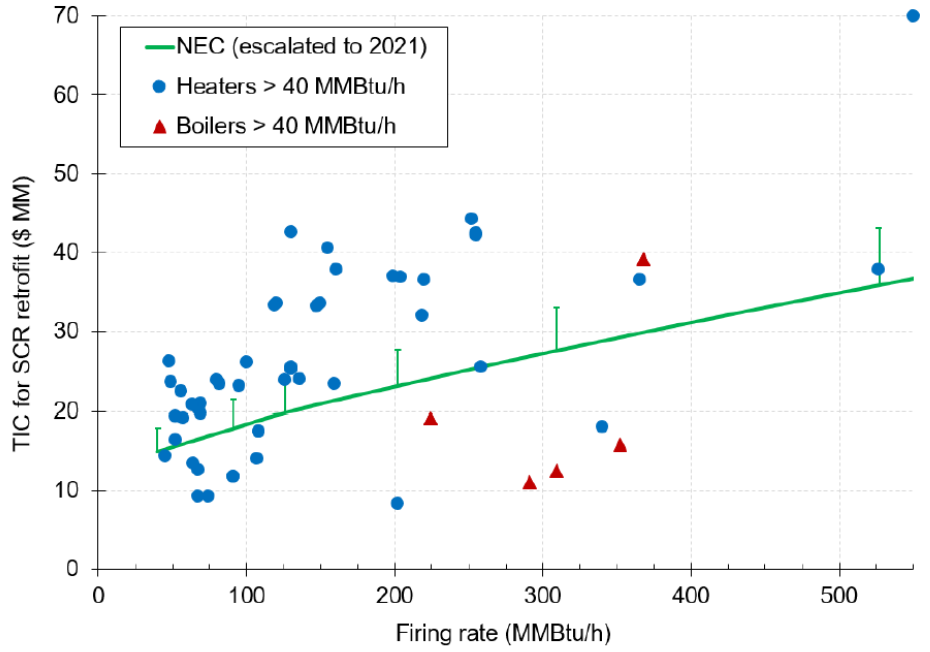
Facility-Revised Cost Data

- Staff is reassessing the proposed NOx BARCT limit for major categories based on the revised cost data provided by the facilities in March 2021
- Summary of facility-provided cost data
  - Received revised cost from facilities in March 2021
  - Received 108 new or revised SCR cost estimates
  - Previously received cost for 58 SCR projects
  - Majority of the facility-revised costs data was for boilers and heaters ≥40 MMBtu/hr retrofits but also received revised costs for NOx controls or unit replacement for FCCUs, gas turbines, vapor incinerators, and flares
  - Received facility-revised cost estimates for SCR, SCR upgrades, wet gas scrubbers, burners, fuel gas treatment, dry low-NOx combustor, and unit replacement
  - Costs ranged from $2 MM to $300 MM per project

Norton Engineering's Feedback on Facility-Revised Cost Data

- Norton reviewed the facility-revised cost data and provided the following cost comparisons:
  - Revised burner costs were compared against a "typical" cost curve for burner upgrades
  - Refinery's initial cost data compared to Norton's escalated cost estimates from the 2014 NOx RECLAIM BARCT feasibility study
  - Refinery's revised cost data compared to Norton's escalated cost estimates from the 2014 NOx RECLAIM BARCT feasibility study (as shown in the graph)
  - Ratio of the refinery's initial and revised costs data
- Norton's 2014 NOx RECLAIM BARCT feasibility study considered costs for:
  - 3-bed catalyst system
  - Material costs including catalyst as provided by a vendor
  - Various infrastructure cost factors for a "typical" facility

Norton's Report – Figure 3: Second submission of TIC estimates for SCR retrofits on heaters and boilers ≥40 MMBtu/hr



Norton Engineering's Feedback on Facility-Revised Cost Data (*cont.*)

- Norton's cost assessment stated:

Facility-Revised Burner Costs

- Most of the facility-revised cost data for burners was consistent with "typical" costs
- 15 of the estimates were within expected range and 5 were outliers

Facility-Revised SCR Costs

- Norton's estimated SCR costs roughly passes through the middle of the refinery's initial cost data but is at the lower end of the facility-revised data
- 15 facility-revised datapoints were significantly higher
- Increases to the cost estimates are not unusual as project scope definition improves during the later stages of engineering design

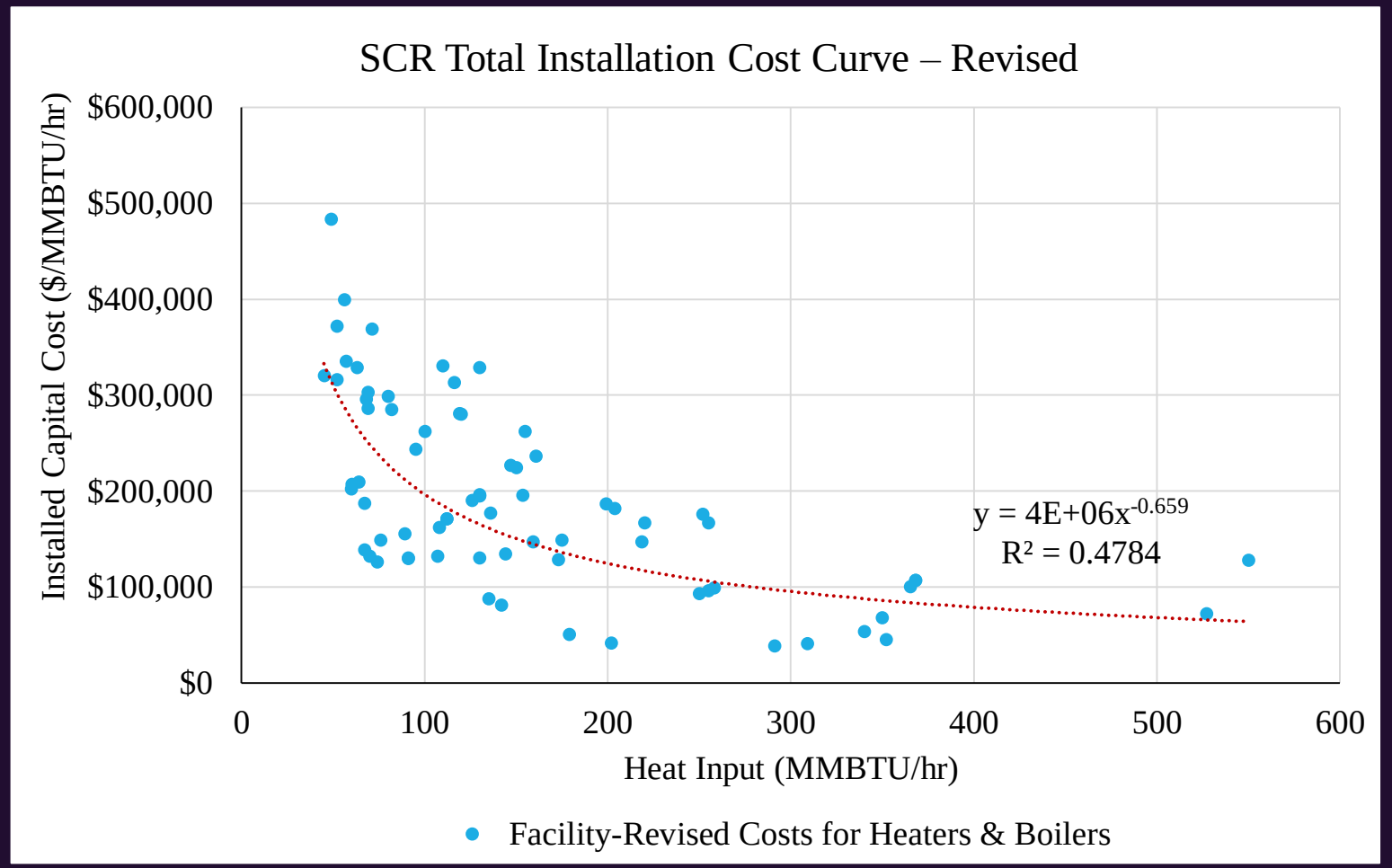
- Norton concluded the costs provided by the facilities are not unreasonable, considering potential complexity

South Coast AQMD-Revised Cost Curves

Boilers & Heaters ≥40 MMBtu/hour

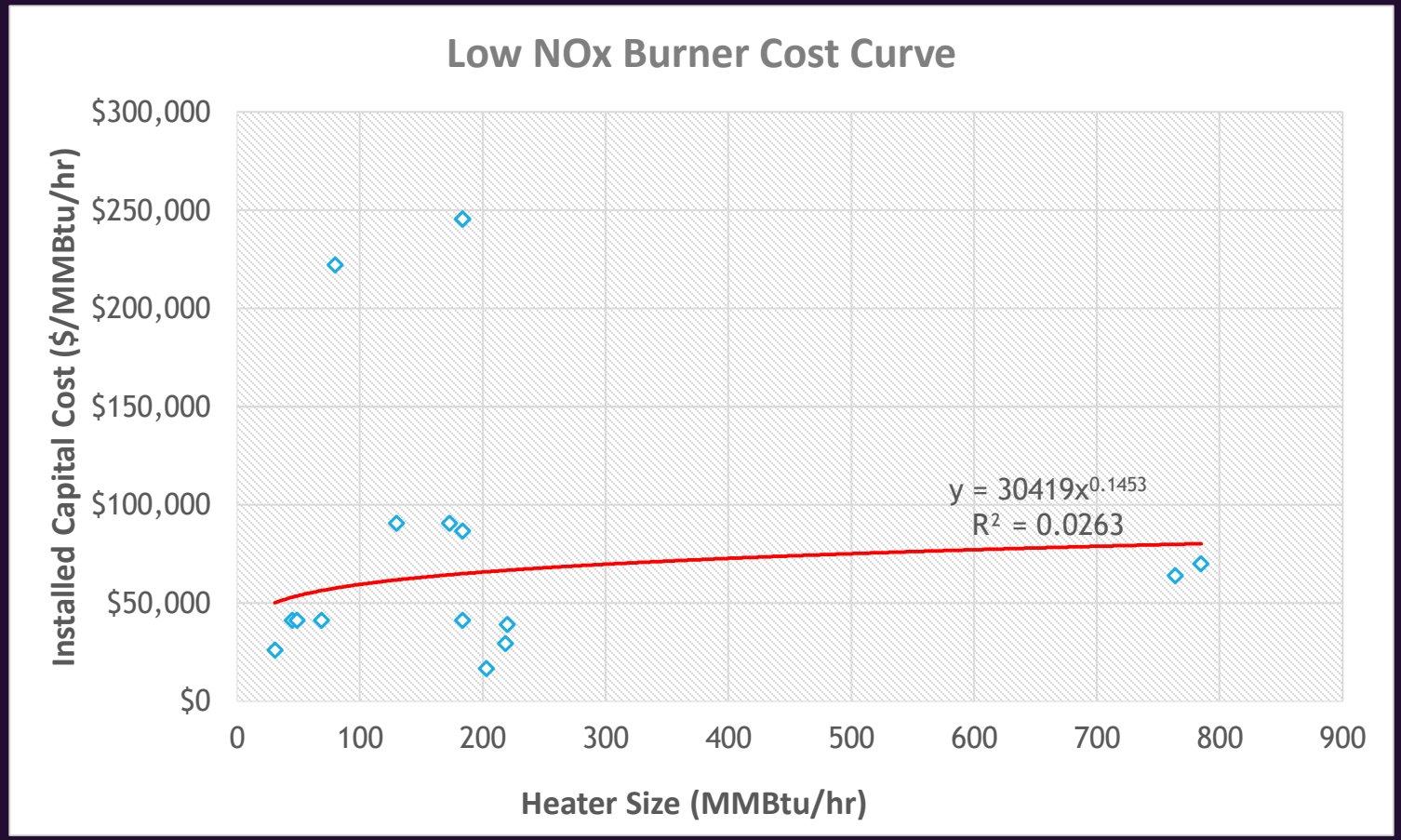
Power Curve used by U.S. EPA SCR Cost Model

- Staff used facility-revised data to update the power curve used by U.S. EPA SCR Cost Model
  - Included all datapoints received for SCR installations on boilers and heaters ≥40 MMBtu/hr
- Graph shows power curve with facility-revised cost data
  - Revised curve used to update the U.S. EPA cost model



South Coast AQMD-Revised Cost Curve for Burners

- Facilities provided 20 revised total installed cost estimates for ULNB/LNB
  - Staff used all facility-revised cost data to update the cost curve used to estimate burner installation costs

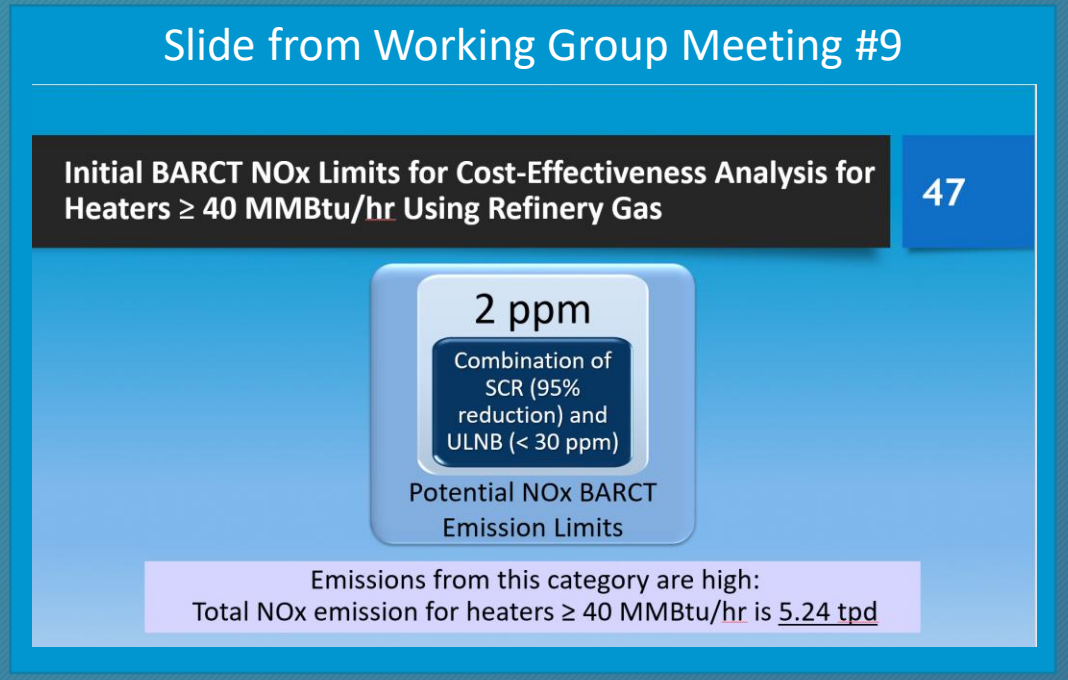


Boilers & Heaters BARCT Reassessment

Boilers and Heaters ≥40 MMBtu/hr - Background

- For boilers and heaters ≥40 MMBtu/hr, staff originally proposed a BARCT limit of 2 ppm with ULNB/SCR in WGM #9 on December 12, 2019
  - Third-Party Engineering Consultants supported staff's conclusion
    - Presented conclusions in WGM #16 on December 10, 2020
- Industry stakeholders' comments:
  - Technical feasibility of achieving 2 ppm with ULNB and SCR
  - Costs used to estimate cost-effectiveness

Slide from Working Group Meeting #9



Boilers and Heaters ≥40 MMBtu/hr - Background (*cont.*)

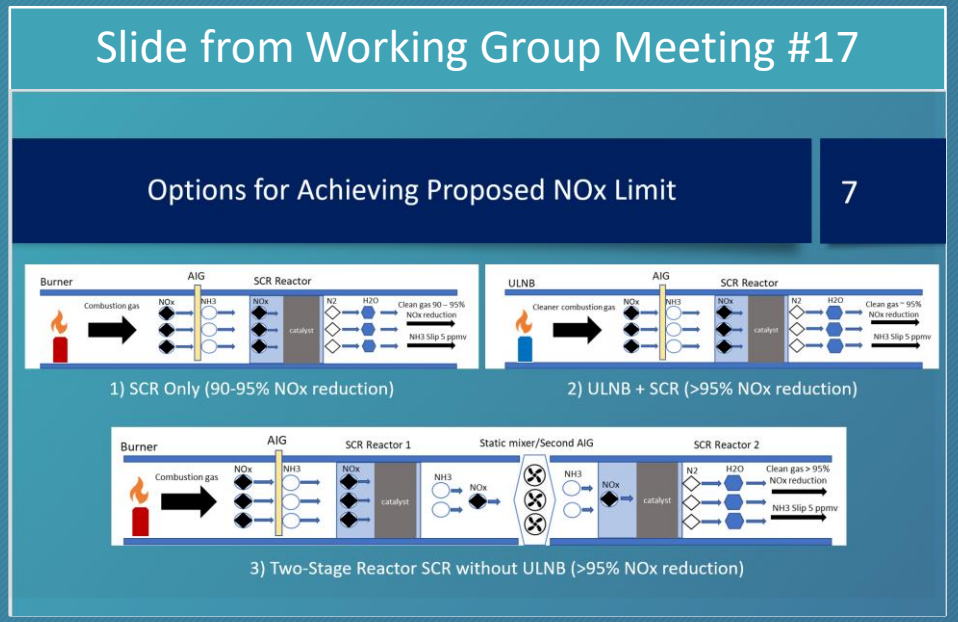
Technology Feasibility to achieve 2 ppm with ULNB and SCR

- Working Group Meeting #17, two-stage SCR presented as alternative pathway to 2 ppm
  - Staff assumed 25% increase in cost
    - Stakeholders indicated costs could increase by over 80% of single-stage SCR installation
    - Space constraint issues and costs are significantly magnified

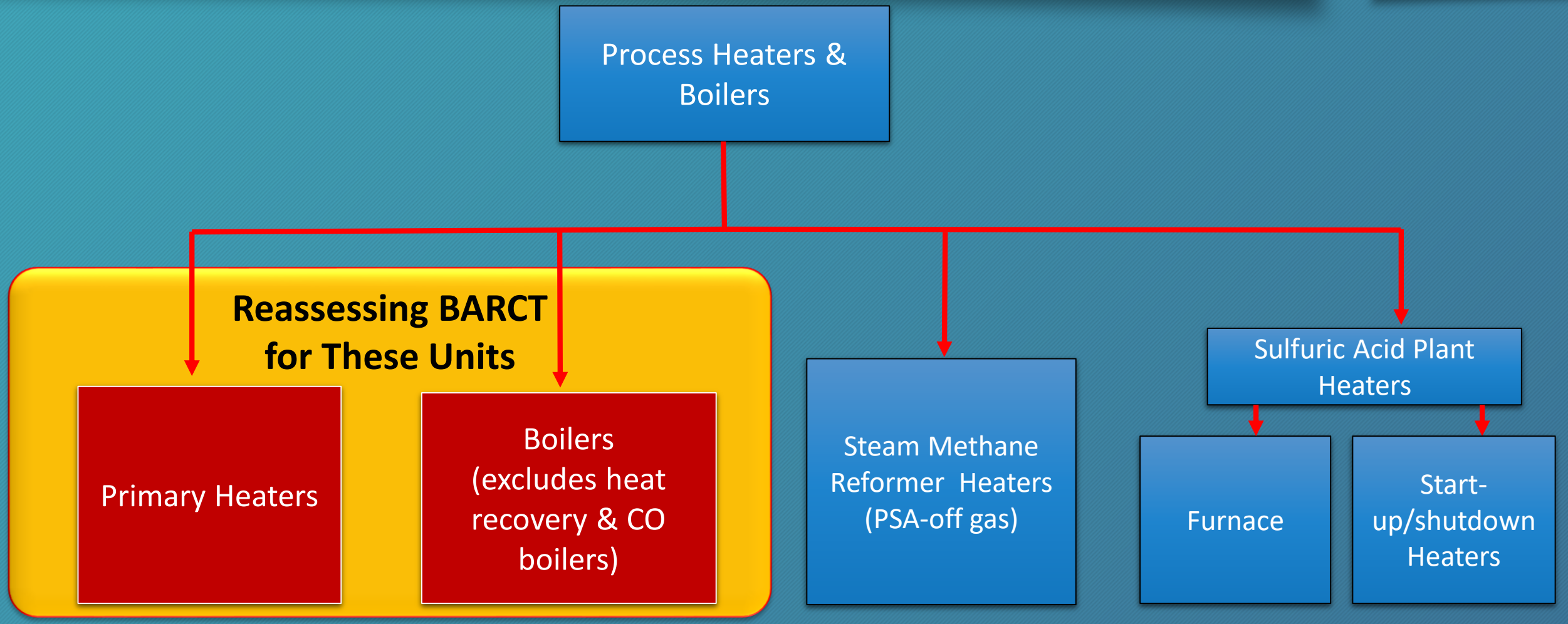
Costs used to estimate cost-effectiveness

- Facilities submitted revised cost data and staff reassessed proposed BARCT limits for major categories
- If cost data was not provided, staff used facilities suggested cost of 80% increase of single-stage reactor for two-stage SCR

Slide from Working Group Meeting #17



Boilers and Heaters by Category



Boilers and Heaters ≥40 MMBtu/hr - Technical Assessment

- Technical assessment to achieve 5 ppm and 2 ppm NOx levels detailed in prior Working Group Meetings
- Technical assessment for 50 ppm level using Low-NOx Burner on following slide

Boilers and Heaters ≥40 MMBtu/hr - Technical Assessment for Burner Technology

- American Petroleum Institute (API) provides recommended guidelines for refinery fired heaters (API 560) and burners (API 535)
- Recommended guidelines include heat density and minimum burner spacing for optimal operation and safety
  - A higher heat density (MMBtu/hr/ft^2) can result in higher flame temperatures and therefore increase NOx emissions
  - If burner spacing is not adequate, this can lead to flame interactions or coalescing which results in increased NOx emissions and potential impingement of the tubes
  - Not operating within guidelines is considered "suboptimal" which can impact burner NOx performance
- Norton's Report concluded:
  - Under optimal conditions, 30 ppm NOx can be achieved with ULNB
  - Suboptimal burner installations will achieve 40 – 50 ppm
- Staff's prior technology assessment concluded that ULNBs *can* achieve 30 ppm
  - Many units already achieving <30 ppm using ULNB technologies
- Staff received considerable feedback from stakeholders regarding the challenges of ULNB installation and has acknowledged not all units can be retrofitted with ULNB
- Technology assessment will consider 50 ppm NOx levels from burner technology

Boilers and Heaters ≥40 MMBtu/hr - Cost Estimates

50 ppm NOx

Low NOx Burners

- Revised cost estimates ranged from $3.4 MM to $31 MM

5 ppm NOx

Single Stage SCR

- Revised cost estimates for boilers ranged from $10 MM to $40 MM
- Revised cost estimates for heaters ranged from $2 MM to $45 MM

2 ppm NOx

Two Stage SCR, ULNB Single Stage, Unit Replacement

- Staff received cost estimates from facilities that included: unit replacement, combined SCR and low-NOx burners, and single SCR projects
- When costs were not provided, staff estimated costs based on dual reactor SCR
- Revised cost estimates for boilers ranged from $2 MM to $70 MM
- Revised cost estimates for heaters ranged from $5 MM to $244 MM

BARCT Reassessment Heaters ≥40 MMBtu/hr

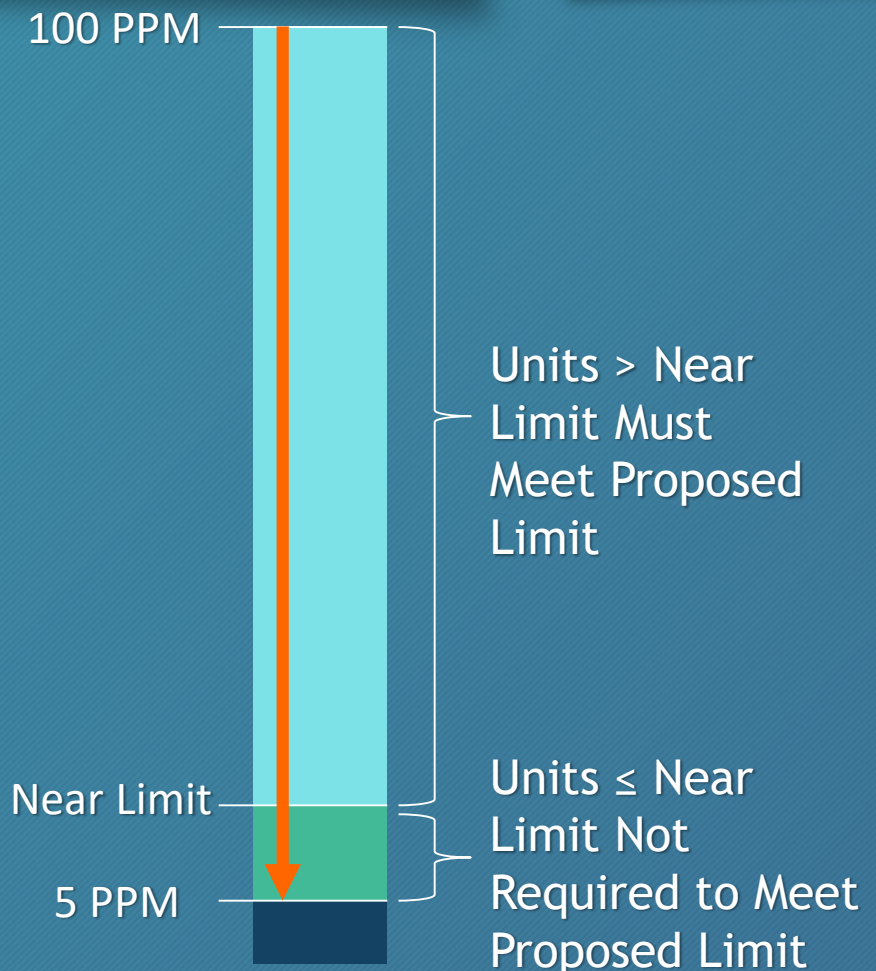
Heaters ≥40 MMBtu/hr - Initial BARCT NOx Limit

	RECLAIM 2005/2015 BARCT	Existing Units	Other Regulatory	Technology Assessment	Initial BARCT NOx Limits	Cost-Effectiveness and Incremental Cost-Effectiveness
40 to 110 MMBtu/hr	25/2 ppm	1.4 - 134 ppm	9 - 30 ppm	50, 5, & 2 ppm	50, 5, & 2 ppm	Need to assess cost-effectiveness and incremental cost-effectiveness
>110 MMBtu/hr	5/2 ppm	1.5 - 70 ppm	9 - 30 ppm	50, 5, & 2 ppm	50, 5, & 2 ppm	Need to assess cost-effectiveness and incremental cost-effectiveness

Emissions from this category are high:
Total NOx emission for heaters ≥ 40 MMBtu/hr is 5.24 tpd

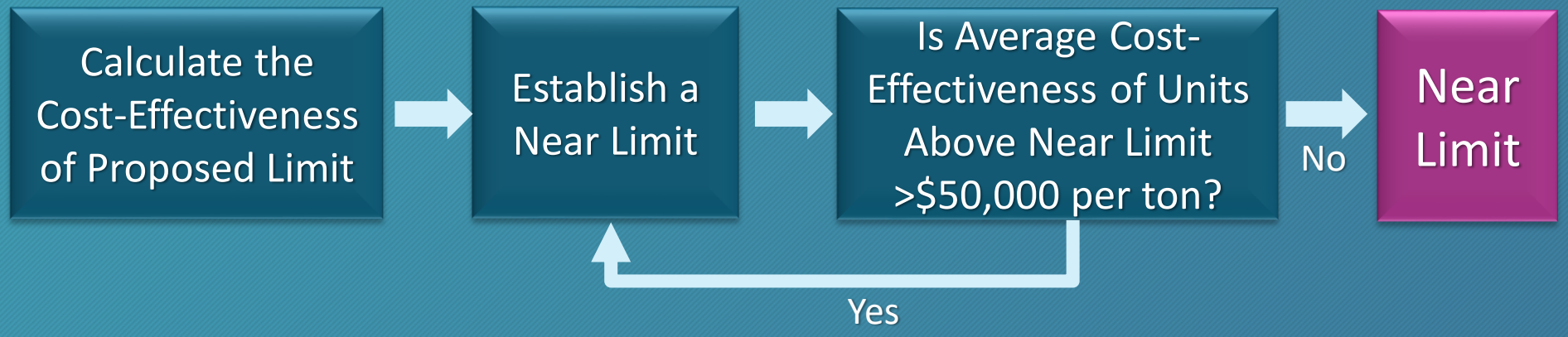
Heaters ≥40 MMBtu/hr - Approach for Establishing Proposed BARCT Limit

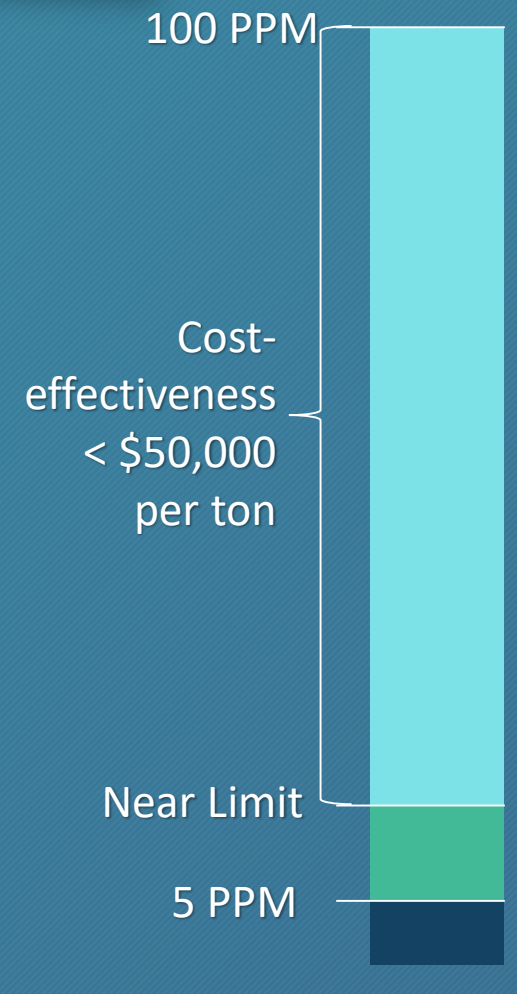
- Based on revised cost estimates, the average cost-effectiveness to achieve either 5 ppm or 2 ppm are above $50,000 per ton of NOx for heaters ≥40 MMBtu/hr
- To reduce the average cost-effectiveness, staff is proposing that units operating between the proposed and near limit would not be required to meet the proposed NOx limits
- Units that are at or below the "near limit" will not be required to meet proposed NOx limit in Table 1 provided:
  - Operator accepts a permit limit at or below the near limit
- Near limit units are excluded from the cost-effectiveness calculation
  - Near limit units will not be required to meet the NOx limits in Table 1
  - No additional retrofit costs associated with these units



Heaters ≥40 MMBtu/hr - Approach to Establishing Near Limits (*cont.*)

- An iterative process was used to identify the near limit NOx concentration level where the cost-effectiveness for units above the near limit would be less than $50,000 per ton of NOx reduced
- For the proposed NOx limit of 2 ppm, no near limit was identified that will reduce the cost-effectiveness to below $50,000 per ton of NOx reduced
- For the proposed NOx limit of 5 ppm, removing units at or below near limits will reduce the cost-effectiveness to below $50,000 per ton of NOx reduced





Heaters ≥40 MMBtu/hr - Approach to Establishing Near Limits (*cont.*)

- Several units with combined stacks that have different sizes
- For near limits assessment, staff considered units with combined stacks to fall into the larger category
  - If multiple units are combined:
    - One unit is >110 MMBtu/hr and the other are less → >110 MMBtu/hr
    - All units are between 40 – 110 MMBtu/hr → 40 – 110 MMBtu/hr
    - One is >40 MMBtu/hr and the other units are less → 40 – 110 MMBtu/hr

Heaters ≥40 MMBtu/hr – Low Use Unit

- In addition to the units performing near the NOx limits, there is one unit >110 MMBtu/hr that is operating at a low capacity (approximately 12 percent)
  - Unit has very high cost-effectiveness ~$184,000 per ton reduced
  - Low emission reductions – 0.02 tpd
- Staff is proposing to include a low-use exemption for units operating less than 15 percent capacity
  - Low-use units will not have to meet the Table 1 NOx limits

Heaters 40 to 110 MMBtu/hr - Establishing a Near Limit to Reduce the Average Cost-Effectiveness

Heaters 40 – 110 MMBtu/hr			
Potential Near Limit (ppm)*	Cost-Effectiveness of Remaining Units	Number Units Meeting Near Limit*	Foregone emissions (tpd)
No Near Limit	**$53,000**	**0/67 unit**	**Baseline**
10	$53,000	1/67 unit	0.001
15	$51,000	8/67 units	0.02
18	$48,000	12/67 units	0.05

* Based on annual average emissions

18	$48,000	12/67 units	0.05

- Cost-effectiveness for the 12 units that are currently achieving NOx levels between 5 and 18 ppm is high
  - Cost-effectiveness ranges between $200,000 to $750,000 per ton of NOx reduced
  - Emission reductions are low compared to other units
- **Staff Recommendations:**
  - Include near limit of 18 ppm
  - Reassess the cost-effectiveness and incremental cost-effectiveness

Revised

Heaters 40 – 110 MMBtu/hr - Cost-Effectiveness and Incremental Cost-Effectiveness

Heaters 40 – 110 MMBtu/hr					
50 ppm		5 ppm*		2 ppm	
Cost Effectiveness	Emission Red (tpd)	Cost Effectiveness	Emission Red (tpd)	Cost Effectiveness	Emission Red (tpd)
$40,000	0.33	$48,000	1.63	$94,000	1.99

	50 → 5 ppm	5 → 2 ppm
Incremental Cost Effectiveness	**$50,000**	**$293,000**
Incremental Emission Reduction (tpd)	**1.30**	**0.37**

* Excludes near limit units

Heaters >110 MMBtu/hr - Establishing a Near Limit to Reduce the Average Cost-Effectiveness

- Some of the heaters >110 MMBtu/hr category have very high emission reduction potentials
- To minimize the amount of foregone emission reductions, staff considered two criteria for evaluating the near limit:
  1. Concentration limit
  2. Overall emission reduction potential for retrofit
- Staff used the iterative process for the different concentration limits but units that have the potential to achieve greater than 20 tons per year NOx reductions were not removed
  - Evaluated a 10 ton per year limit as a secondary limit but cost-effectiveness remained greater than $50,000
- Units that have the potential to achieve 20 tons per year or greater reductions will have to retrofit even if they are achieving less than the near limit

Heaters >110 MMBtu/hr - Establishing a Near Limit to Reduce the Average Cost-Effectiveness

Heaters >110 MMBtu/hr			
Potential Near Limit (ppm)*	Cost-Effectiveness of Remaining Units	Number Units Meeting Near Limit*+	Foregone emissions (tpd)
No Near Limit	**$56,000**	**0/51 unit**	**None**
10	$55,000	5/51 units	0.03
15	$54,000	8/51 units	0.06
18	$52,000	12/51 units	0.15
20	$50,500	13/51 units	0.19
22	$50,000	17/51 units	0.23

* Based on annual average emissions

\+ Excludes low-use unit and units with the potential to reduce more than 20 tpy Nox based on 2017 baseline and Table 1 NOx limits

22	$50,000	17/51 units	0.23

- Cost-effectiveness for the 17 units that are currently achieving NOx levels between 5 and 22 ppm with less than 20 tpy potential reductions is high
  - Average cost-effectiveness for near limit units ~$85,000 per ton
  - Average cost-effectiveness for near limit units with potential reductions greater than 20 tons/year is $44,000 per ton
- **Staff Recommendations:**
  - Include near limit of 22 ppm provided potential emission reductions are not greater than 20 tpy
  - Reassess the cost-effectiveness and incremental cost-effectiveness

Heaters >110 MMBtu/hr - Cost-Effectiveness and Incremental Cost-Effectiveness

Heaters >110 MMBtu/hr					
50 ppm		5 ppm*		2 ppm	
Cost Effectiveness	Emission Red (tpd)	Cost Effectiveness	Emission Red (tpd)	Cost Effectiveness	Emission Red (tpd)
$72,000	0.07	$50,000	1.84	$110,000	2.22

	50 → 5 ppm	5 → 2 ppm
Incremental Cost Effectiveness	**$49,000**	**$400,000**
Incremental Emission Reduction (tpd)	**1.77**	**0.38**

* Excludes near limit units and low-use unit

Heaters ≥40 MMBtu/hr - Staff Recommendation

50 ppm NOx

Does not represent the Best Available Retrofit Technology

SCR achieves significantly greater emission reductions than LNB and is cost-effective

5 ppm NOx

Challenging but technically feasible

Cost-effective provided near limits are allowed for units performing the BARCT limit

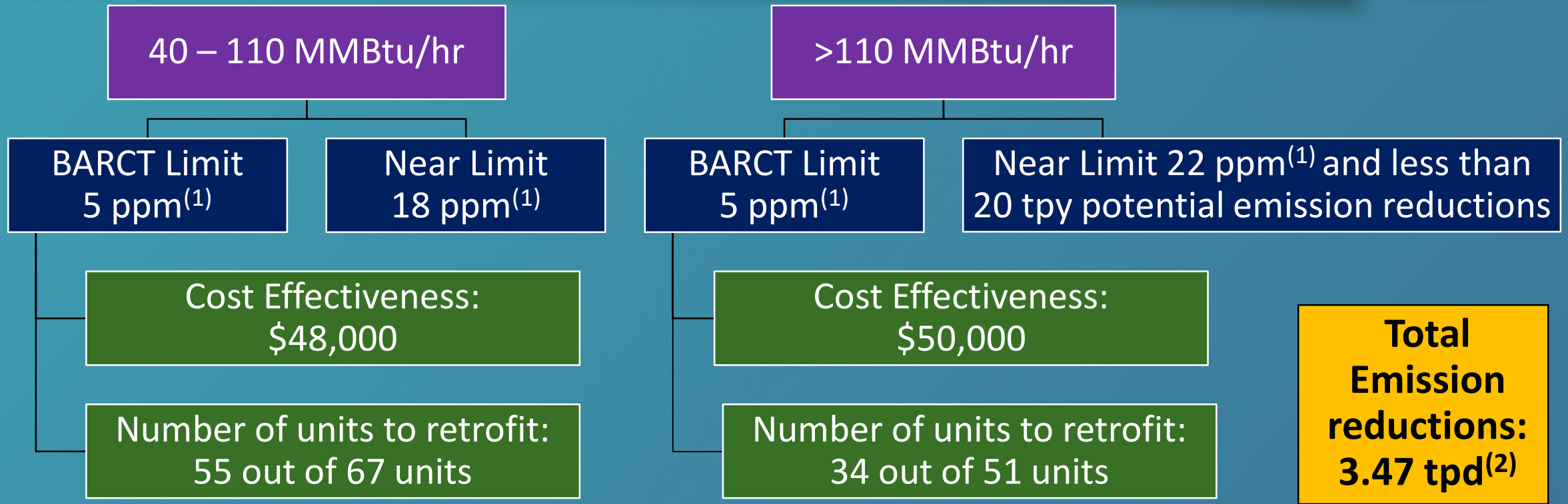
- Near limit units will have to accept a permit limit
- Rule will allow time for facilities to request permit change

2 ppm NOx

Not cost-effective to achieve 2 ppm

Incremental cost-effectiveness is high – considerable cost for diminishing emission reduction

Heaters ≥40 MMBtu/hr - BARCT Assessment



(1) 400 ppm Carbon Monoxide, 3% Oxygen Correction, 24 hour rolling average

(2) Previously estimated emission reduction to 2 ppm without near limits: 4.21 tpd

Boilers (≥40 MMBtu/hr) Reassessment

Boilers ≥40 MMBtu/hr - Initial BARCT NOx Limit

	RECLAIM 2005/2015 BARCT	Existing Units	Other Regulatory	Technology Assessment	Initial BARCT NOx Limits	Cost-Effectiveness and Incremental Cost-Effectiveness
40 to 110 MMBtu/hr	2 ppm	70 - 105 ppm	5 - 9 ppm	50, 5, & 2 ppm	50, 5, & 2 ppm	Need to assess cost-effectiveness and incremental cost-effectiveness
>110 MMBtu/hr	2 ppm	4.2 - 117 ppm	5 - 9 ppm	50, 5, & 2 ppm	50, 5, & 2 ppm	Need to assess cost-effectiveness and incremental cost-effectiveness

Total NOx emission for boilers 40 – 110 MMBtu/hr is 0.052 tpd

Total NOx emission for boilers >110 MMBtu/hr is 2.51 tpd

Boilers ≥40 MMBtu/hr – Cost Submission

Boilers 40 – 110 MMBtu/hr

- 3 boilers at one facility
  - 1 main boiler and 2 back-up
- Staff received capital cost from facility to achieve 5 ppm level of NOx
  - Used 4.5-time multiplier to account for installation costs (per Norton recommendation in the 2015 BARCT assessment)
  - Costs estimated ~ $10.5 MM
- For 2 ppm cost estimate, staff increased cost by 80% to account for two-stage SCR

Boilers >110 MMBtu/hr

- 20 Boilers
- Staff received eight revised cost estimates from facilities to achieve 5 ppm
  - Based on revised costs, SCR costs increased from $3 to $14 MM
- Costs included SCR upgrades or installations and ranged from:
  - $2.4 MM to $39 MM for SCR retrofits
  - $2 MM for SCR upgrades

Boilers 40 – 110 MMBtu/hr - Cost-Effectiveness and Incremental Cost-Effectiveness

Staff Comment:

No near limit provision needed

Boilers 40 – 110 MMBtu/hr					
50 ppm		5 ppm		2 ppm	
Cost Effectiveness	Emission Red (tpd)	Cost Effectiveness	Emission Red (tpd)	Cost Effectiveness	Emission Red (tpd)
$13,000	0.024	$25,000	0.049	$46,000	0.051

	50 → 5 ppm	5 → 2 ppm
Incremental Cost Effectiveness	**$37,000**	**$656,000**
Incremental Emission Reduction (tpd)	**0.025**	**0.002**

Boilers >110 MMBtu/hr - Cost-Effectiveness and Incremental Cost-Effectiveness

Staff Comment:

No near limit provision needed

Boilers > 110 MMBtu/hr					
50 ppm		5 ppm		2 ppm	
Cost Effectiveness	Emission Red (tpd)	Cost Effectiveness	Emission Red (tpd)	Cost Effectiveness	Emission Red (tpd)
$12,000	0.72	$12,000	2.21	$19,000	2.38

	50 → 5 ppm	5 → 2 ppm
Incremental Cost Effectiveness	**$12,000**	**$102,000**
Incremental Emission Reduction (tpd)	**1.49**	**0.18**

Boilers ≥40 MMBtu/hr – Staff Recommendation

50 ppm NOx ✗

- Does not represent the Best Available Retrofit Technology
- SCR achieves significantly greater emission reductions than LNB and is cost-effective

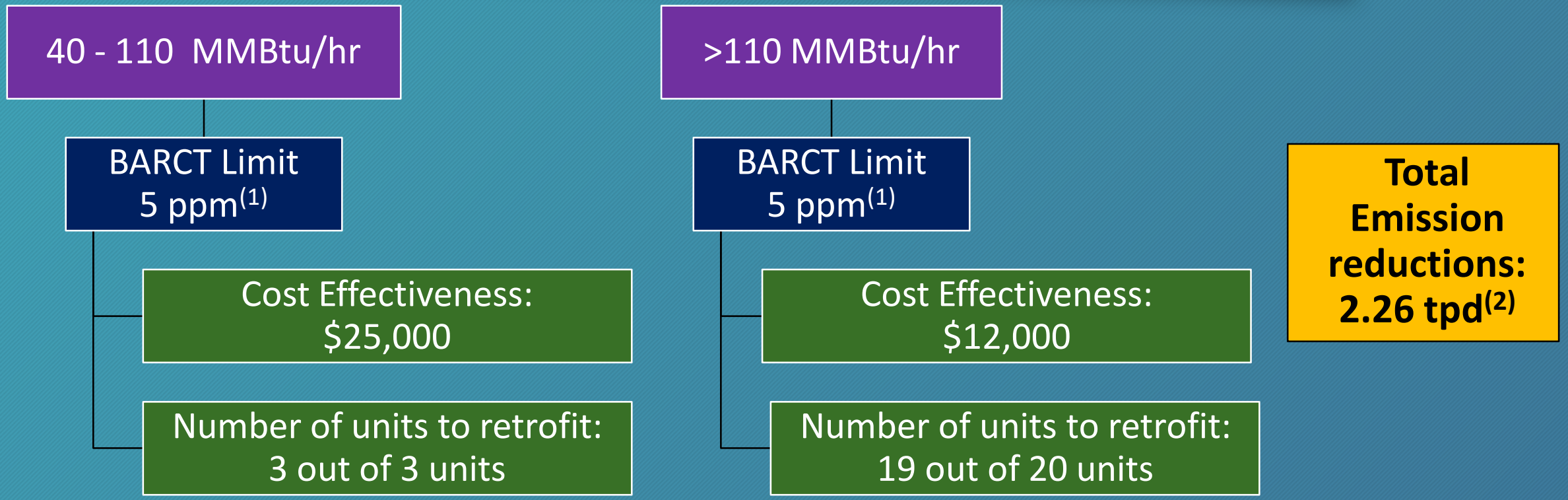
5 ppm NOx ✓

- Challenging but technically feasible
- Cost-effective

2 ppm NOx ✗

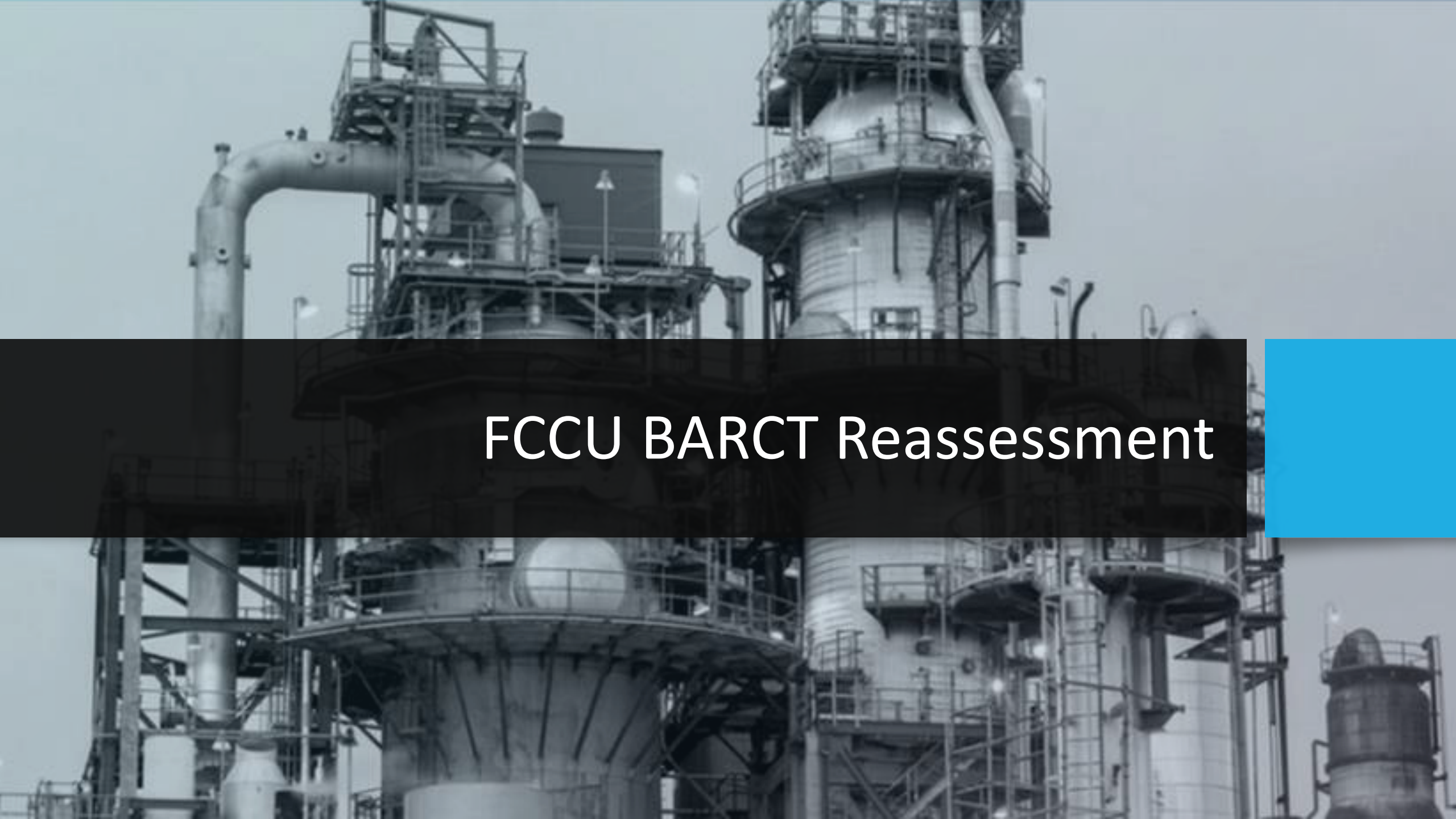
- Technical feasibility is uncertain
- Cost-effective
- Incremental cost-effectiveness is very high
  - No established threshold for I-CE
  - I-CE Assessment shows diminishing emission reductions for significant additional costs

Boilers ≥40 MMBtu/hr - Staff Recommendation



(1) 400 ppm Carbon Monoxide, 3% Oxygen Correction, 24 hour rolling average

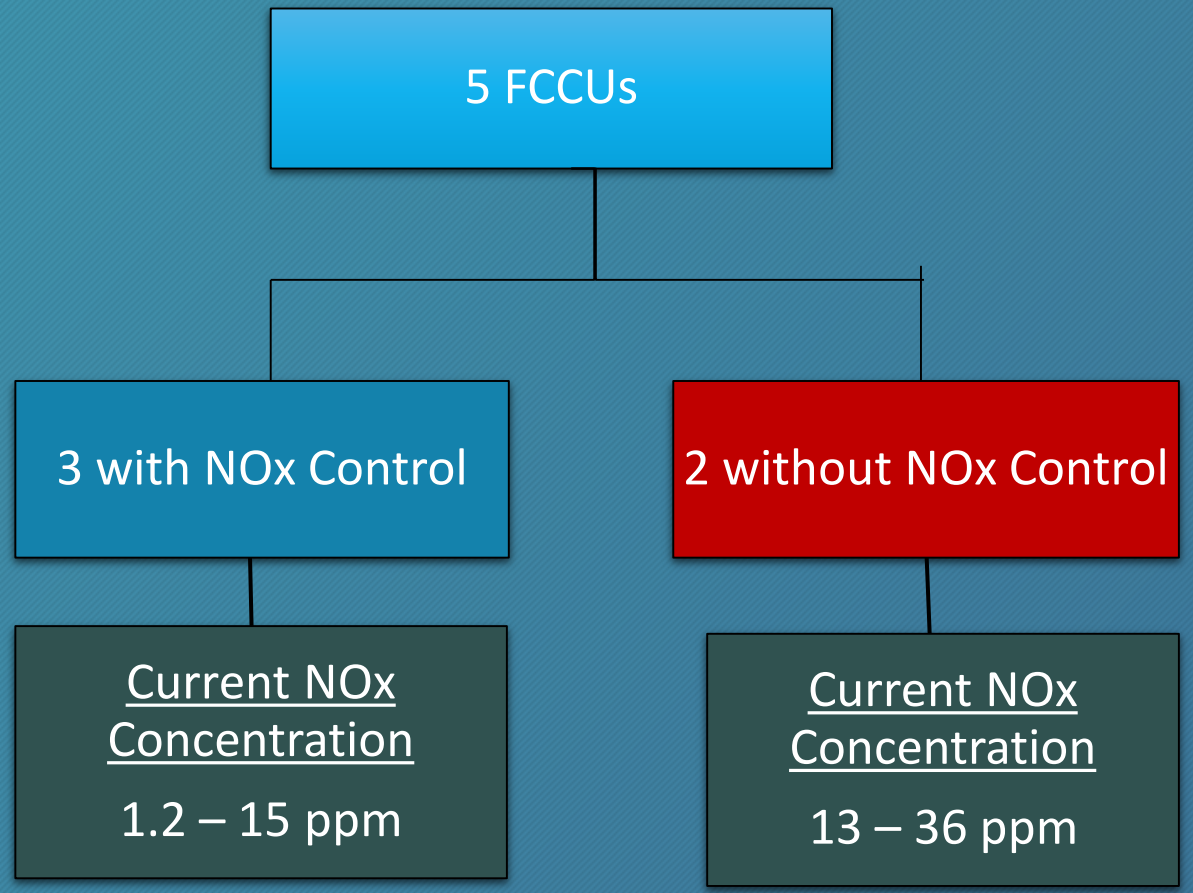
(2) Previously estimated emission reduction to 2 ppm: 2.43 tpd



FCCU BARCT Reassessment

FCCU - BARCT Assessment Follow-Up

- BARCT assessment presented in Working Group Meeting #10 on February 18, 2020
  - Staff recommended 2 ppm limit
  - Cost-Effectiveness $37,000 based on original cost estimates
- Stakeholders raised a concern over the technical feasibility and cost-effectiveness for units with existing SCRs to achieve 2 ppm



FCCU - Technical Assessment to Achieve 2 ppm

- Previously staff assumed FCCUs with existing SCRs would be upgraded to meet the proposed BARCT limit of 2 ppm
- Based on facility engineering assessments:
  - Not technologically feasible to upgrade all units with existing SCRs to achieve <5 ppm NOx
  - Major reconfiguration, re-engineering, and re-design of the existing unit
  - Demolition of existing SCR and structures
  - Major infrastructure modifications to the unit
  - Cost to replace SCR are substantially higher than upgrade
  - Some units will require replacement of the FCCU regenerator (combustor) to achieve 2 ppm
  - Substantial costs and technical feasibility to achieve 2 ppm is not certain
  - SCR upgrade on units with existing SCRs can achieve ~8 ppm NOx

FCCU - BARCT Reassessment

5 FCCUs

- 2 units without NOx Controls
  - 1 unit is in process of installing a SCR designed for 2 ppm
- 3 units with NOx Controls
  - 1 unit performing well below 2 ppm (annual average)
  - 2 units with SCR that would need:
    - SCR replacement and new regenerator to achieve 2 ppm
    - Upgrades to existing SCR to achieve 8 ppm

FCCU BARCT Assessment

	RECLAIM 2015 BARCT	Existing Units	Other Regulatory	Technology Assessment	Initial BARCT NOx Limit	Cost-Effectiveness and Incremental Cost-Effectiveness
FCCU	2 ppm	1.2 – 36 ppm	40 – 125 ppm	8 - 2 ppm	8 - 2 ppm	Need to assess cost-effectiveness and incremental cost-effectiveness

Total NOx emission is 0.43 tpd

FCCU - Cost Estimates

- Staff received 2 facility-revised cost for FCCU retrofit
- Costs include SCR upgrades, SCR installation, regenerator (combustor) replacement, wet gas scrubber (multipollutant control)

8 ppm NOx

Revised cost estimates for SCR upgrade ranged from $1 MM to $3 MM

2 ppm NOx

Staff estimates for new SCR installation ranges from $75 MM to $103 MM based of original costs provided

Facility provided cost for combustor replacement ~$200 MM

Facility Provided Cost for LoTOx wet gas scrubber ~$220

FCCU - BARCT Reassessment

- Staff will reassess the cost-effectiveness for FCCUs to meet 2 ppm and 8 ppm
- One facility provided cost for a wet gas scrubber that can achieve multi-pollutant emission reductions
  - Wet gas scrubber can reduce NOx, SOx, and PM emissions
  - Cost considerably more than SCR
- Only NOx reductions are required for PR 1109.1, so staff evaluated the cost-effectiveness of that unit based on:
  - LoTOx with wet gas scrubber is multi-pollutant control achieving NOx and SOx reductions
  - SCR achieving NOx reductions only
    - SCR capital cost estimated based on vendor quote for similar sized FCCU at another refinery
      - Increased cost by factor of 4.5 for installation costs
      - Increased cost by 20% to account for SB 54 which requires refineries to hire unionized labor
      - Included 2 times retrofit factor to address space constraints – maximum multiplier in U.S. EPA Cost Model

FCCU - Cost Effectiveness to Achieve 2 ppm with Wet Gas Scrubber or SCR

	Multi-Pollutant Scrubber	SCR
Estimated Present Worth Value	$218 MM	$ 76 MM
Emission Reductions (Lifetime tons)	NOx: 2,071 SOx: 2,027	NOx: 2,071
Cost Effectiveness	$46,000	$24,000

FCCU - Outliers Assessment

- Based on facility-revised cost data, 2 ppm is not cost-effective for class and category
  - 2 FCCUs have high cost-effectiveness to achieve 2 ppm
    - Units already equipped with NOx control
    - High cost to replace existing controls or modification to units to achieve 2 ppm
    - Cost outliers due to high cost and the low emission reductions to achieve 2 ppm
- Staff reassessed:
  - Cost-effectiveness and incremental cost-effectiveness of two cost outliers to retrofit to achieve 8 and 2 ppm
  - Cost-effectiveness of remaining two units to achieve 2 ppm with the outliers removed

FCCU - Cost-Effectiveness and Incremental Cost-Effectiveness with Existing SCR

- Based on revised cost estimates from facilities, units with SCR:
  - 8 ppm is cost-effective (upgrades)
  - 2 ppm is not cost-effective
- Incremental assessment
  - No established threshold for I-CE
  - Diminishing emission reductions for considerable cost

Staff Recommendation:

Include a near limit of 8 ppm on 365 day and 10 ppm on 7 day rolling average

FCCU with Existing NOx Controls

8 ppm		2 ppm	
Cost Effectiveness	Emission Red (tpd)	Cost Effectiveness	Emission Red (tpd)
$12,000	0.06	$108,000	0.32

8 → 2 ppm

Incremental Cost-Effectiveness	**$127,000**
Incremental Em Red (tpd)	**0.25**

FCCU – Cost-Effectiveness to Achieve 2 ppm with Outliers Removed

- Staff did not evaluate 8 ppm for the FCCUs without SCR
  - 8 ppm was proposed due to technical feasibility and high cost for retrofitting existing SCRs on FCCUs
- Based on revised cost estimates, 2 ppm is cost-effective for units without NOx controls

FCCU without NOx Controls	
2 ppm	
Cost Effectiveness	Emission Red (tpd)
$24,000	0.36

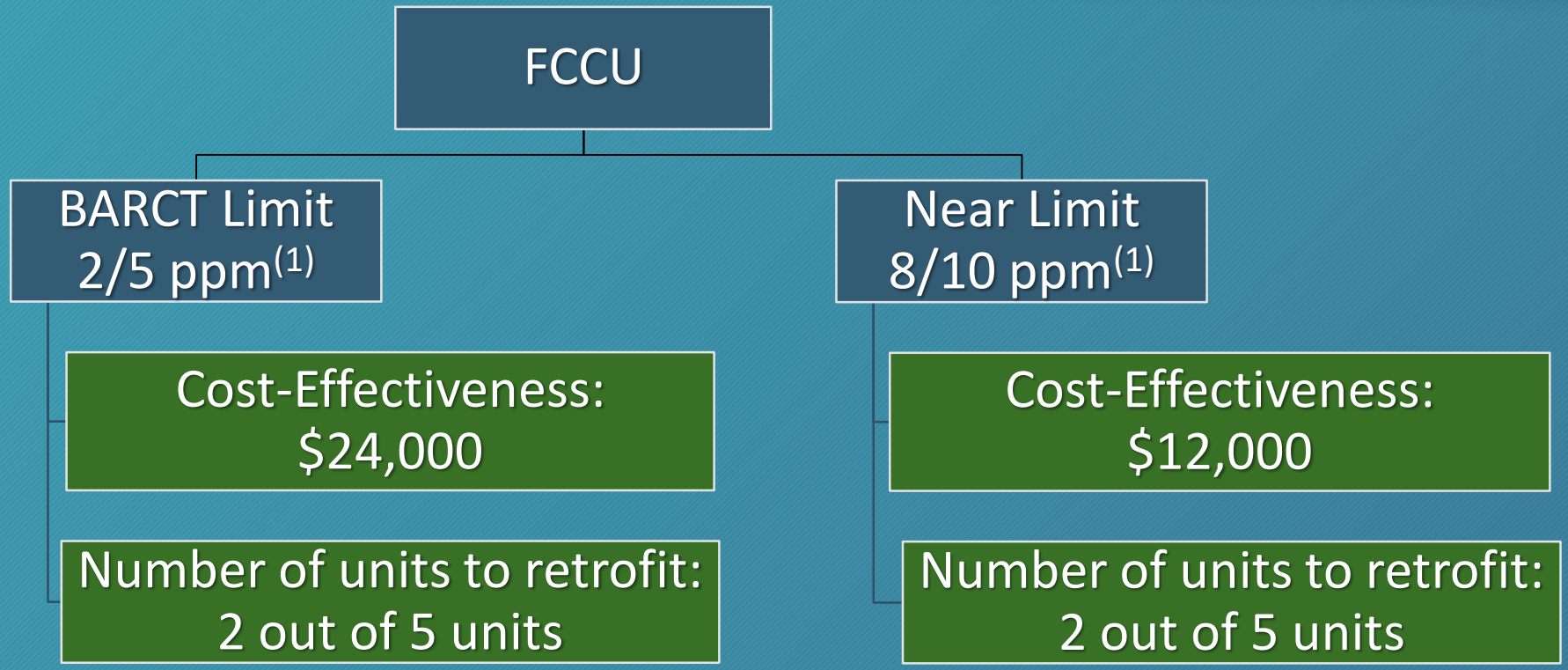
Staff Recommendation:

Maintain 2 ppm NOx Limit for FCCU

Staff Comment:

Multiple potential control options to achieve emission reduction objectives were not identified; therefore, incremental cost-effectiveness not presented

Revised BARCT Assessment for FCCU



Emission Reductions: 0.42 tpd(2)

(1) 500 ppm Carbon Monoxide, 3% Oxygen Correction, 365/7-day rolling average

(2) Previously estimated emission reductions without near limit: 0.67 tpd

FCCU NOx limit and Oxygen Correction

- For the FCCU category, staff proposed that the NOx emission outlet be corrected to zero percent oxygen
- Based on recent permit to construct, permit condition E519.1 requires that NOx emission be corrected to 3 percent oxygen

TABLE 1: NOx AND CO EMISSION LIMITS

FLUIDIZED CATALYTIC CRACKING UNITS				
	NOx (ppmv)	CO (ppmv)	Averaging Time (Rolling Average)	Permit Application Submittal Deadline
	0% O_2			
FCCU	2	500	365 days	July 1, 2022 or pursuant to subdivision (k)
	5	500	7 days	

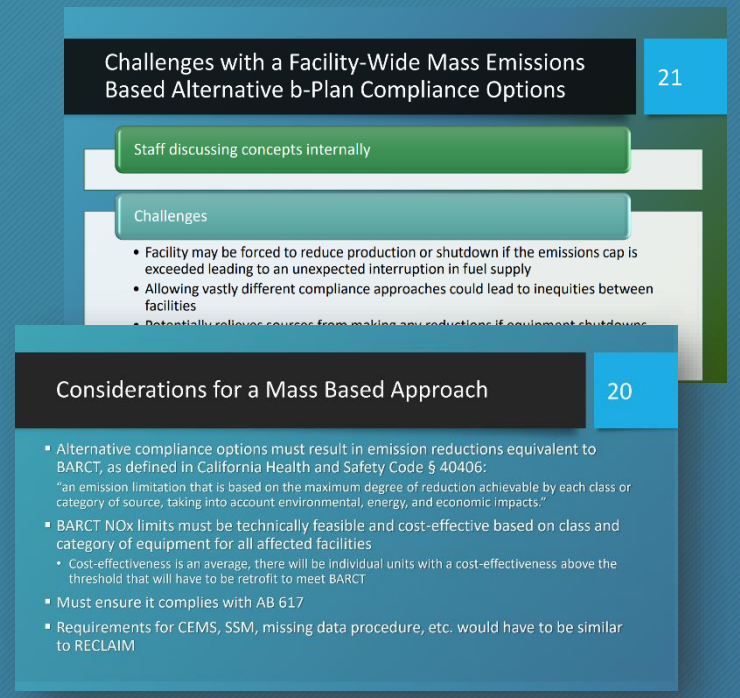
Staff Recommendation:

Change initial proposal for correcting NOx emissions from 0% to 3% oxygen for consistency with existing permit condition E519.1

Initial Concept for Mass Emissions Approach

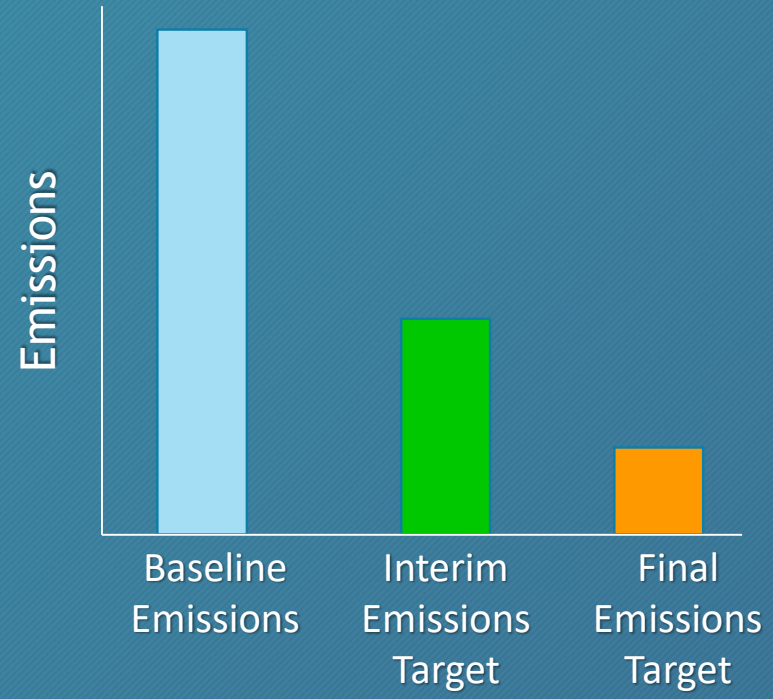
BARCT-Compliance Alternative Plan (B-Cap)

- In Working Group Meeting #20, discussed recommendations by some industry stakeholders to consider a facility-wide mass emissions approach
  - Discussed challenges and consideration for a facility-based mass approach
- Staff has developed initial concepts for a BARCT equivalent facility-wide mass emissions approach which will be referred to as a BARCT-Compliance Alternative Plan (B-Cap)
- B-Cap is an option that is in addition to:
  - Direct compliance with the NOx limits of Table 1; and
  - The B-Plan which achieves BARCT in aggregate
- Presenting initial concept for B-Cap today – will provide additional details in next Working Group Meeting



Initial Concepts for B-Cap

- Final Emissions Target would be based on 2017 activity and proposed NOx limits in Table 1 for each unit
- Interim Emissions Target would be based on committed reductions in the i-Plan (~65 to 70% Phase I)
- Each unit must have a concentration limit
- Each unit must meet a minimum level of control (still developing)
- Cannot use RTCs in lieu of meeting interim or final emission targets
- Can use emission reductions from shutdowns to achieve overall mass emission targets
- Staff believes that if new units are added to the facility, there should be provisions to recognize that reductions from shutdowns lessened the obligation to reduce certain units' NOx emissions to Table 1 limits
  - Seeking input on a provision to require that any new unit stays within the Final Mass Emissions Cap (no increase)



Comparison Between Key Elements of Table 1, B-Plan, and B-Cap

Key Elements	Table 1	B-Plan	B-Cap
How is BARCT achieved	Specified NOx Limits from Table 1	In aggregate, based on Table 1	In aggregate, based on Table 1
Can reductions from shutdowns be used to meet BARCT	No	No	Yes
NOx concentration limits for each unit	Yes	Yes	Yes
Use of RTCs to meet emission reductions	No	No	No
Total emission reductions compared to Table 1	N/A	Same as Table 1	Same as Table 1
Throughput limitation	No	No	Yes
Minimum level of control for each unit	Yes	No	Yes
Future limitations for new units at BACT	No	No	Yes
Implementation Schedule	Table 1 or i-Plan	Table 1 or i-Plan	i-Plan

Next Working Group Meeting

- Scheduled for July 14, 2021
- Staff will present the BARCT reassessment for vapor incinerators and flares
- Continue discussion of additional details of the B-Cap
- Continue discussion on co-pollutants and PM2.5 source test

Next Steps

- Continue Discussions with Stakeholders
- Complete Cost-Effectiveness and BARCT Reassessment
- Release Preliminary Draft Staff Report and Rule Language
- Public Workshop in August 2021
- Public Hearing November 2021

Proposed Rule 1109.1 Staff Contacts

Susan Nakamura
Assistant DEO
snakamura@aqmd.gov
909.396.3105

Michael Krause
Planning & Rules Manager
mkrause@aqmd.gov
909.396.2706

Heather Farr
Program Supervisor
hfarr@aqmd.gov
909.396.3672

Sarady Ka
AQ Specialist
ska@aqmd.gov
909.396.2331

Mojtaba Moghani, Ph.D.
AQ Specialist
mmoghani@aqmd.gov
909.396.2527

Zoya Banan, Ph.D.
AQ Specialist
zbanan@aqmd.gov
909.396.2332

South Coast AQMD

RECLAIM Staff Contacts

Susan Nakamura
Assistant DEO
snakamura@aqmd.gov
909.396.3105

Michael Morris
Planning & Rules Manager
mmorris@aqmd.gov
909.396.3282

Uyen-Uyen Vo
Program Supervisor
uvo@aqmd.gov
909.396.2238

Lizabeth Gomez
AQ Specialist
lgomez@aqmd.gov
909.396.3103

Isabelle Shine
AQ Specialist
ishine@aqmd.gov
909.396.3064

South Coast AQMD

Rule 429 Staff Contacts

Susan Nakamura
Assistant DEO
snakamura@aqmd.gov
909.396.3105

Michael Morris
Planning & Rules Manager
mmorris@aqmd.gov
909.396.3282

Rudy Chacon
Acting Program Supervisor
rchacon@aqmd.gov
909.396.2206

Isabelle Shine
AQ Specialist
ishine@aqmd.gov
909.396.3064

South Coast AQMD