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

Working Group Meeting #21

May 27, 2021

Join Zoom Webinar
https://scaqmd.zoom.us/j/95120853086
Webinar ID: 951 2085 3086
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Agenda

- Progress of Rule Development
- Progress and Status Since Working Group Meeting #20
- Bridge Concepts
- Incremental Cost-Effectiveness Assessment
- Alternative i-Plan Concepts
- Gas Turbine and SMR Heater Follow-up
- Proposed Rule 429.1 Update

Progress of Rule Development

Summary of Working Group # 20 (04/30/21)

- Discussed third party reviewers for the Socioeconomic Impact Analysis
- Summarized the revised cost data received from facilities
- Presented comment letters received and ongoing stakeholder meetings
- Discussed BARCT implementation and compliance plans concepts
- Presented Proposed Rule 429.1: Start-Up and Shutdown Provisions at Petroleum Refineries
- ClearSign™ presented an update on their burner technology

Progress and Status Since WGM #20

Status and Progress Since Last WGM

Continued Meeting with Stakeholders

Norton Engineering's Preliminary Assessment of Revised Costs

Continued BARCT Assessment including Cost-Effective and Incremental Cost-Effective Analysis

Working on Revised Rule Language

Continued Meetings with Stakeholders

Environmental and Community Groups[1]	Chevron	Marathon	Phillips 66	Torrance	Valero
February 28	February 19	January 27	February 16	January 29	January 29
March 11	February 26	February 17	March 4	February 12	February 24
April 2	April 1	February 24	March 31	February 26	April 16
April 30	May 20	March 9		March 12	May 5
		March 23		March 24	May 19
		May 13		April 9	
				April 28	
				May 18	

[1] Biological Diversity, Coalition for Clean Air, Earth Justice, Communities for a Better Environment, Natural Resources Defense Council and East Yard Communities for Environmental Justice

Continued Meetings with Stakeholders – *cont.*

- Staff and stakeholders discussed:
  - i-Plans and b-Plan
  - Applicability of BARCT limits and/or retrofit technologies to specific units/equipment
  - Alternative compliance options – alternative mass cap approach
  - BARCT re-evaluation for the units operating near BARCT limits
  - Start-up, shutdown, and maintenance considerations

Norton Engineering's Preliminary Assessment of Revised Costs

Review and Evaluation of Revised Cost Data

- All costs data provided by the facilities were provided to Norton Engineering Consultants (Norton) on 4/27/21 for their review and evaluation

Preliminary Report

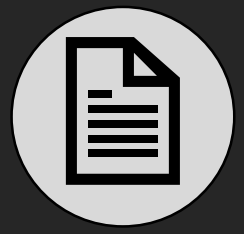
- May 14, 2021, including a review of:
  - Ultra-Low NOx Burner Upgrade Costs
  - SCR Costs for Burner and Heaters

Staff Recommendation

- Re-evaluation of BARCT for specific class and categories will use:
  - All facility-provided revised cost (71% of data for large boilers and heaters is facility data)
  - Updated U.S. EPA SCR model with revised facility cost data (estimate remaining costs)

Continued BARCT Assessment including Cost-Effective and Incremental Cost-Effective Analysis

- Staff is revising the BARCT assessments for major categories based on revised cost estimates received from facilities
  - Evaluating units with high cost-effectiveness (cost outliers) to develop near limits
    - Near limits are for units that are retrofit with NOx control technology and achieving near the proposed limits
    - In lieu of meeting proposed BARCT limit, operators can accept permit limits at the near limit
    - Unit must already meet near limit, cannot retrofit unit to meet near limit
  - Revising cost-effectiveness calculation using modified cost curve
  - Including the incremental cost-effectiveness assessment in BARCT assessment when more than one technology was identified to achieve emission reductions
- Based on new costs, staff anticipates:
  - Development of near limits for large boilers and process heaters, FCCU, gas turbines, and SMR heaters
  - Revised BARCT limits for boilers and process heaters (>40 MMBtu/hr)



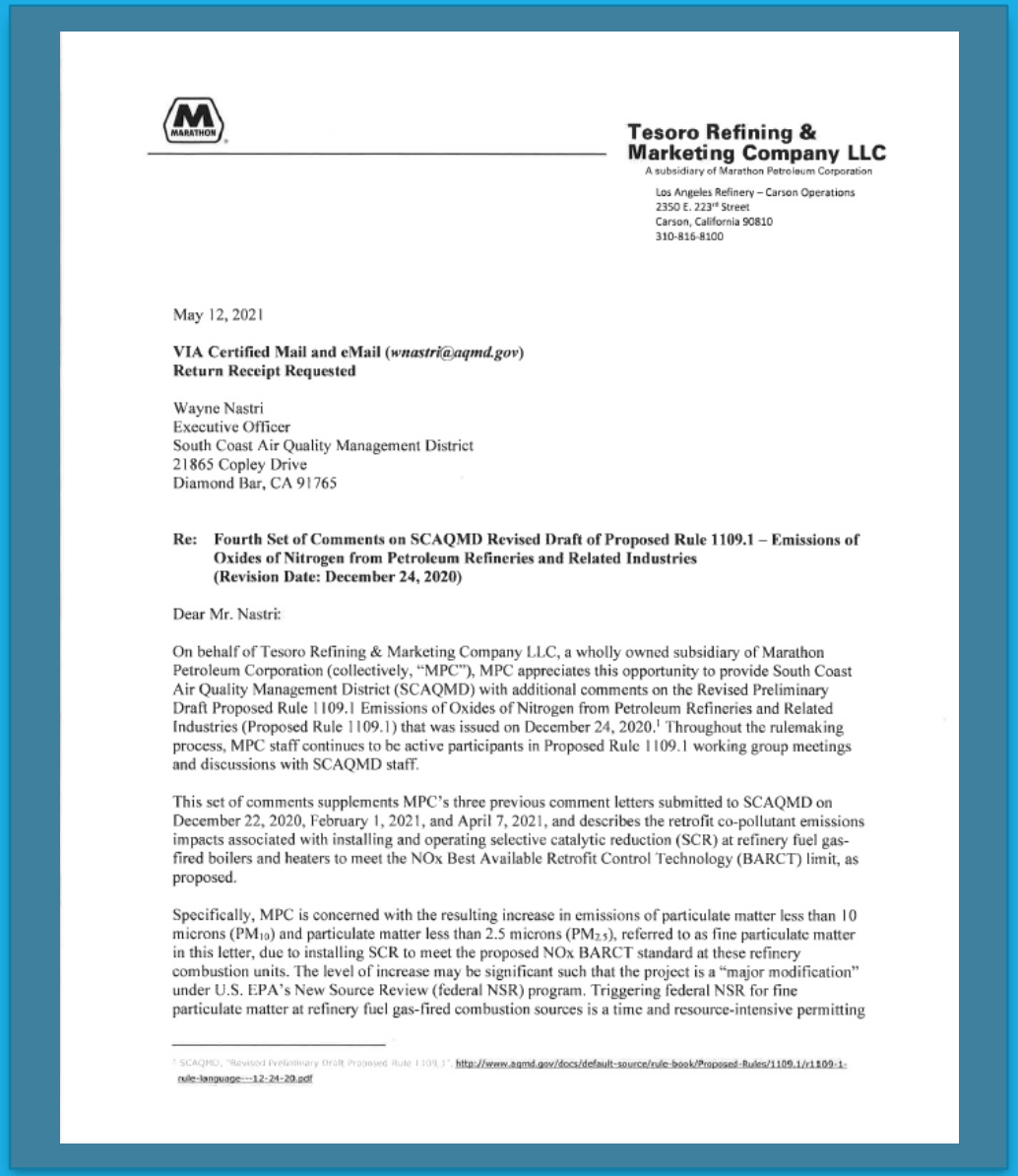
Working on Revised Rule Language

- Staff has been working on revised rule language, including details and provisions corresponding to i-Plan and b-Plan
- The revised rule language contains new and updated provisions added since the latest version of the rule language released in December 2020
- Staff is currently evaluating the BARCT limits which may not be included in this revised version of the rule language

Marathon Petroleum Comment Letter (May 12, 2021)

Marathon Petroleum Comment Letter

- Staff received a letter from Marathon Petroleum Corporation (Marathon) on May 12th
- Marathon anticipates some of their SCR projects may exceed the federal major modification threshold for PM 2.5 which is 10 tons per year which will:
  - Trigger BACT PM requirements
  - Require expensive sulfur cleanup of their refinery fuel gas
- The letter includes a hypothetical example calculation of the potential PM increase based on PM emissions from an actual source test data from their heater



Tesoro Refining & Marketing Company LLC
A subsidiary of Marathon Petroleum Corporation

Los Angeles Refinery – Carson Operations
2350 E. 223rd Street
Carson, California 90810
310-816-8100

May 12, 2021

VIA Certified Mail and eMail (*wnastri@aqmd.gov*)
Return Receipt Requested

Wayne Nastri
Executive Officer
South Coast Air Quality Management District
21865 Copley Drive
Diamond Bar, CA 91765

Re: Fourth Set of Comments on SCAQMD Revised Draft of Proposed Rule 1109.1 – Emissions of Oxides of Nitrogen from Petroleum Refineries and Related Industries (Revision Date: December 24, 2020)

Dear Mr. Nastri:

On behalf of Tesoro Refining & Marketing Company LLC, a wholly owned subsidiary of Marathon Petroleum Corporation (collectively, "MPC"), MPC appreciates this opportunity to provide South Coast Air Quality Management District (SCAQMD) with additional comments on the Revised Preliminary Draft Proposed Rule 1109.1 Emissions of Oxides of Nitrogen from Petroleum Refineries and Related Industries (Proposed Rule 1109.1) that was issued on December 24, 2020.[1] Throughout the rulemaking process, MPC staff continues to be active participants in Proposed Rule 1109.1 working group meetings and discussions with SCAQMD staff.

This set of comments supplements MPC's three previous comment letters submitted to SCAQMD on December 22, 2020, February 1, 2021, and April 7, 2021, and describes the retrofit co-pollutant emissions impacts associated with installing and operating selective catalytic reduction (SCR) at refinery fuel gas-fired boilers and heaters to meet the NOx Best Available Retrofit Control Technology (BARCT) limit, as proposed.

Specifically, MPC is concerned with the resulting increase in emissions of particulate matter less than 10 microns (PM_{10}) and particulate matter less than 2.5 microns ($PM_{2.5}$), referred to as fine particulate matter in this letter, due to installing SCR to meet the proposed NOx BARCT standard at these refinery combustion units. The level of increase may be significant such that the project is a "major modification" under U.S. EPA's New Source Review (federal NSR) program. Triggering federal NSR for fine particulate matter at refinery fuel gas-fired combustion sources is a time and resource-intensive permitting

[1] SCAQMD, "Revised Preliminary Draft Proposed Rule 1109.1", http://www.aqmd.gov/docs/default-source/rule-book/Proposed-Rules/1109.1/r1109-1-rule-language---12-24-20.pdf

Key Comments from Marathon Letter

Comment 1: South Coast AQMD Has Not Shared Results of SOx/PM Survey

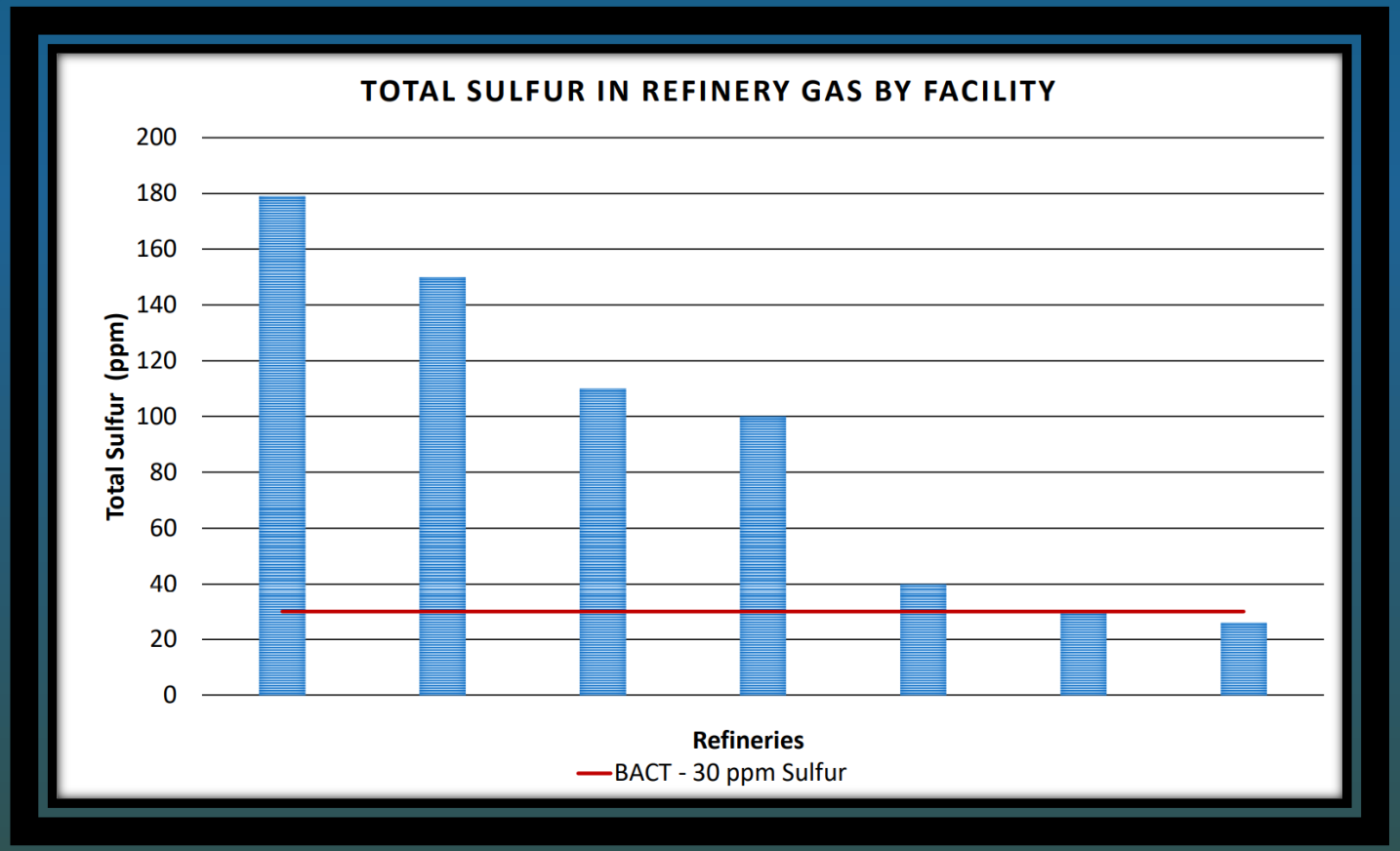
Comment 2: South Coast AQMD Provides No Information to Substantiate that Fine Particulate Would Likely Be Below Federal Major Modification Thresholds

Comment 3: Based on the Example a 425 MMBtu/hour Unit Will Exceed the PM2.5 Federal Major Source Modification Threshold of 10 tons per Year

Comment 4: EPA's "Project Aggregation" Policy Must be Considered if the Emissions Increase for the SCR Project is Combined with other SCR Projects at the Refinery

Comment 1: South Coast AQMD Has Not Shared Results of SOx/PM Survey

- Based on the SOx survey, total sulfur in refinery fuel gas varies between 25 ppm to 180 ppm
- Compared to the BACT limit of 30 ppm sulfur
  - Three facilities are near or below the BACT sulfur limit for refinery fuel gas
  - Four facilities are substantially above the BACT sulfur limit



Comment 2: South Coast AQMD Provides No Information to Substantiate that Fine Particulate Would Likely Be Below Federal Major Modification Thresholds

- Staff evaluated existing units at refineries to determine scenarios where Federal 10 tpy PM threshold could be exceeded
  - PM emissions depend on several variables:

Conversion of SO_2 to SO_3	• Typical conversion rate is ~ 3%, but newer catalyst technology can achieve much lower (1.2% or less)
Sulfur content in the fuel	• Higher sulfur concentration results in higher PM emissions • Sulfur content in refinery fuel gas ranges from ~40 – 180 ppm
Size of the unit	• Higher firing rate results in higher PM emissions • PR 1109.1 units range from 5 – 550 MMBtu/hour

Comment 2: South Coast AQMD Provides No Information to Substantiate that Fine Particulate Would Likely Be Below Federal Major Modification Thresholds *(Continued)*

- To exceed the Federal PM threshold, a heater would have to exceed the following firing rates for various conversion rates and sulfur concentrations
- 3% SO_2 to SO_3 conversion rate is typical for new SCRs
- No single boiler/heater or group of boilers and heaters would exceed the threshold
- If multiple SCR projects were aggregated, it is unlikely the threshold would be exceeded since:
  - 2,540 MMBtu/hour is the highest cumulative total at a refinery for units needing SCR
  - All refineries have communicated that SCR projects will be staggered based on their turnaround schedules

Firing Rate (MMBTU/hr) @ varying total sulfur concentrations required to exceed Federal PM threshold (10 TPY)

Catalyst Conversion SO2 to SO3	40 ppm Sulfur	110 ppm Sulfur	150 ppm Sulfur	179 ppm Sulfur
0.5%	39,152	14,237	10,441	8,749
1.0%	19,576	7,119	5,220	4,375
1.5%	13,051	4,746	3,480	2,916
2.0%	9,788	3,559	2,610	2,187
2.5%	7,830	2,847	2,088	1,750
3.0%	6,525	2,373	1,740	1,458
3.5%	5,593	2,034	1,492	1,250
4.0%	4,894	1,780	1,305	1,094
4.5%	4,350	1,582	1,160	972
5.0%	3,915	1,424	1,044	875

Comment 3: Based on the Example a 425 MMBtu/hour Unit Will Exceed the PM2.5 Federal Major Source Modification Threshold of 10 tons per Year

- Letter provided a hypothetical example (shown here in Table 1) in which Marathon:
  - Pre-project assumes a unit with no SCR
  - Assumed default emission factor of 0.0075 lb /MMBtu
- Post-project assumes unit with SCR
  - Projected actual emissions based on a source test of an old heater retrofit with an old SCR

Marathon example on page 5 of the comment letter

Table 1: Federal NSR applicability calculation for SCR NOx BARCT project example.

NSR Calculation Element	Pre-project (no SCR) Baseline Actual Emissions	Post-project (with SCR) Projected Actual Emissions
Annual heat input (MMBtu/hr)	425	425
PM_{10} and $PM_{2.5}$ emissions factor (lb/MMBtu)	0.0075	0.013
PM_{10} and $PM_{2.5}$ emissions increase under federal NSR (tpy)	14.0	24.2
Emissions increase = post-project - pre-project emissions = 24.2 – 14.0 = 10.2 tpy		

Example is Not a PR 1109.1 Scenario and Overestimates Post-Project Emissions

Marathon example on page 5 of the comment letter

NSR Calculation Element	Pre-project (no SCR) Baseline Actual Emissions	Post-project (with SCR) Projected Actual Emissions
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Emissions increase = post-project - pre-project emissions = 24.2 – 14.0 = 10.2 tpy		

- Source test was for a rating increase of 252 to 302 MMBtu/hour for an existing heater with an existing SCR[1]
- Catalyst has been in operation for over 10 years (per facility permit)
- Newer catalyst have lower PM emissions
- Based on catalyst age, likely does not utilize optimal vanadium loading which can contribute to higher SO_3 conversion

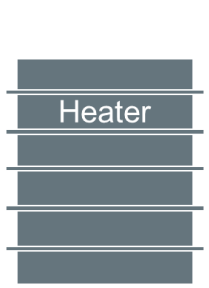
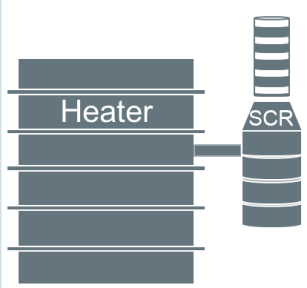
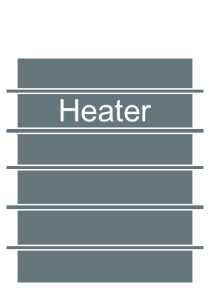
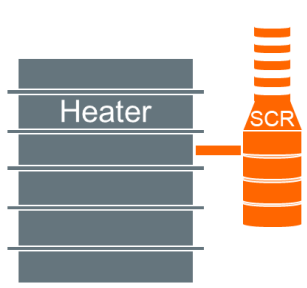
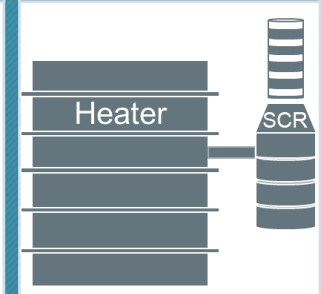
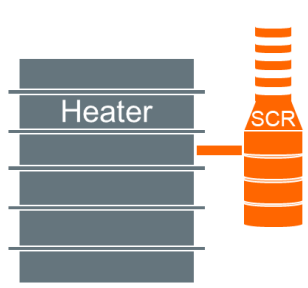
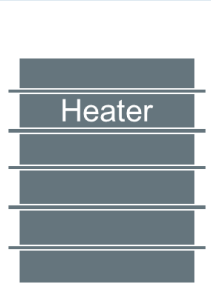
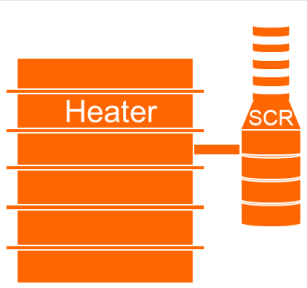
1. Letter to South Coast AQMD from Marathon Petroleum Corporation dated May 12, 2021

Estimated PM Emissions for a 425 MMBtu/Hour Heater with 3% SO_2 to SO_3 Catalyst Conversion

- A new SCR for a 425 MMBtu/hour heater is estimated to emit 2.9 tons per year of PM assuming:
  - 3% SO_2 and SO_3 catalyst conversion rate
  - 179 ppm sulfur content in refinery fuel gas
- A sulfur content of 179 ppm is the highest sulfur content based on the sulfur survey – does not imply sulfur content at Marathon is 179 ppm
- Total emissions of an existing 425 MMBtu/hour heater with a new SCR are estimated to be 16.9 tons per year assuming:
  - Marathon's PM estimate for a heater which is 14.0 tons per year
  - New SCR PM emissions of 2.9 tons per year

Catalyst Conversion SO_2 to SO_3	PM Emissions 179 ppm Sulfur (Tons/Year)
0.5%	0.5
1.0%	1.0
1.5%	1.5
2.0%	1.9
2.5%	2.4
3.0%	2.9
3.5%	3.4
4.0%	3.9
4.5%	4.4
5.0%	4.9

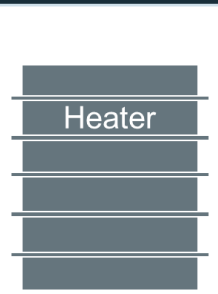
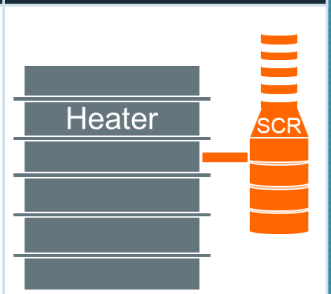
Three Possible Scenarios Under PR 1109.1

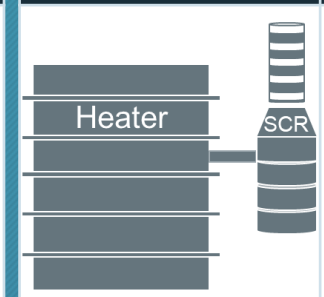
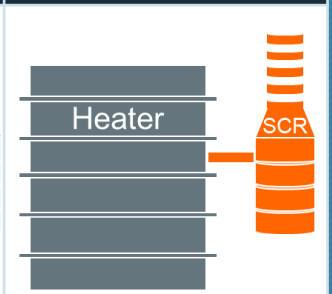
Not a PR 1109.1 Scenario		PR 1109.1 Scenario 1		PR 1109.1 Scenario 2		PR1109.1 Scenario 3	
Pre-Project	Post-Project	Pre-Project	Post-Project	Pre-Project	Post-Project	Pre-Project	Post-Project
							
Existing unit with no SCR	Existing unit with existing SCR	Existing unit with no SCR	Existing unit with **new SCR**	Existing unit with SCR	Existing unit with **new SCR**	Existing unit with no SCR	**New unit with new SCR**

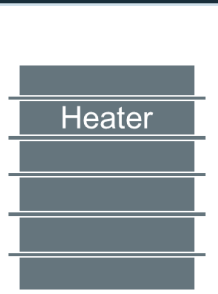
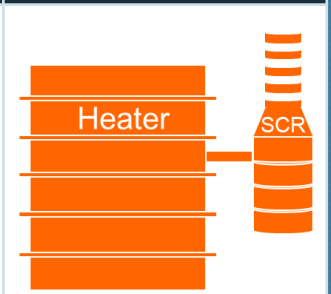
- There are three general scenarios for new SCR installations expected under PR 1109.1
- Marathon's example of a post-project emissions are based on an existing unit with an existing SCR

Estimated PM Emissions for PR 1109.1 Scenarios

- For a 425 MM Btu/hr heater, estimated increase in PM emissions are less than 3 tons/year
- Estimated PM emissions are well below the federal major modification threshold of 10 tons/year

PR 1109.1 Scenario 1	
Pre-Project	Post-Project
	
Existing unit with no SCR	Existing unit with **new SCR**
14 tons/yr	16.9 tons/yr
PM Increase: 2.9 tons/yr	

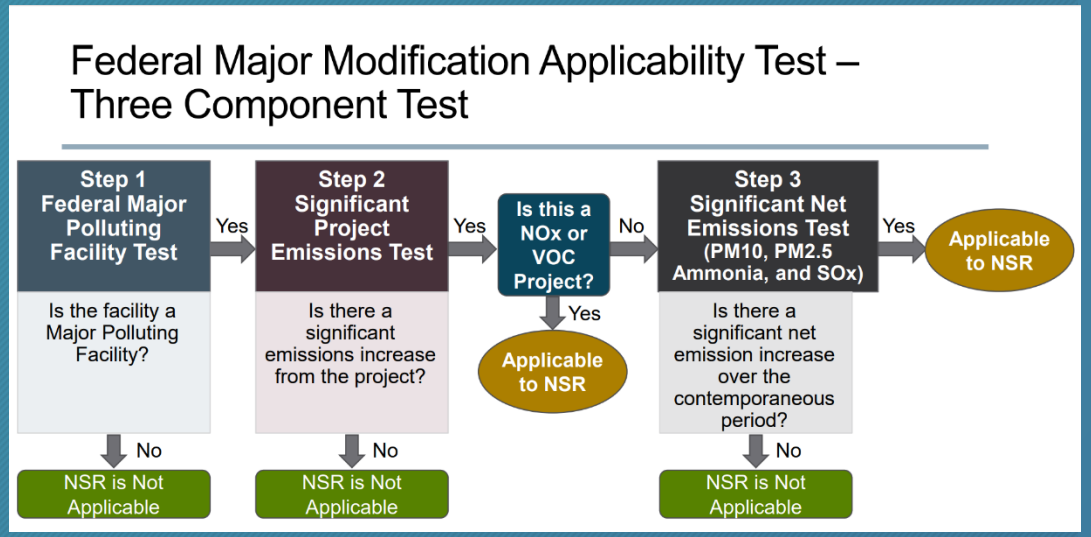
PR 1109.1 Scenario 2	
Pre-Project	Post-Project
	
Existing unit with SCR	Existing unit with **new SCR**
24.2 tons/yr	16.9 tons/yr
PM Decrease: 7.3 tons/yr	

PR 1109.1 Scenario 3	
Pre-Project	Post-Project
	
Existing unit with no SCR	**New unit with new SCR**
14 tons/yr	16.9 tons/yr[1]
PM Increase: 2.9 tons/yr	

[1] Emissions from a new heater with a new SCR for a 425 MMBtu/hour heater are expected be less than an older heater with a new SCR

Comment 4: EPA's "Project Aggregation" Policy Must be Considered if the Emissions Increase for the SCR Project is Combined with other SCR Projects at the Refinery

- Under the federal NSR applicability test, if a project does not have a significant emissions increase the project is:
  - Not applicable to NSR
  - Not evaluated under the final NSR applicability test that evaluates net emissions over a contemporaneous period
- The project aggregation step is to ensure that permitting projects are not separated to avoid NSR
- Based on staff's analysis, aggregating multiple units as one permitting project would not exceed the threshold of 10 tons per year



Summary of Co-Pollutant Issue

- Marathon's example is not representative of a PR 1109.1 scenario that would involve a new SCR
- Staff is developing proposed amendments to Rule 1304 to include limited BACT exemption to address PM increases
- Based on the analysis, unlikely that multiple units will exceed the federal PM threshold
- Likely all permitted projects will fall out of the federal NSR applicability threshold, which will not require projects to evaluate net emissions from contemporaneous projects
- Utilizing a lower conversion rate catalyst will reduce PM increase

Bridge Concepts

Bridge Between RECLAIM and PR 1109.1

- One of the components needed to ensure the RECLAIM transition meets Clean Air Act Section 110(l) is to incorporate enforceable mechanisms in those landing rules with implementation dates that will occur after facilities transition out of RECLAIM
- Staff anticipates that facilities will be ready to exit RECLAIM no earlier than 2024, which is before BARCT requirements in PR 1109.1 will be fully implemented
- U.S. EPA suggests that staff incorporate interim emission limits for all equipment that have compliance dates after the facility transitions out of RECLAIM
- Interim limits would only apply to equipment with compliance dates after the facility exits RECLAIM

Guiding Principles for Establishing Interim Limits

- Interim limits would reflect current operating conditions until BARCT emission limits are achieved and ensure enforceable emission limits are in place
- Interim limits are not an interim step down to BARCT emission limits
  - No additional emission reductions from interim limits is required
  - Designed to ensure no backsliding under Clean Air Act Section 110(l)
- Interim limits will apply to individual units and ensure RACT requirements are being met
- Interim limits will be incorporated in PR1109.1 for units that have compliance dates after January 1, 2024

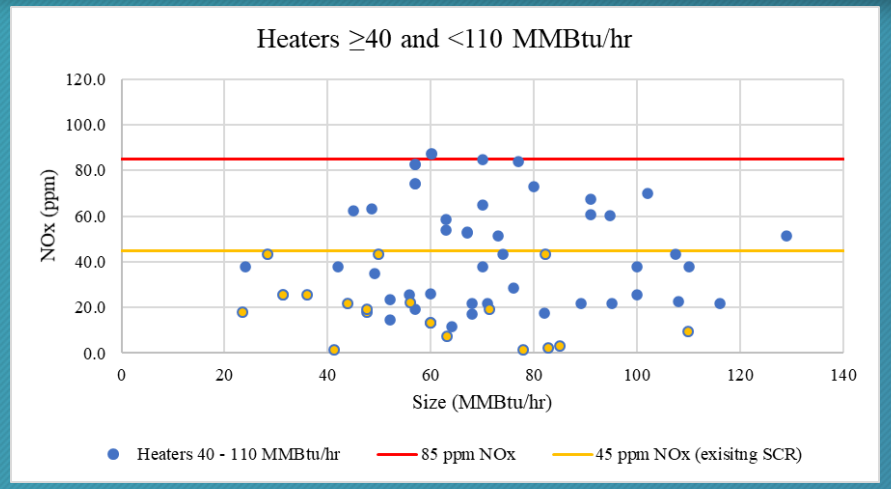
General Approach for Establishing Interim Limits

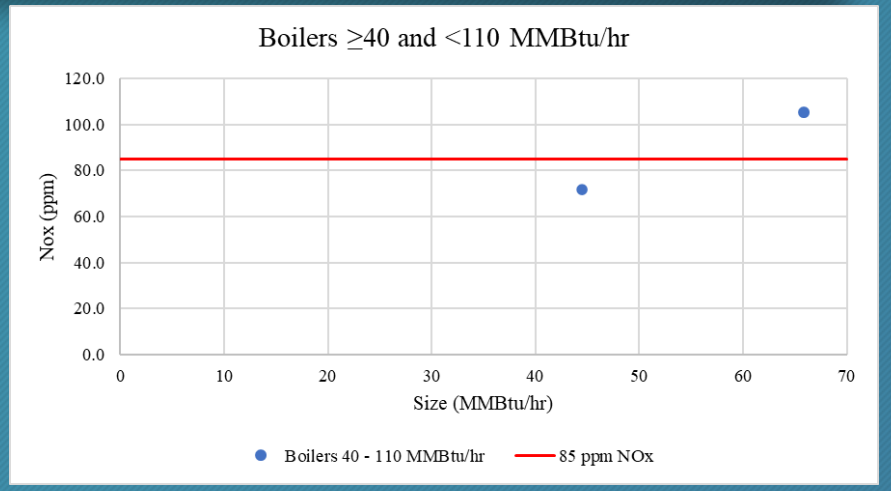
- Interim limits will be based on class and category of equipment
- Staff will use the following information to establish interim limits:
  - Current permit limits
  - Default emission factors used for annual emissions reporting
  - Actual emissions
- Staff has developed initial recommendations for interim limits for all equipment categories except large boilers and heaters ≥40 MMBtu/hour
- Staff is still evaluating large boilers and heaters and has not developed initial recommendations
  - Large boilers and heaters have wide variation and most units do not have existing permit limits
  - Staff is assessing different parameters to establish interim limits such as with and without SCR, unit size, and unit age

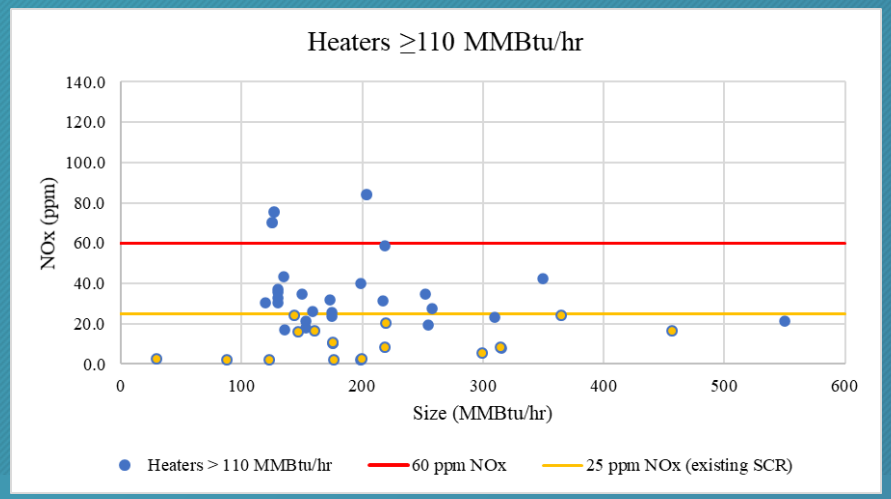
Potential Interim NOx Limits for PR 1109.1 Equipment Categories

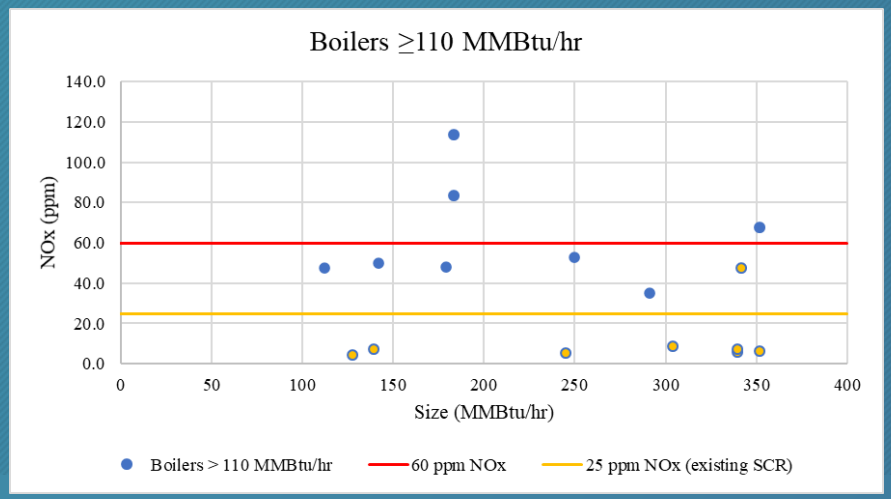
Unit	NOx (ppmv)	CO (ppmv)	Percent O2	Averaging Time (Rolling Average)	Comment
Boilers and Heaters <40 MMBtu/hour	40	400	3	2 hour	Required permit limit
Boilers and Heaters ≥40 MMBtu/hour	Discussed on following slide				
FCCU	40	500	3	365 day	Consent decree or permit limits
Gas Turbines	20	130	15	24 hour	
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

Current NOx Concentration Levels of Boilers and Heaters ≥40 MMBtu/hr





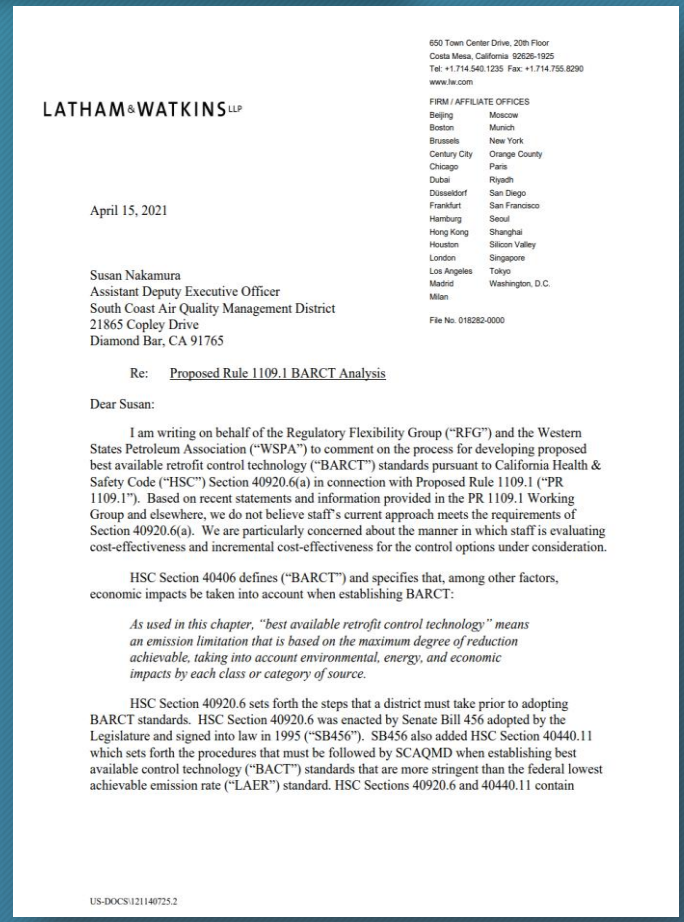




Incremental Cost-Effectiveness

Comment Letter on Cost-Effectiveness and Incremental Cost-Effectiveness

- Latham and Watkins on behalf of the Regulatory Flexibility Group and the Western States Petroleum Association submitted a comment letter on cost-effectiveness and incremental cost-effectiveness when establishing BARCT
- Concerned about the manner in which staff is evaluating cost-effectiveness and incremental cost-effectiveness for the control options under consideration
- Does not believe staff's current approach meets the requirements of Section 40920.6(a)
- Staff provided a detailed response to this letter during the RECLAIM Working Group Meeting held on May 13th



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File No. 018282-0000

April 15, 2021

Susan Nakamura
Assistant Deputy Executive Officer
South Coast Air Quality Management District
21865 Copley Drive
Diamond Bar, CA 91765

Re: Proposed Rule 1109.1 BARCT Analysis

Dear Susan:

I am writing on behalf of the Regulatory Flexibility Group ("RFG") and the Western States Petroleum Association ("WSPA") to comment on the process for developing proposed best available retrofit control technology ("BARCT") standards pursuant to California Health & Safety Code ("HSC") Section 40920.6(a) in connection with Proposed Rule 1109.1 ("PR 1109.1"). Based on recent statements and information provided in the PR 1109.1 Working Group and elsewhere, we do not believe staff's current approach meets the requirements of Section 40920.6(a). We are particularly concerned about the manner in which staff is evaluating cost-effectiveness and incremental cost-effectiveness for the control options under consideration.

HSC Section 40406 defines ("BARCT") and specifies that, among other factors, economic impacts be taken into account when establishing BARCT:

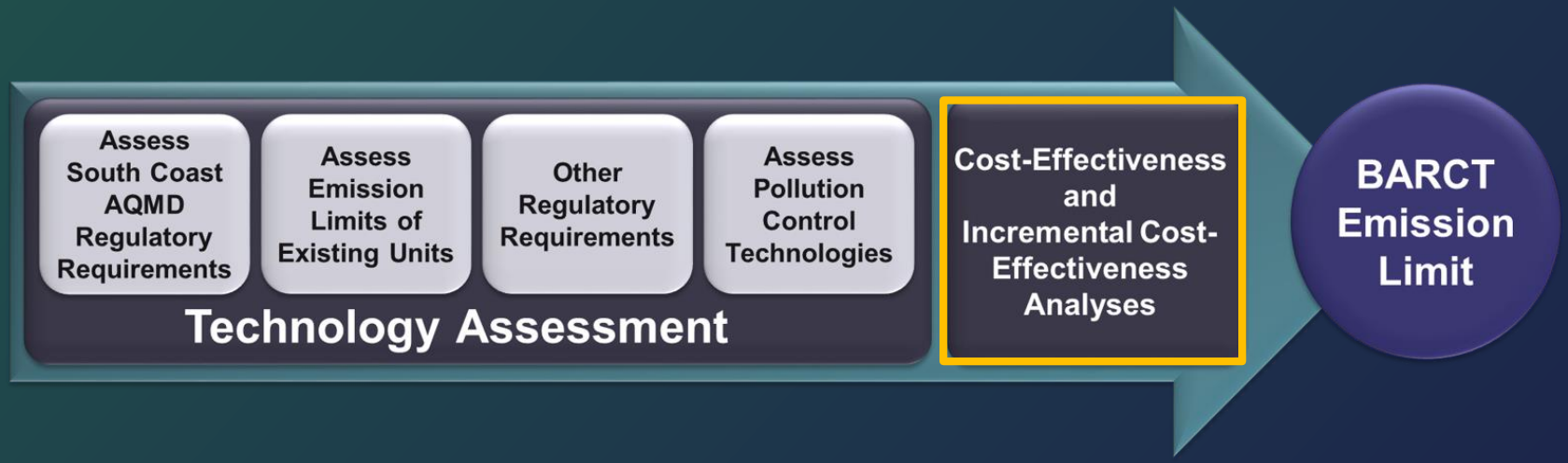
As used in this chapter, "best available retrofit control technology" means an emission limitation that is based on the maximum degree of reduction achievable, taking into account environmental, energy, and economic impacts by each class or category of source.

HSC Section 40920.6 sets forth the steps that a district must take prior to adopting BARCT standards. HSC Section 40920.6 was enacted by Senate Bill 456 adopted by the Legislature and signed into law in 1995 ("SB456"). SB456 also added HSC Section 40440.11 which sets forth the procedures that must be followed by SCAQMD when establishing best available control technology ("BACT") standards that are more stringent than the federal lowest achievable emission rate ("LAER") standard. HSC Sections 40920.6 and 40440.11 contain

US-DOCS\121140725.2

General Summary of Approach to Addressing Incremental Cost-Effectiveness in the BARCT Analysis

- Staff agrees that the cost-effectiveness AND incremental cost-effectiveness is a critical step before the proposed BARCT limit is established
- Staff will modify the BARCT analysis to better integrate the incremental cost-effectiveness analysis as part of the BARCT analysis



i-Plan Considerations

i-Plan Considerations

- Staff is considering allowing multiple i-Plans to accommodate unique challenges at the different refineries
  - Two or three phases
  - Front load reductions where feasible
  - Allow for longer implementation phase for units with long turnaround schedules
- Once revised BARCT limits, near limits, and outliers have been released, staff will send each facility their revised unit shares to achieve BARCT
- Staff will continue to discuss with individual refineries a schedule that will maximize reductions earlier while minimizing or eliminating operational disruptions

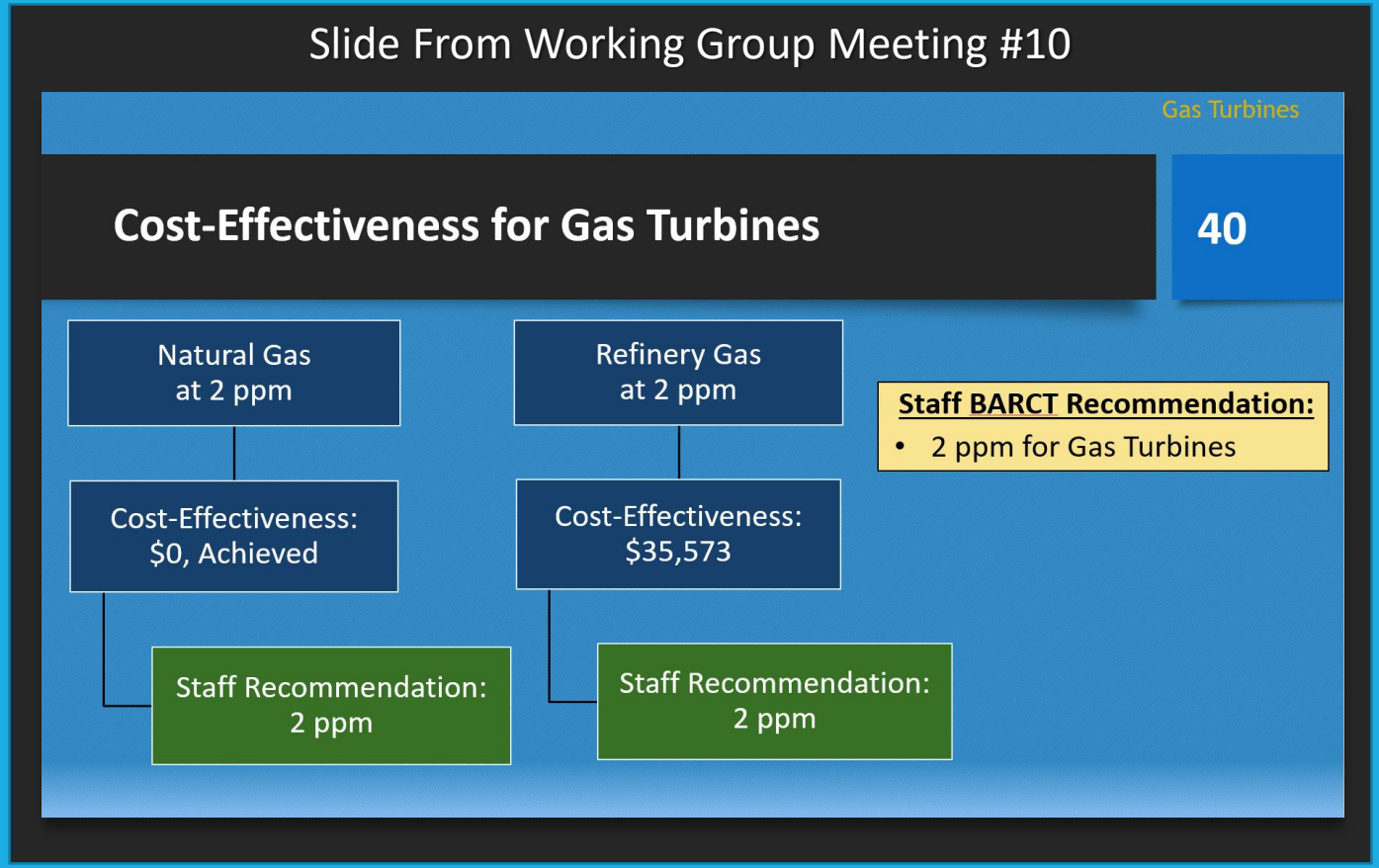
Refinery Gas Turbines Reassessment

35

Gas Turbine Background

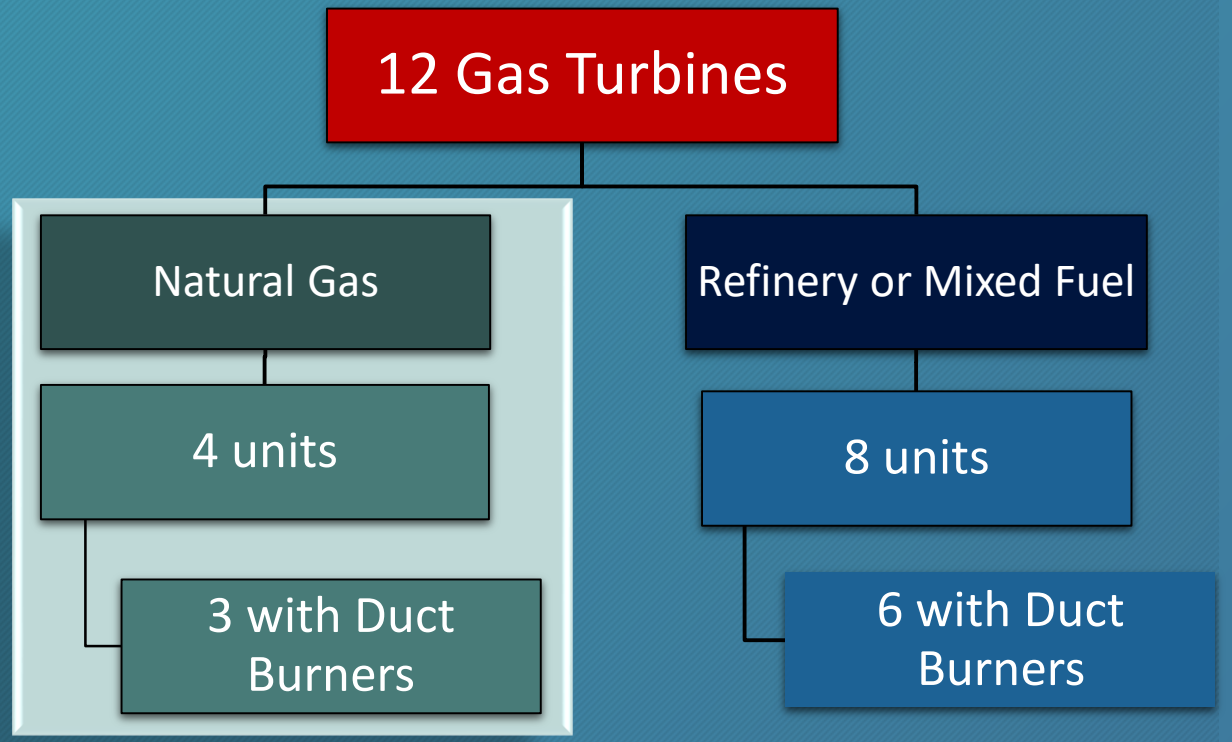
- During Working Group Meeting #10 held on February 18, 2020, staff presented the BARCT assessment for gas turbines
- Concluded 2 ppm was technically feasible and cost effective for both natural gas and refinery gas turbines
- Staff received comments on:
  - Gas turbines fired with natural gas achieving close to the proposed limit
  - Technical challenges for gas turbines fired with refinery gas to achieve 2 ppm with a retrofit

Slide From Working Group Meeting #10



Gas Turbines Operating on Natural Gas

- Four gas turbines at refineries that operate on natural gas*
  - Two units are achieving less than 2 ppm (annual average)
    - One unit has 2 ppm permit limit, the other unit has 2.5 ppm permit limit
  - Facility with 2.5 ppm permit limit requested to keep that limit
  - Following slides calculates:
    - Cost-effectiveness of an existing unit at 2.5 ppm to determine if it is an outlier and include a near limit
    - Cost-effectiveness of remaining units to meet the proposed 2 ppm NOx limit



* Note: Number of units operating on natural gas and mixed fuel has been revised since original BARCT assessment

Outliers Assessment for Gas Turbine Operating on Natural Gas permitted at 2.5 ppm

Staff evaluated cost-effectiveness for unit permitted at 2.5 ppm to achieve 2 ppm

- Assumed SCR replacement at Present Worth Value of ~$9 MM
  - Cost estimate based on U.S. EPA cost model with a 20% increase for labor costs (SB54)
  - Did not use modified cost curve (reflects costs for heaters/boilers)

Cost-Effectiveness
2.5 ppm → 2 ppm NOx Limit
$570,000

Staff Recommendation:

- Include near limit of 2.5 ppm for gas turbines operating on natural gas due to the high cost-effectiveness
  - Unit with 2.5 ppm permit limit does not need to meet the proposed 2 ppm NOx

Cost Effectiveness for Gas Turbines Operating on Natural Gas to achieve 2 ppm without outlier

Staff evaluated cost-effectiveness for remaining units to achieve 2 ppm

- Two units will have to be retrofit to meet 2 ppm
- Assumed SCR replacement at Present Worth Value of ~$12 - 13 MM
  - Cost estimate based on U.S. EPA cost model with a 20% increase for labor costs (SB54)
  - Did not use modified cost curve (reflects costs for heaters/boilers)

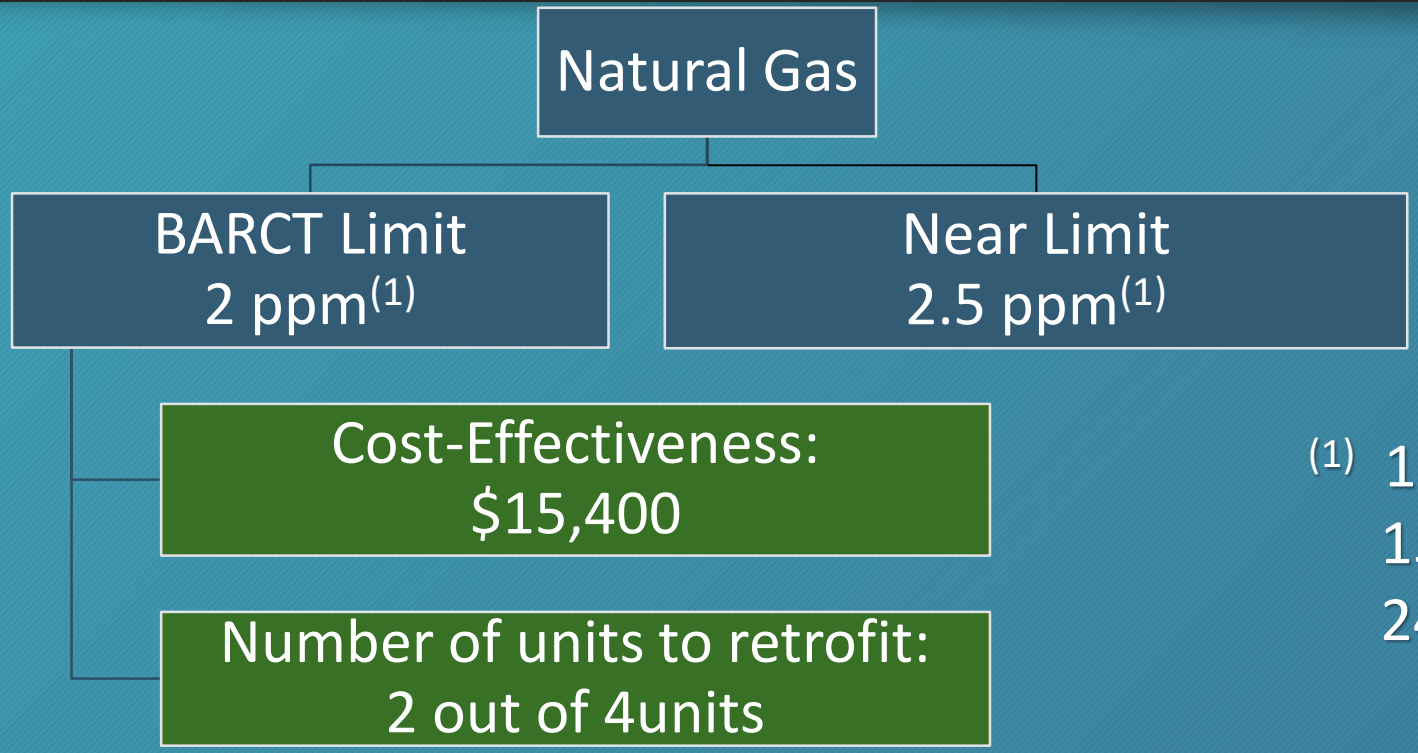
Cost-Effectiveness
2 ppm NOx Limit*
$15,400

* Excludes the unit achieving 2 ppm and the unit permitted at 2.5 ppm

Staff Recommendation:

- Maintain the 2 ppm NOx limit for gas turbines operating on natural gas with a near limit of 2.5 ppm

BARCT Assessment Summary for Gas Turbines Operating on Natural Gas



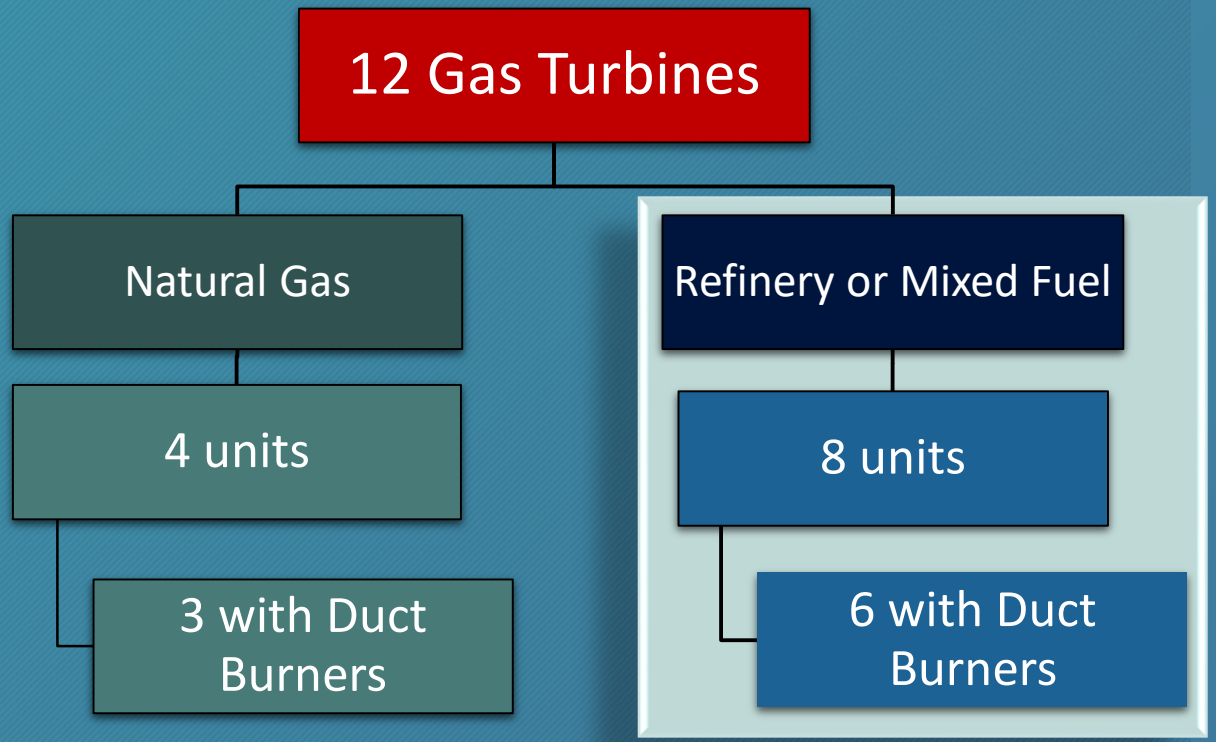
Emission reductions: 0.18 tpd(2)

(1) 130 ppm Carbon Monoxide, 15% Oxygen Correction, 24 hour rolling average

(2) Emission reductions without near limit: 0.18 tpd

Gas Turbines Operating on Refinery Gas

- There are 8 gas turbines at refineries that operate on refinery gas or mixed fuel
  - Existing units achieve between 2.8 ppm to 10 ppm
- Facility upgraded existing SCR (catalyst replacement) on 2 units targeting 2 ppm but are only achieving 3 ppm
  - Upgraded catalyst with state-of-the-art catalyst
    - Staff confirmed with vendor that catalyst type installed is the best performing catalyst for those units
  - FERCo confirmed the ammonia injection grids is designed to achieve optimal NOx reduction
    - Can achieve single digit NH3/NOx RMS



Gas Turbines Operating on Refinery Gas (cont.)

- Combustion fuel can impact NOx emissions
  - Gas turbines operating on natural gas can achieve 2 ppm
    - Achieved in practice on many units in South Coast AQMD and in other jurisdictions
    - Significant data supports a 2 ppm limit
  - Refinery fuel gas has a higher heating value (HHV) and is more variable than natural gas
    - Higher HHV will result in higher NOx
- Staff has not identified any gas turbines operating on refinery fuel gas that has achieved 2 ppm and concerns about the technical feasibility*
- Staff will re-assess the BARCT limit at 3 ppm

* Note: slide 35 in Working Group Meeting #10 presentation stated 2 ppm was achieved in practice for refinery fuel, the unit cited was firing on natural gas, not refinery gas

Technical Assessment for Gas Turbines Operating on Refinery Gas

- All gas turbines have existing SCRs and CO catalysts with steam injection:
  - SCR NOx removal efficiency: 70 - 89%
  - Catalysts age range: 1–12 years
  - Catalyst beds range: 1 - 2
- NOx removal efficiency can be improved by:
  - SCR upgrades (e.g., ammonia injection grid, catalyst, additional catalyst beds)
  - Combustor upgrade to Dry Low NOx (DLN)
    - Combustor upgrade may not be technically feasible
    - Most units installed in the 1980s
    - Combustors are intrinsic to the gas turbine

BARCT Assessment for Gas Turbine Operating on Refinery Gas

	RECLAIM 2005/2015 BARCT	Existing Units	Other Regulatory	Technology Assessment	Initial BARCT NOx Limit	Cost-Effectiveness
Refinery Gas or Refinery Mixed Gas	2 ppm	2.8 - 10 ppm	9 - 50 ppm	3 - 2 ppm	3 – 2 ppm	Need to assess cost-effectiveness and incremental cost-effectiveness

Initial BARCT NOx Limits for Cost-Effectiveness for Gas Turbines Operating on Refinery Gas

3 ppm

Upgrade existing SCR to achieve 95% reduction

OR

2 ppm

Upgrade existing SCR and DLN combustor

Potential NOx BARCT Emission Limits

Total NOx emission is <u>1.16 tpd</u>
2017 Baseline for Gas Turbines Operating on Refinery gas

Cost Assumptions for Gas Turbines with Refinery Gas

- SCR cost estimates
  - SCR cost based on facility submitted costs, if available
  - When facility did not provide cost, cost based on **new** SCR installation (worst-case cost assumption)
    - Used U.S. EPA cost model with a 20% increase for labor costs (SB54)
    - Did not use modified cost curve (reflects costs for heaters/boilers)
  - Cost ranged from $11 MM to $26 MM
- Dry Low-NOx (DLN) combustor cost estimate
  - Provided by gas turbine subject matter expert at Electric Power Research Institute
  - ~ $10 MM per unit

Revised

Gas Turbines fired with Refinery Gas

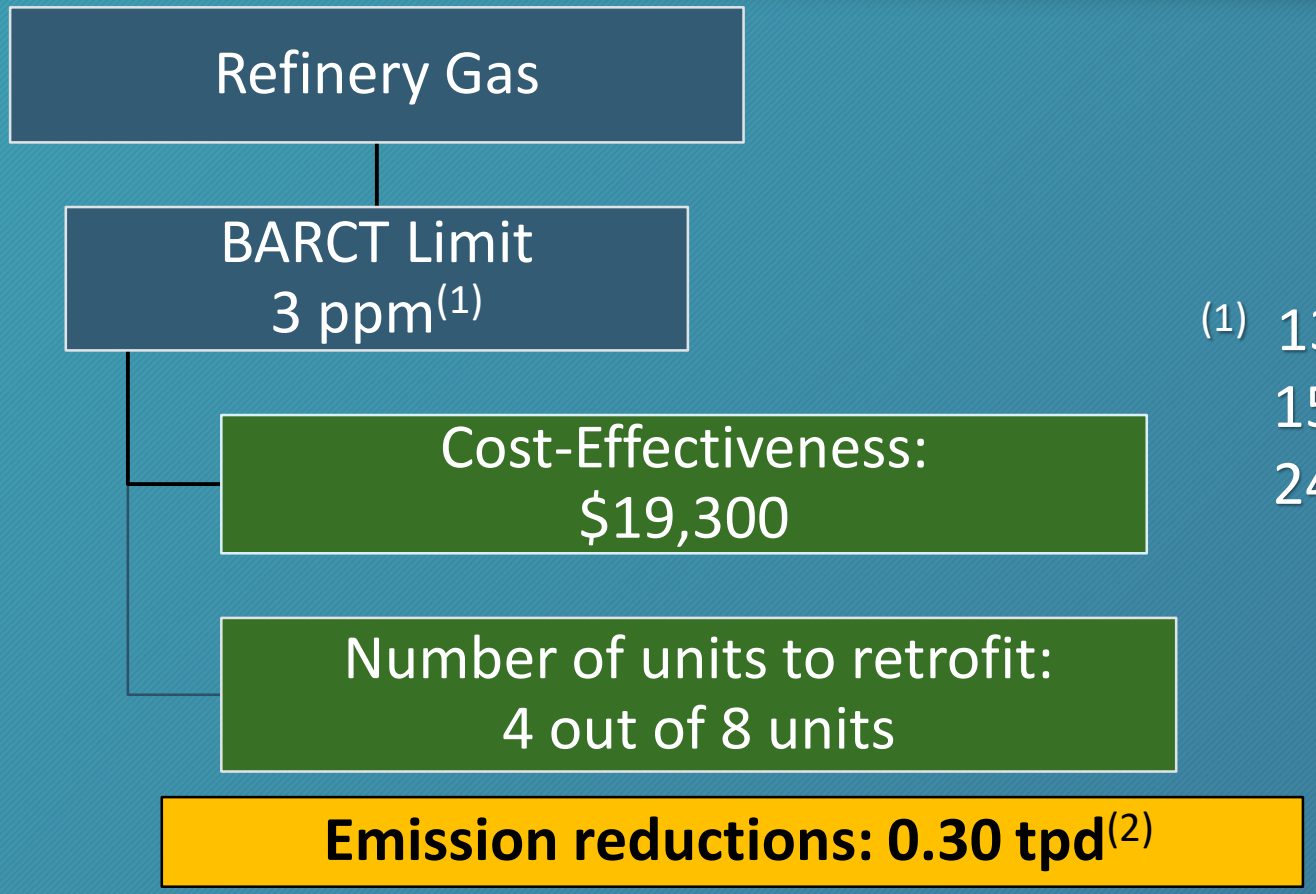
Cost-Effectiveness and Incremental Cost-Effectiveness for Gas Turbines Operating on Refinery Gas

- 2 ppm and 3 ppm is cost effective based on class and category
- Technical feasibility to achieve 2 ppm is uncertain
  - Existing units may not be capable of DLN combustor
- Incremental assessment
  - No established threshold for I-CE
  - I-CE Assessment shows diminishing emission reductions for significant additional costs

Cost-Effectiveness (CE) and Incremental Cost Effectiveness (I-CE)

3 ppm		2 ppm		Incremental (3 to 2 ppm)	
CE	Emission Reductions	CE	Emission Reductions	I-CE	Emission Reductions
$19,300	0.30 tpd	$45,200	0.57 tpd	$74,300	0.27 tpd

BARCT Assessment Summary for Gas Turbines with Refinery Gas



(1) 130 ppm Carbon Monoxide, 15% Oxygen Correction, 24 hour rolling average

(2) Previous emission reductions for these units to achieve 2 ppm: 0.57 tpd

Consideration for Gas Turbines Operating on Refinery Gas

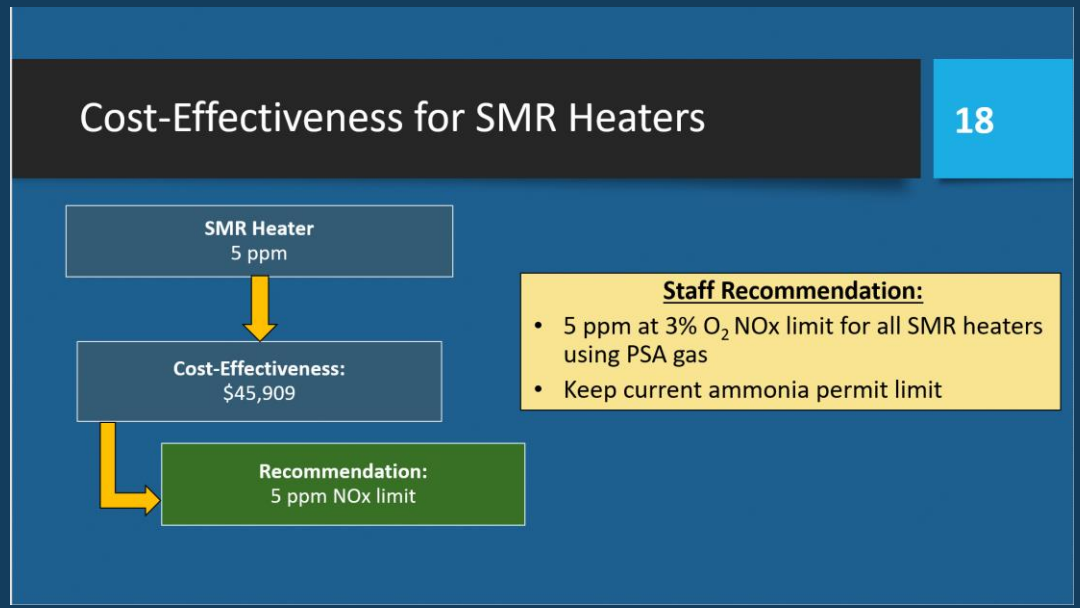
- Staff proposing to include an alternative NOx limit for gas turbines operating on refinery gas during periods of natural gas curtailment
- Natural gas curtailment means a shortage in the supply of pipeline natural gas, due solely to supply limitations or restrictions in distribution pipelines by the utility supplying the gas, and not due to the cost of natural gas
  - Events are infrequent but can impact local refineries
  - Experienced natural gas curtailment this winter during Texas power outage
- Refineries supplement refinery fuel with natural gas, and if not available, must substitute other fuels (e.g., propane or butane)
  - Higher HHV of the alternative fuels will result in higher NOx emissions
- Staff reviewed CEMS data during this winter's natural gas curtailment and is proposing a 5 ppm NOx limit during periods of natural gas curtailment

SMR Heater Follow-up

SMR Heater Background

- Staff presented the BARCT assessment for SMR heaters during Working Group Meeting #11, held on May 21, 2020
- BARCT assessment concluded 5 ppm is technically feasible and cost effective for SMR heater class and category
- Stakeholder requested staff re-evaluate cost effectiveness to retrofit units achieving near the proposed 5 ppm NOx limit considering revised cost data provided by facilities

Slide from Working Group Meeting #11



Performance of SMR Heaters Subject to PR 1109.1

- 11 SMR Heaters achieving between 1.5 and 54 ppm
- Several units performing near the proposed 5 ppm NOx limit
- Staff will reassess cost-effectiveness using revised costs to:
  - Consider outliers – units with high cost-effectiveness to 5 ppm
  - Reassess cost-effectiveness for SMR heater class and category to achieve 5 ppm

Unit	Anticipated Action	Annual CEMS (NOx ppm @3% O_2)
1	New SCR	53.4
2		53.6
3	SCR Upgrades	4.9
4		5.1
5		7.2
6		10.7
7		12.7
8	No Action	1.5
9		3.4
10		3.6
11		3.7

SCR Installation and Upgrade Cost Assumptions

- For units where cost not provided, SCR installation cost estimated based on U.S. EPA cost spreadsheet modified to reflect most recent facility cost estimates (received March 2021)
- One cost was provided by facility for a new SCR installation at $38 MM
- SCR upgrade cost assumptions:
  - Based on technology vendor installation, SCR upgrades cost are 20 - 25% the cost of a new SCR system installation
  - Operation and Maintenance (O&M) cost estimated to be 10% increase from current annual O&M cost reported by facility
    - Increased O&M costs associated with SCR upgrades
- In final NOx BARCT anlaysis report, Norton Engineering recommended that staff increase the upgrade cost estimate range of $4 MM to $7.1 MM to $7.5 MM to $10 MM

Outliers Assessment for SMR Heaters Achieving Near BARCT Limit

- 3 units achieving 4.9 - 7.2 ppm have high cost-effectiveness to meet 5 ppm
  - Estimated Present Worth Value for SCR upgrade to meet 5 ppm: ~$7.5 - $10 MM
  - Emission reductions for 3 units to achieve 5 ppm: 0.015 tpd
- SCR upgrades are not cost effective due to low emission reductions

Cost-Effectiveness
7.2 ppm→5 ppm NOx Limit
$242,000

Staff Recommendation:

Due to high cost-effectiveness, include near limit of 7.5 ppm for SMR heaters

Cost-Effectiveness for SMR Heaters to Achieve 5 ppm without Outliers

- Staff evaluated cost-effectiveness for SMR heaters to achieve 5 ppm based on revised costs, without outliers
  - Estimated Present Worth Value for SCR installation or upgrade: ~$9 and $39 MM
  - Emission reductions: 0.62 tpd

Cost-Effectiveness
5 ppm NOx Limit
$17,000

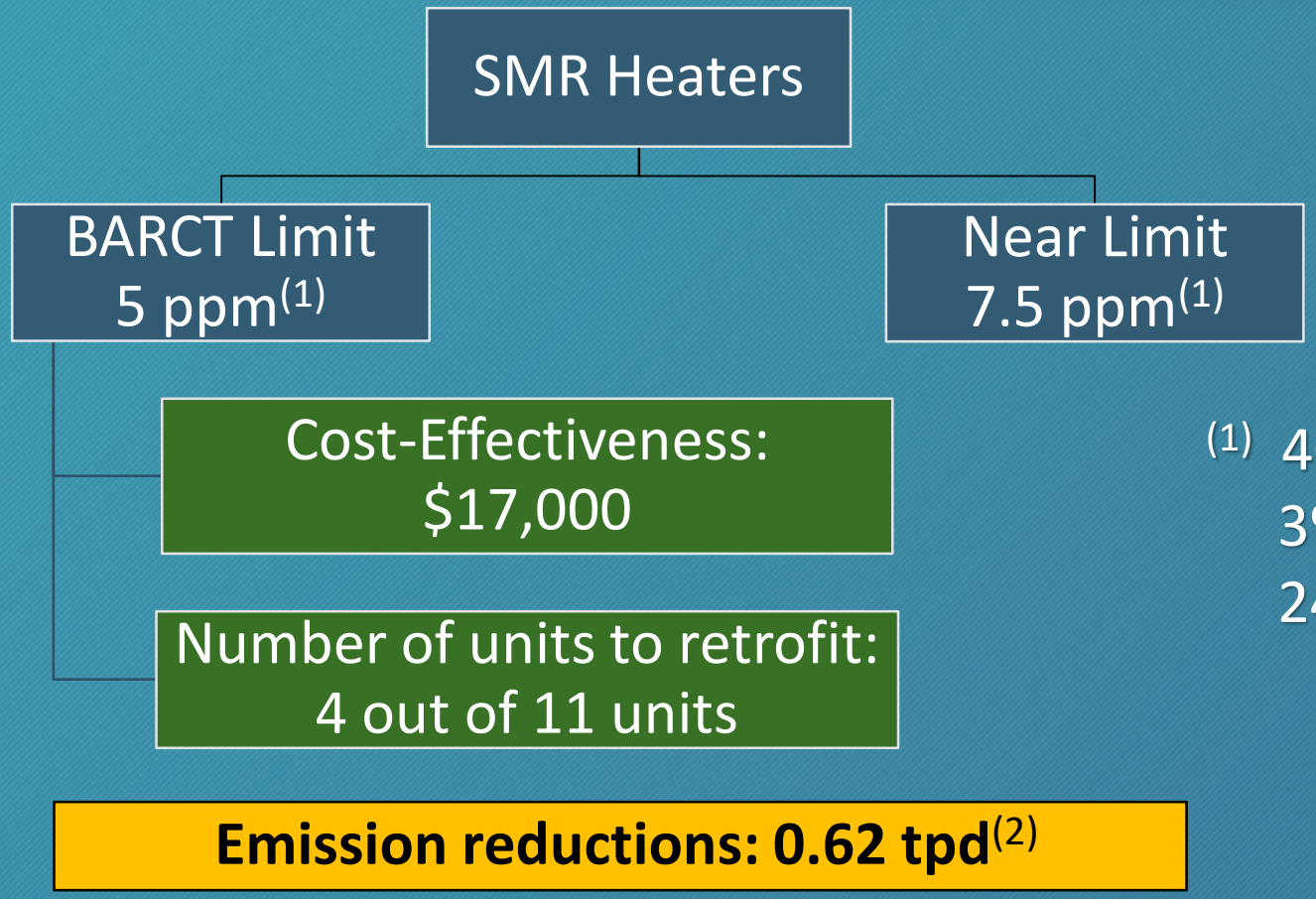
Staff Recommendation:

- Retain 5 ppm limit for SMR heater category

Staff Comment:

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

BARCT Assessment Summary for SMR Heaters



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

(2) Emission reductions without near limit: 0.64 tpd

Proposed Rule 429.1- Startup and Shutdown Provisions at Petroleum Refineries and Related Operations

PR 429.1 Comments at April 30, 2021 Working Group Meeting

Comment	Response
Startup and shutdown duration limits should reflect the maximum permitted hours for each equipment category	• Staff incorporated startup and shutdown duration limits that are generally appropriate for the equipment category • Encourage facilities to meet with staff if there are specific units that cannot meet the proposed startup and shutdown duration limits
Rule provisions need to account for scheduled startups and shutdowns in different years and when a scheduled startup follows an unexpected shutdown	PR 429.1 will limit the number of scheduled startups • Eliminates issues regarding what is considered a scheduled startup and shutdown pair

PR 429.1 Comments at April 30, 2021 Working Group Meeting (Continued)

Comment	Response
Requirement to operate post-combustion control equipment when inlet gas temperature is ≥ 450° F is not appropriate for SCRs that are permitted to begin operation at higher temperatures	Proposed rule language updated: If the temperature of the gas to the inlet of the NOx post-combustion control equipment is greater than or equal to 600° F, an owner or operator of a unit with NOx post-combustion control equipment shall operate NOx post-combustion control equipment, including the injection of any associated chemical reagent into the exhaust stream to control NOx.
Remove requirement to install and maintain a calibrated temperature gauge on units with post-combustion control equipment because it is already required in permits	No changes to the proposed rule language • The requirement for a gauge is consistent for having a temperature requirement to operate NOx post-combustion controls • No impact on facilities if it is already required by permit

Start-up and Shutdown Duration Limits

- Staff updated the startup and shutdown duration limits in response to stakeholder comments
- Some boilers and process heaters rated < 40 MMBtu/hr are equipped with post-combustion control equipment
  - Need longer startup and shutdown for controls to reach optimal temperatures
- Sulfuric acid furnaces need to heat up prior to adding sulfur
  - Previously limit was based only on time after adding sulfur

TABLE 1: STARTUP AND SHUTDOWN DURATION LIMITS

Unit Type	Not to Exceed per Startup or Shutdown Event (hours)
Boilers and Process Heaters without NOx Post-Combustion Control Equipment, Gas Turbines, Flares, Vapor Incinerators	2
Boilers and Process Heaters with NOx Post-Combustion Control Equipment, Steam Methane Reformer Heaters, Sulfuric Acid Furnace	48
Steam Methane Reformer with Gas Turbine	60
FCCU, Petroleum Coke Calciner, SRU/TG Incinerators	120

Limit to the Number of Scheduled Startups

- Staff included provisions to limit the number of scheduled startups
  - Number of scheduled startups allowed varies by equipment type

(2) An owner or operator of a boiler, flare, gas turbine, process heater, steam methane reformer heater, sulfuric acid furnace, or vapor incinerator shall not exceed 10 scheduled startups per calendar year for each unit.

(3) An owner or operator of a FCCU, petroleum coke calciner, or SRU/TG incinerator shall not exceed 3 scheduled startups per calendar year for each unit.

Provision to Limit Bypassing Post-Combustion Control Equipment

(7) An owner or operator of a unit equipped with a bypass stack or duct that exists prior to [*Date of Adoption*] that elects to use the bypass to condition, repair, or replace the catalyst in the NOx post-combustion control equipment shall:

(A) Not use a bypass if the unit is scheduled to operate continuously for less than five years between planned maintenance shutdowns of the unit;

(B) Not use a bypass to condition, repair, or replace the catalyst in the NOx post-combustion control equipment for more than 200 hours in a rolling three-year cycle;

- Only applies to units with existing bypasses
- Bypass can only be used to condition, repair, or replace the catalyst in control equipment
- Only for units that have turnarounds ≥ 5 years
- Limited to 200 hours in a rolling 3-year cycle

Provision to Limit Bypassing Post-Combustion Control Equipment (Continued)

(C) Operate the unit at 25% of the rated capacity of the unit or less when the NOx post-combustion control equipment is bypassed; and

(D) Notify the South Coast AQMD by calling 1-800-CUT-SMOG at least seven days prior to bypassing the NOx post-combustion control equipment. This notification shall contain the date, time, duration that the NOx post-combustion control equipment will be bypassed.

Unit must be operating at 25% rated capacity or less when post-combustion control is bypassed

Notification required 7 days prior to using bypass

- Staff is considering adding provisions for continuous monitoring and fees to address excess emissions during bypass events

Refractory Dryout Exemption

- Staff added an exemption from startup and shutdown duration limits during refractory dryout
  - Refractory dryout is an infrequent process
  - Temperatures are not high enough during refractory dryout to vent to NOx post-combustion control equipment
  - Mass emissions are low during refractory dryout

(2) An owner or operator of a unit is exempt from paragraphs (d)(1) during refractory dryout.

Next Steps

- Continue Discussions with Stakeholders
- Complete Cost-Effectiveness and BARCT Reassessment
- Working Group Meeting #22 Scheduled for June 3rd
- Release Preliminary Draft Staff Report and Rule Language
- Public Workshop
- Public Hearing September 2021

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