Working Group Meeting #3

PROPOSED RULE 1159.1 – CONTROL OF NOx EMISSIONS FROM NITRIC ACID TANKS (PR 1159.1)

South Coast AQMD

July 7, 2022

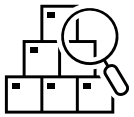
10:00 AM

Zoom webinar link:
https://scaqmd.zoom.us/j/92985704093
Join via teleconference:
Dial-in Number: +1 669 900 6833
Zoom Webinar ID: 929 8570 4093

Agenda

Summary of Working Group #2

Response to Comments

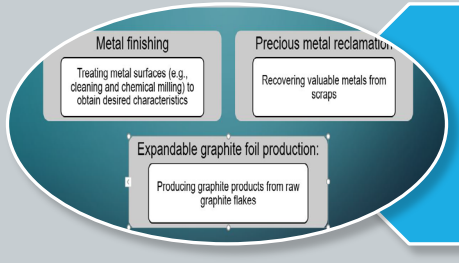


BARCT Analysis Process *(continued)*

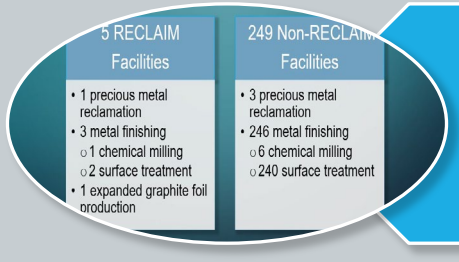
Next Steps

Summary of Working Group #2

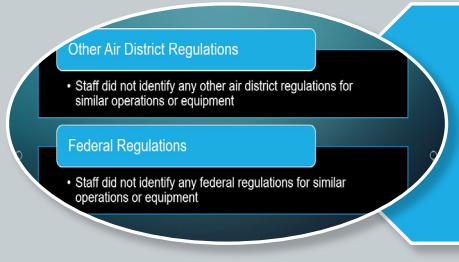
During the second Working Group meeting, staff presented:



Operations subject to PR 1159.1



PR 1159.1 universe of facilities with nitric acid units



Presented regulatory requirements portion of the BARCT Analysis

RESPONSE TO COMMENTS

Comment #1

HOW IS NOx FORMED AND HOW MUCH IS EMITTED FROM UNITS?

Staff Response:

- Nitric acid forms NOx in nitric acid units from:
  - Metal finishing and precious metals reclamation due to chemical reaction with metals
  - Expanded graphite foil production from decomposition of nitric acid when heated
- Amount of nitric acid used (replenishment) determines NOx emissions and assumes:
  - 1 mole of NOx will form from 1 mole of nitric acid
  - NOx is half NO and half NO_2
  - Does not depend on process or type of metal
- One gallon of nitric acid (68 weight percent) would generate ~5 lbs of NOx

Comment #2

WILL A DE MINIMIS BE INCORPORATED INTO THE RULE?

Staff Response:

- As part of the BARCT assessment, control technology is evaluated for cost-effectiveness based on cost per ton of pollutant reduced
- Units with low emissions tend to not be cost-effective to retrofit so most rules include exemptions for low-emitting or low-use units
- Rule 1159.1 will include a low-emitting or low-use exemption

Comment #3

WILL NOx CONTROLS BE REQUIRED FOR NITRIC ACID UNITS THAT HAVE EXISTING CONTROLS FOR OTHER POLLUTANTS?

Staff Response:

- Staff acknowledges potential engineering and permitting considerations when there are add-on controls for other pollutants
  - HEPA control to comply with Rule 1469 for hexavalent chromium
  - Scrubbers designed to control acid fumes
- Staff still assessing how many units would be impacted and potential solutions

Progress Since Last Working Group

Continued BARCT analysis:

- Evaluated current emission limits of nitric acid units in the PR 1159.1 universe
- Evaluated NOx control equipment for nitric acid units in PR 1159.1 universe
- Obtained cost information of NOx control equipment venting nitric acid units

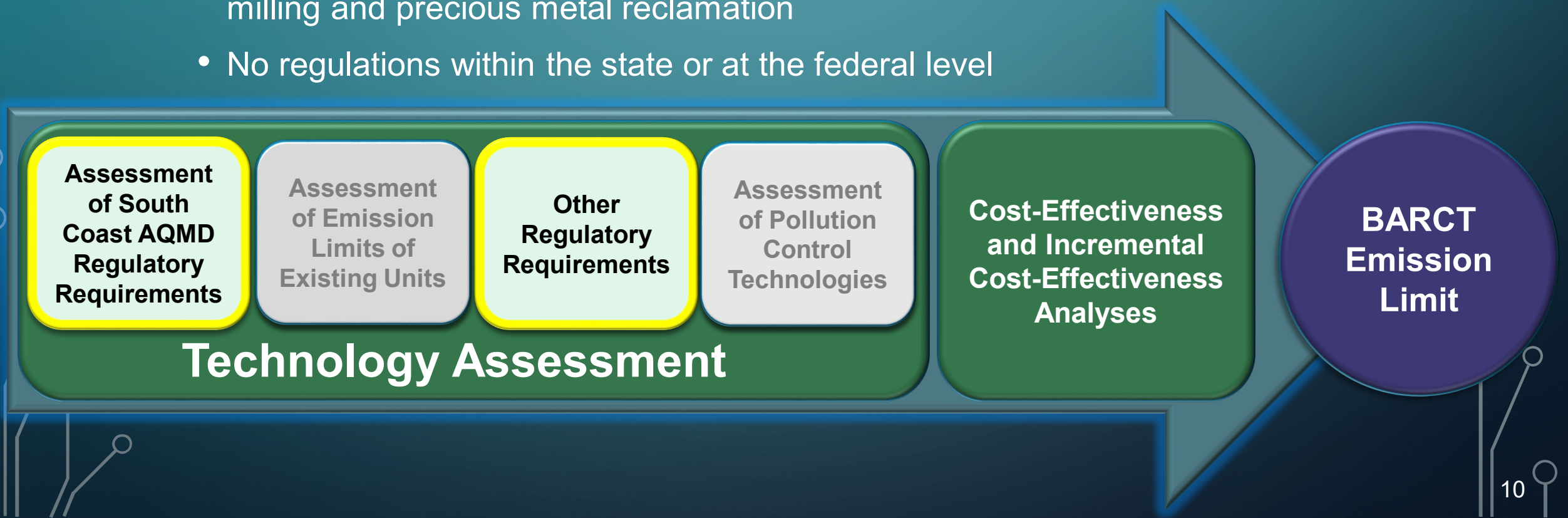
Conducted a cost-effectiveness analysis

Initiate development of rule concepts

BARCT ANALYSIS PROCESS

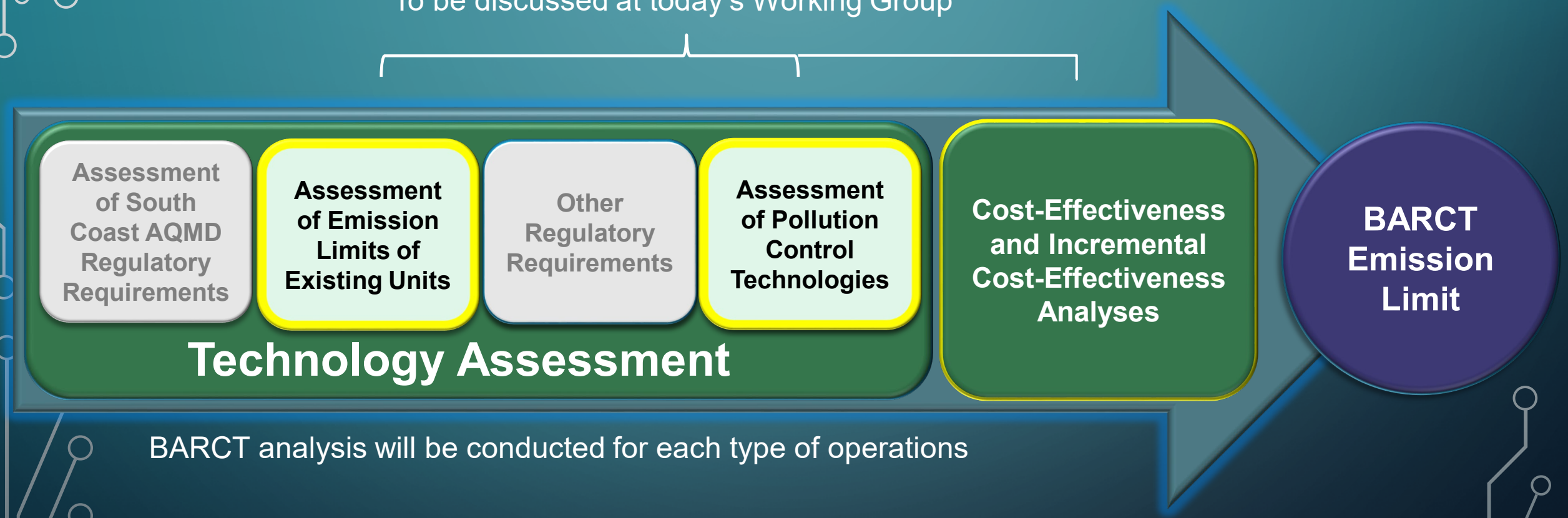
BARCT Steps Covered in Working Group Meeting #2

- Staff presented South Coast AQMD and Other Regulatory Requirements
  - No South Coast AQMD source specific rules; BACT requirements for chemical milling and precious metal reclamation
  - No regulations within the state or at the federal level



BARCT Analysis Process Continued

To be discussed at today's Working Group



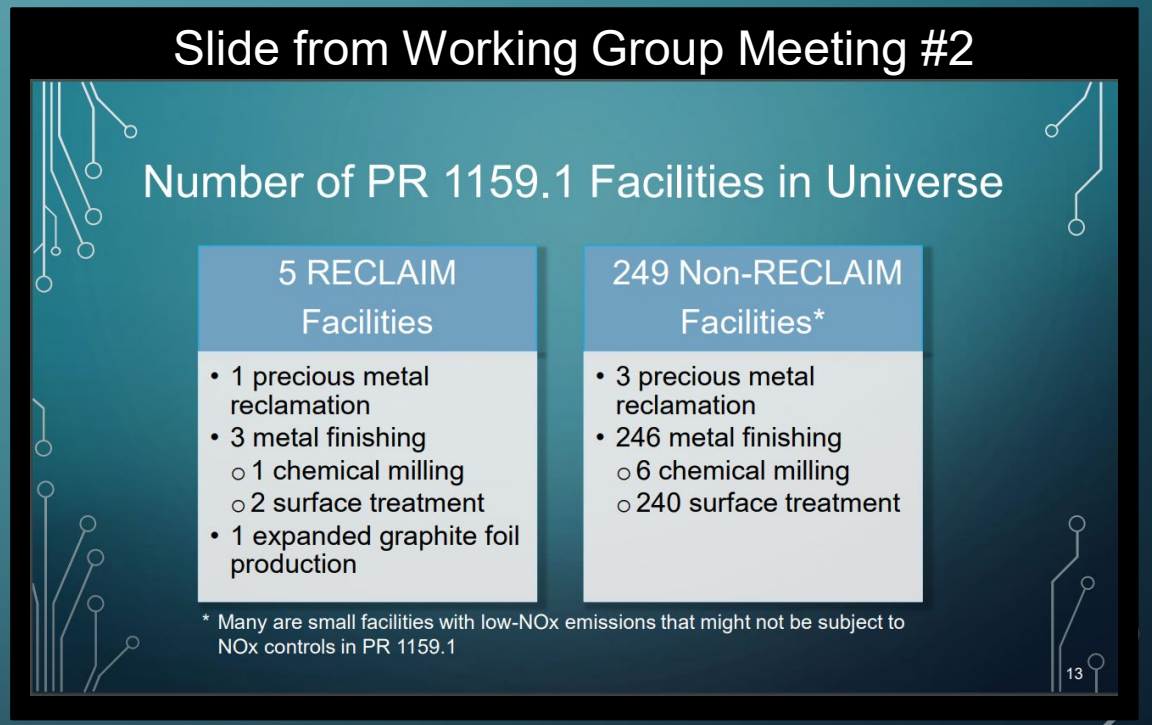
BARCT analysis will be conducted for each type of operations

Emission Limits For Existing Units

Assessment of Emission Limits for Exiting Units

- Staff identified 254 potential PR 1159.1 facilities
- Many facilities are small with no reported emissions or NOx related permit limits
- NOx related permit limits can vary significantly
  - Many permits do not include specific NOx limits
  - NOx related permit conditions can include nitric acid usage or metal throughput limits
  - Larger facilities may require add-on controls and additional requirements such as control efficiencies or throughput limits

Slide from Working Group Meeting #2



Examples of Existing NOx Related Permit Limits

	Facility Operation	# of Units	NOx Related Permit Limit
Facility A	Surface Treatment	2	• 50 gallons of nitric acid (70%)/month
Facility B	Surface Treatment	1	• 20 lbs of nitric acid per day
Facility C	Chemical Milling	2(1)	• 200,000 pieces per month • 5 ppmv NOx
Facility D	Precious metal reclamation	39(1)	• 99% control efficiency
Facility E	Expanded graphite foil	2(1)	• 330 lbs of nitric acid (98%)/hr

(1) Controlled with scrubbers

Available Annual NOx Emission

- Annual NOx emissions available for some PR 1159.1 units
  - 5 RECLAIM facilities report emissions
  - 12 non-RECLAIM facilities report NOx emissions through Annual Emission Reports (AER)

Facility Type	2017 RECLAIM NOx Emissions (lbs/yr)	2021 Non-RECLAIM AER NOx Emissions (lbs/yr)
Surface Treatment	86 - 130	1 - 2200
Chemical Milling	430(1)	NA
Precious Metal Reclamation	1320(1)	
Expanded Graphite Foil	1200(1)	

(1) Controlled with scrubbers

Calculating NOx Emissions

- NOx emissions from nitric acid units can be calculated using:

Mass of Metal Removed/Dissolved	• Challenging to track • Not a common approach
Reference Emission Factors	• Primarily used for emissions reporting • Not the most accurate method
Nitric Acid Usage	• Commonly tracked • More accurate than emission factors
Source Testing	• Provides the most accurate information • Primarily used by larger facilities

Source Tests - Background

- Source tests measure the amount of a pollutant being emitted at time of source test
- Source testing must follow specified protocols in order to get accurate results
- Reasons source tests are performed
  - Rule requirement to determine compliance
  - Permit requirement to determine compliance or emissions
    - Control efficiency (e.g., 95%)
    - Emission rate (e.g., 0.46 lb/hr)
    - Concentration limit (e.g., 15 ppm)

Available Source Tests

- Source tests only required for large sources of NOx emissions equipped with add-on controls
- Staff identified 9 sources test results:
  - 5 were deemed *not* suitable for quantification of NOx emissions
    - One was included to informational purposes (flagged on next slide)
  - 4 were deemed acceptable to assess control efficiency and/or NOx emission rates
- Source tests cover all types of operations that will be subject to PR 1159.1

Source Test Results

Assessment of Emission Limits for Exiting Units

	Facility Operation	# of Units	Control Efficiency	NOx Emission Rate	
Facility C	*Chemical Milling*	*2*	*~ 93.9%(1)*	*~ 0.17 lb/hr(1)*	RECLAIM
Facility D	Precious Metal Reclamation	39	98.4%(2)	0.26 lb/hr	
Facility E	Expanded Graphite Foil Production	2	N/A(3)	0.26 lb/hr	
Facility F	Surface Treatment	1	43.8%(4)	0.29 lb/hr	Non-RECLAIM
Facility G	Chemical Milling	2	97.7%	0.23 lb/hr	

(1) Source test results were outside span range, included as an estimated control efficiency
(2) Average of test results meet the 99% permit condition within acceptable error
(3) Control efficiency could not be calculated due to design of add-on control equipment
(4) Facility equipped with single-stage scrubber, lower control efficiency than multi-stage scrubber

Source Testing Conclusions

Assessment of Emission Limits for Exiting Units

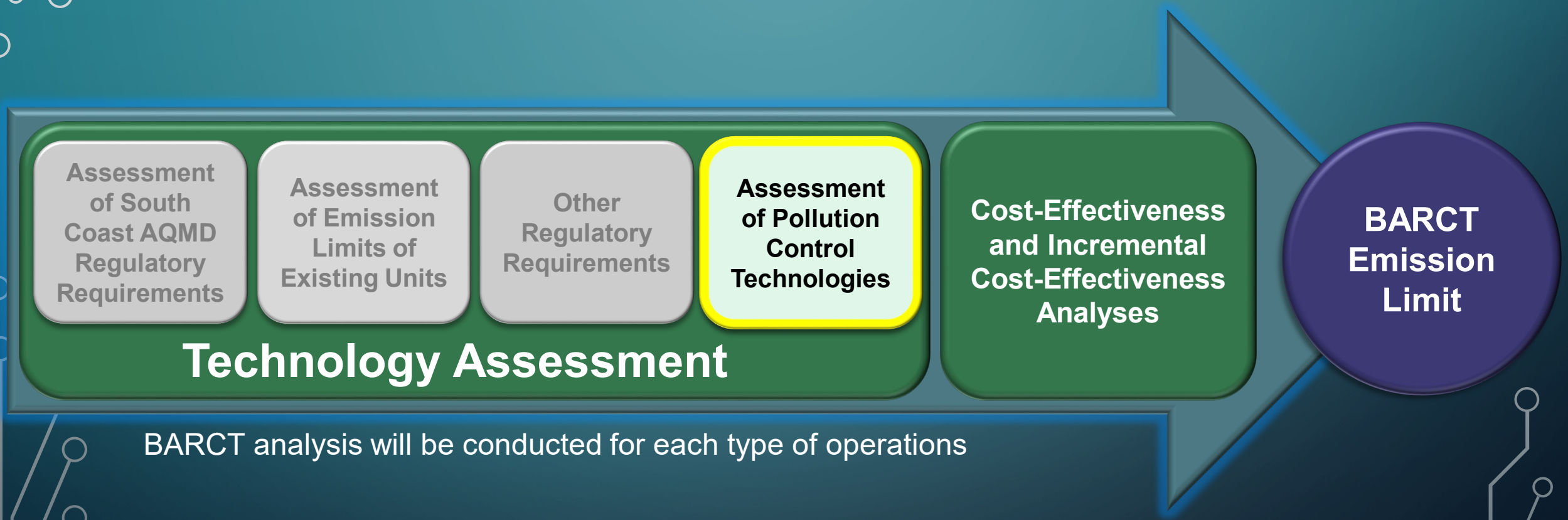
- Availability of source test data limited
  - No existing South Coast AQMD rule requires nitric acid units to be source tested
- All units tested included add-on scrubber technology
- Acceptable source tests demonstrate existing NOx scrubbers are achieving:
  - Control efficiency of at least 97%
    - Exception was metal finishing facility which used single-stage scrubber
    - Expanded graphite foil production facility was unable to demonstrate control efficiency due to configuration of add-on control equipment
  - Emission rates of 0.3 lbs / hour or less for NOx

Assessment of Emission Limits for Existing Units – Conclusions

Assessment of Emission Limits for Exiting Units

- The most emissive nitric acid units are:
  - Expanded graphite foil production (RECLAIM) – already use add-on NOx controls
  - Precious metal reclamation (RECLAIM) – already use add-on NOx controls
  - Chemical milling – most already use add-on NOx controls
- NOx emission limits for PR 1159.1 nitric acid facilities vary
  - Not many direct NOx emission limits
  - NOx related permit limits based on several different metrics
- Source test results provide the most accurate method to characterize emissions for existing units
  - Source test results indicate existing units are achieving an emission rate of 0.3 lbs of NOx/hour or up to 97% control efficiency

BARCT Analysis Process



BARCT analysis will be conducted for each type of operations

Methodology and Approach

Researched multiple sources for add-on control technologies

- Literature on NOx controls for similar equipment
- South Coast AQMD database
- Vendor contacts
- Site visits

Analyzed sources:

- Identify technology used at current facilities
- Identified capabilities and limitations of the technology

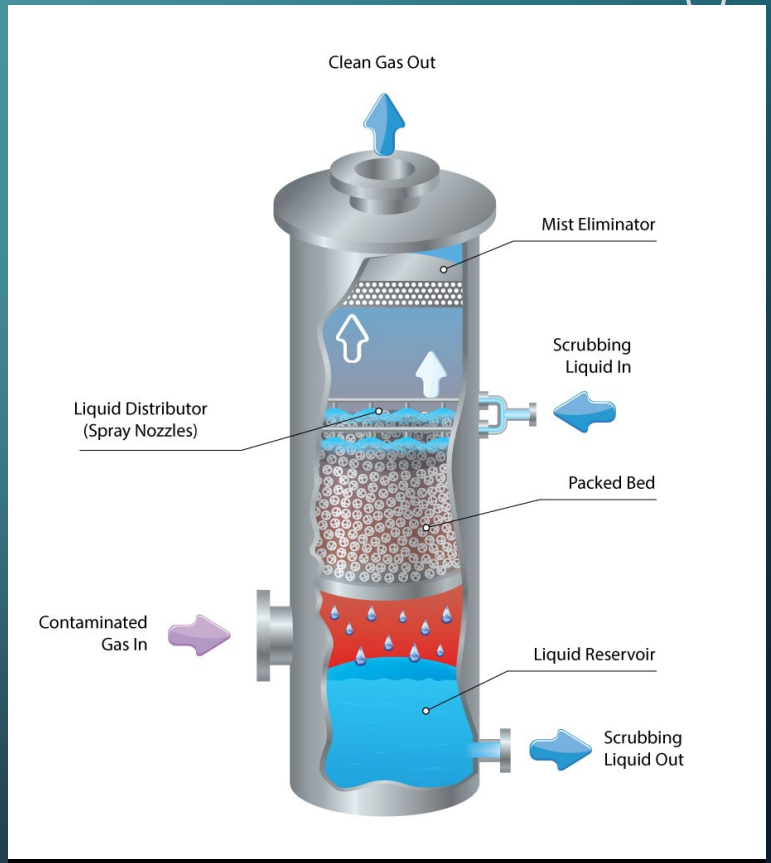
Pollution Control Technologies

Assessment of Pollution Control Technologies

- Common control technology used to control NOx emissions
  - Selective Non-Catalytic Reduction (SNCR) – Approximately 30-50% NOx reduction, high temperatures requirements
  - Selective Catalytic Reduction (SCR) – Approximately 70-90% NOx reduction, high temperature requirements (lower than SNCR)
  - Wet scrubbers (scrubbers) – Up to 99% NOx reduction
- Staff determined that scrubbers are most used to control NOx emissions from nitric acid units
- SNCR and SCR control technologies not appropriate for nitric acid units
  - Require high temperatures found with combustion NOx sources

Scrubbers – Background

- Common add-on control device to reduce particulate and gaseous pollutants
- Designed to reduce specific pollutant(s)
- Available in many configurations (e.g., cross-flow and counterflow)
- Typical packed bed scrubber consists of:
  - Packed bed media increases surface area
  - Spray nozzles spray liquid above packed bed
  - Scrubber liquid to control specific pollutants
- Multiple scrubbers in series are designed to
  - Target multiple pollutants
  - Increase control efficiency as high as 99%



https://www.spray-nozzle.co.uk/spray-nozzle-applications/gas-scrubbing/packed-bed-scrubbers

Pollution Control Technology – Summary

Packed bed scrubber

- Best control technology to reduce NOx emissions for PR 1159.1 operations

Control efficiency

- Properly designed NOx scrubber can achieve up to 99% control efficiency

Initial BARCT Assessment Summary

	South Coast AQMD Regulatory Requirements	Existing Units (Source Tests)	Other Regulatory Requirements	Technology Assessment	INITIAL BARCT EMISSION LIMIT
Metal Finishing	BACT Packed Chemical Scrubber	0.29 lb/hr 44% CE	None	Multi-stage scrubber (99% CE)	0.005 lb/hr
		0.23 lb/hr 97% CE			0.08 lb/hr
Precious Metal Reclamation	BACT 3-Stage NOx Reduction Scrubber	0.26 lb/hr 99% CE			0.3 lb/hr
Expanded Graphite Foil Production	None	0.26 lb/hr Multi-stage scrubber		Multi-stage scrubber	0.3 lb/hr

Summary of Initial BARCT Emission Limits

- Existing regulations (BACT) require scrubbers to control NOx emission for certain nitric acid tanks
- Multi-stage scrubbers can achieve up to 99% NOx emission reductions
- Source tests of NOx scrubbers indicate:
  - 44 – 98% control efficiency (0.30 lbs NOx/ hr) for Metal Finishing
    - Technically feasible to achieve lower NOx emissions
  - 99% control efficiency (0.30 lbs NOx/ hr) for Precious Metal Reclamation or Graphite Foil Production

Initial NOx Limit Identified as BARCT

Metal Finishing

- 0.005 – 0.08 lb NOx per hour

Precious Metal Reclamation or Graphite Foil Production

- 0.3 lb NOx per hour

COST-EFFECTIVENESS

Overview – Cost-Effectiveness

- BARCT analysis process requires that a cost-effectiveness analysis be performed
- Cost-effectiveness is a cost-benefit analysis comparing relative cost and outcomes
- Measured in cost per ton of pollutant (NOx) reduced
  - BARCT cost-effectiveness threshold is $50,000 per ton of NOx as approved in the 2016 Air Quality Management Plan
- For cost-effectiveness analysis, staff will use
  - Multi-stage NOx scrubber controlling emissions from a 7 ft by 3 ft nitric acid tank
  - Capital costs annualized over 25 years at 4% interest rate
  - NOx emissions based on source tests
- Cost-effectiveness analysis based on limited cost data

Cost Information

- Staff obtained cost information for NOx scrubbers from:
  - Previous permit evaluations for NOx scrubbers
  - Vendor provided cost estimates
  - Cost information provided during site visits
- Some vendors had voiced concerns – COVID-19 has increased costs
- Based on collected cost information, staff will use the following assumptions for initial cost-effectiveness analysis for a NOx scrubber
  - Control efficiency of 99%
  - $1,000,000 capital cost
  - $100,000 annual cost (10% of initial capital cost)

Discounted Cash Flow (DCF)

- South Coast AQMD uses Discounted Cash Flow
  - Cost-Effectiveness = Present Value / Emissions Reduced over the equipment's lifetime
  - Present Value = Capital Costs + (Annual Operating Costs * Present Worth Factor)
  - Present Worth Factor = $(1 – 1 / (1 + r)^n) / r$
  - Staff used:
    - Interest rate (r) of 4%
    - Life of equipment (n) of 25 years

Cost-Effectiveness to Achieve Initial NOx Limits Identified as BARCT

Precious Metal Reclamation or Expanded Graphite Foil Production

Initial NOx Limit	Potential Emission Reductions	Cost-Effectiveness	Conclusion
• 0.3 lb/hour	• 0 lb/life of control	• N/A – already achieved	• Cost-effective

Cost-Effectiveness to Achieve Initial NOx Limits Identified as BARCT (Cont.)

Metal Finishing			
Initial NOx Limit • 0.08 lb/hour	Potential Emission Reductions • 3.8 ton/life of control	Cost-Effectiveness • $668K/ton NOx Reduced	Conclusion • Not cost-effective
Initial NOx Limit • 0.005 lb/hour	Potential Emission Reductions • 7.1 ton/life of control	Cost-Effectiveness • $360K /ton NOx Reduced	Conclusion • Not cost-effective

BARCT Assessment for Metal Finishing

- Initial NOx limit identified as BARCT for metal finishing not cost-effective
  - One unit has multi-stage scrubber achieving near the control efficiency identified as BARCT
    - Achieving 97% versus 99% control efficiency
  - One unit with lower emission only using single-stage scrubber
    - Achieving ~44% control efficiency
- Multi-stage scrubber achieving 99% control efficiency not cost-effective
  - Next available control technology would be single-stage scrubber or multi-stage with 97% control efficiency
  - Revised NOx limit of 0.3 lb/hr identified as BARCT for metal finishing

Cost-Effectiveness to Achieve Revised NOx Limits identified as BARCT

Metal Finishing			
Revised NOx Limit • 0.3 lb/hour	Potential Emission Reductions • 0 lb/life of control	Cost-Effectiveness • N/A –already achieved	Conclusion • Cost-effective

Proposed NOx limits identified as BARCT

Metal Finishing

- 0.3 lb NOx per hour

Precious Metal Reclamation or Expanded Graphite Foil Production

- 0.3 lb NOx per hour

NEXT STEPS

Next Working Group Meeting

Discuss Methodologies for Determining NOx Emissions

Exemption Threshold for Low-Use or Low-Emitting Units

Rule Concepts

Next Steps

Continue discussions with stakeholders

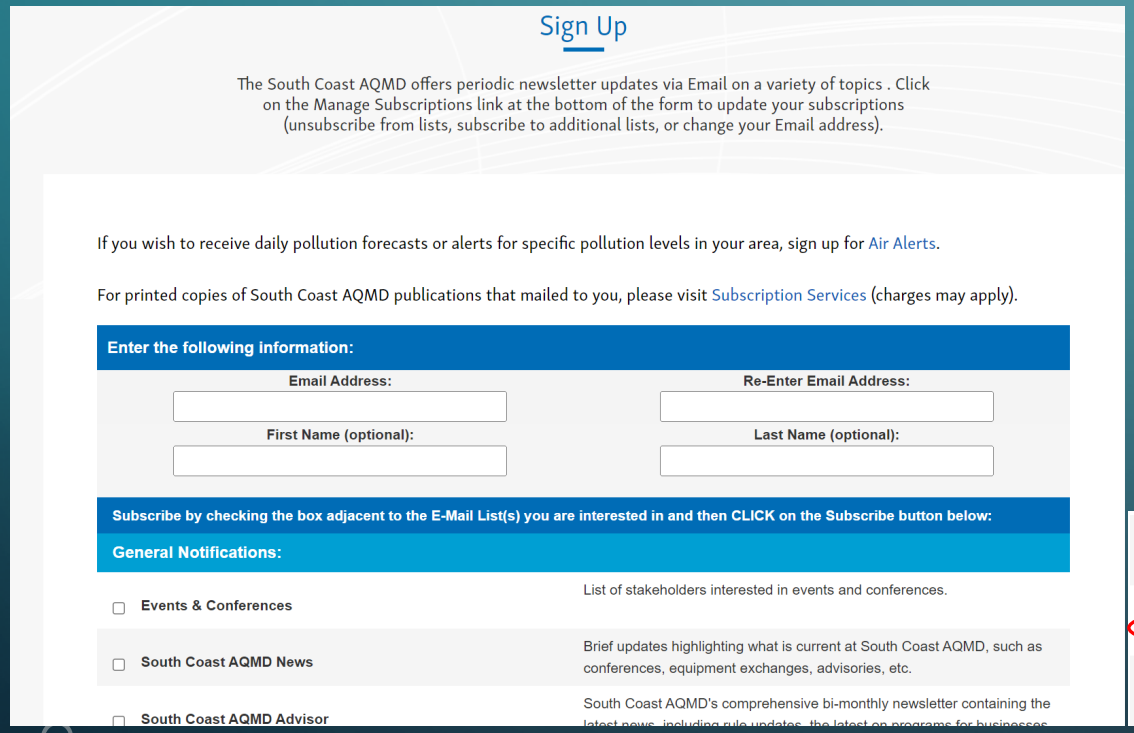
Release proposed rule language for PR 1159.1

Next Working Group Meeting in August

Public Hearing scheduled for December

Staying Updated with PR 1159.1

- Sign up and receive email updates via *http://www.aqmd.gov/sign-up*



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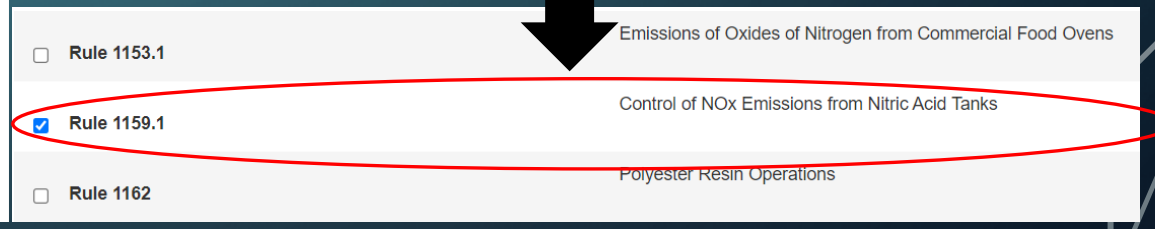

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