Proposed Amended Rule 1153.1

Emissions of Oxides of Nitrogen from Commercial Food Ovens

Working Group Meeting #3
July 27, 2022

Join Zoom Webinar Meeting

https://scaqmd.zoom.us/j/99936500985

Teleconference Dial-In: 1-669-900-6833

Webinar Meeting ID: 999 3650 0985

Agenda

- Summary of Working Group Meeting #2
- Follow-Up to Comments
- Baseline Emissions
- BARCT Assessment
- Technology Demonstration and Emerging Technology
- Next Steps

Summary of Working Group Meeting #2

- Working Group Meeting #2 held on June 8, 2022
- Staff presented:
  - Background on Rule 1153.1
  - Overview of BARCT Assessment and Cost-Effectiveness
  - First three steps of BARCT Technology Assessment
    - Current South Coast AQMD requirements
    - Emission Limits of Existing Units
    - Other Regulatory Requirements
- Stakeholders provided comments

Follow-Up to Stakeholder Comments

Comments From Last Working Group Meeting

- Three key comments received during last working group meeting:

Comment #1:
Provide further details on the source test results staff presented

Comment #2:
Consider the additional cost for thermal oxidizers or afterburners required downstream of bakery ovens to control VOCs

Comment #3:
Consider Rondo Energy heat battery system technology for commercial food ovens

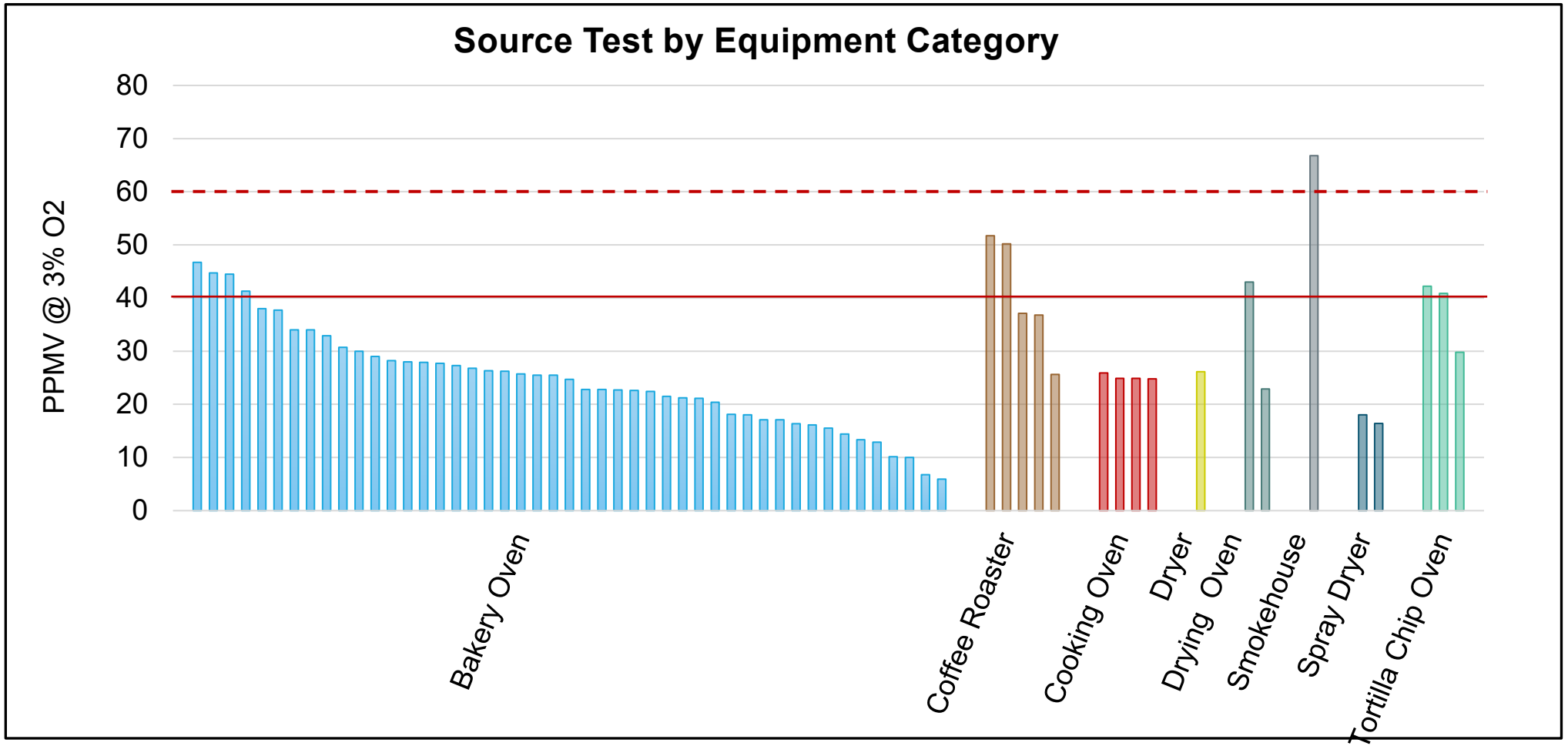
Comment #1

Source Test Results

- Stakeholder requested additional information on the source test results presented
  - Number of units source tested
  - If the source test results were from new units installed at BACT
- Revised table includes requested information

Equipment Type	Permit Limit (<500 °F)	Source Test	Permit Limit (≥500 °F)	Source Test	Number of Units Source Tested	Number of Units at BACT
	(ppmv at 3% O_2, dry)					
Food Ovens	30 to 60	5 to 46	25 to 60	17 to 44	54	10
Dryers	30 to 40	19 to 28	N/A	N/A	4	0
Roasters	30	13 to 37	60	49 to 52	5	1
Smokehouses	30 to 102**	15 to 67	N/A	N/A	5	0

NOx Emissions by Equipment Type



Thermal Oxidizers/Afterburners

Comment #2

Comment

- Facilities may have to replace thermal oxidizers to comply with Rule 1147, staff should consider those costs
- Thermal oxidizers or afterburners used to control VOCs add NOx emissions causing compliance challenges

Staff Response

- Cost effectiveness assessment for thermal oxidizers or afterburners to achieve NOx limits were evaluated during the Rule 1147 amendment
- Paragraph (d)(7) establishes compliance options for facilities with multiple food ovens with a common exhaust
  - Test each unit separately to demonstrate compliance
  - Test after the last unit of the series to demonstrate that all units meet
- Staff will consider expanding provision to allow same flexibility for thermal oxidizer or afterburner with a common exhaust

Rondo Energy Heat Battery

Comment #3

Comment

- Staff should look at Rondo Energy's heat battery system as an alternative heat source for food ovens
- Potentially replace the need for natural gas
- Zero emission technology can provide clean heat energy when combined with renewable energy sources

Staff Response

- Staff met with Rondo Energy to discuss the technology on July 12th to learn more about the technology and the potential for technology transfer to commercial ovens
- Discussion on technology will be discussed in later slides regarding emerging technology

Baseline Emissions

Revised Baseline Emissions

- Staff will rely on 2019 emissions as the baseline
  - Most representative
- Total of 97 permitted facilities
  - 6 RECLAIM
  - 91 non-RECLAIM
- RECLAIM Universe: 6 facilities, 1 facility uses steam boiler subject to Rule 1146 as heat source
  - Working Group Meeting #1, NOx emissions included emissions for all units at the facilities, not just Rule 1153.1 units (e.g., units subject to 1146 and 1147)
  - Revised baseline: 0.028 tpd

Non- RECLAIM Emissions

- Non-RECLAIM universe:
  - 91 facilities, including those exempt due to low-emitting exemption
  - Only have emissions for 9 facilities that are required to submit AER
    - Total of 0.047 tpd NOx emission
- Staff made some assumption to estimate emissions for other 82 facilities based on:
  - Equipment type
  - Operational days per week (average)
  - Burner size
    - Compared to facilities equipment category with similar sized burners and emissions data
    - Averaged the emissions for similar equipment to estimate lbs/day

Updated

Emissions Baseline Estimate

Non-RECLAIM Facility 2019 Emission Estimates						
Equipment	**Burner Size (MMBtu/hr)**	**Number of Facilities***	**Operational Days per Week**	**NOx Emissions Assumption (lbs/day)**	**NOx Emissions (tons/year)**	**NOx Emissions Estimate (tons/day)**
Roasters	3 or less	38	5	0.9	4.4	0.012
Dryers/Spray dryers	3.2 or less	5	7	4.5	4.1	0.011
Smokehouses/ Drying Ovens	5 or less	4	7	4.5	3.3	0.009
Baking & Cooking Ovens	7.2 or less	33	7	5.2	31.2	0.085
Non-RECLAIM with AER	9 Facilities					0.047
					RECLAIM	0.028
					Rule Total	0.192

* One smokehouse oven is steam heated, did not include in emissions estimates

Class and Category

Class and Category of Equipment

Rule 1153.1 currently does not distinguish between types of food ovens

- Different types of ovens use different burners
  - Ribbon burners
  - Infrared burners (IR)
  - Combination Ribbon/IR
  - Traditional LNB (direct or indirect fired)

- Staff reviewed universe and is considering including different class and categories of ovens
  - Roasters
  - Smokehouses
  - Tortilla ovens
  - Bakery ovens
  - Cooking ovens

BACT Guidelines for Food Ovens

- Best Available Retrofit Control Technologies (BACT) establishes guidelines based on type of burners used in commercial food ovens
- Staff reviewed facility permits and confirmed that burner type will vary based on equipment type or category
  - Burner type and cost will depend on food product being produced and equipment type
- For BARCT assessment, staff will consider separate equipment categories

BACT NOx Limits ppmv at 3% O_2, dry		
Subcategory	**Process Temp. ≤500 °F**	**Process Temp. >500 °F**
Ribbon Burner	30	60

BACT NOx Limits ppmv @ 3% O_2, dry	
Subcategory	
Other Direct Fired Burners	30
Infrared Burners (IR)	30

Bakery Ovens and Tortilla Ovens

- Conveyor type, continually take in food product for cooking
- Some ovens bake multiple products on same oven line
- Large tunnel ovens
- Tortilla ovens operate at >500°F
- Burner type used are ribbon, combination ribbon/infrared (IR)
- Burner type selection will vary based on product being cooked and operational characteristics
  - Large ovens can have up to 73 ribbon burners across the entire line
- Ovens are designed for a specific type of burner
- Cost of ribbon burners are more than traditional LNB used in other categories

Dryers, Drying Ovens, and Cooking Ovens

- Dryers:
  - Spray dryers used to make food flavoring powders
  - Rotary and fluidized bed used in food and feed drying
  - Operate below 500°F
  - Some units use steam as heat source
    - Steam provided via boilers subjected to Rule 1146
- Drying Ovens:
  - Used to dry food products such as meats and baked products prior to frying
  - Operate below 500°F
- Cooking Ovens:
  - Used to cook meat products

Smokehouses

Smokehouses:

Batch operations, product put in and removed when complete

- Used to smoke and dry meat products
- Equipment in category are comprised of a smoke generator and oven
- Smoke generators used are electric and ovens are direct fired units with a single burner
  - Smoke ovens operates between 110 to 190 °F

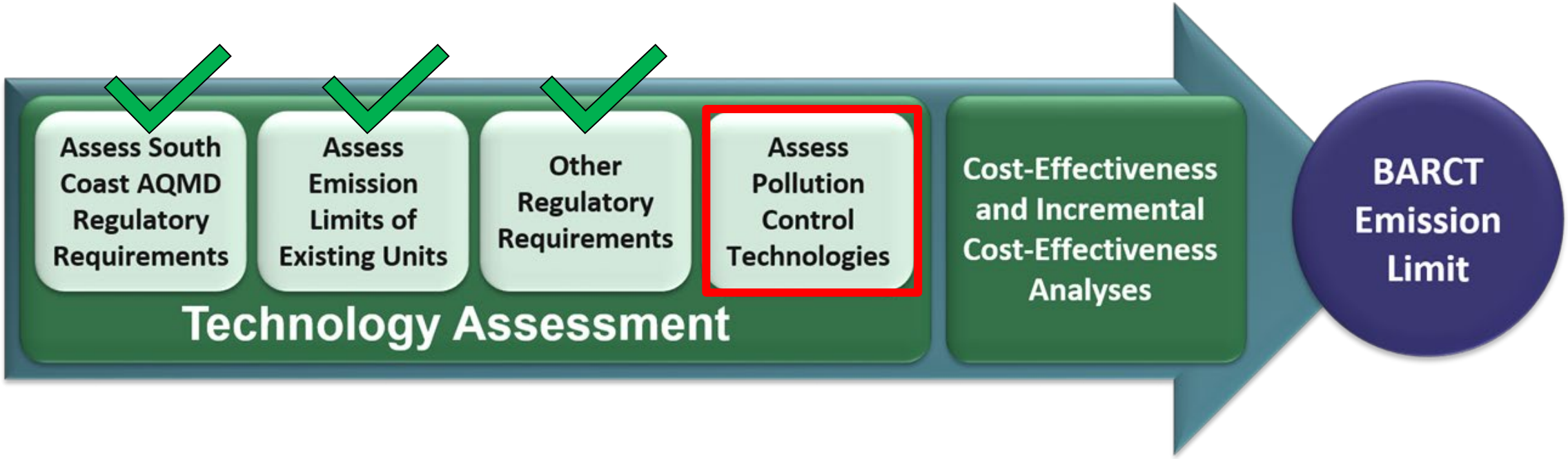
- All units in category can either be indirect or direct fired units with one or two burners
- LNB is feasible control and commercially available

Roasters

- Batch operations
- Used in coffee and nut roasting operations
- Most are indirect-fired units with one or two LNB burners
- Most have a permit limit of 30 or 40 ppm
  - Some older units have a 60 ppm permit limit
- All roasters are located at non-RECLAIM facilities
- Most units emit less than one pound per day and are exempt
- Traditional LNB is feasible option and is commercially available

BARCT Assessment Continued

Assessment of Pollution Control Technologies



Assessment of Pollution Control Technologies

Assessment of Pollution Control Technologies

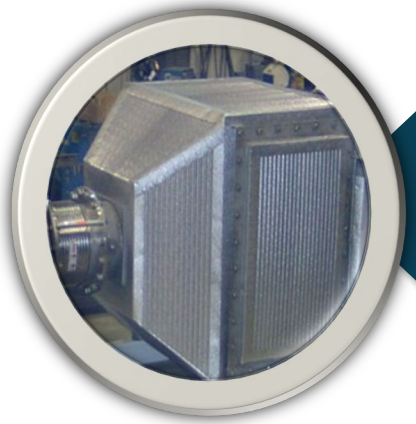
Objective:
Identify and evaluate control technologies, approaches, and potential emission reductions

- Staff will consider:
  - Commercially available NOx control technologies
    - Combustion control (e.g., low NOx burners)
    - Post-combustion control (add-on controls)
  - Burner retrofit
  - Unit replacement
  - Emerging Technology

NOx Control Techniques

Combustion Control

Minimizing NOx at the point of formation during the combustion Process utilizing Low NOx burners



Post-Combustion Control

Treatment of flue gas by converting NOx to different form

- Each NOx control technique will have varying degree of reduction efficiency and associated cost

Key NOx Control Technologies

Assessment of Pollution Control Technologies

Potential Control Technologies			
Control Type	**Key Features**	**Considerations**	**Initial Conclusions**
LoTOx™ w/Wet Gas Scrubber	• Low operating temperature • Multi-pollutant control	• Requires wastewater treatment • Large space requirements • **High capital and operating costs**	• Not technically feasible due to space requirements • Not cost effective due to low emissions and high costs
Selective Catalytic Reduction (SCR)	• High NOx removal • Requires high operating temperatures	• Large space requirements • Hazardous chemical storage • Waste disposal • **High capital and operating cost**	• Not technically feasible due to temperature and space requirements • Not cost effective due to low emissions and high costs
Low-NOx Burners (LNB)	• Low operating cost • Most ovens can be retrofit with low-NOx burners reducing overall costs	• Can have complex designs • May need further fan capacity	• Most Feasible option • Several options and burner types available for various applications

Preliminary Conclusion on Technology Assessment

Assessment of Pollution Control Technologies

- Post combustion control such as SCR require high flue gas temperatures which may require additional burners and equipment for proper operation
  - Not applicable to all units
  - Requires the use of hazardous chemicals at food manufacturer facilities
  - High capital and annual operating costs
- Combustion control technology such as low NOx burners are the most feasible option and applicable to most commercial food ovens
  - Burner control is commercially available from many manufacturers
- Staff will consider burner technology for the BARCT Assessment

Burner Control Technology for Food Ovens

Assessment of Pollution Control Technologies

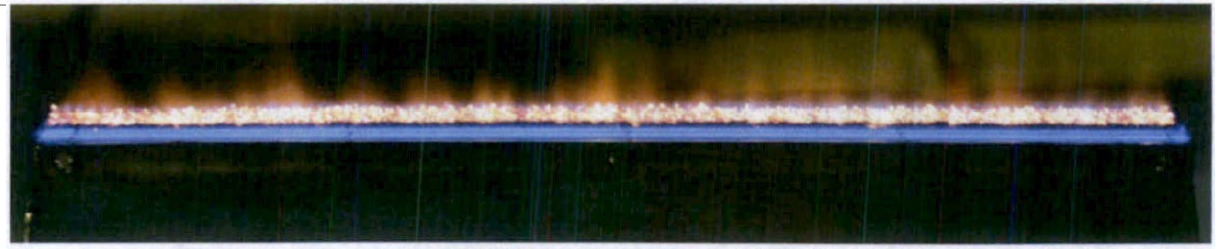
- Food ovens are designed for a specific type of burner
- Most bakery and tortilla ovens use ribbon burners that can achieve NOx levels between 25 to 30 ppm
  - Modern ribbon burners along with control systems meet a 30 ppm NOx limit
  - Some units have replaced or upgraded to newer burner controls such as combination ribbon IR and currently meet a 30 ppm NOx limit
  - Cost for ribbon burners exceed that for traditional low-NOx burners
- Other types of food ovens and dryers use traditional low-NOx burners for air heating and/or infrared burners meet a NOx limit of 30 ppm
- Roasters are indirect-fired units that use traditional low-NOx burners that meet a 30 ppm limit

Technology Demonstration and Emerging Technology

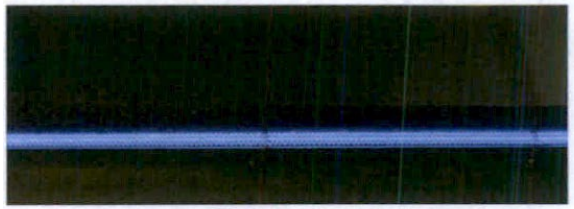
Technology Demonstration

Assessment of Pollution Control Technologies

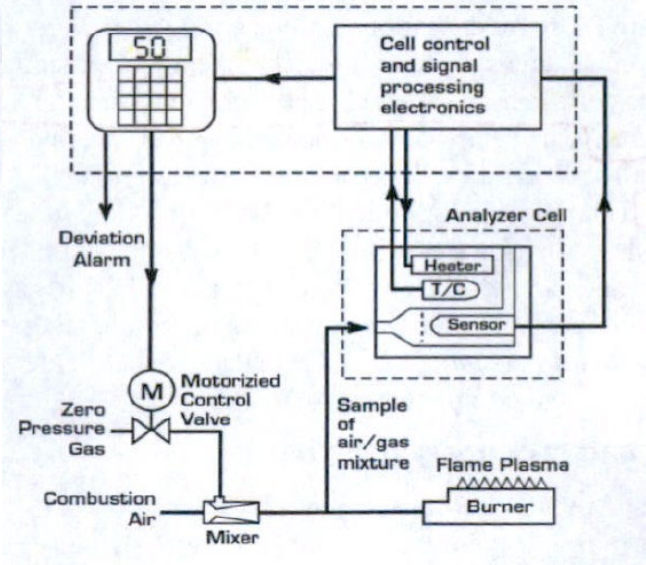
- South Coast AQMD, Gas Technology Institute, and Flynn Burners currently have a demonstration project at local commercial bakery
- Goal is 25% reduction in NOx emissions
  - Striving to achieve 30 ppm NOx
- The demonstration will utilize:
  - Combination infrared/ribbon burner arranged in five zones
  - Flame analyzers and advanced combustion flow controls
- Project was delayed due to COVID-19
  - Data collection will resume in August 2022
- Staff planning site visit to assess progress



Infrared-Ribbon Simultaneous Operation

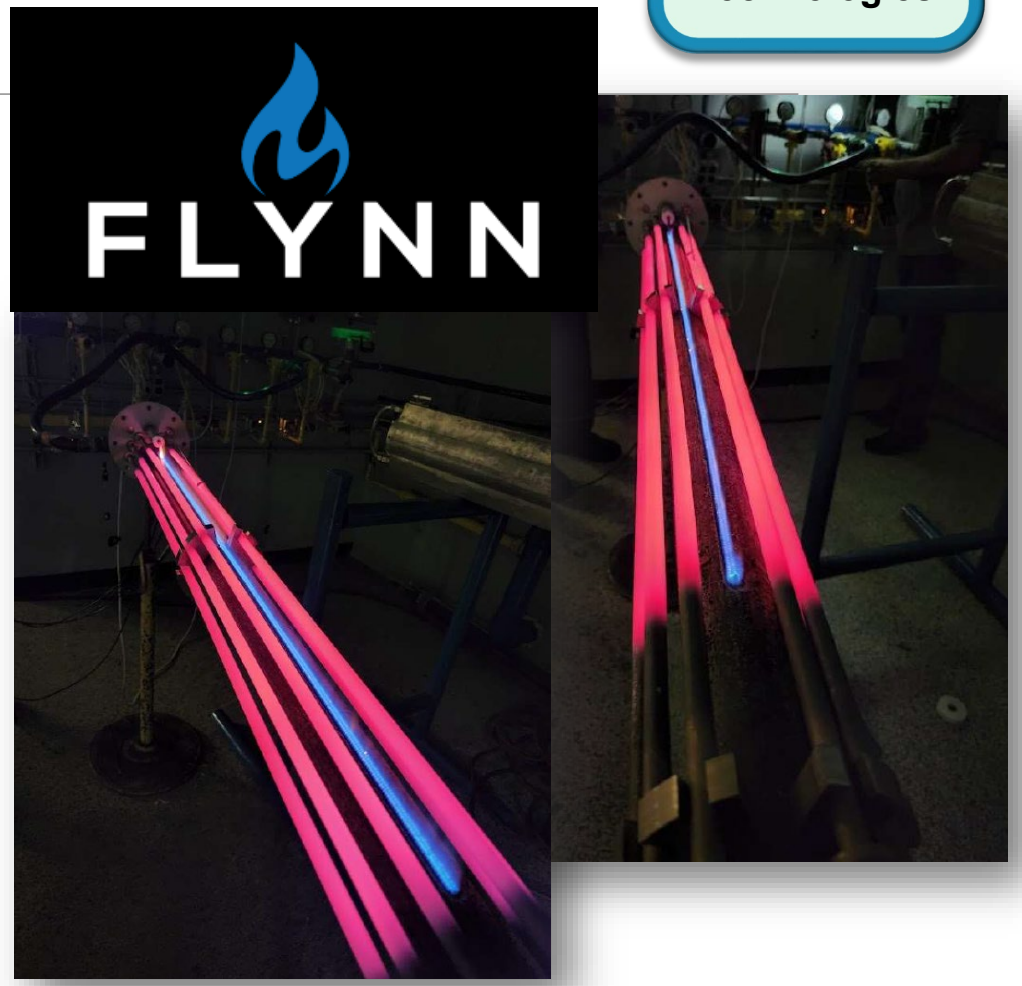


Ribbon Fire Only



Emerging Technology: Hybrid Electric-Ribbon Burners

- Hybrid electric-ribbon burner technology currently being developed by Flynn Burners
- Uses gas burner and electric heating elements
  - Initially fired on gas, then switch to electric mode under normal baking or cooking operations
  - Near-zero or zero emission under normal operations
- Potential option for bakery ovens that use ribbon burners in baking process
- Requires increased electricity to operate



Electric Bakery Ovens

AMF BAKERY SYSTEMS

Assessment of Pollution Control Technologies

- Electric tunnel oven technology currently available from AMF Den Boer
- Heat is generated by electrical elements directly above and under product line
- Retrofit option available where combustion burners are replaced with heating elements
  - Unit sits on top of oven
- Since there is no moisture from combustion gases, good option for: pizza, flatbreads, cookies, biscuits, and rusk
- Cost of additional electricity required is a challenge

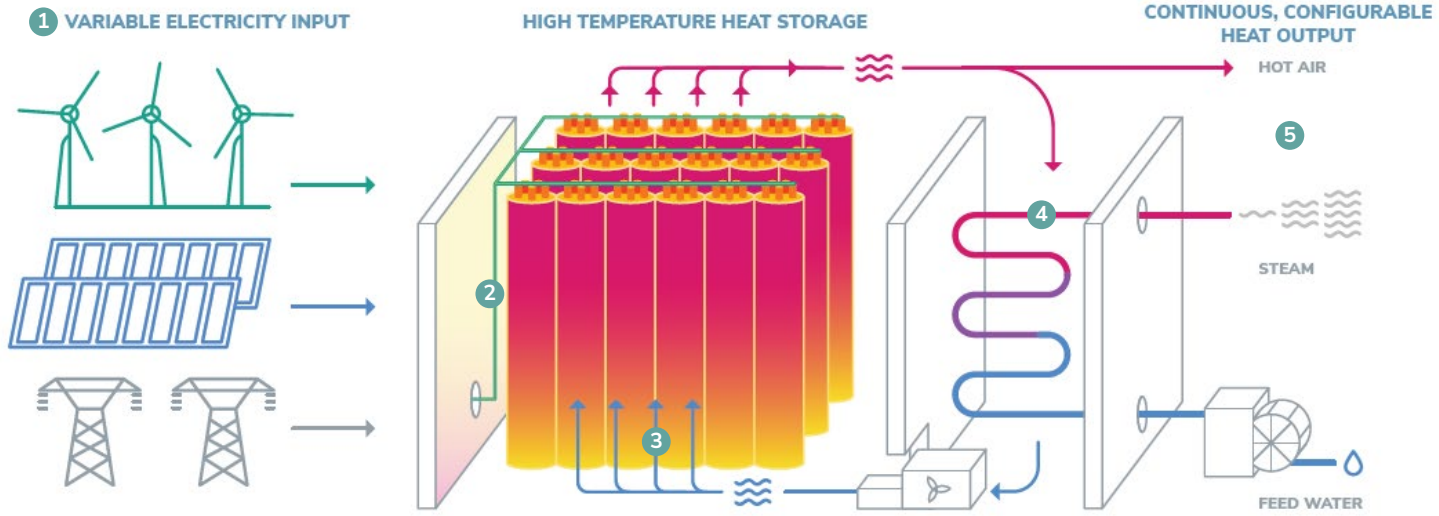
Emerging Technology Transfer

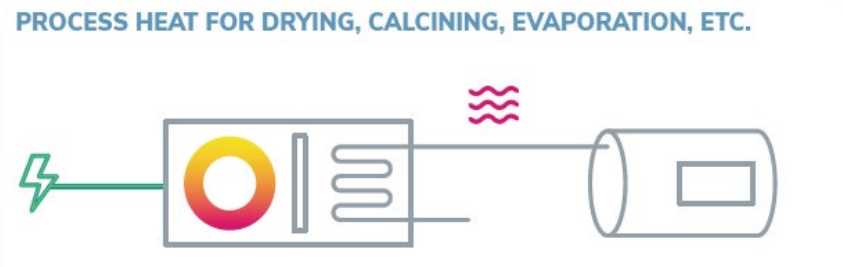
Assessment of Pollution Control Technologies

Rondo Heat Battery - HB100

LOW-COST, DISPATCHABLE HEAT FOR PROCESS LOADS — WITHOUT INFRASTRUCTURE OVERHAUL

Standard Electricity Input, Modular Storage Capacity, Configurable Heat Output up to 2,100°F





Rondo delivers hot water, air, or steam to a variety of industrial processes to replace fossil fuels in direct- and indirect-fired processes

1. Low-cost, intermittent electricity powers electric heaters.
2. Electric heaters store thermal energy in bricks at temperatures up to 2,100°F.
3. Air is heated by passing through the bricks.
4. Air can be used to generate steam through a boiler package.
5. Air and/or steam is delivered to any industrial process.

RONDO HB100 TECHNICAL SPECIFICATIONS	
Typical Daily Output $_{th}$	160 MWh | 545 MMBTU
Max. Charge Rate $_{el}$	15-30 MW
Max. Discharge Rate $_{th}$	10 MW | 34 MMBTU/hour heat
Depth of Discharge	100%
Number of Cycles	Unlimited, 50 years
Round Trip Efficiency	> 98%
Typical Connections Electrical - 3 phase	4160V
Temperature Range	80°C - 1100°C (180°F - 2000°F)
Footprint	14 x 10 meters | 46 x 30 feet

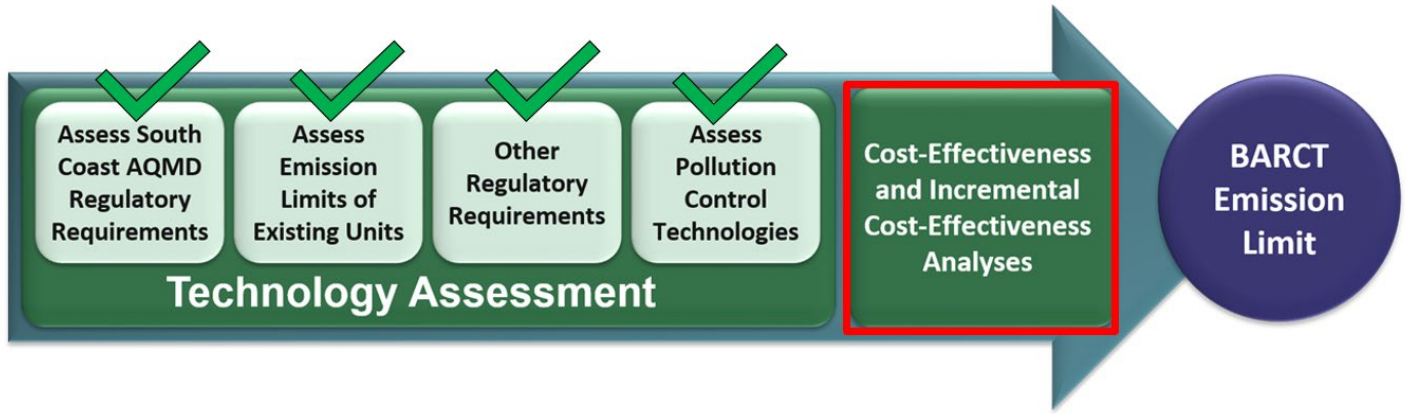
Preliminary Conclusions on Pollution Control Technologies

Assessment of Pollution Control Technologies

- Low-NOx burners can achieve NOx levels of 30 ppm
  - Bakery and tortilla ovens utilize ribbon style burners that are potentially more challenging and have higher cost ~ $2 to 4.2 million per burner
  - Other equipment categories utilize traditional low-NOx burner have lower burner cost ~ $5 to 10,000
- New food ovens can achieve 30 ppm
  - BACT determination
- Emerging technologies can achieve zero or near-zero

Initial NOx BARCT Limit

- All units could achieve 30 ppm based on technology assessment
- Next meeting staff will conduct cost effectiveness of the initial BARCT NOx limit



Initial BARCT NOx Limit:

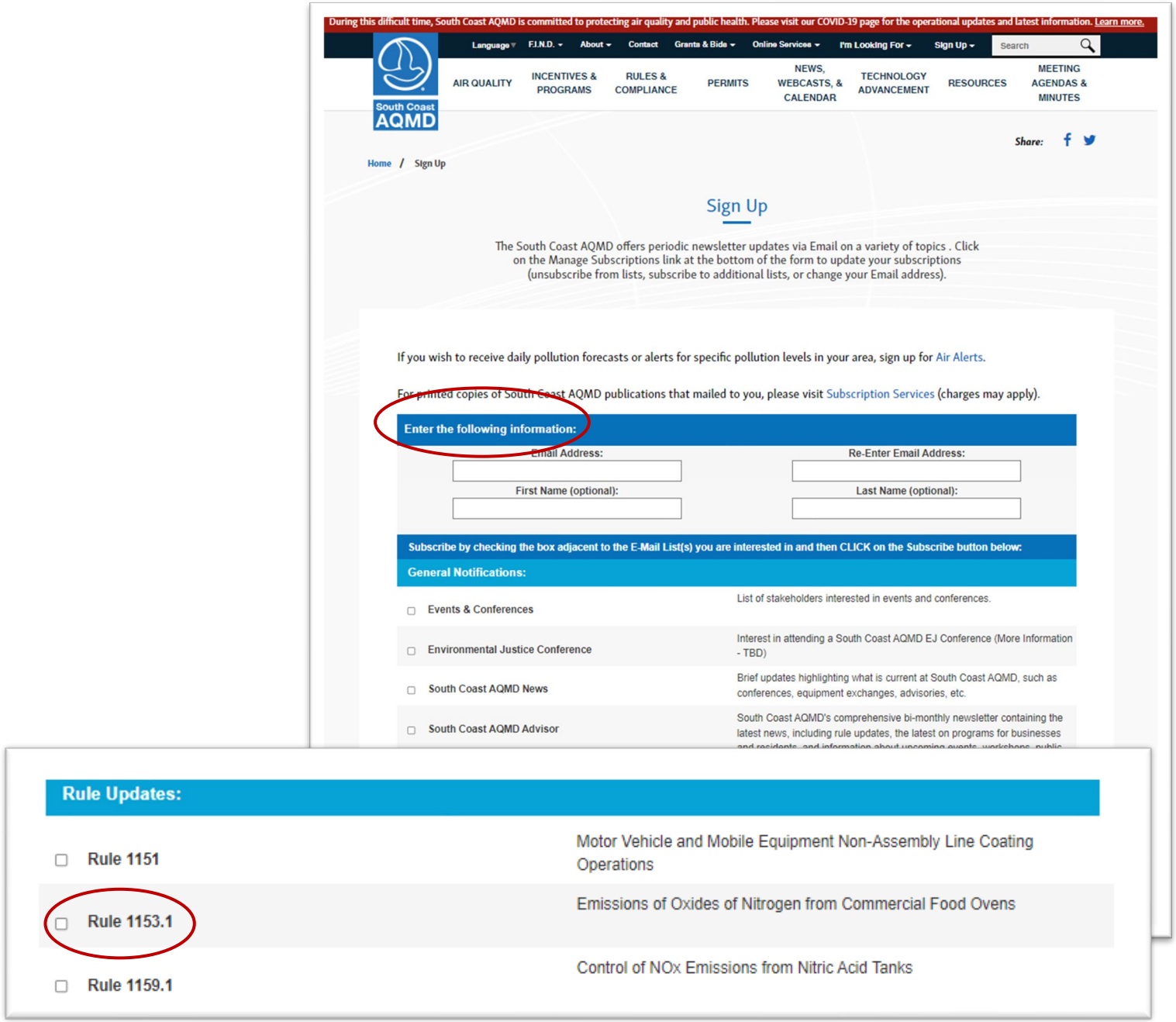
- 30 ppm

Next Steps

- Continue Site Visits and Stakeholder Meetings
- Continue Meeting with Technology Vendors
- Cost-Effectiveness Analysis
- Release Preliminary Draft Documents
- Public Workshop 4th Quarter 2022

Receiving PAR 1153.1 Updates

- To receive email updates, sign up at South Coast AQMD sign up page *http://www.aqmd.gov/sign-up*
- Enter email address and name
- Subscribe by scrolling down to “Rule Updates” and check the box for Rule 1153.1 and click on the subscribe button at bottom of page
- Future meeting notices, links to documents, and any updates will be sent via email



Staff Contacts

Michael Krause
Assistant DEO
mkrause@aqmd.gov
909.396.2706

Heather Farr
Planning and Rules Manager
hfarr@aqmd.gov
909.396.3672

Sarady Ka
Program Supervisor
ska@aqmd.gov
909.396.2331

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