Proposed Amended Rule 1153.1
Emissions of Oxides of Nitrogen from Commercial Food Ovens

Working Group Meeting #3
July 27, 2022
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
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.
### 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

<table>
<thead>
<tr>
<th>Equipment Type</th>
<th>Permit Limit (&lt;500 °F)</th>
<th>Source Test</th>
<th>Permit Limit (≥500 °F)</th>
<th>Source Test</th>
<th>Number of Units Source Tested</th>
<th>Number of Units at BACT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food Ovens</td>
<td>30 to 60</td>
<td>5 to 46</td>
<td>25 to 60</td>
<td>17 to 44</td>
<td>54</td>
<td>10</td>
</tr>
<tr>
<td>Dryers</td>
<td>30 to 40</td>
<td>19 to 28</td>
<td>N/A</td>
<td>N/A</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Roasters</td>
<td>30</td>
<td>13 to 37</td>
<td>60</td>
<td>49 to 52</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Smokehouses</td>
<td>30 to 102**</td>
<td>15 to 67</td>
<td>N/A</td>
<td>N/A</td>
<td>5</td>
<td>0</td>
</tr>
</tbody>
</table>

(PPmv at 3% O₂, dry)
NOx Emissions by Equipment Type

Source Test by Equipment Category

PPM V @ 3% O2
Thermal Oxidizers/Afterburners

Comment #2

- 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

• 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
# Emissions Baseline Estimate

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Burner Size (MMBtu/hr)</th>
<th>Number of Facilities*</th>
<th>Operational Days per Week</th>
<th>NOx Emissions Assumption (lbs/day)</th>
<th>NOx Emissions (tons/year)</th>
<th>NOx Emissions Estimate (tons/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Roasters</td>
<td>3 or less</td>
<td>38</td>
<td>5</td>
<td>0.9</td>
<td>4.4</td>
<td>0.012</td>
</tr>
<tr>
<td>Dryers/Spray dryers</td>
<td>3.2 or less</td>
<td>5</td>
<td>7</td>
<td>4.5</td>
<td>4.1</td>
<td>0.011</td>
</tr>
<tr>
<td>Smokehouses/Drying Ovens</td>
<td>5 or less</td>
<td>4</td>
<td>7</td>
<td>4.5</td>
<td>3.3</td>
<td>0.009</td>
</tr>
<tr>
<td>Baking &amp; Cooking Ovens</td>
<td>7.2 or less</td>
<td>33</td>
<td>7</td>
<td>5.2</td>
<td>31.2</td>
<td>0.085</td>
</tr>
<tr>
<td>Non-RECLAIM with AER</td>
<td></td>
<td>9 Facilities</td>
<td></td>
<td></td>
<td></td>
<td>0.047</td>
</tr>
</tbody>
</table>

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

| RECLAIM                      | 0.028                  |
| Rule Total                   | 0.192                  |
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

<table>
<thead>
<tr>
<th>Subcategory</th>
<th>Process Temp. ≤500 °F</th>
<th>Process Temp. &gt;500 °F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ribbon Burner</td>
<td>30</td>
<td>60</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Subcategory</th>
<th>BACT NOx Limits ppmv @ 3% O₂, dry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other Direct Fired Burners</td>
<td>30</td>
</tr>
<tr>
<td>Infrared Burners (IR)</td>
<td>30</td>
</tr>
</tbody>
</table>
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:
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 operate 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

- Assess South Coast AQMD Regulatory Requirements
- Assess Emission Limits of Existing Units
- Other Regulatory Requirements
- Assess Pollution Control Technologies

Cost-Effectiveness and Incremental Cost-Effectiveness Analyses

BARCT Emission Limit
## 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

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

• 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

- 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

- 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
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**

- 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
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.

PROCESS HEAT FOR DRYING, CALCINING, EVAPORATION, ETC.

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

Emerging Technology Transfer

Assessment of Pollution Control Technologies

Rondo Heat Battery - HB100

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PROCESS HEAT FOR DRYING, CALCINING, EVAPORATION, ETC.
Preliminary Conclusions on 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](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
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