Boiler NOx Emissions and Energy Efficiency

Prepared For:

Boiler NOx Webinar
November 5, 2010

Prepared By:

enovity inc
100 Montgomery Street, Suite 600
San Francisco, CA 94104

Pacific Gas and Electric Company
245 Market Street
San Francisco, CA 94105
Review of Regulations
• Bay Area Air Quality Management District (Julian Elliot, BAAQMD)
• San Joaquin Valley Air Pollution Control District (Joy Ulickey, Enovity)

Energy Efficiency Opportunities (Justin Nagy, Enovity)
• Combining Energy Efficiency with NOx Reduction
• Example Energy Efficiency Measures

Getting Rebates Through the Boiler Efficiency Program (Keelan McClymont, Enovity)
• Eligibility
• Services Offered

Questions
June 2010

Bay Area AQMD
Requirements for Boilers

Julian Elliot
Senior Air Quality Engineer

www.baaqmd.gov
Contact Information

BAAQMD website:  www.baaqmd.gov

Rules are available at:


Julian Elliot:

jelliot@baaqmd.gov  |  415 749 4705
BAAQMD Jurisdiction

NINE COUNTY JURISDICTION OF THE BAAQMD

Marin
Sonoma
Napa
Solano
Contra Costa
San Mateo
Santa Clara
Alameda

SF
BAAQMD Boiler Regulation

• BAAQMD regulates air emissions, not safety.

• Requires permits for certain boilers (see Reg 2-1-114.1):
  - natural gas & LPG-fired: input rating ≥10 MM BTU/hr
  - all other fuels: input rating ≥1 MM BTU/hr

• Has rules that apply to boiler emissions and operation:
  - Reg 9, Rule 6: natural gas-fired up to 2 MM BTU/hr
  - Reg 9, Rule 7:
    >2 MM BTU/hr for natural gas & LPG-fired
    ≥1 MM BTU/hr for all other fuels
Recent BAAQMD Actions

Permit Requirements
• No change

Reg 9, Rule 6 – *Natural Gas* Water Heaters & Boilers (2007)
• New NOx standards go into effect 2009 through 2013, depending on heater size and application
• Emissions limits apply only to new heaters (up to 2 MM BTU/hr)

Reg 9, Rule 7 – Boilers, Steam Generators, Process Heaters (2008)
• New NOx standards go into effect 2011 and later
• New efficiency requirements go into effect 2009 through 2011
• Registration in 2011 for boilers that do not need permits
• Standards apply to new AND existing heaters (“retrofit rule”)

Slide 5
Regulation 9, Rule 7
Permits & Registration

• No new permit requirements, BUT operators who modify or replace a boiler to comply with Reg 9-7 must submit permit application if modified or replacement boiler is subject to permit requirements.

• New registration requirements for heaters that do not require permits (Effective January 1, 2011):
  - Natural gas & LPG-fired heaters rated >2 to <10 MM BTU/hr
  - One-Time Registration fees: $425 per facility with an affected heater plus $50 for each heater after the first one
  - Will be available on BAAQMD website in 2010:
Device using <10% of "annual maximum heat capacity" each year are not subject to new NOx or efficiency requirements:

- 1 to <10 MM BTU/hr (non-gas-fired) and >2 to <10 (gas-fired):
  - perform annual tune-up, operate fuel meter, keep fuel records
- 10 MM BTU/hr and higher:
  - 30 ppmv NOx limit (in effect since 1993)
  - operate fuel meter & keep fuel records to verify exempt status
- District may approve fuel-use monitoring other than a fuel meter (see Regulation 9-7-504.1)
BAAQMD Regulation 9, Rule 7
Annual Maximum Heat Capacity Exemption

Example: Boiler with 3 million BTU/hr input rating

Less than 10% of annual maximum heat capacity =

\(< (3,000,000 \text{ BTU/hr}) (8,760 \text{ hr/yr}) (\text{therm/100,000 BTU}) (0.10) \)
\(< 26,280 \text{ therm/yr} \)

So if this boiler used less than 26,280 therms per year of fuel, it would qualify for an exemption.
### BAAQMD Regulation 9, Rule 7
Natural Gas & LPG NOx Limits

<table>
<thead>
<tr>
<th>Input (MM BTU/hr)</th>
<th>Old NOx Limit</th>
<th>New NOx Limit</th>
<th>Effective Date (Single-Heater Facilities)</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt;2 to 5</td>
<td>None</td>
<td>30 ppmv</td>
<td>1/1/2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(10 yrs after manufacture date if before 1/1/2011)</td>
</tr>
<tr>
<td>&gt;5 to &lt;10</td>
<td>None</td>
<td>15 ppmv</td>
<td>1/1/2012</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(10 yrs after manufacture date if before 1/1/2012)</td>
</tr>
<tr>
<td>10 to &lt;20</td>
<td>30 ppmv</td>
<td>15 ppmv</td>
<td></td>
</tr>
<tr>
<td>20 to &lt;75</td>
<td>30 ppmv</td>
<td>9 ppmv</td>
<td>1/1/2012</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(5 yrs after manufacture date if before 1/1/2012)</td>
</tr>
<tr>
<td>75 &amp; up</td>
<td>30 ppmv</td>
<td>5 ppmv</td>
<td></td>
</tr>
</tbody>
</table>
De-Rating is Allowed
A boiler may be physically modified to have a lower input heat rating to avoid NOx limits and other requirements applicable to a larger boiler.

Multiple-Heater Facilities
If there are other heaters at the facility subject to the same NOx limit as the 1st heater, then:
- at least 33% of heaters must comply on 1st effective date
- at least 66% of heaters must comply 1 year after 1st effective date
- all heaters must comply 2 years after 1st effective date
BAAQMD Regulation 9, Rule 7
Other Fuels – NOx Limits

<table>
<thead>
<tr>
<th>Fuel</th>
<th>NOx Limit</th>
<th>Effective Date (Single-Heater Facilities)</th>
</tr>
</thead>
<tbody>
<tr>
<td>landfill or digester gas</td>
<td>30 ppmv</td>
<td>already in effect</td>
</tr>
<tr>
<td>liquid fuel</td>
<td>40 ppmv*</td>
<td>&lt;10 MM BTU/hr: effective 1/1/2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>≥10 MM BTU/hr: already in effect</td>
</tr>
</tbody>
</table>

* 150 ppmv NOx limit applies to liquid fuel use during natural gas curtailment or testing of backup liquid fuel for limited periods – see Regulation 9-7-113.1.
BAAQMD Regulation 9, Rule 7
Load-Following Device NOx Limits

Load-following device, 20 MM BTU/hr and higher:

- 15 ppmv NOx limit.
- Operator must apply for a permit modification, as described in Regulation 9-7-408, to qualify for this relaxed NOx limit.
BAAQMD Regulation 9, Rule 7
Energy Efficiency Measures

Note: Heaters using <10% of “annual max heat capacity” are exempt

Insulation Requirement (Effective 1/1/2010):
• Exposed surfaces limited to 120°F
• Applies only to boilers and steam generators (not process heaters)
• Other exemptions in Regulation 9-7-311.1 through 311.5

Stack Gas Temperature Limits (Effective 1/1/2011):
• Limits stack gas temperature limits to ensure reasonable heat transfer to heated material (see table in Regulation 9-7-312)
• Applies only to boilers and steam generators (not process heaters)
BAAQMD Regulation 9, Rule 7
Energy Efficiency Measures

Note: Heaters using <10% of “annual max heat capacity” are exempt

- **Annual Tune-Up**
  - Effective 1/1/2009 (1st tune-up must occur in 2009)

- **Elements of Tune-Up:**
  - Compliance verification for insulation
  - Compliance verification for stack gas temperature
  - Minimization of Excess Air
  - Optimization of Liquid Blowdown
  - See BAAQMD Manual of Procedures, Volume 1, Chapter 5
BAAQMD Regulation 9, Rule 7
Initial Demonstration of Compliance

Devices rated 10 to <20 MM BTU/hr:
• Must be tested within 1 year of new NOx standard effectiveness
• May be tested with approved hand-held analyzer (see rule Attachment 1 for analyzer requirements)

Devices rated 20 MM BTU/hr and higher:
• Must be tested within 1 year of new NOx standard effectiveness
• Test must be a standard District source test
BAAQMD Regulation 9, Rule 7
Periodic Monitoring

**Note:** Periodic testing may be performed with a hand-held analyzer

<table>
<thead>
<tr>
<th>Device Size (MM BTU/hr)</th>
<th>Testing Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 to &lt;20 (gas-fired)</td>
<td>Every 2 years</td>
</tr>
<tr>
<td>20 and higher (gas-fired)</td>
<td>Every year</td>
</tr>
<tr>
<td>1 and higher (non-gas-fuel)</td>
<td>Every year that non-gas-fuel is used, except for testing purposes</td>
</tr>
</tbody>
</table>
Questions?
San Joaquin Valley Boiler Emissions Overview

Prepared For:
Boiler NOx Webinar
November 5, 2010

Prepared By:
enovity inc
100 Montgomery Street, Suite 600
San Francisco, CA 94104
AGENDA

Introduction
  • SJV APCD Territory
  • NOx Emission Limit Overview

Rule 4307
  • Affected Devices
  • Limits and Deadlines

Rule 4320
  • Affected Devices
  • Limits and Deadlines
  • Fee Option
SAN JOAQUIN VALLEY APCD
Rule 4307*

- Was amended October 16, 2008
- Affects boilers between 2.0 and 5.0 MMBtu/hr
- Requires existing units to meet 30 ppm NOx
- Requires units installed after January 1, 2010 to meet:
  - 12 ppm if atmospheric
  - 9 ppm if non-atmospheric

*See actual regulation for more information and specific compliance requirements.
Rule 4320*

- Was adopted October 16, 2008
- Replaces Rule 4306
- Affects boilers larger than 5.0 MMBtu/hr
- Has compliance dates ranging from 2010 to 2014
- Offers three compliance options
  - Standard schedule
  - Enhanced schedule
  - Annual emissions fee (starting January 2010)
- Requires operators to submit Emissions Control Plan by January 1, 2010

*See actual regulation for more information and specific compliance requirements.
## COMPLIANCE SUMMARY

<table>
<thead>
<tr>
<th>Rated Input (MMBtu/hr)</th>
<th>Rated Output (HP)</th>
<th>NOx Limit (@ 3% O₂)</th>
<th>Compliance Option / Schedule</th>
<th>Compliance Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>&gt; 2 to 5</td>
<td>&gt; 60 to 150</td>
<td>30 ppmv</td>
<td>Existing Units</td>
<td>July 1, 2009</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12 ppmv</td>
<td>New Atmospheric Units</td>
<td>January 1, 2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9 ppmv</td>
<td>New Non-Atmospheric Units</td>
<td>January 1, 2010</td>
</tr>
<tr>
<td>&gt; 5 to 20</td>
<td>&gt; 150 to 600</td>
<td>9 ppmv</td>
<td>A. Standard Schedule</td>
<td>July 1, 2012</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6 ppmv</td>
<td>B. Enhanced Schedule</td>
<td>July 1, 2014</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N/A</td>
<td>C. Pay Annual Fee</td>
<td>January 1, 2010</td>
</tr>
<tr>
<td>&gt; 20</td>
<td>&gt; 600</td>
<td>7 ppmv</td>
<td>A. Standard Schedule</td>
<td>July 1, 2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5 ppmv</td>
<td>B. Enhanced Schedule</td>
<td>July 1, 2014</td>
</tr>
<tr>
<td></td>
<td></td>
<td>N/A</td>
<td>C. Pay Annual Fee</td>
<td>January 1, 2010</td>
</tr>
</tbody>
</table>

**Notes:**
Table does not include oilfield/refineries, schools, and low usage boilers.
Table only includes boilers firing at least 50% PUC-quality natural gas.
See actual regulations for further information and specific compliance requirements.
CONTACT SJV APCD

www.ValleyAir.org
sjvapcd@valleyair.org
QUESTIONS
Combining Energy Efficiency with NOx Upgrades

Prepared For:

Boiler NOx Webinar

November 5, 2010

Prepared By:

enovity inc

100 Montgomery Street, Suite 600
San Francisco, CA 94104

Pacific Gas and Electric Company

245 Market Street
San Francisco, CA 94105
Introduction

Combining Energy Efficiency with NOx Reduction
  • Benefits
  • Example Energy Efficiency Upgrades

Getting Rebates through the Boiler Efficiency Program
  • Eligible Customers
  • Services Offered
  • Incentives and Rebates
  • Getting Started

Questions
Enovity:

• Is an energy engineering and sustainability consulting firm

• Offers an array of services:
  – Utility Programs
  – Energy Services
  – Building Commissioning
  – Building Automation
  – Advanced Operations and Maintenance
  – Sustainability Services

• Has a team of 80+ mechanical and controls engineers, project managers, O&M, and admin staff

• Operates offices in San Francisco, Sacramento, Irvine, and Phoenix
WHY INCLUDE ENERGY EFFICIENCY?

Reasons to include energy efficiency with NOx upgrades include:

- Mitigating efficiency decrease and/or operating cost increase from NOx reduction
- Energy and utility cost savings
- Some advantages of implementing as a single project:
  - Downtime is limited
  - Upgrades may be more cost-effective
  - Project can generate a ROI
- Greenhouse gas emission reductions
- Taking advantage of rebates available for energy efficiency upgrades
- Increasing boiler capacity
- Improving operations and maintenance
- Replacing aged equipment
VARIABLE FREQUENCY DRIVES

Variable frequency drives for:
- Boiler burner combustion air fan
- Feedwater pumps
- Condensate return pumps
- Process water pumps
EXAMPLE BURNER FAN VFD RESULTS

- Pre-installation Fan kW
- Post-installation VFD Fan kW

Boiler Part-Load (%)

Burner Fan kW

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

0 10 20 30 40 50 60 70 80 90 100
When replacing a boiler, consider:

- High-efficiency boilers
- Condensing boilers
- Direct-contact water heaters
- Steam generators
- Switching from steam to hot water
HEAT RECOVERY OPPORTUNITIES

- Pipe, tank, and other heated surface insulation
- Exhaust stack economizers (feedwater or condensing)
- Blowdown heat recovery
- Condensate recovery
- Mechanical vapor recompression or other custom efficiency upgrades for evaporators
- Flash steam recovery
- Thermosorber heat pump
- Process heat recovery
• Replace old or failed steam traps
• Repair/replace control linkage
• Repair/replace failed blowdown controls or reduce excessive blowdown
• Reduce or eliminate boiler cycling

• Repair/replace dirty heat exchanger or boiler economizer
• Replace boiler refractory
• Reduce boiler steam pressure or hot water supply temperature set points
• Repair/replace failed VFD
The Program:

- Is a PG&E Third Party Program
- Offers incentives/rebates and no-cost technical services to commercial, industrial, and agricultural customers
- Evaluates opportunities for boiler system energy efficiency
- Focuses on achieving installed energy savings
- Is vendor-neutral

This program is funded by California utility customers and administered by PG&E under the auspices of the California Public Utilities Commission.
SERVICES

All projects:

• Advice and recommendations for energy efficiency projects
• Report on energy savings and greenhouse gas reductions
• Implementation coordination assistance
• Cash incentives and rebates to buy down the cost of projects

Larger, more complex projects:

• Customized analysis and measurements to determine system efficiency
• Detailed evaluation and analysis of energy savings
• Independent verification of savings achieved after installation
Customers must:

- Pay the Public Good Charge or Public Purpose Program Surcharge as part of PG&E bill
- Operate hot water, steam boilers or thermal fluid heaters
- Have funds available to implement energy efficiency projects

Past participants include:

- Hotels
- Hospitals
- High-tech facilities and labs
- Office buildings
- Fruit and vegetable packers
- Wineries
- Creameries
- Tomato processors
- Industrial bakeries
- Paper product manufacturers

Other eligibility requirements may apply. Please contact Enovity to confirm eligibility.
Offer a fixed dollar amount per unit of equipment:

- High-efficiency process, space heating, and domestic hot water boilers
- Condensing boilers
- Direct-contact water heaters
- Steam traps
- Pipe and tank insulation (low- to medium- temperature)
- VFD on new burner fan

See the Rebate Catalog for full details, including rebate rates and eligibility requirements.
Based on the one-year energy savings for a project:

- $100 per peak kW reduced
- $0.09 per kWh saved
- $1.00 per therm saved

Incentives can cover up to 50% of the incremental project cost.
CONTACT ENOVITY

BOILER EFFICIENCY PROGRAM

415-974-0390 ext. 148
BoilerEfficiency@enovity.com
www.BoilerEnergyEfficiency.com

100 Montgomery Street, Suite 600, San Francisco, CA 94104
Phone: 415.974.0390 Fax: 415.974.0399
CONTACT PG&E

BUSINESS CUSTOMER SERVICE CENTER

1-800-468-4743

245 Market Street, San Francisco, CA 94104
QUESTIONS
Providing commissioning, energy engineering, sustainable design and building operations and maintenance services to the construction and property management industry.