### Equipment Information

<table>
<thead>
<tr>
<th>Permit Number:</th>
<th>24855</th>
</tr>
</thead>
<tbody>
<tr>
<td>Equipment Description:</td>
<td>BOILER/HEATER</td>
</tr>
<tr>
<td>Unit Size/Rating/Capacity:</td>
<td>Boiler/Heater &gt;= 2 and &lt; 5 mmbtu/hr, Propane Fired</td>
</tr>
<tr>
<td>Equipment Location:</td>
<td>TELFER PAVEMENT TECHNOLOGIES, LLC 5330 SHELTER RD MCCLELLAN, CA</td>
</tr>
</tbody>
</table>

### BACT Determination Information

#### ROCs

| Standard: | Good combustion practice; Use of LPG |
| Technology Description: |  |
| Basis: | Achieved in Practice |

#### NOx

| Standard: | 12 ppmvd |
| Technology Description: | Ultra Low-NOx burner |
| Basis: | Achieved in Practice |

#### SOx

| Standard: | Good combustion practice; Use of LPG |
| Technology Description: |  |
| Basis: | Achieved in Practice |

#### PM10

| Standard: | Good combustion practice; Use of LPG |
| Technology Description: |  |
| Basis: | Achieved in Practice |

#### PM2.5

| Standard: | Good combustion practice; Use of LPG |
| Technology Description: |  |
| Basis: | Achieved in Practice |

#### CO

| Standard: | Firetube: 50 ppmvd; Watertube: 100 ppmvd |
| Technology Description: | Ultra Low-NOx burner |
| Basis: | Achieved in Practice |

#### LEAD

| Standard: |  |
| Technology Description: |  |
| Basis: |  |

**Comments:** PPMVD is corrected to 3% O2.

**District Contact:** Felix Trujillo Phone No.: (916) 874 - 7357 email: ftrujillo@airquality.org

Printed: 3/7/2018
BEST AVAILABLE CONTROL TECHNOLOGY DETERMINATION

DETERMINATION NO.: 130
DATE: 4/7/16
ENGINEER: Felix Trujillo, Jr.

Category/General Equip Description: Boiler/Heater – LPG/Propane

Equipment Specific Description: Boiler/heater greater or equal to 2 and less than 5 MMBTU/hr, fired on LPG/propane

Equipment Size/Rating: Minor Source BACT

Previous BACT Det. No.: 54, 61, and 62

This BACT determination will update the following determinations:

#54 which was made on 4/25/2012 for non-atmospheric boilers/heaters ≥ 2 and < 5 MMBtu.
#61 which was made on 3/15/2013 for non-atmospheric boilers/heaters ≥ 2 and < 5 MMBtu.
#62 which was made on 3/15/2013 for atmospheric boilers/heaters ≥ 2 and < 5 MMBtu.

The District performed the BACT determinations listed above with the assumption that the limits would apply to both natural gas and LPG/propane. RF MacDonald informed the District that LPG/propane fired units would not be able to meet the 9 ppm @ 3% O₂ NOx limit for boilers in this size range. RF MacDonald provided a letter to the District stating the boiler companies that they represent (Cleaver Brooks, Fulton Boiler, Camus) do not manufacture boilers that can meet this limit for LPG/propane fired units in this size range. Cleaver Brooks reiterated this statement in an email to the District dated 10/29/15. The District contacted other boiler (Unilux) and burner manufacturers (Maxon, Coen, Johnson burners) and none had a propane fired unit that can meet the 9 ppm @ 3% O₂ NOx limit (see Attachment E for correspondence). According to Cleaver Brooks, LPG/propane has a higher flame temperature and length than natural gas, which prevents them from guaranteeing the 9 ppm @ 3% O₂ NOx limit for LPG/propane. Upon further review it was determined that LPG fired units are currently unable to meet the 9 ppm @ 3% O₂ NOx limit. Therefore, a new BACT determination addressing units in this size range and fired on LPG will be performed. A separate BACT determination for natural gas fired units in this size range will be performed under BACT #112.

BACT ANALYSIS

A: ACHIEVED IN PRACTICE (Rule 202, §205.1a)

The following control technologies are currently employed as BACT for boilers/heaters greater or equal to 2 and less than 5 MMBTU/hr by the following air pollution control districts:
<table>
<thead>
<tr>
<th>District/Agency</th>
<th>Best Available Control Technology (BACT)/Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>US EPA</strong></td>
<td><strong>BACT</strong> Source: EPA RACT/BACT/LAER Clearinghouse</td>
</tr>
<tr>
<td></td>
<td>RBLC ID: CA-1190</td>
</tr>
<tr>
<td></td>
<td>For LPG/propane fired units with a rating of ≥ 2 to &lt;5 MMBtu/hr</td>
</tr>
<tr>
<td></td>
<td><strong>VOC</strong> No standard</td>
</tr>
<tr>
<td></td>
<td><strong>NOx</strong> 12 ppmvd corrected to 3% O₂*</td>
</tr>
<tr>
<td></td>
<td><strong>SOx</strong> No standard</td>
</tr>
<tr>
<td></td>
<td><strong>PM10</strong> No standard</td>
</tr>
<tr>
<td></td>
<td><strong>CO</strong> No standard</td>
</tr>
</tbody>
</table>

* This BACT determination was found to be the most stringent Achieved in Practice BACT determination published in the EPA clearinghouse. See Attachment A for more information.

**RULE REQUIREMENTS:**
None.

<table>
<thead>
<tr>
<th><strong>ARB</strong></th>
<th><strong>BACT</strong> Source: ARB BACT Clearinghouse</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ATC 12949-01 (1-24-12) SBAPCD</td>
</tr>
<tr>
<td></td>
<td>For LPG/propane fired units with a rating of ≥ 2 to &lt;5 MMBtu/hr</td>
</tr>
<tr>
<td></td>
<td><strong>VOC</strong> No standard</td>
</tr>
<tr>
<td></td>
<td><strong>NOx</strong> 20 ppmvd corrected to 3% O₂ [SBAPCD]</td>
</tr>
<tr>
<td></td>
<td><strong>SOx</strong> No standard</td>
</tr>
<tr>
<td></td>
<td><strong>PM10</strong> No standard</td>
</tr>
<tr>
<td></td>
<td><strong>PM2.5</strong> No standard</td>
</tr>
<tr>
<td></td>
<td><strong>CO</strong> No standard</td>
</tr>
</tbody>
</table>

**RULE REQUIREMENTS:**
None
### SMAQMD

**BACT**
Source: SMAQMD BACT Clearinghouse (last updated 3/8/16)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOC</td>
<td>No standard</td>
</tr>
<tr>
<td>NOx</td>
<td>No standard</td>
</tr>
<tr>
<td>SOx</td>
<td>No standard</td>
</tr>
<tr>
<td>PM10</td>
<td>No standard</td>
</tr>
<tr>
<td>PM2.5</td>
<td>No standard</td>
</tr>
<tr>
<td>CO</td>
<td>No standard</td>
</tr>
</tbody>
</table>

### RULE REQUIREMENTS:

**Rule 411 – NOx from Boilers, Process Heaters and Steam Generators (8/23/07)**

For gaseous fired units with a rating of ≥ 2 and < 5 MMBtu/hr, emissions shall not exceed the following levels:
1. 30 ppmvd of NOx corrected to 3% O2
2. 400 ppmvd of CO corrected to 3% O2

### South Coast AQMD

**BACT**
Source: SCAQMD BACT Guidelines for Non-Major Polluting Facilities, page 13 (10/3/08)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Requirement</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOC</td>
<td>No standard</td>
</tr>
<tr>
<td>NOx</td>
<td>12 ppmvd corrected to 3% O2 (A)</td>
</tr>
<tr>
<td>SOx</td>
<td>Use of natural gas (B)</td>
</tr>
<tr>
<td>PM10</td>
<td>Use of natural gas (B)</td>
</tr>
<tr>
<td>PM2.5</td>
<td>No standard</td>
</tr>
</tbody>
</table>
| CO        | Firetube Boiler: 50 ppmvd corrected to 3% O2  
            Watertube Boiler: 100 ppmvd corrected to 3% O2 |

(A) This limit was verified by source test on 1/21/16 (see Attachment B). Based on the research that was performed for this determination, Power Flame has provided the lowest NOx limit for units in this size range and fired on LPG/propane. The tested boiler is equipped with a Power Flame ultra low NOx burner. Power Flame provided an emissions sheet showing the limits that are achievable by their burners when fired on natural gas and LPG (see Attachment C). Power Flame was contacted on 4/14/16 for an updated emissions sheet and the response was that limits provided in the 2009 version were still current. 12 ppmvd @ 3% O2 is the lowest limit that is listed for LPG fired units.

(B) Pursuant to SCAQMD’s BACT Clean Fuel Policy, LPG/propane is considered a clean fuel and equivalent to natural gas.
<table>
<thead>
<tr>
<th>District/Agency</th>
<th>Best Available Control Technology (BACT)/Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RULE REQUIREMENTS:</strong></td>
<td></td>
</tr>
<tr>
<td>Requirements Table 1146-1</td>
<td></td>
</tr>
<tr>
<td>Category</td>
<td>NOx Limit</td>
</tr>
<tr>
<td>LPG/propane Fired Units</td>
<td>30 ppmvd @ 3% $O_2$</td>
</tr>
<tr>
<td><strong>BACT</strong></td>
<td></td>
</tr>
<tr>
<td>Source: NSR Requirements for BACT, page 3-5 (6/11)</td>
<td></td>
</tr>
<tr>
<td>Note: SDCAPCD BACT Guidelines do not contain a specific determination for boilers/heaters in the size range of 2 to less than 5 MMBtu/hr, since these units are not required to obtain a written permit, pursuant to SDAPCD Regulation II Rule 11 – Exemptions from Rule 10 Permit Requirements (11/19/11).</td>
<td></td>
</tr>
<tr>
<td><strong>SDAPCD Rule 11(d)</strong></td>
<td></td>
</tr>
<tr>
<td>Any equipment, operation, or process that is listed below in Subsections (d)(1) through (d)(20), and that meets the stated exemption provision, parameter, requirement, or limitation, is exempt from the requirements of Rule 10. (d)(2)(v) Any boiler, process heater, or steam generator with a manufacturer's maximum gross heat input rating of less than 5 million BTU per hour fired exclusively with natural gas and/or liquefied petroleum gas.</td>
<td></td>
</tr>
<tr>
<td><strong>San Diego County APCD</strong></td>
<td></td>
</tr>
<tr>
<td>The SDCAPCD has a BACT determination that applies to natural gas or propane fired boilers/heaters with a rating of less than 50 MMBtu/hr. The SDCAPCD has a BACT trigger level of 10.0 lb/day for NOx, VOC, SOx and PM10. No limits have been established for PM2.5 or CO. Since, boilers in the size range of 2 to less than 5 MMBtu/hr are exempt from permit requirements, this BACT guideline does not apply.</td>
<td></td>
</tr>
<tr>
<td><strong>RULE REQUIREMENTS:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Regulation 4, Rule 69.2.1 – Industrial and Commercial Boilers, Process Heaters and Steam Generators (3/25/09)</strong></td>
<td></td>
</tr>
<tr>
<td>For any unit with a heat input rating from 600,000 Btu/hr to 2 MMBtu/hr. (Note that for this BACT determination only units rated exactly at 2 MMBtu/hr would apply)</td>
<td></td>
</tr>
<tr>
<td>1. 30 ppmvd of NOx when operated on a gaseous fuel, corrected to 3% $O_2$</td>
<td></td>
</tr>
<tr>
<td>2. 40 ppmvd of NOx when operated on a liquid fuel, corrected to 3% $O_2$</td>
<td></td>
</tr>
<tr>
<td>3. 400 ppmvd of CO corrected to 3% $O_2$</td>
<td></td>
</tr>
<tr>
<td>The SDCAPCD does not have a prohibitory rule that applies to boilers rated at greater than equal to 2 MMBtu/hr and less than 5 MMBtu/hr.</td>
<td></td>
</tr>
<tr>
<td>District/Agency</td>
<td>Best Available Control Technology (BACT)/Requirements</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------------------------------------------------------</td>
</tr>
</tbody>
</table>
| Bay Area AQMD   | **BACT**  
Source: BAAQMD BACT Guideline  
Note: BAAQMD BACT Guidelines do not contain a determination for boilers/heaters 10 MMBtu/hr or less fired exclusively on natural gas or LPG, since these units are not required to obtain a written permit, pursuant to BAAQMD Regulation 2, Rule 1 – General Requirements.  

BAAQMD Rule 2-1-114 – General Requirements (4/18/12)  
The following equipment is exempt from the, requirements of Sections 2-1-301 and 302 (requirement to obtain an ATC or PTO): (114.1) Boilers, Heaters, Steam Generators, Duct Burners, and Similar Combustion Equipment:  
1.2 Any of the above equipment with less than 10 million BTU per hour rated heat input if fired exclusively with natural gas (including compressed natural gas), liquefied petroleum gas (e.g. propane, butane, isobutane, propylene, butylenes, and their mixtures), or any combination thereof.  

**RULE REQUIREMENTS:**  
None |
| San Joaquin Valley APCD | **BACT**  
Source: SJVUAPCD BACT Guideline 1.1.1, Last Update: 10-26-09 (Rescinded)  
The boiler BACT determinations listed in the SJVAPCD Clearinghouse have been rescinded.  

Note: SJVUAPCD BACT Guidelines do not contain a determination for boilers 5 MMBtu/hr or less, since these units are not required to obtain a written permit, pursuant to SJVUAPCD Rule 2020 - Exemptions.  

SJVUAPCD Rule 2020 §6.0 (12/18/14)  
No Authority to Construct or Permit to Operate shall be required for (§6.1) steam generators, steam superheaters, water boilers, water heaters, steam cleaners, and closed indirect heat transfer systems that have a maximum input heat rating of 5,000,000 Btu per hour (gross) or less and is equipped to be fired exclusively with (§6.1.1.1) natural gas, (§6.1.1.2) liquefied petroleum gas, or (§6.1.1.3) any combination of the two.  

**RULE REQUIREMENTS:**  

**Rule 4307 – Boilers, Steam Generators, and Process Heaters (5/19/11)**  
For units ≥ 2 MMBtu/hr and ≤ 5 MMBtu/hr
<table>
<thead>
<tr>
<th>District/Agency</th>
<th>Best Available Control Technology (BACT)/Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type</td>
</tr>
<tr>
<td></td>
<td>New or replacement atmospheric units not listed below</td>
</tr>
<tr>
<td></td>
<td>New or replacement atmospheric unit that is one of the following:</td>
</tr>
<tr>
<td></td>
<td>- A unit used at a school, or</td>
</tr>
<tr>
<td></td>
<td>- A unit in an oil field or refinery, or</td>
</tr>
<tr>
<td></td>
<td>- a glycol reboiler, or</td>
</tr>
<tr>
<td></td>
<td>- A unit with a heat input of greater than 1.8 billion Btu but less than 5.0 billion Btu per calendar year.</td>
</tr>
<tr>
<td></td>
<td>New or replacement non-atmospheric units not listed below</td>
</tr>
<tr>
<td></td>
<td>New or replacement non-atmospheric unit that is one of the following:</td>
</tr>
<tr>
<td></td>
<td>- A unit used at a school, or</td>
</tr>
<tr>
<td></td>
<td>- A unit in an oil field or refinery, or</td>
</tr>
<tr>
<td></td>
<td>- a glycol reboiler, or</td>
</tr>
<tr>
<td></td>
<td>- A unit with a heat input greater than 1.8 billion Btu but less than 5.0 billion Btu per calendar year.</td>
</tr>
</tbody>
</table>

The SJVAPCD has a permit registration program that is regulated under Rule 2250 Permit Exempt Equipment Registration (10/19/06) for units that would normally be exempt from permitting requirements. There are currently no certified LPG/propane fired units at the SJVAPCD. The District received confirmation from the SJVAPCD on 4/18/16 stating no LPG/propane fired boilers in this size range have been tested in their district (see Attachment F for correspondence). Therefore, these limits have not been achieved in practice for LPG/propane.
The following control technologies have been identified and are ranked based on stringency:

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Standard</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOC</td>
<td>No standard</td>
<td></td>
</tr>
<tr>
<td>NOx</td>
<td>12 ppmvd corrected to 3% O₂</td>
<td>SCAQMD (BACT), EPA, ARB</td>
</tr>
<tr>
<td>SOx</td>
<td>Use of LPG (A)</td>
<td>SCAQMD (BACT)</td>
</tr>
<tr>
<td>PM10</td>
<td>Use of LPG (A)</td>
<td>SCAQMD (BACT)</td>
</tr>
<tr>
<td>PM2.5</td>
<td>No standard</td>
<td></td>
</tr>
<tr>
<td>CO</td>
<td>Firetube Boilers: 50 ppmvd at 3% O₂, Watertube Boilers: 100 ppmvd at 3% O₂</td>
<td>SCAQMD (BACT)</td>
</tr>
</tbody>
</table>

(A) Pursuant to the SCAQMD’s BACT Clean Fuel Policy, the use of LPG is equivalent to natural gas.
B: TECHNOLOGICALLY FEASIBLE AND COST EFFECTIVE (Rule 202, §205.1.b.)

Technologically Feasible Alternatives:
Any alternative basic equipment, fuel, process, emission control device or technique, singly or in combination, determined to be technologically feasible by the Air Pollution Control Officer.

The table below shows the technologically feasible alternatives identified as capable of reducing emissions beyond the levels determined to be “Achieved in Practice” as per Rule 202, §205.1.a.

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Technologically Feasible Alternatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOC</td>
<td>Good combustion practice</td>
</tr>
<tr>
<td>NOx</td>
<td>Selective Catalytic Reduction (SCR)</td>
</tr>
<tr>
<td>SOx</td>
<td>Good combustion practice</td>
</tr>
<tr>
<td>PM10</td>
<td>Good combustion practice; Use of LPG</td>
</tr>
<tr>
<td>PM2.5</td>
<td>Good combustion practice; Use of LPG</td>
</tr>
<tr>
<td>CO</td>
<td>Good combustion practice</td>
</tr>
</tbody>
</table>

Cost Effective Determination:
After identifying the technologically feasible control options, a cost analysis is performed to take into consideration economic impacts for all technologically feasible controls identified.

Maximum Cost per Ton of Air Pollutants Controlled

1. A control technology is considered to be cost-effective if the cost of controlling one ton of that air pollutant is less than the limits specified below (except coating operations):

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Maximum Cost ($/ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOC</td>
<td>17,500</td>
</tr>
<tr>
<td>NOx</td>
<td>24,500</td>
</tr>
<tr>
<td>PM10</td>
<td>11,400</td>
</tr>
<tr>
<td>SOx</td>
<td>18,300</td>
</tr>
<tr>
<td>CO</td>
<td>TBD if BACT triggered</td>
</tr>
</tbody>
</table>

Cost Effectiveness Analysis Summary

Selective Catalytic Reduction:
Typically selective catalytic reduction (SCR) can be used to reduce emissions from larger boilers. SCR requires ammonia or urea for NOx reduction and units of this size range are typically used in residences and service/commercial applications where storage of these materials is impractical and could pose a health risk. Additionally, SCR is designed for industrial units that run full time and can maintain a temperature that the catalyst requires for NOx reduction, whereas smaller units are turned on and off throughout the day and cannot maintain the required temperatures. Finally, SCR systems require frequent maintenance for operation which may not be practical in a residential or small service/commercial setting.
BACT Determination
Boilers/Heaters ≥2 and <5 MMBTU/hr fired on LPG fuel
April 7, 2016
Page 9 of 10

District Staff has done an analysis\(^1\) for using SCR on a boiler rated at 20 MMBTU/hr and the cost effectiveness was $53,084 per ton of NOx reduced. As the rating of the unit goes down the total emission reduction will decrease while cost will stay relatively equivalent and therefore the cost effectiveness will increase. Therefore, SCR is not only technologically infeasible for this size range of boilers/heaters but it is also not cost effective and is eliminated as a control option. Although this analysis was done for a natural gas boiler it would still apply to LPG boilers/heaters.

**FGR with a Low-NOx Burner:**
Adding FGR to a smaller unit would result in minimal additional reductions when paired with a low-NOx burner, and would cost more than a low-NOx burner alone. Like SCR, the system requires frequent maintenance for operation which may not be practical in a residential or small service/commercial setting. The BAAQMD did an analysis of adding FGR to a boiler in the 400,000 to 2,000,000 Btu/hr range in their 2007 Staff Report for Regulation 9, Rule 6 and found that the incremental cost effectiveness of adding FGR over a low-NOx burner is estimated at $60,000 per ton of NOx reduced. Therefore, FGR added to a boiler/heater with a low-NOx burner is not cost effective and is eliminated as a control option.

**Good Combustion Practice:**
Owners/operators of boilers/heaters should be maintaining good combustion practices as part of proper operation of a boiler/heater and requiring good combustion practices to continue would not add any additional costs. Therefore, because these requirements would not add any additional cost it is a valid control option.

**Using the PM10 BACT standard for PM2.5:**
LPG is already required as BACT for PM10. Since both, PM10 and PM2.5 trigger BACT at >0 lb/day and PM2.5 is a subset of PM10, BACT for PM2.5 will be triggered whenever BACT is triggered for PM10. Therefore, there is no additional cost associated with requiring LPG as BACT for PM2.5 for new emission units.

**C: SELECTION OF BACT**

Based on the cost effectiveness determinations, BACT for NOx will remain at what is currently achieved in practice and BACT for PM2.5 will be set to be the same as for PM10 (good combustion practice and use of LPG).

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Standard</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOC</td>
<td>Good combustion practice; Use of LPG</td>
<td></td>
</tr>
<tr>
<td>NOx</td>
<td>12 ppmvd at 3% (O_2)</td>
<td>SCAQMD (current BACT)</td>
</tr>
<tr>
<td>SOx</td>
<td>Good combustion practice; Use of LPG</td>
<td>SCAQMD (current BACT)</td>
</tr>
</tbody>
</table>

\(^1\) SCAQMD, “BACT Determination: Boilers/Heaters ≥5 and <20 MMBTU/hr fired on natural gas or LPG,” June 3, 2015
BACT for Boilers/Heaters ≥ 2 MMBtu/hr and < 5 MMBtu/hr

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Standard</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM10</td>
<td>Good combustion practice; Use of LPG</td>
<td>SCAQMD (current BACT)</td>
</tr>
<tr>
<td>PM2.5</td>
<td>Good combustion practice; Use of LPG</td>
<td></td>
</tr>
</tbody>
</table>
| CO        | Firetube Boilers: 50 ppmvd at 3% O$_2$  
Watertube Boilers: 100 ppmvd at 3% O$_2$ | SCAQMD (BACT)           |

**D: SELECTION OF T-BACT:**
Toxics are in the form of VOCs and particulate matter. Since toxic emissions from LPG fired boilers in the 2 to less than 5 MMBtu/hr size range are so small and the cancer risk is not expected to be anywhere close to 1 in a million cases, T-BACT was not evaluated for this determination. In addition, none of the Districts’, EPA or ARB BACT Clearinghouses have a T-BACT determination for this source category.

**REVIEWED BY:** [Signature]  
**DATE:** 4-25-16

**APPROVED BY:** [Signature]  
**DATE:** 4-25-16
Attachment A

Review of BACT Determinations Published by EPA
List of BACT determinations published in EPA’s RACT/BACT/LAER Clearinghouse for boilers ≥ 2 MMBtu/hr to < 5 MMBtu/hr:

<table>
<thead>
<tr>
<th>Capacity MMBtu/hr</th>
<th>Source</th>
<th>Date</th>
<th>Type</th>
<th>NOx ppmv @ 3% O₂</th>
<th>CO ppmv @ 3% O₂</th>
<th>VOC lb/MMBtu</th>
<th>Filerable PM10 lb/MMBtu</th>
<th>SO₂ lb/MMBtu</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.00</td>
<td>SANTA BARBARA COUNTY APCD</td>
<td>1/24/2012</td>
<td>Not Specified</td>
<td>12</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>2.00</td>
<td>SANTA BARBARA COUNTY APCD</td>
<td>1/24/2012</td>
<td>Not Specified</td>
<td>20</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
</tbody>
</table>

= Selected as the most stringent BACT determination achieved in practice.
Technology Transfer Network
Clean Air Technology Center (ACTC) / RACT / LAER / Clean Air Technology Center

Process Information - Details

For information about the pollutants related to this process, click on the specific pollutant in the list below.

<table>
<thead>
<tr>
<th>Process Information - Details</th>
<th>Process Information - Details</th>
</tr>
</thead>
</table>

**RBL ID:** CA-1189  
**Corporate/Company:** PETROOCK- TUNNELL LEASE  
**Facility Name:** PETROOCK- TUNNELL LEASE  
**Process:** Boiler

**Primary Fuel:** Propane, field gas, PUC natural gas  
**Throughput:** 2.60 MMBTU/H  
**Process Code:** 13.310

**Pollutant Information - List of Pollutants**

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Primary Emission Limit</th>
<th>Basis</th>
<th>Verified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>20.0000</td>
<td>OTHER</td>
<td>CASE-BY- UNKNOWN</td>
</tr>
<tr>
<td>Oxides</td>
<td>PPM/VOL%3%</td>
<td>02</td>
<td>CASE</td>
</tr>
<tr>
<td>(NOx)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Process Notes:** Oilfield tank heater
Technology Transfer Network

Facility Information

To learn more about the processes associated with this facility, click the Process List button. You can then view pollutant information for each process.

RBLC Home | Now Search | Search Results | Facility Information | Process List

Date Entered: 04/23/2012
Date Last Modified: 09/06/2012

RBLC ID: CA-1190
Corporate/Company: PETROROCK - TUNNELL LEASE
Facility Name: PETROROCK - TUNNELL LEASE
Facility Description:

State: CA
County: SANTA BARBARA
EPA Region: 9
Zip Code: 93454
Country: USA

Facility Contact Information:

Name: [Redacted]
Phone: [Redacted]
E-Mail: [Redacted]

Agency Contact Information:

Agency: CA023 - SANTA BARBARA COUNTY AECO, CA
Contact: [Redacted]
Address: SANTA BARBARA COUNTY AIR POLLUTION CONTROL DISTRICT
260 NORTH SAN ANTONIO RD.
SUITE A.
SANTA BARBARA, CA 93110-1315
Phone: (805) 961-6979
Other Agency Contact Info: 805-961-5600

EST/ACT DATE

Complete Application ACT 03/07/2011
Date: Permit Issuance ACT 01/24/2012

FAB Number: Not Available
SIC Code: 1311
NAICS Code: 211111

Permit Number: MVC-12949-01 [3]

Permit Type: B; add new process to existing facility

http://cfpub.epa.gov/rbld/index.cfm?action=PermitDetail.FacilityInfo&facility_id=27288

2/1/2016
Affected Class I / U.S. Border Area:

No affected Class I areas identified.

Facility-Wide Emission Increase/Decrease:
(After prevention/control measures)

No facility-wide emissions data available for this facility.

Other Permitting Information:
Technology Transfer Network
Clean Air Act Section 114 Information System and RACT/BACT/LAER Clearinghouse Technology Center

Process Information - Details

For information about the pollutants related to this process, click on the specific pollutant in the list below.

| RBLC Home | New Search | Search Results | Facility Information | Process List | Process Information |

__________________________

RBLC ID: CA-1190
Corporate/Company: PETRO ROCK- TUNNELL LEASE
Facility Name: PETRO ROCK- TUNNELL LEASE
Process: Heater

Primary Fuel: Propane, field gas, PUC natural gas
Throughput: 3.00 MMBTU/H
Process Code: 13.3.1.0

Pollutant Information - List of Pollutants

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Primary Emission Basis</th>
<th>Verifiable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen Oxides (NOx)</td>
<td>PPMVD@3%</td>
<td>OTHER CASE=SY= UNKNOWN CASE</td>
</tr>
</tbody>
</table>

Process Notes:

Facility Information

To learn more about the processes associated with this facility, click the Process List button. You can then view pollutant information for each process.

RBLIC Home | New Search | Search Results | Facility Information | Process List

Date Entered: 04/23/2012
Date Last Modified: 09/06/2012

RBLIC ID: CA-1189
Corporate/Company: PETROROCK- TUNNELL LEASE
Facility Name: PETROROCK- TUNNELL LEASE
Facility Description:

State: CA
County: SANTA BARBARA
EPA Region: 9
Zip Code: 93454
Country: USA

Facility Contact Information:

Name:
Phone:
E-Mail:

Agency Contact Information:

Agency: CA033 - SANTA BARBARA COUNTY APCD, CA
Contact: MR. EHN BILLENBERGER
Address: SANTA BARBARA COUNTY AIR POLLUTION CONTROL DISTRICT
280 NORTH SAN ANTONIO RD.
SUITE A.
SANTA BARBARA, CA 93101-1315
Phone: (805) 961-8878
Other Agency Contact Info:

Permit Number: AEC-12949-01 (2)

Permit Date: R: Add new process to existing facility

PERMIT URL:

http://cfpub.epa.gov/rblc/index.cfm?action=PermitDetail.FacilityInfo&facility_id=27287

http://cfpub.epa.gov/rblc/index.cfm?action=PermitDetail.FacilityInfo&facility_id=27287
2/1/2016
Affected Class I / U.S. Border Area:
No affected Class I areas identified.

Facility-Wide Emission Increase/Decrease:
(After prevention/control measures)
No facility-wide emissions data available for this facility.

Other Permitting Information:
BACT Determination Detail

Category

Source Category: Boiler: < 5 MMBtu/hr
SIC Code: 1311
NAICS Code: 211111

Emission Unit Information

Manufacturer: Rite Engineering & Manufacturing
Type:
Model: W200WG
Equipment Description: Hot Water Heater
Capacity / Dimensions: 2.00 MMBtu/hr
Fuel Type: Field Gas
Multiple Fuel Types: Propane, Field Gas, PUC natural gas
Continuous (24/7/52)

http://www.arb.ca.gov/bact/bactnew/determination.php?var=992

2/1/2016
Operating Schedule
(hours/day)/(days/week)/(weeks/year)

Function of Equipment
Cilfield tank heater

## Bact Information

| NOx Limit | 20 |
| NOx Limit Units | ppmvd @ 3% O2 |
| NOx Average Time | 40 minutes |
| NOx Control Method | Pollution Prevention |
| NOx Control Method Desc | Low-Nox burner |
| NOx Percent Control Efficiency | |
| NOx Cost Effectiveness (%/ton) | |
| NOx Incremental Cost Effectiveness (%/ton) | |
| NOx Cost Verified (Y/N) | |
| NOx Dollar Year | |

## Project / Permit Information

Application/Permit No.: ATC 12949-01 (2)

Application Completeness Date: 2/1/2016

http://www.arb.ca.gov/bact/bactnew/determination.php?var=992
New Construction/Modification: New Construction

ATC Date: 01-24-2012

PTO Date:

Startup Date: 01-31-2012

Technology Status: BACT Determination

Source Test Available: No

Source Test Results:

---

**Facility / District Information**

Facility Name: PetroRock - Tunnell Lease

Facility Zip Code: 93464

Facility County: Santa Barbara

District Name: Santa Barbara County APCD

District Contact: Ben Ellenberger

Contact Phone No.: (805) 961-8800

Contact E-Mail: cbe@sbcapcd.org

---

**Notes**

http://www.arb.ca.gov/bact/bactnew/determination.php?var=992

2/1/2016
BACT Determination Detail

Notes:

Report Error in Determination

http://www.arb.ca.gov/bact/bactnew/determination.php?var=992

2/1/2016
**SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT**

**Best Available Control Technology (BACT) Guidelines for Non-Major Polluting Facilities**

10-20-2000 Rev. 0
10-03-2008 Rev. 1

**Equipment or Process:** Boiler

<table>
<thead>
<tr>
<th>Subcategory/Rating/Size</th>
<th>VOC</th>
<th>NOx(^1)</th>
<th>SOx</th>
<th>CO</th>
<th>PM10</th>
<th>Inorganic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural Gas or Propane Fired, &lt; 20 MM Btu/HR</td>
<td>≤ 12 ppmv dry corrected to 3% O(_2)(^2) (10-20-2000)</td>
<td>Natural Gas (10-20-2000)</td>
<td>≤50 ppmv for firetube type, ≤ 100 ppmv for watertube type, dry corrected to 3% O(_2) (04-10-98)</td>
<td>Natural Gas (04-10-98)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Natural Gas or Propane Fired, ≥ 20 MM Btu/HR</td>
<td>With Low-NOx Burner: ≤ 9 ppmv dry corrected to 3% O(_2) With Add-On Controls: ≤ 7 ppmv dry corrected to 3% O(_2) (10-20-2000)</td>
<td>Natural Gas (10-20-2000)</td>
<td>Same as above. (04-10-98)</td>
<td>Natural Gas (04-10-98)</td>
<td>With Add-On Controls: ≤ 5 ppmvd NH(_3), corrected to 3% O(_2) ≤ 1 ppmvd ozone, corrected to 3% O(_2) (10-20-2000)</td>
<td></td>
</tr>
<tr>
<td>Oil Fired(^3)</td>
<td>Compliance with AQMD Rule 1146 or 1146.1 (10-20-2000)</td>
<td>Sulfur Content ≤ 0.05% by Weight (10-20-2000) or 0.0015% by weight if purchased after May 31, 2004 (10-03-2008)</td>
<td>Same as above (10-20-2000)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Landfill or Digester Gas Fired, &lt; 75 MMBTU/HR</td>
<td>≤ 30 ppmvd at 3% O(_2) dry. (04-10-98)</td>
<td></td>
<td>≤ 100 ppmvd at 3% O(_2) dry. (04-10-98)</td>
<td></td>
<td>≤ 0.1 gr/scf at 12% CO(_2) (Rule 409) (04-10-98)</td>
<td></td>
</tr>
</tbody>
</table>

* Means those facilities that are not major polluting facilities as defined by Rule 1302 - Definitions

BACT Guidelines - Part D

Boiler
Attachment B

SCAQMD Source Test Results
COMPLIANCE SOURCE TEST REPORT PERFORMED ON 1/21/2016 AT THE SANCON ENGINEERING, INC., HURST BOILER
FACILITY ID 108214, APPLICATIONS NUMBER 512499

Prepared for, Facility:

Sancon Engineering, Inc.
5841 Engineer Dr.
Huntington Beach, CA 92649

Facility Contact: Gary Drew
Equipment Description: Hurst Boiler
Applications Numbers: 512499
Test Date(s): 1/21/2016
Issue Date: 1/25/2016

Prepared by: Wally Moe
Source Testing Manager

Reviewed by: Hassan Amin
Project Manager

Source Testing Firm:

Accurate Environmental Services, Inc.
8200 Katella Ave, Suite D
Stanton, CA 90680
(714) 379-9200

Report Identification Number: R 04006 SEI
2.0 Summary of Results

The source testing was conducted on the Hurst Boiler in order to determine the emissions of nitrogen oxides (NO\textsubscript{x}), carbon monoxide (CO), carbon dioxide (CO\textsubscript{2}), and oxygen (O\textsubscript{2}) at the exhaust. The source test also determined flow rate, temperature, and moisture at the exhaust of the unit. SCAQMD method 100.1 was used to measure NO\textsubscript{x}, CO, CO\textsubscript{2}, and O\textsubscript{2}. The NO\textsubscript{x} and CO concentrations were corrected to 3% oxygen. Moisture at the exhausts of the unit was calculated using Oxygen concentration calculations. The stack gas flow rate was measured using SCAQMD methods 1.1-3.1. The results show the boiler is in compliance with the permitted NO\textsubscript{x} and CO concentration limits. The Compliance Test results are summarized in Tables 2-1. Tables 2-2 & 2-3 presents a Summary of the Reference Method Quality Assurance Checks.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>High Load</th>
<th>Low Load</th>
<th>Average Load</th>
<th>Normal Load</th>
<th>Allowable Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>NO\textsubscript{x}, Concentration</td>
<td>ppm</td>
<td>6.07</td>
<td>5.87</td>
<td>6.01</td>
<td>6.93</td>
<td>N/A</td>
</tr>
<tr>
<td>NO\textsubscript{x}, @ 3% O\textsubscript{2}</td>
<td>ppm</td>
<td>8.42</td>
<td>8.26</td>
<td>8.41</td>
<td>9.57</td>
<td>12</td>
</tr>
<tr>
<td>CO\textsubscript{x}, Emission Rate</td>
<td>lb/hr</td>
<td>0.039</td>
<td>0.011</td>
<td>0.026</td>
<td>0.030</td>
<td>N/A</td>
</tr>
<tr>
<td>CO, Concentration</td>
<td>ppm</td>
<td>16.08</td>
<td>15.48</td>
<td>15.48</td>
<td>15.96</td>
<td>N/A</td>
</tr>
<tr>
<td>CO, @ 3% O\textsubscript{2}</td>
<td>ppm</td>
<td>22.29</td>
<td>21.79</td>
<td>21.64</td>
<td>22.05</td>
<td>50</td>
</tr>
<tr>
<td>CO Emission Rate</td>
<td>lb/hr</td>
<td>0.06</td>
<td>0.02</td>
<td>0.04</td>
<td>0.04</td>
<td>N/A</td>
</tr>
<tr>
<td>Total Stack Flow Rate, measured</td>
<td>dscfm</td>
<td>873</td>
<td>251</td>
<td>588</td>
<td>602</td>
<td>N/A</td>
</tr>
<tr>
<td>Total Stack Flow Rate, calculated</td>
<td>dscfm</td>
<td>914</td>
<td>273</td>
<td>554</td>
<td>564</td>
<td>N/A</td>
</tr>
<tr>
<td>% Difference</td>
<td>%</td>
<td>4.63</td>
<td>8.53</td>
<td>5.72</td>
<td>6.31</td>
<td>15</td>
</tr>
<tr>
<td>Stack Gas Flow Rate, Actual</td>
<td>acfm</td>
<td>1,579</td>
<td>432</td>
<td>1,029</td>
<td>1,057</td>
<td>N/A</td>
</tr>
<tr>
<td>Fuel Flow Rate</td>
<td>scfm</td>
<td>25.66</td>
<td>7.54</td>
<td>15.44</td>
<td>15.91</td>
<td>N/A</td>
</tr>
<tr>
<td>Stack Temperature</td>
<td>°F</td>
<td>365.58</td>
<td>327.58</td>
<td>340.25</td>
<td>340.87</td>
<td>N/A</td>
</tr>
<tr>
<td>Air/Fuel Ratio</td>
<td>N/A</td>
<td>35.98</td>
<td>35.18</td>
<td>40.26</td>
<td>40.06</td>
<td>N/A</td>
</tr>
<tr>
<td>O\textsubscript{2}</td>
<td>%</td>
<td>7.99</td>
<td>8.18</td>
<td>8.10</td>
<td>7.95</td>
<td>N/A</td>
</tr>
<tr>
<td>Firing Rate</td>
<td>MMBTU/hr</td>
<td>3.89</td>
<td>1.14</td>
<td>2.34</td>
<td>2.41</td>
<td>N/A</td>
</tr>
<tr>
<td>% of Full Load</td>
<td>%</td>
<td>92.52</td>
<td>27.2</td>
<td>55.7</td>
<td>57.4</td>
<td>N/A</td>
</tr>
</tbody>
</table>
3.0 Processes and Equipment Description

The Hurst Boiler, Fire-Tube Type Model S5-X-100-150, with one Low-Nox Burner, Model NP2-520-G-30, Rated at 4,200 MMBTU/hr, Liquid Propane Gas Fired. A block flow diagrams are presented as Figures 3-1.

Figure 3-1
Simplified Boiler Diagram

Hurst Boiler

Combustion Air

Propane Fuel
# Typical Flue Product Emissions Data for Power Flame Burners

<table>
<thead>
<tr>
<th></th>
<th>Natural Gas</th>
<th>L.P. Gas</th>
<th>#2 Fuel Oil (1)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Carbon Monoxide - CO</strong></td>
<td>0.037 lb CO per 10^6 BTU input (50 PPM)</td>
<td>0.037 lb CO per 10^6 BTU input (50 PPM)</td>
<td>0.037 lb per 10^6 BTU INPUT (50 PPM)</td>
</tr>
<tr>
<td><strong>Sulfur Dioxide - SO₂</strong></td>
<td>(1.05) x ( % Sulfur by weight in fuel) = lb SO₂ per 10^6 BTU input</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Particulate Matter</strong></td>
<td>0.048 lb PM per 10^6 BTU input</td>
<td>0.048 lb PM per 10^6 BTU input</td>
<td>0.143 lb PM per 10^6 BTU input</td>
</tr>
<tr>
<td><strong>Hydrocarbons</strong></td>
<td>0.025 lb HC's per 10^6 BTU input</td>
<td>0.025 lb HC's per 10^6 BTU input</td>
<td>0.028 lb HC's per 10^6 BTU input</td>
</tr>
<tr>
<td><strong>CO₂</strong></td>
<td>9.5% to 10%</td>
<td>10% to 12%</td>
<td>10% to 13%</td>
</tr>
<tr>
<td><strong>Nitrogen Oxides - NOₓ</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard J, FDM &amp; X4 Gas Burners</td>
<td>0.088 lb NOₓ per 10^6 BTU input (75 PPM)</td>
<td>0.082 lb NOₓ per 10^6 BTU input (75 PPM)</td>
<td>N/A</td>
</tr>
<tr>
<td>Standard C(R) Burners</td>
<td>0.088 lb NOₓ per 10^6 BTU input (75 PPM)</td>
<td>0.092 lb NOₓ per 10^6 BTU input (75 PPM)</td>
<td>N/A</td>
</tr>
<tr>
<td>LNIC(R) Burners</td>
<td>0.029 lb NOₓ per 10^6 BTU input (25 PPM)</td>
<td>0.031 lb NOₓ per 10^6 BTU input (25 PPM)</td>
<td>N/A</td>
</tr>
<tr>
<td>Fire box/Cast iron boilers</td>
<td>0.029 lb NOₓ per 10^6 BTU input (25 PPM)</td>
<td>0.031 lb NOₓ per 10^6 BTU input (25 PPM)</td>
<td>N/A</td>
</tr>
<tr>
<td>LNVC Burners</td>
<td>0.024 lb NOₓ per 10^6 BTU input (20 PPM)</td>
<td>0.031 lb NOₓ per 10^6 BTU input (20 PPM)</td>
<td>N/A</td>
</tr>
<tr>
<td>Water tube boilers</td>
<td>0.029 lb NOₓ per 10^6 BTU input (20 PPM)</td>
<td>0.031 lb NOₓ per 10^6 BTU input (20 PPM)</td>
<td>N/A</td>
</tr>
<tr>
<td>LNIC Burners</td>
<td>0.029 lb NOₓ per 10^6 BTU input (20 PPM)</td>
<td>0.031 lb NOₓ per 10^6 BTU input (20 PPM)</td>
<td>N/A</td>
</tr>
<tr>
<td>CM Burners</td>
<td>0.070 lb NOₓ per 10^6 BTU input (90 PPM)</td>
<td>0.074 lb NOₓ per 10^6 BTU input (90 PPM)</td>
<td>N/A</td>
</tr>
<tr>
<td>IFGR LNIC NOₓ Burners</td>
<td>0.029 lb NOₓ per 10^6 BTU input (25 PPM)</td>
<td>0.031 lb NOₓ per 10^6 BTU input (25 PPM)</td>
<td>N/A</td>
</tr>
<tr>
<td>LNICM Burners</td>
<td>0.029 lb NOₓ per 10^6 BTU input (25 PPM)</td>
<td>0.031 lb NOₓ per 10^6 BTU input (25 PPM)</td>
<td>N/A</td>
</tr>
<tr>
<td>NPM Premix Burners</td>
<td>0.029 lb NOₓ per 10^6 BTU input (25 PPM)</td>
<td>0.031 lb NOₓ per 10^6 BTU input (25 PPM)</td>
<td>N/A</td>
</tr>
<tr>
<td>Nova Plus Burners</td>
<td>0.010 lb NOₓ per 10^6 BTU input (19 PPM)</td>
<td>0.016 lb NOₓ per 10^6 BTU input (12 PPM)</td>
<td>N/A</td>
</tr>
<tr>
<td>NVC AND NP2</td>
<td>0.010 lb NOₓ per 10^6 BTU input (19 PPM)</td>
<td>0.016 lb NOₓ per 10^6 BTU input (12 PPM)</td>
<td>N/A</td>
</tr>
</tbody>
</table>

NOₓ emissions at 3% O₂ will vary based on the percent of fuel bound nitrogen (these are based on 0.2%) and boiler or heat exchanger configurations.

99 PPM NOₓ on cast iron sectional, fire box and water tube boiler, 120 PPM on fire tube boilers.

Burning natural gas the VOC are estimated at 0.003 # per million BTU and SO₂ are 0.0005 # per million BTU.

These emission rates are general estimates and do not constitute guarantees by Power Flame Inc.

In instances where guarantees are required, please consult the factory with the specific application information.

All NOₓ numbers stated are corrected to 3% O₂.
Attachment D

Cost Effectiveness Determination for SCR
4.999 MMBtu/hr BOILER SCR COST EFFECTIVENESS CALCULATION

Section 4.2 - NOx Post-Combustion, Chapter 2 - Selective Catalytic Reduction

Cost Effectiveness = $\ 33,533.73 \$/ton

**Equipment**

- Boiler rating: 4.999 mmBTU/hr
- Boiler Operating hours: 8760 hours
- Boiler capacity factor: 1
- SCR Operating Days: 365 days
- Total Capacity Factor: 1
- Baseline NOx (30 ppm): 0.0364 lb/mmBTU
- SCR NOx (5 ppm): 0.006067 lb/mmBTU
- Ammonia Slip: 10 ppm
- Ammonia Stoichiometric Ratio: 1.05
- Stored Ammonia Conc: 29 %
- Amonnulia Storage days: 90 days
- Sulfur Content: 0.005 %
- Pressure drop for SCR Ductwork: 3 inches W.G.
- Pressure drop for each Catalyst Layer: 1 inche W.G.
- Temperature at SCR Inlet: 650 degrees F
- Cost year: 1998
- Equipment Life: 20 years
- Annual interest Rate: 7 %
- Catalyst cost, Initial: 240 $/ft2
- Catalyst cost, replacement: 290 $/ft2
- Electrical Power cost: 0.05 $/KWh
- Ammonia Cost: 0.101 $/lb
- Catalyst Life: 24000 hr
- Catalyst Layers: 2 full, 1 empty

**Boiler Calculations**

- $Q_b = 4.999 \text{ mmBTU/hr}$
- $q_{\text{flue gas}} = 1781.28066 \text{ acfm}$
- $N_{\text{NOx}} = 0.833324176$
SCR Reactor Calculations

$V_{\text{Catalyst}} = 11.22514556$ ft$^3$

$A_{\text{Catalyst}} = 1.855500688$ ft$^2$

$A_{\text{SCR}} = 2.133825791$ ft$^2$

$I=W=1.460762058$ ft

$n_{\text{layer}} = 2$

$h_{\text{layer}} = 4.024829263$

$n_{\text{total}} = 3$

$h_{\text{SCR}} = 42.07448779$ ft

Reagent Calculations

$m_{\text{reagent}} = 0.07071902$ lb/hr

$m_{\text{sol}} = 0.24385869$ lb/hr

$q_{\text{sol}} = 0.032576908$ gph

Tank Volume = 70.36612171 gal

Cost Estimation

Direct Costs

DC = $135,387.79

Indirect Costs

General Facilities = $6,769.39

Engineering and home office fees = $13,538.78

Process Contingency = $6,769.39

Total Indirect Installation Costs = $27,077.56

Project Contingency = $24,369.80

Total Plant Cost = $186,835.15

Preproduction Cost = $3,736.70

Inventory Capital = $53.20

Total Capital Investment = $190,625.06

Direct Annual Costs

Maintenance Costs = $2,859.38 per yr

Power = 1.59060664 kW

Annual Electricity = $696.69 per yr

Reagent Solution Cost = $215.76 per yr

Catalyst Replacement

FWF = 0.311051666

Annual Catalyst Replacement = $506.28 per yr
<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Variable Direct Cost</td>
<td>$1,418.72</td>
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<tr>
<td>Total Direct Annual Cost</td>
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<td>CRF</td>
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<tr>
<td>Indirect Annual Cost</td>
<td>$17,993.66</td>
<td>per yr</td>
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<tr>
<td>Total annual Cost</td>
<td>$22,271.76</td>
<td>per yr</td>
</tr>
<tr>
<td>NOx Removed</td>
<td>0.66</td>
<td>tons</td>
</tr>
<tr>
<td>Cost of NOx removal</td>
<td>$33,533.73</td>
<td>per ton</td>
</tr>
</tbody>
</table>
Cost Effectiveness = $45,163.99 $/ton

Equipment
- Boiler rating: 2 mmBTU/hr
- Boiler Operating hours: 8760 hours
- Boiler capacity factor: 1
- SCR Operating Days: 365 days
- Total Capacity Factor: 1
- Baseline NOx (30 ppm): 0.0364 lb/mmBTU
- SCR NOx (5 ppm): 0.006068 lb/mmBTU
- Ammonia Slip: 10 ppm
- Ammonia Stoichiometric Ratio: 1.05
- Stored Ammonia Conc: 29 %
- Ammonia Storage days: 90 days
- Sulfur Content: 0.005 %
- Pressure drop for SCR Ductwork: 3 W.G.
- Pressure drop for each Catalyst Layer: 1 inch W.G.
- Temperature at SCR Inlet: 650 degrees F
- Cost year: 1998
- Equipment Life: 20 years
- Annual interest rate: 7 %
- Catalyst cost, Initial: 240 $/ft^2
- Catalyst cost, replacement: 290 $/ft^2
- Electrical Power cost: 0.05 $/KWh
- Ammonia Cost: 0.101 $/lb
- Catalyst Life: 24000 hr
- Catalyst Layers: 2 full, 1 empty

Boiler Calculations
- $Q_b$: 2 mmBTU/hr
- $Q_{fuel\ gas}$: 712,654,7952 acfm
- $N_{NOx}$: 0.833296703
SCR Reactor Calculations

$V_{C_{\text{Catalyst}}} = 4.490844708 \text{ ft}^3$
$A_{C_{\text{Catalyst}}} = 0.742348745 \text{ ft}^2$
$A_{SCR} = 0.853701057 \text{ ft}^2$
$l = w = 0.923959445 \text{ ft}$
$n_{layer} = 2$
$h_{layer} = 4.024754025$
$n_{total} = 3$
$h_{SCR} = 42.07426207 \text{ ft}$

Reagent Calculations

$m_{\text{reagent}} = 0.028293267 \text{ lb/hr}$
$m_{\text{sol}} = 0.097562989 \text{ lb/hr}$
$q_{\text{sol}} = 0.01303337 \text{ gph}$
Tank Volume = 28.1520791 gal

Cost Estimation

Direct Costs
DC = $74,233.09

Indirect Costs
General Facilities = $3,711.65
Engineering and home office fees = $7,423.31
Process Contingency = $3,711.65
Total Indirect Installation Costs = $14,846.62
Project Contingency = $13,361.96
Total Plant Cost = $102,441.67
Preproduction Cost = $2,048.83
Inventory Capital = $21.28
Total Capital Investment = $104,511.78

Direct Annual Costs
Maintenance Costs = $1,567.68 per yr
Power = 0.63636972 KW
Annual Electricity = $278.73 per yr
Reagent Solution Cost = $86.32 per yr

Catalyst Replacement
FWF = 0.311051666
Annual Catalyst Replacement = $202.55 per yr
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<tr>
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</tr>
<tr>
<td>Total Direct Annual Cost</td>
<td>$2,135.27</td>
<td>per yr</td>
</tr>
<tr>
<td>CRF</td>
<td>0.094392926</td>
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</tr>
<tr>
<td>Indirect Annual Cost</td>
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<td>per yr</td>
</tr>
<tr>
<td>Total annual Cost</td>
<td>$12,000.45</td>
<td>per yr</td>
</tr>
<tr>
<td>NOx Removed</td>
<td>0.27</td>
<td>tons</td>
</tr>
<tr>
<td>Cost of NOx removal</td>
<td>$45,163.99</td>
<td>per ton</td>
</tr>
</tbody>
</table>
Attachment E

Correspondence from Boiler and Burner Manufacturers
FELIX TRUJILLO JR.

From: Tony Fix <tfix@powerflame.com>
Sent: Wednesday, April 13, 2016 2:02 PM
To: FELIX TRUJILLO JR.
Subject: RE: Information Request for 2 - <5MMBtu/hr Propane Fired Boiler
Attachments: Emission Standards 7 LP.pdf

Felix,
Nice to hear from you again. The emissions data on the attached document is still current. I have checked for a more recent revision and this is the most current one.

Thanks,

Tony Fix
Product Support Team Service Technician
Power Flame Inc.
tfix@powerflame.com
Product Support Direct Service Line (620) 820-8301
620-421-0480 Main
620-820-8361 Direct
620-421-0948 Fax

From: FELIX TRUJILLO JR. [mailto:FTrujillo@airquality.org]
Sent: Wednesday, April 13, 2016 3:57 PM
To: Tony Fix
Subject: RE: Information Request for 2 - <5MMBtu/hr Propane Fired Boiler

Hi Tony,
You had previously sent me an emissions document showing the emissions limits for different types of fuels. The revision date on the sheet showed that it was revised in 2009. I wanted to know if there has been another sheet with a more recent revision. If not, if you could confirm that the emissions listed on the sheet still hold true. Thank you.

Felix Trujillo, Jr.
Associate Air Quality Engineer
Stationary Source Division
Sacramento Metropolitan AQMD
777 12th Street, 3rd Floor
Sacramento, CA 95814
Phone: (916) 874-7357
Fax: (916) 874-4899
E-mail: ftrujillo@airquality.org
Felix, in follow up to our conversation, here is the letter from our engineering director stating that there is no know boiler in this size range that can meet 9ppm NOx on propane.

I am still waiting for confirmation from the San Joaquin Valley APCD on their findings.

Sincerely,

*Doug Vickery*

Boiler Sales Engineer

Ph: 209-576-0726
February 17, 2015

To: Sacramento Metropolitan AQMD

Attn: Felix Trujillo, Jr.

Re: BACT for Propane Fired Boilers

Based on our field experience and as a representative for three major boiler manufacturers (Cleaver-Brooks, Fulton Boiler, Camus-Hydronics) which have the lowest NOx and CO emissions in the industry. Based on that experience we can confirm that the Best Available Control Technology for a 2.5MMbtu/hr hot water boiler is 9PPM NOx while firing natural gas only. 9PPM NOx can not be achieved with burner technology alone while firing Propane.

Feel free to give me a call if you have any further questions.

Regards,

[Signature]

AJ Feliz
Central Sales and Engineering Manager
RF MacDonald Co.
10261 Matern Place
Santa Fe Springs, CA 90670
Phone: (714) 257 - 0900 x246
Fax: (714) 257 - 1176
Anthony.feliz@rfmacdonald.com
FELIX TRUJILLO JR.

From: Brian Huibregtse <BHuibregtse@cleaverbrooks.com>
Sent: Thursday, October 29, 2015 4:12 PM
To: FELIX TRUJILLO JR.
Cc: Sean Lobdell; Doug Vickery
Subject: RE: Propane Fired Boiler Question

Felix,

Thank you for your inquiry. We have reviewed this topic with our engineering team. With propane combustion, it is more challenging to obtain low NOx levels when compared to natural gas. In the case of high efficiency condensing HHW boilers, the practical limit Cleaver-Brooks can meet when firing propane is 30 ppm NOx. When firing natural gas, our standard NOx limit is 20ppm NOx.

Cleaver-Brooks does have an option for 9ppm NOx on natural gas for high efficiency boilers greater than 2.0 mmBtu/h. However, the combustion characteristics of propane prevent us from offering a similar NOx level offering. These characteristics include higher flame temperatures and increased flame length. The higher flame temperatures increase NOx formation. Longer flames lead to furnace wall impingement resulting in combustion instability. Cleaver-Brooks has conducted extensive low NOx testing with both fuels on our high efficiency condensing boilers in our Milwaukee Research & Development Lab and has determined these are the NOx limits that we can support with present technology.

Also of note, Cleaver-Brooks, along with many other manufacturers, has pre-certified our high efficiency (model ClearFire-C) boilers with SCAQMD to Rule 1146.2 (scope covers boilers <2.0 mmBtu/h) which stipulates <30 ppm NOx limit for natural gas. I do not believe it addresses propane in this rule, nor was propane evaluated as part of this certification.

If you have any other questions or would like to discuss further, please feel free to contact us. Thanks again for allowing Cleaver-Brooks to provide input in this area.

Sincerely,

Brian Huibregtse
Product Engineering - Commercial Boilers
Packaged Boiler Systems

Cleaver Brooks\textsuperscript{TM} CERTIFIED INTERGRIC SOLUTIONS SPECIALIST\textsuperscript{TM}

Office: 414.577.2743 | Mobile: 414.336.8483
bhuibregtse@cleaver-brooks.com
cleaverbrooks.com

From: FELIX TRUJILLO JR. [mailto:FTrujillo@airquality.org]
Sent: Tuesday, October 27, 2015 4:31 PM
To: Brian Huibregtse
Subject: Propane Fired Boiler Question

Hi Brian,
I have been in contact with Doug Vickery at the RF MacDonald location in Modesto, CA. The Sacramento Metropolitan AQMD issued an Authority to Construct permit for a 2.5 MMBtu/hr propane fired boiler with a NOx limit of 9 ppm @ 3% O2. This was based on what was determined to be Best Available Control Technology. We looked at other districts BACT guidelines and rules, in their were indications that the 9 ppm was achievable for boilers 2 MMBtu/h to less than 5 MMBtu/hr. But RF MacDonald informed us this was not the case. That propane fired units in this size range are unable to meet a 9 ppm limit with just the use of an ultra low NOx burner. So I just need to confirm if this is the case with Cleave Brooks boilers. If 9 ppm is not achievable for propane, what emissions limit would you guarantee for this size of boilers? South Coast AQMD has a BACT guideline for boilers less than 20 MMBtu/hr for natural gas and propane that lists a NOx limit of 12 ppm. Any information that you can provide is greatly appreciated. Thank you.


Felix Trujillo, Jr.
Associate Air Quality Engineer
Stationary Source Division
Sacramento Metropolitan AQMD
777 12th Street, 3rd Floor
Sacramento, CA 95814
Phone: (916) 874-7357
Fax: (916) 874-4899
E-mail: ftrujil@airquality.org

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Dear Mr. Trujillo,

I have looked into this with our burner suppliers based upon your inquiry. The best that they have indicated being able to guarantee when firing propane is less than 12 ppm NOx in this size range. I have asked Power Flame to find some installations that they have done firing propane and achieving less than 12 ppm NOx. I'll get back to you with this as soon as I hear from them. Thank you,

Sincerely,

Dean T. Wadland, P.E.
Vice President
Unilux Advanced Manufacturing

---

Sent from my iPhone

Begin forwarded message:

From: FELIX TRUJILLO JR. <FTrujillo@airquality.org>
Date: October 23, 2015 at 4:11:23 PM EDT
To: "info@unilux.com" <info@unilux.com>
Subject: 2 MMBtu/hr to 5 MMBtu/hr Propane Fired Boiler Information Request

Hi,

I am doing some research on propane fired boilers and I am trying to see if you have an propane fired boilers in the above range that can meet a NOx limit of 9 ppm @ 3% O2 with just the use of an ultra low NOx burner. If not what is achievable for this size range of boilers? If so have any units been tested to confirm the limit? Your help in this matter is greatly appreciated. Thank you.

Felix Trujillo, Jr.
Associate Air Quality Engineer
Stationary Source Division
Sacramento Metropolitan AQMD
777 12th Street, 3rd Floor
Sacramento, CA 95814
Phone: (916) 874-7357
FELIX TRUJILLO JR.

From: Lou Brizzolara <lbrizzolara@ahmassoc.com>
Sent: Thursday, October 29, 2015 4:25 PM
To: FELIX TRUJILLO JR.
Cc: Kyle Richards
Subject: FW: Information Request for 2 - < 5 MMBtu/hr Propane Fired Boiler

Felix,

Though Coen could technically do this, they don’t make burners for this small capacity. However, ST Johnson do make burners for this capacity range and can meet the 9 ppm NOx (3% O2 ref.). ST Johnson are located in Fairfield, Ca. and have well over 400 gas fired burners operating at 9 ppm NOx (3% ref.). I will be in Sacramento next week and would be happy to discuss this further as well as provide additional information. Feel free to visit our website at www.ahmassoc.com where can access the ST Johnson website.

Regards,
Lou Brizzolara
AHM Associates, Inc.
lbrizzolara@ahmassoc.com
Phone: 510-785-6670

Hi,

I am doing some research on propane fired boilers in the size range of 2 MMBtu/hr to less than 5 MMBtu/hr. I am trying to determine if a boiler in this size range with an ultra low NOx burner and fired on propane can meet a NOx limit of 9 ppm @ 3% O2. Do you know if COEN has such a unit and would they guarantee such a limit for propane and for units in this size range? Is this achievable for propane fired units with just the use of an ultra low NOx burner? Your help is greatly appreciated. Thank you.

Felix Trujillo, Jr.
Associate Air Quality Engineer
Stationary Source Division
Sacramento Metropolitan AQMD
FELIX TRUJILLO JR.

From: Robert Nickeson <mickeson@johnsonburners.com>
Sent: Wednesday, December 02, 2015 11:46 AM
To: FELIX TRUJILLO JR.
Subject: RE: Propane Boiler (2 to less than 5 MMBtu/hr) Emissions Information Request

Felix – sorry for the delayed response, but operating on propane we have a 15 ppm NOx, corrected to 3% O2, emissions guarantee on those burners. Hope this is helpful.
Bob

---

From: FELIX TRUJILLO JR. [mailto:FTrujillo@airquality.org]
Sent: Tuesday, December 01, 2015 1:43 PM
To: mickeson@johnsonburners.com
Subject: Propane Boiler (2 to less than 5 MMBtu/hr) Emissions Information Request

HI Bob,

I was looking at your website and saw that you have a NOxMatic Mini ultra low NOx burner in the 2 to less than 5 MMBtu/hr size range that can meet a NOx limit of 9 ppm @ 3% O2 when fired on natural gas. I wanted to know if the same boiler when fired on propane can also meet the same limit. If not what is the limit that is achievable for propane? I am working on a BACT determination for this size of boilers here in Sacramento Metro AQMD. So far the lowest limits that I have seen from other agencies are 12 ppm @ 3% O2 (South Coast AQMD BACT Guideline for natural gas or propane fired boilers with a rating of less than 20 MMBtu/hr) and 20 ppm @ 3% O2 from the Ventura County APCD for propane fired boilers (Per their Boiler Rule 74.15.1). Thank you.

Felix Trujillo, Jr.
Associate Air Quality Engineer
Stationary Source Division
Sacramento Metropolitan AQMD
777 12th Street, 3rd Floor
Sacramento, CA 95814
Phone: (916) 874-7357
Fax: (916) 874-4899
E-mail: ftrujillo@airquality.org
FELIX TRUJILLO JR.

From: Helverson, Vernon (KS07) <vhelverson@maxoncorp.com>
Sent: Friday, November 20, 2015 1:05 PM
To: FELIX TRUJILLO JR.
Subject: Maxon Contact information

Felix,

Thank you for your inquiry. Per our conversation, Maxon doesn’t really have burners that are specific to boilers. We have seen some Maxon burners used on Fulton boilers, but it’s not very common.

That being said, we do have multiple burners used in process applications. We have burners that are used to satisfy the requirement for 30 ppm NOx cor 3% O2 as well as under 10 ppm NOx cor 3% O2. We do not offer a blanket guarantee of emissions for any of our burners. Maxon prefers to evaluate case by case. We do this because many factors (burner included) affect process NOx emissions. The following is how Maxon typically assists a customer in order to help them achieve emissions.

Maxon will collect application information from the customer. This includes a confirmation from the local agency having jurisdiction as to the actual emission requirements. Maxon will evaluate the information and make a burner recommendation. Depending on the requirements, Maxon may require additional equipment to be purchased in conjunction with the burner in order to meet the emissions requirements. Maxon will make the emissions guarantee and offer a guarantee letter upon receipt of a confirming purchase order.

Please let me know if you have additional questions. Thanks again for your time.

Best Regards,

Vernon Helverson
Engineer App/Sys Sales

Honeywell
Commercial & Industrial Combustion
MAXON & Honeywell Brand Products

Cell (913) 522-3350
vhelverson@maxoncorp.com

http://customer.honeywell.com
http://www.maxoncorp.com
Attachment F

Correspondence from SJVAPCD
Good morning Mr. Trujillo,

We have no record of any testing done for one of these smaller units fired on propane/LPG. A quick search in the database did not disclose other than one of these that uses propane as a backup – but this is an existing unit that is required to meet 30 ppm (they will have to meet the lower limits when the unit is replaced, or if the burner is changed).

Sorry this is not much help for you, but please let me know if I can provide anything else.

Mike Oldershaw
Manager
Southern Region Compliance Department
34049 Flyover Court
Bakersfield, CA 93306
661-392-6621

HEALTHY AIR LIVING
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Make one change for clean air