SMAQMD BACT CLEARINGHOUSE

EXPIRED

CATEGORY Type: **BOILER/HEATER > 5 MMBTU**

BACT Category: MINOR SOURCE

BACT Determination Number: 157	**BACT Determination Date:** 6/19/2018

Equipment Information

Permit Number: N/A -- Generic BACT Determination

Equipment Description: BOILER

Unit Size/Rating/Capacity: ≥5 MMBtu/hr and ≤ 10 MMBtu/hr at ≤ 50% capacity

Equipment Location:

BACT Determination Information

District Contact: Jeffrey Quok Phone No.: (916) 874-4863 email: jquok@airquality.org

ROCs	**Standard:**	
	Technology Description:	Good combustion practice and use of natural gas or LPG
	Basis:	Achieved in Practice
NOx	**Standard:**	9 ppm at 3% O2
	Technology Description:	9 ppm at 3% O2, Low NOx burner
	Basis:	Achieved in Practice
SOx	**Standard:**	
	Technology Description:	Good combustion practice and use of natural gas or LPG
	Basis:	Achieved in Practice
PM10	**Standard:**	
	Technology Description:	Good combustion practice and use of natural gas or LPG
	Basis:	Achieved in Practice
PM2.5	**Standard:**	
	Technology Description:	Good combustion practice and use of natural gas or LPG
	Basis:	Achieved in Practice
CO	**Standard:**	50/100 ppm @ 3% O2 for firetube/watertube
	Technology Description:	Firetube Boilers: 50 ppmvd corrected to 3% O2 Watertube Boilers: 100 ppmvd corrected to 3% O2
	Basis:	Achieved in Practice
LEAD	**Standard:**	
	Technology Description:	
	Basis:	

Comments: 50% annual capacity is equivalent to full fire at 4,380 hours/year.

SMAQMD BACT CLEARINGHOUSE

EXPIRED

CATEGORY Type: **BOILER/HEATER > 5 MMBTU**

BACT Category: MINOR SOURCE

BACT Determination Number: 177	**BACT Determination Date:** 6/19/2018

Equipment Information

Permit Number: N/A -- Generic BACT Determination

Equipment Description: BOILER

Unit Size/Rating/Capacity: ≥5 MMBtu/hr and ≤ 10 MMBtu/hr > at 50% Capacity

Equipment Location:

BACT Determination Information

District Contact: Jeffrey Quok Phone No.: (916) 874-4863 email: jquok@airquality.org

ROCs	**Standard:**	
	Technology Description:	Good combustion practice and use of natural gas
	Basis:	Achieved in Practice
NOx	**Standard:**	7 ppm at 3% O2
	Technology Description:	Ultra Low NOx burner
	Basis:	Cost Effective
SOx	**Standard:**	
	Technology Description:	Good combustion practice and use of natural gas
	Basis:	Achieved in Practice
PM10	**Standard:**	
	Technology Description:	Good combustion practice and use of natural gas
	Basis:	Achieved in Practice
PM2.5	**Standard:**	
	Technology Description:	Good combustion practice and use of natural gas
	Basis:	Achieved in Practice
CO	**Standard:**	
	Technology Description:	Firetube Boilers: 50 ppmvd corrected to 3% O2 Watertube Boilers: 100 ppmvd corrected to 3% O2
	Basis:	Achieved in Practice
LEAD	**Standard:**	
	Technology Description:	
	Basis:	

Comments: 50% annual capacity is equivalent to full fire at 4,380 hours/year.

Printed: 2/9/2021

SMAQMD BACT CLEARINGHOUSE

EXPIRED

CATEGORY Type: **BOILER/HEATER > 5 MMBTU**

BACT Category: MINOR SOURCE

BACT Determination Number: 185	**BACT Determination Date:** 6/19/2018

Equipment Information

Permit Number: N/A -- Generic BACT Determination

Equipment Description: BOILER

Unit Size/Rating/Capacity: >10 MMBtu/hr to ≤ 20 MMBtu/hr at ≤ 30% Capacity

Equipment Location:

BACT Determination Information

District Contact: Jeffrey Quok Phone No.: (916) 874-4863 email: jquok@airquality.org

ROCs	**Standard:**	
	Technology Description:	Good combustion practice and use of natural gas or LPG
	Basis:	Achieved in Practice
NOx	**Standard:**	9 ppm at 3% O2
	Technology Description:	Low NOx burner
	Basis:	Achieved in Practice
SOx	**Standard:**	
	Technology Description:	Good combustion practice and use of natural gas or LPG
	Basis:	Achieved in Practice
PM10	**Standard:**	
	Technology Description:	Good combustion practice and use of natural gas or LPG
	Basis:	Achieved in Practice
PM2.5	**Standard:**	
	Technology Description:	Good combustion practice and use of natural gas or LPG
	Basis:	Achieved in Practice
CO	**Standard:**	
	Technology Description:	Firetube Boilers: 50 ppmvd corrected to 3% O2 Watertube Boilers: 100 ppmvd corrected to 3% O2
	Basis:	Achieved in Practice
LEAD	**Standard:**	
	Technology Description:	
	Basis:	

Comments: 30% annual capacity is equivalent to full fire at 2,592 hours/year.

Printed: 2/9/2021

SMAQMD BACT CLEARINGHOUSE

EXPIRED

CATEGORY Type: **BOILER/HEATER > 5 MMBTU**

BACT Category: MINOR SOURCE

BACT Determination Number: 186	**BACT Determination Date:** 6/19/2018

Equipment Information

Permit Number: N/A -- Generic BACT Determination

Equipment Description: BOILER

Unit Size/Rating/Capacity: >10 MMBtu/hr to ≤ 20 MMBtu/hr at > 30% Capacity

Equipment Location:

BACT Determination Information

District Contact: Jeffrey Quok Phone No.: 916 874-4863 email: jquok@airquality.org

ROCs	**Standard:**	
	Technology Description:	Good combustion practice and use of natural gas
	Basis:	Achieved in Practice
NOx	**Standard:**	7 ppm at 3% O2
	Technology Description:	Ultra Low NOx burner
	Basis:	Cost Effective
SOx	**Standard:**	
	Technology Description:	Good combustion practice and use of natural gas
	Basis:	Achieved in Practice
PM10	**Standard:**	
	Technology Description:	Good combustion practice and use of natural gas
	Basis:	Achieved in Practice
PM2.5	**Standard:**	
	Technology Description:	Good combustion practice and use of natural gas
	Basis:	Achieved in Practice
CO	**Standard:**	
	Technology Description:	Firetube Boilers: 50 ppmvd corrected to 3% O2 Watertube Boilers: 100 ppmvd corrected to 3% O2
	Basis:	Achieved in Practice
LEAD	**Standard:**	
	Technology Description:	
	Basis:	

Comments: 30% annual capacity is equivalent to full fire at 2,592 hours/year.

Printed: 2/9/2021

777 12th Street, Third Floor

SACRAMENTO METROPOLITAN AIR QUALITY MANAGEMENT DISTRICT

Sacramento, CA 95814

BEST AVAILABLE CONTROL TECHNOLOGY DETERMINATION

DETERMINATION NO.: 157, 177, 185, & 186

DATE: June 19, 2018

ENGINEER: Jeffrey Quok

Category/General Equip Description: Boiler/Heater – Natural gas or LPG

Equipment Specific Description:

#157 – Boiler/heater greater or equal to 5 MMBtu/hr to less than or equal to 10 MMBtu/hr, at less than or equal to 50% annual capacity

#177 – Boiler/heater natural gas fired greater or equal to 5 MMBtu/hr to less than or equal to 10 MMBtu/hr, at greater than 50% annual capacity

#185 – Boiler/heater greater than 10 MMBtu/hr to less than or equal to 20 MMBtu/hr, at less than or equal to 30% annual capacity

#186 – Boiler/heater greater natural gas fired greater than 10 MMBtu/hr to less than or equal to 20 MMBtu/hr, at greater than 30% annual capacity

Equipment Size/Rating: Minor Source BACT

Previous BACT Det. No.: 109

This BACT determination will update Determination #109 for boilers/heaters greater or equal to 5 to 20 MMBtu/hr.

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 5 to 20 MMBTU/hr by the following air pollution control districts:

<table>
<tr><th>District/Agency</th><th>Best Available Control Technology (BACT)/Requirements</th></tr>
<tr><td>US EPA</td><td>

BACT

Source: EPA RACT/BACT/LAER Clearinghouse
RBLC ID: TX-0691 (5/20/2014) & TX-0693 (4/22/14)

<table>
<tr><th colspan="2">For units with a rating of 5 to 20 MMBtu/hr</th></tr>
<tr><td>VOC</td><td>N/A – No BACT determinations found in the ≥ 5 to < 20 MMBtu/hr range</td></tr>
<tr><td>NOx</td><td>0.036 lb/MMBtu (30 ppm NOx @ 3% O_2) [TX-0693]</td></tr>
<tr><td>SOx</td><td>N/A – No BACT determinations found in the ≥ 5 to < 20 MMBtu/hr range</td></tr>
<tr><td>PM10</td><td>N/A – No BACT determinations found in the ≥ 5 to < 20 MMBtu/hr range</td></tr>
<tr><td>PM2.5</td><td>N/A – No BACT determinations found in the ≥ 5 to < 20 MMBtu/hr range</td></tr>
<tr><td>CO</td><td>0.054 lb/MMBtu (73 ppm CO @ 3% O_2) [TX-0691]</td></tr>
</table>

RULE REQUIREMENTS:

40 CFR 60 Subpart Dc – Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units

This regulation applies to steam generating units rated at between 10-100 MMBtu/hr. However, no standards within the subpart are applicable to units fired by natural gas only. Therefore, this NSPS is not applicable.

</td></tr>
<tr><td>ARB</td><td>

BACT

Source: ARB BACT Clearinghouse
SCAQMD Permit No. 362616 (2/1/2000)

<table>
<tr><th colspan="2">For units with a rating of 5 to 20 MMBtu/hr</th></tr>
<tr><td>VOC</td><td>No standard</td></tr>
<tr><td>NOx</td><td>11 ppmvd at 3% O_2 [SCAQMD]</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>50 ppmvd corrected to 3% O_2 [SCAQMD]</td></tr>
</table>

RULE REQUIREMENTS:
None

</td></tr>
</table>

<table>
<tr><th>District/Agency</th><th>Best Available Control Technology (BACT)/Requirements</th></tr>
<tr><td>SMAQMD</td><td>

BACT

<table>
<tr><th colspan="2">For units with a rating of ≥ 5 to < 20 MMBtu/hr</th></tr>
<tr><td>VOC</td><td>Good combustion practice and natural gas or LPG fuel</td></tr>
<tr><td>NOx</td><td>9 ppmvd at 3% O_2, low NOx boiler</td></tr>
<tr><td>SOx</td><td>Natural gas or LPG fuel</td></tr>
<tr><td>PM10</td><td>Good combustion practice and natural gas or LPG fuel</td></tr>
<tr><td>PM2.5</td><td>Good combustion practice and natural gas or LPG fuel</td></tr>
<tr><td>CO</td><td>Firetube Boilers: 50 ppmvd corrected to 3% O_2
Watertube Boilers: 100 ppmvd corrected to 3% O_2</td></tr>
</table>

RULE REQUIREMENTS:

Rule 411 (8/23/07)
For units with a rating of 5 to <20 MMBtu/hr emissions shall not exceed the following levels:
1. 15 ppmvd of NOx corrected to 3% O2
2. 400 ppmvd of CO corrected to 3% O2

</td></tr>
<tr><td>South Coast AQMD</td><td>

BACT

Source: SCAQMD BACT Guidelines for Non-Major Polluting Facilities, page 13. (12/2/16)

<table>
<tr><th colspan="2">For natural gas fired units with a rating > 2 and < 20 MMBtu/hr</th></tr>
<tr><td>VOC</td><td>No standard</td></tr>
<tr><td>NOx</td><td>Compliance with SCAQMD Rules 1146 or 1146.1 (9 ppm corrected to 3% O_2 or 0.011 lbs/10^6 BTU)</td></tr>
<tr><td>SOx</td><td>Use of Natural gas</td></tr>
<tr><td>PM10</td><td>Use of Natural Gas</td></tr>
<tr><td>PM2.5</td><td>No standard</td></tr>
<tr><td>CO</td><td>Firetube Boiler: 50 ppmvd corrected to 3% O_2
Watertube Boiler: 100 ppmvd corrected to 3% O_2</td></tr>
</table>

</td></tr>
</table>

<table>
<tr><th>District/Agency</th><th>Best Available Control Technology (BACT)/Requirements</th></tr>
<tr><td>South Coast AQMD</td><td>

<table>
<tr><th colspan="2">For propane fired units with a rating > 2 and < 20 MMBtu/hr</th></tr>
<tr><td>VOC</td><td>No standard</td></tr>
<tr><td>NOx</td><td>12 ppmvd corrected to 3% O_2</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>Firetube Boiler: 50 ppmvd corrected to 3% O_2
Watertube Boiler: 100 ppmvd corrected to 3% O_2</td></tr>
</table>

<table>
<tr><th colspan="2">For atmospheric(A) units with a rating ≥ 2 and ≤ 10 MMBtu/hr</th></tr>
<tr><td>VOC</td><td>No standard</td></tr>
<tr><td>NOx</td><td>Compliance with SCAQMD Rules 1146 and 1146.1 (12 ppm corrected to 3% O_2 or 0.015 lbs/10^6 BTU)</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>Compliance with SCAQMD Rules 1146 and 1146.1 (400 ppm corrected to 3% O_2 or 0.3 lbs/10^6 BTU)</td></tr>
</table>

(A) Atmospheric unit is defined as any natural gas fired unit with a heat input less than or equal to 10 million Btu per hour with a non-sealed combustion chamber in which natural draft is used to exhaust combustion gases.

RULE REQUIREMENTS:

Reg XI, Rule 1146 (11/1/13)
Requirements Table 1146-1 & Table 1146-2

Category	NOx Limit	Unit Shall be in Full Compliance on or before
Group III Units(A) 100% of units (by heat input)	9 ppm or 0.011 lbs/10^6 BTU	Applications submitted before 1-1-2014 unit shall be in full compliance on or before 1-1-2015
Atmospheric Units(B)	12 ppm or 0.015 lbs/10^6 BTU	Applications submitted before 1-1-2013 unit shall be in full compliance on or before 1-1-2014

(A) GROUP III UNIT means any unit burning gaseous fuels, excluding digester and landfill gases, and thermal fluid heaters with a rated heat input less than 20 million Btu per hour down to and including 5 million Btu per hour, and all units operated at schools and universities greater than or equal to 5 million Btu per hour. Excludes NOx RECLAIM facilities.

</td></tr>
</table>

<table>
<tr><td>District/Agency</td><td>Best Available Control Technology (BACT)/Requirements</td></tr>
<tr><td>South Coast AQMD</td><td>(B) Atmospheric unit is defined as any natural gas fired unit with a heat input less than or equal to 10 million Btu per hour with a non-sealed combustion chamber in which natural draft is used to exhaust combustion gases.</td></tr>
<tr><td>San Diego County APCD</td><td>
<u>BACT</u>

Source: NSR Requirements for BACT, page 3-5. (6/2011)

<table>
<tr><td colspan="2">For boilers with a rating of less than 50 MMBtu/hr</td></tr>
<tr><td>VOC</td><td>NG or LPG fuel (If using NG or LPG fuel)</td></tr>
<tr><td>NOx</td><td>1. 9 ppmvd corrected to 3% O_2
2. Low NOx burner, FGR, and oxygen controller (If using NG or LPG fuel)
3. Low NOx burner, FGR, and oxygen controller (If using No. 2 oil as a backup fuel)</td></tr>
<tr><td>SOx</td><td>1. NG or LPG fuel (If using NG or LPG fuel)
2. No. 2 fuel oil with <0.05% sulfur content (If using No. 2 oil as a backup fuel)</td></tr>
<tr><td>PM10</td><td>1. 0.10 gr/dscf (verified by use of NG or LPG fuel)
2. NG or LPG fuel (If using NG or LPG fuel)
3. Low ash fuel (If using No. 2 oil as a backup fuel)</td></tr>
<tr><td>PM2.5</td><td>No standard</td></tr>
<tr><td>CO</td><td>No standard</td></tr>
</table>

<u>RULE REQUIREMENTS</u>:

Regulation 4, Rule 69.2 (9/27/94)
For any unit with a heat input rating less than or equal to 50 million Btu/hr and an annual heat input of 220,000 therms or more, or for any unit with a heat input rating greater than 50 million Btu/hr and an annual capacity factor 10% or greater, emissions shall not exceed the following levels:

1. 30 ppmvd of NOx when operated on a gaseous fuel, corrected to 3% O_2
2. 40 ppmvd of NOx when operated on a liquid fuel, corrected to 3% O_2
3. 400 ppmvd of CO corrected to 3% O_2
</td></tr>
</table>

<table>
<tr><th>District/Agency</th><th>Best Available Control Technology (BACT)/Requirements</th></tr>
<tr><td>Bay Area AQMD</td><td>

BACT

Source: BAAQMD BACT Guideline 17.1.1 (8/4/10)

<table>
<tr><th colspan="2">For boilers with a rating of 5 MMBtu/hr to less than 33.5 MMBtu/hr</th></tr>
<tr><td>VOC</td><td>Good combustion practice</td></tr>
<tr><td>NOx</td><td>Low NOx burners + flue gas recirculation</td></tr>
<tr><td>SOx</td><td>Natural gas or treated refinery gas fuel with ≤100 ppmv total reduced sulfur</td></tr>
<tr><td>PM10</td><td>Natural gas or treated refinery gas fuel</td></tr>
<tr><td>PM2.5</td><td>No standard</td></tr>
<tr><td>CO</td><td>Firetube Boilers: 50 ppmvd corrected to 3% O_2
Watertube Boilers: 100 ppmvd corrected to 3% O_2</td></tr>
</table>

RULE REQUIREMENTS:

Reg 9, Rule 7 (5/4/2011)
For units with a rating of greater than 5 MMBtu/hr and less than 20 MMBtu/hr:
1. NOx limit of 15 ppmvd corrected to 3% O_2
2. CO limit of 400 ppmvd corrected to 3% O_2

For units with a rating of 20 MMBtu/hr and less than 75 MMBtu/hr:
1. NOx limit of 9 ppmvd corrected to 3% O_2
2. CO limit of 400 ppmvd corrected to 3% O_2

</td></tr>
<tr><td>San Joaquin Valley APCD</td><td>

BACT

Source: SJVUAPCD BACT Guideline (Rescinded)
The boiler BACT determinations listed in the SJVAPCD Clearinghouse have been rescinded.

RULE REQUIREMENTS:

Rule 4306 (10/16/2008)
For units ≤ 20 MMBtu/hr
1. 9 ppm of NOx corrected to 3% O2
2. 400 ppm of CO corrected to 3% O2

Units rated at 5 MMBtu/hr (gross) or less are exempt from permit requirement per SJVAPCD Rule 2020.

</td></tr>
</table>

District/Agency	Best Available Control Technology (BACT)/Requirements
San Joaquin Valley APCD	Rule 4320 (10/16/2008) For units > 5.0 MMBtu/hr to ≤ 20 MMBtu/hr (Standard Schedule) 1. 9 ppm NOx corrected to 3% O2 or 0.011 lb NOx/MMBtu 2. 400 ppm CO corrected to 3% O2 For units > 5.0 MMBtu/hr to ≤ 20 MMBtu/hr (Enhanced Schedule) 1. 6 ppm NOx corrected to 3% O2 or 0.007 lb NOx/MMBtu 2. 400 ppm CO corrected to 3% O2 The enhanced schedule limits are not required for new boilers and are therefore not considered achieved in practice. Particulate Matter Control Requirements 1. Operators shall fire units exclusively on PUC-quality natural gas, commercial propane, butane, LPG, or a combination of such gases. 2. Operators shall limit fuel sulfur content to no more than 5 grains of total sulfur per 100 standard cubic feet; OR 3. Operators shall install an emission control system that reduces SO2 emissions by 95% by weight; or limit exhaust SO2 to less than or equal to 9 ppmv corrected to 3.0 O2.

The following control technologies have been identified and are ranked based on stringency:

POLLUTANT	SUMMARY OF ACHIEVED IN PRACTICE CONTROL TECHNOLOGIES
VOC	1. Good combustion practice – [BAAQMD, SMAQMD] 2. NG or LPG fuel (If using NG or LPG fuel) – [SDCAPCD, SMAQMD] 3. No standard – [SCAQMD, SJVAPCD]
NOx	1. 9 ppmvd at 3% O_2 – [SMAQMD, SCAQMD, SJVAPCD, SDCAPCD] 2. 12 ppmvd at 3% O_2 for propane fired units – [SCAQMD] 3. 12 ppmvd at 3% O_2 for atmospheric units – [SCAQMD] 4. 15 ppmvd corrected to 3% O_2 – [BAAQMD] 5. 0.036 lb/MMBtu (30 ppmvd @ 3% O_2) [US EPA, RBLC ID:TX-0693] 6. Low NOx burner, FGR, and oxygen controller (If using NG or LPG fuel) – [SDCAPCD] 7. Low NOx burner, FGR, and oxygen controller (If using No. 2 oil as a backup fuel) – [SDCAPCD]
SOx	1. Use of natural gas or LPG fuel(A) (If using NG or LPG fuel) – [SCAQMD, SDCAPCD, SMAQMD] 2. Natural gas or treated refinery gas fuel with ≤100 ppmv total reduced sulfur – [BAAQMD] 3. No. 2 fuel oil with <0.05% sulfur content (If using No. 2 oil as a backup fuel) – [SDCAPCD] 4. No standard – [SJVAPCD]

POLLUTANT	SUMMARY OF ACHIEVED IN PRACTICE CONTROL TECHNOLOGIES
PM10	1. Good combustion practice and use of natural gas or LPG fuel – [SCAQMD](A) 2. 0.10 gr/dscf (verified by use of NG or LPG fuel) – [SDCAPCD](B) 3. NG or LPG fuel (If using NG or LPG fuel) – [SDCAPCD] 4. Use of PUC-quality natural gas, commercial propane, butane, LPG, or a combination of such gases. [SJVAPCD] 5. Natural gas or treated refinery gas fuel – [BAAQMD] 6. Low ash fuel (If using No. 2 oil as a backup fuel) – [SDCAPCD]
PM2.5	1. Good combustion practice and use of natural gas or LPG fuel – [SCAQMD](A) 2. No standard – [SCAQMD, SDCAPCD, BAAQMD, & SJVAPCD]
CO	1. Firetube Boilers: 50 ppmvd corrected to 3% O_2 – [SMAQMD, SCAQMD, & BAAQMD] Watertube Boilers: 100 ppmvd corrected to 3% O_2 – [SCAQMD, BAAQMD] 2. 0.054 lb/MMBtu (73 ppmvd @ 3% O_2) [US EPA, RBLC ID: TX-0691](C) 3. 400 ppm of CO corrected to 3% O2 – [SDCAPCD, BAAQMD, & SJVAPCD]

(A) Pursuant to the SCAQMD's BACT Clean Fuel Guidelines, the use of LPG is equivalent to natural gas.

(B) The 0.10 gr/dscf limit has not been demonstrated to be achieved in practice by source testing, it has only been assumed to be achievable by the use of natural gas or LPG. Therefore, the use of natural gas or LPG when natural gas is not available will be considered Achieved in Practice BACT.

(C) This BACT determination did not specify if the boiler was a firetube or watertube boiler.

The following control technologies have been identified as the most stringent, achieved in practice control technologies:

BEST CONTROL TECHNOLOGIES ACHIEVED		
Pollutant	**Standard**	**Source**
VOC	Good combustion practice and use of natural gas or LPG	SMAQMD, BAAQMD
NOx	9 ppm at 3% O_2, Low NOx burner	SMAQMD, SDCAPCD, SCAQMD (Rule 1146.1), SJVAPCD (Rule 4306 & 4320)
SOx	Good combustion practice and use of natural gas or LPG	SMAQMD, SDCAPCD
PM10	Good combustion practice and use of natural gas or LPG	SMAQMD, SDCAPCD
PM2.5	Good combustion practice and use of natural gas or LPG	SMAQMD
CO	Firetube Boilers: 50 ppmvd corrected to 3% O_2 Watertube Boilers: 100 ppmvd corrected to 3% O_2	SMAQMD, BAAQMD, SCAQMD (Rule 1146.1)

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.

Pollutant	Technologically Feasible Alternatives
VOC	No other technologically feasible option identified
NOx	1. Selective Catalytic Reduction 2. Ultra Low NOx Burner (7ppm)
SOx	No other technologically feasible option identified
PM10	No other technologically feasible option identified
PM2.5	No other technologically feasible option identified
CO	No other technologically feasible option identified

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):

Pollutant	Maximum Cost ($/ton)
VOC	17,500
NO_X	24,500
PM10	11,400
SO_X	18,300
CO	TBD if BACT triggered

Cost Effectiveness Analysis Summary

SCR:

As shown in Attachment D, the cost effectiveness for the add on SCR system to control NOx to a 5 ppm level was calculated to be **$87,130/ton** for a 5 MMBtu/hr boiler and **$57,672/ton** for a 20 MMBtu/hr boiler (see attached Boiler Cost Effectiveness Analysis). Since BACT for a 20 MMBtu/hr boiler is never triggered for CO (141 lbs/day max) even with a boiler meeting Rule 411 limits (400 ppmv CO at 3%O2), the cost for the added CO control was not analyzed. The

following basic parameters were used in the analysis.

For a 5 MMBtu/hr boiler:

NOx Control Level = 5 ppmv

NOx Baseline Level = 15 ppmv

Boiler Rating = 5 MMBtu/hr

Equipment Life = 20 years

Direct Cost = $134,408

Direct Annual Cost = $5,285 per year

Indirect Annual Cost = $17,861 per year

Total Annual Cost = $23,146 per year

NOx Removed = 0.27 tons per year

Cost of NOx Removal = $87,130 per ton reduced

Therefore, add on SCR system is considered not cost effective and is eliminated.

For a 20 MMBtu/hr boiler:

NOx Control Level = 5 ppmv

NOx Baseline Level = 15 ppmv

Boiler Rating = 20 MMBtu/hr

Equipment Life = 20 years

Direct Cost = $334,448

Direct Annual Cost = $16,850 per year

Indirect Annual Cost = $44,447 per year

Total Annual Cost = $61,297 per year

NOx Removed = 1.06 tons per year

Cost of NOx Removal = $57,672 per ton reduced

Therefore, add on SCR system is considered not cost effective and is eliminated.

Ultra Low NOx Burner (ULNB):

California Boiler was contacted to provide cost estimates for boilers between 5-20 MMBtu/hr that meet a 15 ppm, 9 ppm, or 7 ppm NOx level. In order to provide a 7 ppm NOx level a variable frequency drive (VFD), controls for the combustion blower motor, and a O_2 trim system must be added. California Boiler gave estimated cost differences between 15 ppm and 7 ppm boilers of $17,000 to $40,000 (See Attachment F for California Boiler's Cost Estimates).

As shown in Attachment E, the cost effectiveness for the add on of an ULNB system that controls NOx to a 7 ppm level was calculated to be **$24,645.16/ton** for a 5 MMBtu/hr boiler at a 50% annual capacity, **$24,645.16/ton** for a 10 MMBtu/hr boiler at 50% annual capacity, and **$24,500/ton** for a 20 MMBtu/hr boiler at 25% annual capacity. Since BACT for a 20 MMBtu/hr boiler is never triggered for CO (141 lbs/day max) even with a boiler meeting Rule 411 limits (400 ppmv CO at 3%O2), the cost for the added CO control was not analyzed. The following basic parameters were used in the analysis.

A. For a 5 MMBtu/hr boiler at 50% annual capacity:

NOx Control Level = 7 ppmv

NOx Baseline Level = 15 ppmv

Boiler Rating = 5 MMBtu/hr

Boiler Annual Capacity = 50% (4360 hours/year)

Direct Cost = $17,000

Direct Annual Cost = $358.94 per year

Indirect Annual Cost = $2,258.75 per year

Total Annual Cost = $2,617.69 per year

NOx Removed = 0.10622 tons per year

Cost of NOx Removal = $24,645.16 per ton reduced

Therefore, add on ULNB system is not considered cost effective for 5 MMBtu/hr boilers at 50% annual capacity.

B. For a 10 MMBtu/hr boiler at 50% annual capacity:

NOx Control Level = 7 ppmv

NOx Baseline Level = 15 ppmv

Boiler Rating = 10 MMBtu/hr

Boiler Annual Capacity = 50% (4360 hours/year)

Direct Cost = $34,000

Direct Annual Cost = $717.88 per year

Indirect Annual Cost = $4,517.49 per year

Total Annual Cost = $5,235.37 per year

NOx Removed = 0.21243 tons per year

Cost of NOx Removal = $24,645.16per ton reduced

Therefore, add on ULNB system is not considered cost effective for 10 MMBtu/hr boilers at 50% annual capacity.

C. For a 20 MMBtu/hr boiler at 30% annual capacity:

NOx Control Level = 7 ppmv

NOx Baseline Level = 15 ppmv

Boiler Rating = 20 MMBtu/hr

Boiler Annual Capacity = 30% (2592 hours/year)

Direct Cost = $40,000

Direct Annual Cost = $844.56 per year

Indirect Annual Cost = $5,314.70 per year

Total Annual Cost = $6,159.26 per year

NOx Removed = 0.2514 tons per year

Cost of NOx Removal = $24,500.00 per ton reduced

Therefore, add on ULNB system is not considered cost effective for 20 MMBtu/hr boilers at 30% annual capacity.

C: SELECTION OF BACT

Based on the cost effectiveness determinations, BACT will be broken down into four categories to account for ultra low NOx burners being cost effective for boilers at certain annual capacities. The new BACT categories are summarized in the tables below.

BACT #157 FOR BOILERS ≥ 5 AND ≤ 10 MMBTU/HR AT ≤ 50% ANNUAL CAPACITY (A)		
Pollutant	**Standard**	**Source**
VOC	Good combustion practice and use of natural gas or LPG	SMAQMD, BAAQMD
NOx	9 ppm at 3% O_2, Low NOx burner	SMAQMD, SDCAPCD, SCAQMD (Rule 1146.1), SJVAPCD (Rule 4306 & 4320))
SOx	Good combustion practice and use of natural gas or LPG	SMAQMD, SDCAPCD
PM10	Good combustion practice and use of natural gas or LPG	SMAQMD, SDCAPCD
PM2.5	Good combustion practice and use of natural gas or LPG	SMAQMD
CO	Firetube Boilers: 50 ppmvd corrected to 3% O_2 Watertube Boilers: 100 ppmvd corrected to 3% O_2	SMAQMD, BAAQMD, SCAQMD (Rule 1146.1)

(A) Note: 50% annual capacity is equivalent to the boiler operating at full fire for 4,380 hours/year.

BACT #177 FOR NATURAL GAS BOILERS ≥ 5 AND ≤ 10 MMBTU/HR AT > 50% ANNUAL CAPACITY (A)		
Pollutant	**Standard**	**Source**
VOC	Good combustion practice and use of natural gas	SMAQMD, BAAQMD
NOx	7 ppm at 3% O_2, Ultra Low NOx burner	SMAQMD (Cost Effectiveness Analysis)
SOx	Good combustion practice and use of natural gas	SMAQMD, SDCAPCD
PM10	Good combustion practice and use of natural gas	SMAQMD, SDCAPCD
PM2.5	Good combustion practice and use of natural gas	SMAQMD
CO	Firetube Boilers: 50 ppmvd corrected to 3% O_2 Watertube Boilers: 100 ppmvd corrected to 3% O_2	SMAQMD, BAAQMD, SCAQMD (Rule 1146.1)

(A) Note: 50% annual capacity is equivalent to the boiler operating at full fire for 4,380 hours/year.

BACT #185 FOR BOILERS > 10 AND ≤ 20 MMBTU/HR AT ≤ 30% ANNUAL CAPACITY (A)		
Pollutant	**Standard**	**Source**
VOC	Good combustion practice and use of natural gas or LPG	SMAQMD, BAAQMD
NOx	9 ppm at 3% O_2, Low NOx burner	SMAQMD, SDCAPCD, SCAQMD (Rule 1146.1), SJVAPCD (Rule 4306 & 4320)
SOx	Good combustion practice and use of natural gas or LPG	SMAQMD, SDCAPCD
PM10	Good combustion practice and use of natural gas or LPG	SMAQMD, SDCAPCD
PM2.5	Good combustion practice and use of natural gas or LPG	SMAQMD
CO	Firetube Boilers: 50 ppmvd corrected to 3% O_2 Watertube Boilers: 100 ppmvd corrected to 3% O_2	SMAQMD, BAAQMD, SCAQMD (Rule 1146.1)

(A) Note: 30% annual capacity is equivalent to the boiler operating at full fire for 2,592 hours/year.

BACT #186 FOR NATURAL GAS BOILERS > 10 AND ≤ 20 MMBTU/HR AT > 30% ANNUAL CAPACITY (A)		
Pollutant	**Standard**	**Source**
VOC	Good combustion practice and use of natural gas	SMAQMD, BAAQMD
NOx	7 ppm at 3% O_2, Ultra Low NOx burner	SMAQMD (Cost Effectiveness Analysis)
SOx	Good combustion practice and use of natural gas	SMAQMD, SDCAPCD
PM10	Good combustion practice and use of natural gas	SMAQMD, SDCAPCD
PM2.5	Good combustion practice and use of natural gas	SMAQMD
CO	Firetube Boilers: 50 ppmvd corrected to 3% O_2 Watertube Boilers: 100 ppmvd corrected to 3% O_2	SMAQMD, BAAQMD, SCAQMD (Rule 1146.1)

(A) Note: 30% annual capacity is equivalent to the boiler operating at full fire for 2,592 hours/year.

REVIEWED BY: _____ **DATE:** _____

APPROVED BY: _____ **DATE:** 6/19/18

Attachment A

Review of BACT Determinations published by EPA

List of BACT determinations published in EPA's RACT/BACT/LAER Clearinghouse (RBLC) for Automotive Refinishing:

RBLC	Permit Date	Process Code (A)	Process/Equipment	Pollutant	Standard	Control Technology	Case-By-Case Basis
TX-0691	05/20/2014	13.310	Fuel Gas Heater 18.0 MMBtu/hr	NOx	0.1 lb/MMBtu	N/A	BACT-PSD
				CO	0.054 lb/MMBtu	N/A	BACT-PSD
TX-0693	04/22/2014	13.310	Heater 5.5 MMBtu/hr	NOx	0.036 lb/MMBtu	N/A	BACT-PSD
				CO	0.08 lb/MMBtu	N/A	BACT-PSD

(A) Process Code 13.310 includes commercial and industrial natural gas (includes propane and LPG) boilers < 100 million BTU/hr.

= Selected as the most stringent BACT determination achieved in practice.

Attachment B

Review of BACT Determinations published by ARB

List of BACT determinations published in ARB's BACT Clearinghouse for boilers > 5 MMBtu/hr to ≤ 33.5 MMBtu/hr:

Capacity	Source	Date	NOx	VOC	CO	PM10
5.05 MMBtu/hr	SCAQMD	3/16/2000	20 ppm @ 3%O_2		50 ppm @ 3%O_2	
20.9 MMBtu/hr	SCAQMD					
16.5 MMBtu/hr	SCAQMD	12/7/1999	7 ppm @ 3%O_2		50 ppm @ 3%O_2	
6.2 MMBtu/hr	SJVUAPCD	2/1/2000	12 ppm @ 3%O_2		50 ppm @ 3%O_2	
10 MMBTU/HR	SCAQMD	4/24/2003	12 ppm @ 3%O_2		50 ppm @ 3%O_2	
21.46 MMBtu/hr	SCAQMD					
21 MMBtu/hr	SCAQMD					
16.4 MMBtu/hr	SCAQMD	2/1/2000	11 ppm @ 3%O_2		50 ppm @ 3%O_2	
8.5 MMbtu/hr	SCAQMD	12/21/1999	12 ppm @ 3%O_2		50 ppm @ 3%O_2	
16.8 MMbtu/hr	SCAQMD	3/10/2000	12 ppm @ 3%O_2		50 ppm @ 3%O_2	
21 MMbtu/hr	SCAQMD					
25 MMBtu/hr	SBCAPCD					
7 MMBtu/hr	SBCAPCD	9/26/2006	12 ppm @ 3%O_2		50 ppm @ 3%O_2	
29.4 MMBtu/hr	SDCAPCD					

= Boilers outside the range (Not in the >5 MMBtu/hr and ≤ 20 MMBtu/hr rage)

= Selected as the most stringent BACT determination achieved in practice.

Note: There is a 1999 BACT determination made by SCAQMD requiring a NOx concentration of 7 ppm @ 3%O_2. However, all subsequent BACT determinations are much higher, including another SCAQMD BACT determination made only 2 weeks later. Therefore, 7 ppm @ 3%O_2 will not be considered a true BACT determination achieved in practice.

Attachment C

SCAQMD's Clean Fuel Guidelines

Team.[14] The BACT Team will review this LAER determination with the BACT SRC prior to listing in the BACT Guidelines.

Whenever permitting staff makes a LAER determination that is more stringent than what SCAQMD has previously required as LAER, the permit to construct may be subject to a public review. In any event depending on Rule 212, the permitting team will forward the preliminary LAER determination to the BACT Team, who will prepare and send a public notice of the preliminary determination to the BACT SRC, potentially interested persons, and anyone else requesting the information. Staff will consider all comments filed during the 30-day review period before making a permit decision. Staff will make every effort to conduct the public review consistent with the requirements of state law. However, if the 30-day review period conflicts with the deadline of the Permit Streamlining Act[15] for issuing the permit, the permit will be issued in accordance with state law. The 30-day public review may also be done in parallel with other public reviews mandated by *Rule 212 - Standards for Approving Permits and Issuing Public Notice* or *Regulation XXX - Title V Permits* in applicable cases.

On a periodic basis, the SCAQMD BACT Team will provide standing status reports to the SCAQMD Governing Board's Stationary Source Committee and to the Governing Board.

In summary, as technology advances, many categories in the SCAQMD's BACT Guidelines will be updated with new listings. This on-going process will reflect new lower emitting technologies not previously identified in the Guidelines.

CLEAN FUEL GUIDELINES

In January 1988, the SCAQMD Governing Board adopted a Clean Fuels Policy that included a requirement to use clean fuels as part of BACT/LAER. A clean fuel is one that produces air emissions equivalent to or lower than natural gas for NO_x, SO_x, ROG, and fine respirable particulate matter (PM_{10}). Besides natural gas, other clean fuels are liquid petroleum gas (LPG), hydrogen and electricity. Utilization of zero and near-zero emission technologies are also integrated into the Clean Fuels Policy. The burning of landfill, digester, refinery and other by-product gases is not subject to the clean fuels requirement. However, the combustion of these fuels must comply with other SCAQMD rules, including the sulfur content of the fuel.

The requirement of a clean fuel is based on engineering feasibility. Engineering feasibility considers the availability of a clean fuel and safety concerns associated with that fuel. Some state and local safety requirements limit the types of fuel, which can be used for emergency standby purposes. Some fire departments or fire marshals do not allow the storage of LPG near occupied buildings. Fire officials have, in some cases, vetoed the use of methanol in hospitals. If special handling or safety considerations preclude the use of the clean fuel, the SCAQMD has allowed the use of fuel oil as a standby fuel in boilers and heaters, fire suppressant pump engines and for emergency standby generators. The use of these fuels must meet the requirements of SCAQMD rules limiting NO_x and sulfur emissions.

[14] To reduce the burden on SCAQMD of preparing hundreds of LAER Determination Forms each month, forms will not be prepared for routine LAER determinations after Part B, Section I of the guidelines has sufficient entries to demonstrate typical LAER requirements.

[15] The requirements of the Permit Streamlining Act are also found in SCAQMD's Rule 210.

Attachment D

Cost Effectiveness Determination for SCR

5 MMBTU/HR BOILER SCR COST EFFECTIVENESS CALCULATION

EPA AIR POLLUTION CONTROL COST MANUAL, Sixth Edition, EPA/452/B-02-001, January 2002

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

Cost Effectiveness = $ 87,129.99 $/ton

Equipment

Boiler rating		5	mmBTU/hr
Boiler Operating hours		8760	hours
Boiler capacity factor		1	
SCR Operating Days		365	days
Total Capacity Factor		1	
Baseline NOx (15 ppm)		0.0182	lb/mmBTU
SCR NOx (5 ppm)		0.00607	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	inches W.G.
Pressure drop for each Catalyst Layer		1	inches 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		0.138	$/KWh
Ammonia Cost		0.101	$/lb
Catalyst Life		24000	hr
Catalyst Layers	2 full, 1 empty		

Boiler Calculations

Q_B	5	mmBTU/hr
$q_{flue\ gas}$	1781.636988	acfm
N_{NOx}	0.666483516	

SCR Reactor Calculations

$Vol_{Catalyst}$	9.467023703	ft3

$A_{Catalyst}$		1.855871862	ft2
A_{SCR}		2.134252642	ft2
l=w=		1.460908157	ft
n_{layer}		2	
h_{layer}		3.55055963	
n_{total}		3	
h_{SCR}		40.65167889	ft

Reagent Calculations

$m_{reagent}$		0.035366583	lb/hr
m_{sol}		0.121953736	lb/hr
q_{sol}		0.016291712	gph
Tank Volume		35.19009887	gal

Cost Estimation

Direct Costs

DC	$	134,407.97

Indirect Costs

General Facilities	$	6,720.40	
Engineering and home office fees	$	13,440.80	
Process Contingency	$	6,720.40	
Total Indirect Installation Costs	$	26,881.59	
Project Contingency	$	24,193.43	
Total Plant Cost	$	185,483.00	
Preproduction Cost	$	3,709.66	
Inventory Capital	$	26.61	
Total Capital Investment	$	189,219.27	

Direct Annual Costs

Maintenance Costs	$	2,838.29	per yr
Power		1.58136825	KW
Annual Electricity	$	1,911.68	per yr
Reagent Solution Cost	$	107.90	per yr

Catalyst Replacement

FWF		0.311051666	
Annual Catalyst Replacement	$	426.99	per yr
Total Variable Direct Cost	$	2,446.57	per yr
Total Direct Annual Cost	$	5,284.86	per yr

CRF		0.094392926	
Indirect Annual Cost	$	17,860.96	per yr
Total annual Cost	$	23,145.82	per yr
NOx Removed		0.27	tons
Cost of NOx removal	$	87,129.99	per ton

20 MMBTU/HR BOILER SCR COST EFFECTIVENESS CALCULATION

EPA AIR POLLUTION CONTROL COST MANUAL, Sixth Edition, EPA/452/B-02-001, January 2002

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

Cost Effectiveness = $ 57,672.23 $/ton

Equipment

Boiler rating	20	mmBTU/hr
Boiler Operating hours	8760	hours
Boiler capacity factor	1	
SCR Operating Days	365	days
Total Capacity Factor	1	
Baseline NOx (15 ppm)	0.0182	lb/mmBTU
SCR NOx (5 ppm)	0.006067	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	inches W.G.
Pressure drop for each Catalyst Layer	1	inches 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	0.138	$/KWh
Ammonia Cost	0.101	$/lb
Catalyst Life	24000	hr
Catalyst Layers	2 full, 1 empty	

Boiler Calculations

Q_B	20	mmBTU/hr
$q_{flue\ gas}$	7126.547952	acfm
N_{NOx}	0.666648352	

SCR Reactor Calculations

$Vol_{Catalyst}$	37.87475183	ft3
$A_{Catalyst}$	7.42348745	ft2
A_{SCR}	8.537010567	ft2

l=w=	2.921816313	ft
n_{layer}	2	
h_{layer}	3.551008006	
n_{total}	3	
h_{SCR}	40.65302402	ft

Reagent Calculations

$m_{reagent}$	0.141466333	lb/hr
m_{sol}	0.487814943	lb/hr
q_{sol}	0.06516685	gph
Tank Volume	140.7603955	gal

Cost Estimation

Direct Costs

DC	$ 334,447.66

Indirect Costs

General Facilities	$ 16,722.38
Engineering and home office fees	$ 33,444.77
Process Contingency	$ 16,722.38
Total Indirect Installation Costs	$ 66,889.53
Project Contingency	$ 60,200.58
Total Plant Cost	$ 461,537.77
Preproduction Cost	$ 9,230.76
Inventory Capital	$106.42
Total Capital Investment	$ 470,874.94

Direct Annual Costs

Maintenance Costs	$ 7,063.12	per yr
Power	6.3254793	KW
Annual Electricity	$ 7,646.75	per yr
Reagent Solution Cost	$ 431.60	per yr

Catalyst Replacement

FWF	0.311051666	
Annual Catalyst Replacement	$ 1,708.25	per yr
Total Variable Direct Cost	$ 9,786.59	per yr
Total Direct Annual Cost	$ 16,849.71	per yr
CRF	0.094392926	
Indirect Annual Cost	$ 44,447.26	per yr

Total annual Cost	$ 61,296.98	per yr
NOx Removed	1.06	tons
Cost of NOx removal	**$ 57,672.23**	**per ton**

Attachment E

Cost Effectiveness Determination for ULNB

5 MMBTU/HR BOILER ULNB COST EFFECTIVENESS CALCULATION

EPA AIR POLLUTION CONTROL COST MANUAL, Sixth Edition, EPA/452/B-02-001, January 2002

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

Cost Effectiveness = $ 24,645.16 $/ton

Equipment

Boiler rating	5	mmBTU/hr
Boiler Operating hours	4380	hours
Boiler capacity factor	1	
Boiler Operating Days	365	days
Total Capacity Factor	1	
LNB NOx (15 ppm)	0.0182	lb/mmBTU
ULNB NOx (7 ppm)	0.0085	lb/mmBTU
LNB NOx (lbs/year)	398.58	
ULNB NOx (lbs/year)	186.15	
NOx Reduction (tons/year)	0.106215	

Cost Estimation

Direct Costs

DC	$	17,000.00	

Indirect Costs

General Facilities	$	850.00	
Engineering and home office fees	$	1,700.00	
Process Contingency	$	850.00	
Total Indirect Installation Costs	$	3,400.00	
Project Contingency	$	3,060.00	
Total Plant Cost	$	23,460.00	
Preproduction Cost	$	469.20	
Total Capital Investment	$	23,929.20	

Direct Annual Costs

Maintenance Costs	$	358.94	per yr
Total Direct Annual Cost	$	358.94	per yr
Annual Interest Rate		7%	
CRF		0.094392926	
Indirect Annual Cost	$	2,258.75	per yr
Total annual Cost	$	2,617.69	per yr
NOx Removed		0.10622	tons
Cost of NOx removal	$	24,645.16	per ton

10 MMBTU/HR BOILER ULNB COST EFFECTIVENESS CALCULATION

EPA AIR POLLUTION CONTROL COST MANUAL, Sixth Edition, EPA/452/B-02-001, January 2002

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

Cost Effectiveness =	**$ 24,645.16**	**$/ton**

Equipment

Boiler rating	10	mmBTU/hr
Boiler Operating hours	4380	hours
Boiler capacity factor	1	
Boiler Operating Days	365	days
Total Capacity Factor	1	
LNB NOx (15 ppm)	0.0182	lb/mmBTU
ULNB NOx (7 ppm)	0.0085	lb/mmBTU
LNB NOx (lbs/year)	797.16	
ULNB NOx (lbs/year)	372.3	
NOx Reduction (tons/year)	0.21243	

Cost Estimation

Direct Costs

DC	$	34,000.00	

Indirect Costs

General Facilities	$	1,700.00	
Engineering and home office fees	$	3,400.00	
Process Contingency	$	1,700.00	
Total Indirect Installation Costs	$	6,800.00	
Project Contingency	$	6,120.00	
Total Plant Cost	$	46,920.00	
Preproduction Cost	$	938.40	
Total Capital Investment	$	47,858.40	

Direct Annual Costs

Maintenance Costs	$	717.88	per yr
Total Direct Annual Cost	$	717.88	per yr
Annual Interest Rate		7%	
CRF		0.094392926	
Indirect Annual Cost	$	4,517.49	per yr
Total annual Cost	$	5,235.37	per yr
NOx Removed		0.21243	tons
Cost of NOx removal	$	24,645.16	per ton

20 MMBTU/HR BOILER ULNB COST EFFECTIVENESS CALCULATION

EPA AIR POLLUTION CONTROL COST MANUAL, Sixth Edition, EPA/452/B-02-001, January 2002

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

Cost Effectiveness = $ 24,500.00 $/ton

Equipment

Boiler rating	20	mmBTU/hr
Boiler Operating hours	2591.735443	hours
Boiler capacity factor	1	
Boiler Operating Days	365	days
Total Capacity Factor	1	
LNB NOx (15 ppm)	0.0182	lb/mmBTU
ULNB NOx (7 ppm)	0.0085	lb/mmBTU
LNB NOx (lbs/year)	943.3917014	
ULNB NOx (lbs/year)	440.5950254	
NOx Reduction (tons/year)	0.251398338	

Cost Estimation

Direct Costs

DC	$	40,000.00	

Indirect Costs

General Facilities	$	2,000.00	
Engineering and home office fees	$	4,000.00	
Process Contingency	$	2,000.00	
Total Indirect Installation Costs	$	8,000.00	
Project Contingency	$	7,200.00	
Total Plant Cost	$	55,200.00	
Preproduction Cost	$	1,104.00	
Total Capital Investment	$	56,304.00	

Direct Annual Costs

Maintenance Costs	$	844.56	per yr
Total Direct Annual Cost	$	844.56	per yr
Annual Interest Rate		7%	
CRF		0.094392926	
Indirect Annual Cost	$	5,314.70	per yr
Total annual Cost	$	6,159.26	per yr
NOx Removed		0.25140	tons
Cost of NOx removal	$	24,500.00	per ton

Attachment F

California Boiler Cost Estimations

CALIFORNIA BOILER®
Complete Boiler Service, Sales, Parts & Rentals

January 17, 2018

Sacramento Metropolitan Air Quality Management District
Attn: Jeffrey Quok
777 12th Street
Sacramento, CA 95814

Subject: Ultra Low NOx Boiler Costing for Various Size Boiler Based on Company 15 PPM NOx Equipment with 9 PPM and 7 PPM NOx Burner

Jeffrey,

Since California Boiler is the Hurst Representative for the entire state of California, we are responding to your request.

We have many units throughout the state in the 5mm BTU to 20mm BTU range. Most of these are operating in the 3 to 7 ppm NOx range. These units can run 3 to 4 ppm NOx from 25% to 90% depending on outside temperature. We guarantee 9 ppm NOx on all boilers in this size range. We will guarantee 7ppm NOx on certain size boilers above 5mm BTU after reviewing the pertinent data to ensure the product complies to our guarantee.

If we guarantee lower than 6 ppm NOx, we provide an SCR system for backend clean-up of the exhaust. We do not guarantee a burner below 7 ppm NOx without an SCR system. We need to ensure our products are in compliance with the requirements, and as the weather changes throughout the state of California, we see NOx swings of 1 to 3ppm. To ensure compliance, we need the burner to operate 2 to 3 ppm below the guaranteed NOx requirement. For example, if we guarantee 7ppm we need the burner to operate, under best conditions, at 5ppm from 25% to 100% of the firing rating. We can add a SCR to any unit and guarantee 5ppm NOx, but this adds $150,000.00 to $250,000.00 to the price of the boiler/burner system depending on the system's size.

If the NOx requirement is set at to 15ppm NOx guarantee we can lower the boiler price slightly but can increase the boiler efficiency by lowering the O2, turndown on the burner plus reduce the amount of FGR to meet the emission requirements. All three of those can increase the boiler overall efficiency by 1% - 3% thus reducing emissions from the system. This would provide safer and more efficient operations (that is why the China EPA decided on 15 ppm NOx and lower o2 for their rules.

CALIFORNIA BOILER®

Complete Boiler Service, Sales, Parts & Rentals

Here is a price list of boilers with 15 ppm burner based on fire tube boilers, 150# steam design, indoor service, operating at 100# steam, burning natural gas only. This all included Power Flame UMC burners not metal mess but use some FGR to meet emissions

On all boilers 5mm BTU and above, if we can guarantee 7 ppm NOx if we add VFD's and controls for the combustion blower motor and a 0^2 trim system. The additional features/costs are not required we guarantee 9ppm NOx. The cost difference of these options is between $20,000.00 to $26,000.00 per unit depending on size.

Some of the companies that are promoting 5 or 6 ppm NOx with burner technology are only doing that on certain size new boilers where the burner and boiler furnace have been designed together. They cannot meet those NOx levels on a retrofit of an existing boiler or on different size boilers not covered by their design. Most of these designs will do 4.8 ppm NOx to 5.6 ppm

NOx with no allowance for temperature changes and the associated NOx swings (1-3ppm). The "swings" will put the boilers out of compliance on some firing rates.

The following table shows a costing example for 5 mm BTU and 20 mm BTU 150# steam Fire tube Hurst Boiler with several NOx levels. From 5 to 15 PPM NOx.

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BOILER PRICING AT DIFFERENT NOX LEVELS

	15 PPM NOx	9 PPM NOx	7 PPM NOx	5 PPM NOx
1. 5mm BTU, 150# steam Boiler set up for indoor service. Hurst model S500-125-150 with Power Flame NP2 Burner (parallel positioning controls standard).	$117,000.00	$124,000.00	$134,000.00 (Add VFD on combustion Blower and 0^2 trim control)	$250,000.00 (Add SCR system) – this is boiler plus SCR
2. 200 HP (8.4) MMBTU	$128,000.00	$142,000.00	$160,000.00	$290,000.00
3. 300 HP	$166,000.00	$182,000.00	$200,000.00	$360,000.00
4. 20mm BTU, 150# steam boiler, indoor service. Hurst model S500-500-150 with Power Flame NVC10 or UCM 500 burners with parallel positioning.	$200,000.00	$225,000.00	$240,000.00	$400,000.00

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My suggestion to the district, based upon the above issues, is 7ppm for boilers above 5mm BTU and 9ppm below those sizes. Note if there option for 15 ppm NOx for boilers below 20 MMBTU or even 10 MMBTU. The over reduction in emission would be about the same as a unit operation at 7 to 9 ppm NOx since a 15 ppm NOx unit will run at lower O2, less FGR with a better turndown (lower the amount of boiler recycles). For boilers below 20mm BTU, the cost of an SCR can double or triple the cost of the boiler system. I, therefore, would not recommend a NOx requirement below 7ppm for any boiler system below 20mm BTU. Boilers above 20mm BTU (steam service) could meet 5ppm NOx with the addition of an SCR system. The extra cost of an SCR on larger boilers is easier to justify relative to the total equipment expenditure.
Regards,

John Clarkson

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