BEST AVAILABLE CONTROL TECHNOLOGY DETERMINATION

DETERMINATION NO.: 112

DATE: August 6, 2015

ENGINEER: Joe Carle

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

Equipment Specific Description: Boiler/heater greater or equal to 75,000 Btu/hr and less than 2.0 MMBtu/hr, fired on natural gas or LPG

Equipment Size/Rating: Small Emitter BACT (PTE < 10 lb/day)

Previous BACT Det. No.: 60

This BACT determination will update Determination #60 for boilers/heaters greater than or equal to 75,000 Btu/hr and less than 2 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 75,000 Btu/hr and less than 2.0 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><u>BACT</u>
<u>Source: EPA RACT/BACT/LAER Clearinghouse</u>

<table>
<tr><td colspan="2">For units with a rating of ≥ 0.075 MMBtu/hr (75,000 Btu/hr) to <2 MMBtu/hr</td></tr>
<tr><td>VOC</td><td>N/A – No BACT determinations found in the ≥ 0.075 to <2 MMBtu/hr range</td></tr>
<tr><td>NOx</td><td>N/A – No BACT determinations found in the ≥ 0.075 to <2 MMBtu/hr range</td></tr>
<tr><td>SOx</td><td>N/A – No BACT determinations found in the ≥ 0.075 to <2 MMBtu/hr range</td></tr>
<tr><td>PM10</td><td>N/A – No BACT determinations found in the ≥ 0.075 to <2 MMBtu/hr range</td></tr>
<tr><td>PM2.5</td><td>N/A – No BACT determinations found in the ≥ 0.075 to <2 MMBtu/hr range</td></tr>
<tr><td>CO</td><td>N/A – No BACT determinations found in the ≥ 0.075 to <2 MMBtu/hr range</td></tr>
</table>
<u>RULE REQUIREMENTS:</u>
None</td></tr>
</table>

<table>
<tr><th>District/Agency</th><th>Best Available Control Technology (BACT)/Requirements</th></tr>
<tr><td>ARB</td><td><u>BACT</u>
<u>Source: ARB BACT Clearinghouse</u>

<table>
<tr><td colspan="2">For units with a rating of ≥ 0.075 MMBtu/hr (75,000 Btu/hr) to <2 MMBtu/hr</td></tr>
<tr><td>VOC</td><td>N/A – No BACT determinations found in the ≥ 0.075 to <2 MMBtu/hr range</td></tr>
<tr><td>NOx</td><td>N/A – No BACT determinations found in the ≥ 0.075 to <2 MMBtu/hr range</td></tr>
<tr><td>SOx</td><td>N/A – No BACT determinations found in the ≥ 0.075 to <2 MMBtu/hr range</td></tr>
<tr><td>PM10</td><td>N/A – No BACT determinations found in the ≥ 0.075 to <2 MMBtu/hr range</td></tr>
<tr><td>PM2.5</td><td>N/A – No BACT determinations found in the ≥ 0.075 to <2 MMBtu/hr range</td></tr>
<tr><td>CO</td><td>N/A – No BACT determinations found in the ≥ 0.075 to <2 MMBtu/hr range</td></tr>
</table>

<u>RULE REQUIREMENTS:</u>
None</td></tr>
<tr><td>SMAQMD</td><td><u>BACT</u>
<u>Source: SMAQMD BACT Clearinghouse, BACT Determination Number 60</u>

<table>
<tr><td colspan="2">For units with a rating of < 2 MMBtu/hr</td></tr>
<tr><td>VOC</td><td>No standard</td></tr>
<tr><td>NOx</td><td>20 ppmvd at 3% O_2, low NOx burner</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>400 ppmvd at 3% O_2, Burner technology controlling NOx as a priority</td></tr>
</table>

<u>RULE REQUIREMENTS:</u>
<u>Rule 414 - Water Heaters, Boilers And Process Heaters Rated Less Than 1,000,000 BTU Per Hour</u>
For units with a rating of ≥ 75,000 Btu/hr to < 400,000 Btu/hr
Pool/Spa Heater – 55 ppmvd of NOx corrected to 3% O_2
All others – 20 ppmvd of NOx corrected to 3% O_2

For units with a rating of ≥ 400,000 Btu/hr to < 1 MMBtu/hr
20 ppmvd of NOx corrected to 3% O_2
400 ppmvd of CO corrected to 3% O_2

<u>Rule 411 - NOx from Boilers, Process Heaters and Steam Generators</u>
For units with a rating of ≥ 1 MMBtu/hr to < 2 MMBtu/hr
30 ppmvd of NOx corrected to 3% O_2
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>South Coast AQMD</td><td>
<u>BACT</u>
Source: <u>SCAQMD BACT Guidelines for Non-Major Polluting Facilities</u>.

SCAQMD BACT Guidelines do not contain a determination for boilers/heaters 2 MMBtu/hr or less, since these units are not required to obtain a written permit, pursuant to SCAQMD Rule 219.

<u>SCAQMD Rule 219(b)(2)</u>
Written permits are not required for boilers, process heaters, or any combustion equipment that has a rated maximum heat input capacity of 2,000,000 Btu per hour (gross) or less and are equipped to be heated exclusively with natural gas, methanol, liquefied petroleum gas, or any combination thereof.

<u>RULE REQUIREMENTS:</u>
<u>Reg XI, Rule 1146.2 – Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers and Process Heaters</u>

<table>
<tr><th>Category</th><th>NOx Limit</th><th>CO Limit</th><th>Units manufactured for use or offered for sale after</th></tr>
<tr><td>Type 1 Unit (except pool heaters)</td><td>14 nanograms per joule of heat output (20 ppmvd @ 3% O_2)</td><td>No standard</td><td>January 1, 2012</td></tr>
<tr><td>Type 1 Unit (pool heater)</td><td>40 nanograms per joule of heat output (55 ppmvd NOx @3% O_2)</td><td>No standard</td><td>January 1, 2001</td></tr>
<tr><td>Type 2 Unit</td><td>14 nanograms per joule of heat output (20 ppmvd @ 3% O_2)</td><td>400 ppmvd @ 3% O_2</td><td>January 1, 2010</td></tr>
</table>
(A) TYPE 1 UNIT means any water heater, boiler or process heater with a RATED HEAT INPUT CAPACITY less than or equal to 400,000 BTU per hour excluding TANK TYPE WATER HEATERS subject to the limits of District Rule 1121.
(B) TYPE 2 UNIT means any water heater, boiler or process heater with a RATED HEAT INPUT CAPACITY greater than 400,000 BTU per hour up to and including 2,000,000 BTU per hour.
</td></tr>
</table>

<table>
<tr><th>District/Agency</th><th>Best Available Control Technology (BACT)/Requirements</th></tr>
<tr><td>San Joaquin Valley APCD</td><td>
<u>BACT</u>
Source: <u>SJVUAPCD BACT Guideline (Rescinded)</u>

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 SJUVAPCD Rule 2020.

<u>SJVUAPCD Rule 2020 §6.0</u>
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.

<u>RULE REQUIREMENTS:</u>

<u>SJVAPCD Rule 4308 – Boilers, Steam Generators, and Process Heaters – 0.075 MMBtu/hr to less than 2.0 MMBtu/hr</u>

<table>
<tr><th colspan="3">Emission Limits (Effective on or after January 1, 2015)</th></tr>
<tr><th rowspan="2">Type and Size of Unit, in MMBtu/hr</th><th colspan="2">NOx Limit (corrected to 3% O2)</th></tr>
<tr><th>PUC Gas</th><th>Non-PUC Gas or Liquid</th></tr>
<tr><th></th><th>lb/MMBtu of heat input (ppmvd)</th><th>lb/MMBtu of heat input (ppmvd)</th></tr>
<tr><td>Units ≥ 0.075 and ≤ 0.4, except as below</td><td>0.024 (20)</td><td>0.093 (77)</td></tr>
<tr><td>Units > 0.4 and < 2.0, except as below</td><td>0.024 (20)</td><td>0.036 (30)</td></tr>
<tr><td>Instantaneous water heaters ≥ 0.075 and ≤ 0.4</td><td>0.024 (20)</td><td>0.093 (77)</td></tr>
<tr><td>Instantaneous water heaters >0.4 and <2.0</td><td>0.024 (20)</td><td>0.036 (30)</td></tr>
<tr><td>Pool heaters ≥ 0.075 and ≤ 0.4</td><td>0.068 (55)</td><td>0.093 (77)</td></tr>
<tr><td>Pool heaters > 0.4 and < 2.0</td><td>0.024 (20)</td><td>0.036 (30)</td></tr>
</table>
For units with a rating of ≥ 0.4 MMBtu/hr and < 2.0 MMBtu/hr: 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>San Diego County APCD</td><td>
<u>BACT</u>
Source: <u>NSR Requirements for BACT</u>

SDAPCD BACT Guidelines do not contain a determination for boilers/heaters 5 MMBtu/hr or less, since these units are not required to obtain a written permit, pursuant to SDAPCD Rule 11.

<u>SDAPCD Rule 11(d)</u>
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.

<u>RULE REQUIREMENTS:</u>
<u>Regulation 4, Rule 69.2.1 – Small Boilers, Process Heaters, and Steam Generators</u>

<table>
<tr><th colspan="3">Emission Limits (Effective on or after March 25, 2010)</th></tr>
<tr><td rowspan="2">Type of equipment and size, in MMBtu/hr</td><td>NOx</td><td>CO</td></tr>
<tr><td>ppmvd</td><td>ppmvd</td></tr>
<tr><td>Units ≥ 0.6 and ≤ 2.0, except as below, fired on gaseous fuel</td><td>30</td><td>400</td></tr>
<tr><td>Units ≥ 0.6 and ≤ 2.0, except as below, fired on liquid fuel</td><td>40</td><td>400</td></tr>
<tr><td>Units < 0.6</td><td>Rule not applicable</td><td>Rule not applicable</td></tr>
</table>
(A) This rule does not apply to waste heat recovery boilers
(B) This rule does not apply to Furnaces, kilns, and any combustion equipment where the material being heated is in direct contact with the products of combustion.
(C) This rule does not apply to thermal oxidizers and associated waste heat recovery equipment.
</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>
<u>BACT</u>
Source: <u>BAAQMD BACT Guideline</u>

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.

<u>BAAQMD Rule 2-1-114</u>
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.

<u>RULE REQUIREMENTS:</u>

<u>BAAQMD Reg 9, Rule 6 – Nitrogen Oxide Emissions from Natural Gas-fired Boilers and Water Heaters</u>

<table>
<tr><th colspan="3">Emission Limits (Effective January 1, 2013)</th></tr>
<tr><th>Type of unit</th><th>Size of Unit in Btu/hr</th><th>NOx Limit in nanograms per joule of heat output (ppmvd @ 3% O2)</th></tr>
<tr><td>Pool/spa heater</td><td>75,001 to 400,000</td><td>No standard</td></tr>
<tr><td>Pool/spa heater</td><td>400,001 to 2,000,000</td><td>14 (20)</td></tr>
<tr><td>Other boilers/heaters</td><td>75,001 to 2,000,000</td><td>14 (20)</td></tr>
</table>
</td></tr>
</table>

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

SUMMARY OF ACHIEVED IN PRACTICE CONTROL TECHNOLOGIES	
VOC	1. No standard [SMAQMD, SCAQMD, SJVUAPCD, SDCAPCD, BAAQMD]
NOx	1. Boilers/heaters < 2 MMBtu/hr: 20 ppmvd at 3% O_2 – [SMAQMD (BACT)][1] 2. Pool/spa heaters ≥ 75,000 Btu/hr and < 400,000 Btu/hr: 55 ppmvd at 3% O_2 All Other Boilers/Heaters ≥ 75,000 Btu/hr and < 2,000,000 Btu/hr: 20 ppmvd at 3% O_2 – [SCAQMD, SJVAPCD] 3. Pool/spa heaters ≥ 75,000 Btu/hr and < 400,000 Btu/hr: no standard All Other Boilers/Heaters ≥ 75,000 Btu/hr and < 2,000,000 Btu/hr: 20 ppmvd at 3% O_2 – [BAAQMD] 4. Boilers/heaters ≥ 75,000 Btu/hr and < 600,000 Btu/hr: no standard Boilers/heaters ≥ 600,000 Btu/hr and < 2,000,000 Btu/hr: 30 ppmvd at 3% O_2 – [SDCAPCD]
SOx	1. No standard [SMAQMD, SCAQMD, SJVUAPCD, SDCAPCD, BAAQMD]
PM10	1. No standard [SMAQMD, SCAQMD, SJVUAPCD, SDCAPCD, BAAQMD]
PM2.5	1. No standard [SMAQMD, SCAQMD, SJVUAPCD, SDCAPCD, BAAQMD]
CO	1. Boilers/heaters < 2 MMBtu/hr: 400 ppmvd at 3% O_2 – [SMAQMD (BACT)] 2. Boilers/heaters ≥ 75,000 Btu/hr and < 400,000 Btu/hr: no standard Boilers/heaters ≥ 400,000 Btu/hr and < 2,000,000 Btu/hr: 400 ppmvd at 3% O_2 – [SCAQMD, SJVUAPCD] 3. Boilers/heaters ≥ 75,000 Btu/hr and < 600,000 Btu/hr: no standard Boilers/heaters ≥ 600,000 Btu/hr and < 2,000,000 Btu/hr: 400 ppmvd at 3% O_2 – [SDCAPCD] 4. No standard [BAAQMD]

[1] Although this is the most stringent regulatory requirement it is recognized that pool/spa heaters have not actually achieved 20 ppmvd of NOx at 3% O_2 in practice and have only been shown to achieve levels of 55 ppmvd of NOx at 3% O_2. The following control technologies have been identified as the most stringent, achieved in practice control technologies:

BEST CONTROL TECHNOLOGIES ACHIEVED		
Pollutant	**Standard**	**Source**
VOC	No standard	
NOx	Boilers/heaters < 2 MMBtu/hr: 400 ppmvd at 3% O_2	SMAQMD (current BACT)
SOx	No standard	
PM10	No standard	
PM2.5	No standard	
CO	Boilers/heaters < 2 MMBtu/hr: 400 ppmvd at 3% O_2	SMAQMD (current BACT)

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.

VOC	Good combustion practice; Use of natural gas or LPG if natural gas is not available
NOx	1. Selective Catalytic Reduction (SCR) 2. Flue Gas Recirculation (FGR) with a Low-NOx burner
SOx	Good combustion practice; Use of natural gas or LPG if natural gas is not available
PM10	Good combustion practice; Use of natural gas or LPG if natural gas is not available
PM2.5	Good combustion practice; Use of natural gas or LPG if natural gas is not available
CO	Good combustion practice; Use of natural gas or LPG if natural gas is not available

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

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)
ROG	17,500
NO_X	24,500
PM_{10}	11,400
SO_X	18,300
CO	TBD if BACT triggered

SCR:

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.

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.

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

[1] SMAQMD, "BACT Determination: Boilers/Heaters ≥5 and <20 MMBTU/hr fired on natural gas or LPG," June 3,2015

$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; Use of Natural Gas or LPG if Natural Gas is Not Available:
Since this determination is for boilers/heaters that use natural gas or LPG continued use of these fuels will maintain pollutant levels lower than use of other fossil fuels and will not add any additional costs. 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.

C. SELECTION OF BACT:

Because no other technically feasible alternatives are available for the size range of these boilers/heaters BACT for NOx and CO will remain at what is currently achieved in practice. BACT for all other pollutants will be to require good combustion practices and use of natural gas or LPG if natural gas is not available because it will maintain pollutants at their current levels and no other technically feasible alternatives were identified.

BACT FOR BOILERS/HEATERS ≥ 75,000 AND < 2,000,000 BTU/HR		
Pollutant	**Standard**	**Source**
VOC	Good combustion practice; Use of natural gas or LPG if natural gas is not available	
NOx	Pool/spa heaters: 55 ppmvd at 3% O_2 All other boilers/heaters: 20 ppmvd at 3% O2	SCAQMD (Rule 1146.2), SJVUAPCD (Rule 4308)
SOx	Good combustion practice; Use of natural gas or LPG if natural gas is not available	
PM10	Good combustion practice; Use of natural gas or LPG if natural gas is not available	
PM2.5	Good combustion practice; Use of natural gas or LPG if natural gas is not available	
CO	400 ppmvd at 3% O_2	SCAQMD (Rule 1146.2) SJVUAPCD (Rule 4308)

REVIEWED BY: Brian F Kelly **DATE:** 8-12-15

APPROVED BY: [signature] **DATE:** 8/14/15

SMAQMD BACT CLEARINGHOUSE

CATEGORY: **BOILER/HEATER < 5 MMBTU**

BACT Size: Small Emitter BACT (PTE < 10 lb/day) **BOILER**

BACT Determination Number: 112	**BACT Determination Date:** 8/6/2015

Equipment Information

Permit Number: N/A -- Generic BACT Determination
Equipment Description: BOILER
Unit Size/Rating/Capacity: BOILER/HEATER >=75,000 BTU/HR and < 2 MMBTU/HR
Equipment Location:

BACT Determination Information

ROCs	**Standard:**	Good combustion practices; Use of NG or LPG
	Technology Description:	
	Basis:	Achieved in Pactice
NOx	**Standard:**	Pool/spa heaters: 55 ppmv. All other: 20 ppmv
	Technology Description:	Low-NOx burner
	Basis:	Achieved in Pactice
SOx	**Standard:**	Good combustion practices; Use of NG or LPG
	Technology Description:	
	Basis:	Achieved in Pactice
PM10	**Standard:**	Good combustion practices; Use of NG or LPG
	Technology Description:	
	Basis:	Achieved in Pactice
PM2.5	**Standard:**	Good combustion practices; Use of NG or LPG
	Technology Description:	
	Basis:	Achieved in Pactice
CO	**Standard:**	400 ppmv
	Technology Description:	Low-NOx burner
	Basis:	Achieved in Pactice
LEAD	**Standard:**	
	Technology Description:	
	Basis:	

Comments: PPMV is corrected to 3% O2
Only use LPG if natural gas is not available

District Contact: Joe Carle Phone No.: (916) 874 - 4838 email: jcarle@airquality.org

Printed: 8/14/2015