SMAQMD BACT CLEARINGHOUSE

ACTIVE

CATEGORY Type: **BOILER**

BACT Category: Minor Source BACT

BACT Determination Number: 343	**BACT Determination Date:** 2/9/2024

Equipment Information

Permit Number: N/A -- Generic BACT Determination

Equipment Description: BOILER > 5 MMBTU

Unit Size/Rating/Capacity: > 20 MMBtu/hr, natural gas or LPG fired

Equipment Location:

BACT Determination Information

District Contact: Jeff Quok Phone No.: (279) 207-1145 email: jquok@airquality.org

ROCs	**Standard:**	PUC quality natural gas or propane with LPG backup
	Technology Description:	
	Basis:	Achieved in Practice
NOx	**Standard:**	2.5 ppm @ 3% O2 or 0.003 lb/MMBtu
	Technology Description:	
	Basis:	Achieved in Practice
SOx	**Standard:**	PUC quality natural gas or propane with LPG backup
	Technology Description:	
	Basis:	Achieved in Practice
PM10	**Standard:**	PUC quality natural gas or propane with LPG backup
	Technology Description:	
	Basis:	Achieved in Practice
PM2.5	**Standard:**	PUC quality natural gas or propane with LPG backup
	Technology Description:	
	Basis:	Achieved in Practice
CO	**Standard:**	50 ppm @ 3% O2 or 0.037 lb/MMBtu
	Technology Description:	
	Basis:	Achieved in Practice
LEAD	**Standard:**	
	Technology Description:	
	Basis:	

Comments: This is a generic BACT determination based on BACT determinations made, and published, by other air agencies in California and/or other States.

Printed: 3/28/2024

SMAQMD BACT CLEARINGHOUSE

ACTIVE

CATEGORY Type: **BOILER**

BACT Category: Minor Source BACT

BACT Determination Number: 344	**BACT Determination Date:** 2/9/2024

Equipment Information

Permit Number: N/A -- Generic BACT Determination

Equipment Description: RENTAL BOILER > 5 MMBTU

Unit Size/Rating/Capacity: > 20 MMBtu/hr, Natural gas or LPG fired

Equipment Location:

BACT Determination Information

District Contact: Jeff Quok Phone No.: (279) 207-1145 email: jquok@airquality.org

ROCs	**Standard:**	PUC quality natural gas or propane with LPG backup
	Technology Description:	
	Basis:	Achieved in Practice
NOx	**Standard:**	5 ppm @ 3% O2 or 0.0062 lb/MMBtu
	Technology Description:	
	Basis:	Achieved in Practice
SOx	**Standard:**	PUC quality natural gas or propane with LPG backup
	Technology Description:	
	Basis:	Achieved in Practice
PM10	**Standard:**	PUC quality natural gas or propane with LPG backup
	Technology Description:	
	Basis:	Achieved in Practice
PM2.5	**Standard:**	PUC quality natural gas or propane with LPG backup
	Technology Description:	
	Basis:	Achieved in Practice
CO	**Standard:**	50 ppm @ 3% O2 or 0.037 lb/MMBtu
	Technology Description:	
	Basis:	Achieved in Practice
LEAD	**Standard:**	
	Technology Description:	
	Basis:	

Comments: This is a generic BACT determination based on BACT determinations made, and published, by other air agencies in California and/or other States.

Printed: 3/28/2024

777 12th Street, Ste. 300

SACRAMENTO METROPOLITAN AIR QUALITY MANAGEMENT DISTRICT

Sacramento, CA 95814

BEST AVAILABLE CONTROL TECHNOLOGY DETERMINATION

DETERMINATION NOS.:	343 & 344
DATE:	2/9/2024
ENGINEER:	Jeffrey Quok

Category/General Equip Description:	Boiler/Heater – Natural Gas or LPG Fired
Equipment Specific Description:	**#343** – Boiler/Heater Natural Gas or LPG Fired, > 20 MMBtu/hr **#344** – Rental Boiler/Heater Natural Gas or LPG Fired, > 20 MMBtu/hr
Equipment Size/Rating:	Minor Source BACT
Previous BACT Det. No.:	N/A

These determinations will focus on both stationary and rental natural gas and LPG boilers/heaters, which include external combustion equipment used to produce hot water or steam and units which transfer heat from combustion gases to water or process streams. Heaters do not include any dryer in which the material being dried is in direct contact with the products of combustion, cement or lime kilns, glass melting furnaces, or smelters. Rental boilers are units that are rented out to provide facilities temporary support to increase capacity or to provide temporary support while boilers are under repair or replacement.

BACT/T-BACT ANALYSIS

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

The following control technologies are currently employed as BACT/T-BACT for boilers/heaters greater than 20 MMBtu/hr by the following air pollution control districts:

US EPA

BACT
Source: EPA RACT/BACT/LAER Clearinghouse (See Attachment A)
RBLC ID: OH-0387

For Natural Gas, 29.4 MMBtu/hr Boiler	
VOC	0.005 lb/MMBtu (Good combustion practices and use of natural gas)
NOx	0.011 lb/MMbtu (9 ppm @ 3% O_2)
SOx	No standard
PM10	0.0005 lb/MMBtu (Good combustion practices and use of natural gas)
PM2.5	0.0004 lb/MMBtu (Good combustion practices and use of natural gas)
CO	0.037 lb/MMBtu (Good combustion practices and use of natural gas)

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.

Note: The BACT emission limits for VOC, NOx, PM10, PM2.5, and CO are based on good combustion practices and the use of natural gas. Since these emission limits are not verified through testing, good combustion practices and use of natural gas will be considered BACT.

T-BACT
There are no T-BACT standards published in the clearinghouse for this category.

RULE REQUIREMENTS:

40 CFR 60 Subpart Dc – Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units (1/13/2007)

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 or LPG only. Therefore, this NSPS is not applicable.

40 CFR 60 Subpart Db – Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units (1/13/2007)

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

40 CFR Part 63, Subpart JJJJJJ – National Emission Standards for Hazardous Air Pollutants for Industrial, Commercial, and Institutional Boilers at Area Sources (2/21/2011)
This rule applies if you own or operate a boiler combusting solid fossil fuels, biomass, or liquid fuels located at an area source, except for emergencies, gas curtailment or periodic testing. Boilers fired on natural gas or LPG as a primary fuel are not covered in this subpart. Since

this BACT is for natural gas and LPG fuels, this regulation does not apply.

40 CFR Part 63, Subpart DDDDD – National Emission Standards for Hazardous Air Pollutants for Industrial, Commercial, and Institutional Boilers for Major Sources (2/21/2011) will be discussed here. This rule only applies to boilers located at a major source of HAPs. A major source is a facility that has a potential to emit 10 tons per year of any single air toxic or 25 tons per year of any combination of air toxics. This rule sets emission standards for Particulate Matter, Mercury, Hydrochloric acid, Carbon Monoxide, and Dioxins/Furans for all boilers that are not burning a fuel that qualifies as Gas 1 (i.e., natural gas). All boilers that combust fuels that qualify as Gas 1 or any other boiler ≥ 10 MMBtu/hr will be required to perform an annual tune-up. Lastly, any existing boiler located at a major source must have a one-time energy assessment performed on the major source facility by qualified energy assessor. Since these BACTs are only for minor sources, this regulation does not apply.

California Air Resource Board (CARB)

BACT
Source: ARB BACT Clearinghouse
CARB BACT Guidelines Search
App No. 562449 (3-22-16) SCAQMD

For Natural gas, Watertube, 39.9 MMBtu/hr Boiler with SCR	
VOC	No standard
NOx	5 ppmvd corrected to 3% O_2 with 15 minute averaging time.
SOx	No standard
PM10	No standard
PM2.5	No standard
CO	100 ppmvd corrected to 3% O_2 with 15 minute averaging time.
Inorganic	For Selective Catalytic Reduction (SCR): 5 ppmvd NH3 slip corrected to 3% O_2 with 60-minute averaging time.

Inorganic BACT standard for ammonia (NH_3) will be considered on a case-by-case basis as ammonia slip can differ depending on NOx emissions of the specific unit.

T-BACT
Source: ARB BACT Clearinghouse
CARB BACT Guidelines Search

T-BACT
There are no T-BACT standards published in the clearinghouse for this category.

RULE REQUIREMENTS:
None.

Sacramento Metropolitan AQMD

BACT
Source: SMAQMD BACT Clearinghouse
No BACT Determinations for this category in the Clearinghouse.

T-BACT
No T-BACT Determinations for this category in the Clearinghouse.

RULE REQUIREMENTS:
Rule 411 – NOx from Boilers, Process Heaters, and Steam Generators (8-23-2007)
For units with a rating of > 20 MMBtu/hr, emissions shall not exceed the following levels:

1. 9 ppmvd of NOx corrected to 3% O_2
2. 400 ppmvd of CO corrected to 3% O_2

South Coast AQMD

BACT
Source: SCAQMD BACT Guidelines for Non-Major Polluting Facilities, page 13 (9/2/2022)

For natural gas or propane fired with a rating of ≥ 20:	
VOC	No Standard
NOx	Compliance with SCAQMD Rules 1146 (2-1-2019) (see below)
SOx	Use of natural gas
PM10	Use of natural gas
PM2.5	No standard
CO	Firetube Boiler: 50 ppmvd corrected to 3% O_2 Watertube Boiler: 100 ppmvd corrected to 3% O_2

T-BACT
There are no T-BACT standards published in the clearinghouse for this category.

RULE REQUIREMENTS:

Reg XI, Rule 1146 – Emissions of Oxides of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters (12-4-2020)

Requirements Table 1146-1

Category - Boiler Rating ≥ 20 and < 75 MMBTU/hr (Group II Units)	NOx Limit
Group II Units (All others) (A)	5 ppmvd @ 3% O_2 or 0.0062 lbs/10^6 Btu

(A) Group II Units (All Others) includes any unit with a rated heat input capacity less than 75 million Btu per hour down to and including 20 million Btu per hour, excluding thermal fluid heaters and units operated at schools and universities. All other units would include LPG/propane fired.

All units rated greater than or equal to 5 MMBtu/hr must have CO emissions ≤ 400 ppmvd @ 3% O_2.

San Joaquin Valley APCD

BACT
Source: SJVUAPCD BACT Guideline 1.1.2 (11/30/22)

For natural gas or propane fired boilers/steam generators with heat input rating greater than 20 MMBTU/hr:	
VOC	PUC quality natural gas or propane with LPG backup
NOx	2.5 ppm @ 3% O_2 (0.003 lb/MMBtu)
SOx	PUC quality natural gas or propane with LPG backup
PM10	PUC quality natural gas or propane with LPG backup
PM2.5	No Standard
CO	50 ppm @ 3% O_2 (0.037 lb/MMBtu)

After discussions with R.F. MacDonald Company, it was found that current SCR boiler rental fleets can only meet 5 ppm NOx at 3% O_2 (See Attachment B). Since no SCR rental boilers can currently meet the 2.5 ppm NOx standards, SJVAPCD's NOx standard will be considered not achieved in practice for rental boilers.

T-BACT
There are no T-BACT standards published in the clearinghouse for this category.

RULE REQUIREMENTS:
Rule 4306 – Boilers, Steam Generators, and Process Heaters – Phase 3 (12-17-2020)

Until 12/31/23

Type (Gaseous Fuel Fired)	**NOx Limit ppmvd @ 3% O_2**	**CO Limit ppmvd @ 3% O_2**
Units with a rated heat input greater than 20.0 MMbtu/hr except categories oilfield steam generators, refinery units, load following units, and units limited to an annual heat input of 9 billion Btu/year to 30 billion Btu/year	9 or 0.011 lb/MMBtu	400
Units limited to an annual heat input of 9 billion Btu/year to 30 billion Btu/year	30 or 0.036 lb/MMBtu	400

After 12/31/23

Type (Gaseous Fuel Fired)	**NOx Limit ppmvd @ 3% O_2**	**CO Limit ppmvd @ 3% O_2**
Units with a total rated heat input > 20.0 MMBtu/hr and ≤ 75 MMBtu/hr	7 or 0.0085 lb/MMBtu	400

San Diego County APCD

BACT
Source: NSR Requirements for BACT, page 3-5 and 3-6

For boiler with a rating of < 50 MMBTU/hr :	
VOC	Natural gas or LPG fuel
NOx	9 ppm @ 3% O_2, natural gas or LPG
SOx	Natural gas or LPG fuel
PM10	Natural gas or LPG fuel
PM2.5	Natural gas or LPG fuel
CO	No Standard

For boiler with a rating of 50 to < 250 MMBTU/hr :	
VOC	Natural gas or LPG fuel
NOx	9 ppm @ 3% O_2, natural gas or LPG (Achieved in Practice) 5 ppm @ 3% O_2, natural gas or LPG (Technologically feasible)
SOx	Natural gas or LPG fuel
PM10	Natural gas or LPG fuel
PM2.5	Natural gas or LPG fuel
CO	No Standard

T-BACT
There are no T-BACT standards published in the clearinghouse for this category.

RULE REQUIREMENTS:
Regulation 4, Rule 69.2 – Industrial and Commercial Boilers, Process Heaters and Steam Generators (9-27-1994)

This rule applies to any unit with a heat input rating of 5 MMBtu/hr or more.

Equipment Type	Fuel	Heat Input Rating (Btu per hour)	Concentration of NOx (ppmv at 3% O_2)	Concentration of CO (ppmv at 3% O_2)
New Unit	Gaseous Fuel	Greater than or equal to 5 MMBtu/hr	30	400

Bay Area AQMD

BACT
Source: BAAQMD BACT Workbook

BACT Guideline 17.1.1 (8/4/2010) For boiler with a rating of 5 to < 33.5 MMBTU/hr :	
VOC	Good Combustion Practice
NOx	Low NOx burners and Flue Gas Recirculation
SOx	Natural gas with ≤ 100 ppmvd total reduced sulfur
PM10	Natural gas
PM2.5	Natural gas
CO	Firetube Boiler: 50 ppmvd corrected to 3% O_2 Watertube Boiler: 100 ppmvd corrected to 3% O_2

BACT Guideline 17.2.1 (8/4/2010) **For boiler with a rating of 33.5 to < 50 MMBTU/hr :**	
VOC	Good Combustion Practice
NOx	Low NOx burners and Flue Gas Recirculation
SOx	Natural gas with ≤ 100 ppmv total reduced sulfur
PM10	Natural gas
PM2.5	Natural gas
CO	100 ppmvd corrected to 3% O_2

BACT Guideline 17.3.1 (8/4/2010) **For boiler with a rating of ≥ 50 MMBTU/hr :**	
VOC	Good Combustion Practice
NOx	40 ppm NOx @ 3% O_2, Ultra Low NOx burners and Flue Gas Recirculation
SOx	Natural gas with ≤ 100 ppmv total reduced sulfur
PM10	Natural gas
PM2.5	Natural gas
CO	50 ppmvd corrected to 3% O_2

T-BACT
There are no T-BACT standards published in the clearinghouse for this category.

RULE REQUIREMENTS:
Regulation 9, Rule 7 – Nitrogen Oxides and Carbon Monoxide from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters (5-4-2011)

For gaseous, except landfill or digester gas 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

Summary of Achieved in Practice Control Technologies

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

SUMMARY OF ACHIEVED IN PRACTICE CONTROL TECHNOLOGIES	
VOC	For Stationary Boilers 1. PUC quality natural gas or propane with LPG backup – [SJVAPCD] 2. Good combustion practice and use of natural gas – [EPA, SMAQMD, BAAQMD] 3. Natural gas or LPG fuel – [SDAPCD] 4. No standard – [ARB, SCAQMD] For Rental Boilers 1. PUC quality natural gas or propane with LPG backup – [SJVAPCD] 2. Good combustion practice and use of natural gas – [EPA, SMAQMD, BAAQMD] 3. Natural gas or LPG fuel – [SDAPCD] 4. No standard – [ARB, SCAQMD]
NOx	For Stationary Boilers 1. 2.5 ppm @ 3% O_2 (0.003 lb/MMBtu) – [SJVAPCD] 2. 5 ppmvd @ 3% O_2 or 0.0062 lbs/MMBtu [SCAQMD] 3. 9 ppmvd corrected to 3% O_2 – [EPA, SMAQMD, SDAPCD, BAAQMD] For Rental Boilers 1. 5 ppmvd @ 3% O_2 or 0.0062 lbs/MMBtu [SCAQMD] 2. 9 ppmvd corrected to 3% O_2 – [SMAQMD, SDAPCD, BAAQMD]
SOx	For Stationary Boilers 1. PUC quality natural gas or propane with LPG backup – [SJVAPCD] 2. Natural gas with ≤ 100 ppmvd total reduced sulfur – [BAAQMD] 3. Use of natural gas – [SCAQMD] 4. Natural gas or LPG fuel – [SDAPCD] 5. No standard – [EPA, CARB, SMAQMD] For Rental Boilers 1. PUC quality natural gas or propane with LPG backup – [SJVAPCD] 2. Natural gas with ≤ 100 ppmvd total reduced sulfur – [BAAQMD] 3. Use of natural gas – [SCAQMD] 4. Natural gas or LPG fuel – [SDAPCD] 5. No standard – [EPA, CARB, SMAQMD]
PM10	For Stationary Boilers 1. PUC quality natural gas or propane with LPG backup – [SJVAPCD] 2. Good combustion practice and use of natural gas – [EPA] 3. Use of natural gas – [SCAQMD, BAAQMD] 4. Natural gas or LPG fuel – [SDAPCD] 5. No standard – [CARB, SMAQMD] For Rental Boilers 1. PUC quality natural gas or propane with LPG backup – [SJVAPCD] 2. Good combustion practice and use of natural gas – [EPA] 3. Use of natural gas – [SCAQMD, BAAQMD] 4. Natural gas or LPG fuel – [SDAPCD] 5. No standard – [CARB, SMAQMD]

SUMMARY OF ACHIEVED IN PRACTICE CONTROL TECHNOLOGIES	
PM2.5	<u>For Stationary Boilers</u> 1. Good combustion practice and use of natural gas – [EPA, SMAQMD] 2. PUC quality natural gas or propane with LPG backup – [SJVAPCD] 3. Use of natural gas – [SCAQMD] 4. Natural gas or LPG fuel – [SDAPCD] <u>For Rental Boilers</u> 1. Good combustion practice and use of natural gas – [EPA, SMAQMD] 2. PUC quality natural gas or propane with LPG backup – [SJVAPCD] 3. Use of natural gas – [SCAQMD] 4. Natural gas or LPG fuel – [SDAPCD]
CO	<u>For Stationary Boilers</u> 1. 50 ppm @ 3% O_2 (0.037 lb/MMBtu) – [SJVAPCD, BAAQMD] 2. Firetube Boilers: 50 ppmvd corrected to 3% O_2, and Watertube Boilers: 100 ppmvd corrected to 3% O_2 – [SCAQMD, BAAQMD] 3. Good combustion practices and use of natural gas – [EPA] 4. No standard – [SMAQMD, SDAPCD] <u>For Rental Boilers</u> 1. 50 ppm @ 3% O_2 (0.037 lb/MMBtu) – [SJVAPCD, BAAQMD] 2. Firetube Boilers: 50 ppmvd corrected to 3% O_2, and Watertube Boilers: 100 ppmvd corrected to 3% O_2 – [SCAQMD, BAAQMD] 3. Good combustion practices and use of natural gas – [EPA] 4. No standard – [SMAQMD, SDAPCD]

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

BEST CONTROL TECHNOLOGIES ACHIEVED		
Pollutant	**Standard**	**Source**
VOC	<u>For Stationary Boilers</u> PUC quality natural gas or propane with LPG backup <u>For Rental Boilers</u> PUC quality natural gas or propane with LPG backup	SJVAPCD
NOx	<u>For Stationary Boilers</u> 2.5 ppm @ 3% O_2 or 0.003 lb/MMBtu <u>For Rental Boilers</u> 5 ppmvd @ 3% O_2 or 0.0062 lbs/MMBtu	SJVAPCD SCAQMD
SOx	<u>For Stationary Boilers</u> PUC quality natural gas or propane with LPG backup <u>For Rental Boilers</u> PUC quality natural gas or propane with LPG backup	SJVAPCD

BEST CONTROL TECHNOLOGIES ACHIEVED		
Pollutant	**Standard**	**Source**
PM10	For Stationary Boilers PUC quality natural gas or propane with LPG backup For Rental Boilers PUC quality natural gas or propane with LPG backup	SJVAPCD
PM2.5	For Stationary Boilers PUC quality natural gas or propane with LPG backup For Rental Boilers PUC quality natural gas or propane with LPG backup	SJVAPCD
CO	For Stationary Boilers 50 ppm @ 3% O_2 or 0.037 lb/MMBtu For Rental Boilers 50 ppm @ 3% O_2 or 0.037 lb/MMBtu	SJVAPCD, BAAQMD

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 Alternative
VOC	No other technologically feasible option identified
NOx	Stationary Boilers Selective Catalytic Reduction (SCR) – [BAAQMD, SDAPCD] Rental Boilers SCR for Rental Boilers with 2.5 ppm NOx emissions – [SJVACPD]
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

BAAQMD and SDAPCD both list SCR as a technologically feasible alternative. However, SJVAPCD's BACT Guideline 1.1.2 standard of 2.5 ppm NOx is based on using SCR control technology. Therefore, no cost effectiveness determination will be performed on SCR for stationary boilers. A cost effectiveness analysis was performed on rental boilers for SCR that

can meet 2.5 ppm NOx emissions.

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:

Pollutant	Maximum Cost ($/ton) (Amended 9/5/23)
VOC	25,300
NO_X	35,300
PM10	11,400
SO_X	18,300
CO	300

Cost Effectiveness Analysis Summary

This BACT determination will perform a cost effectiveness analysis in accordance with the updated EPA OAQPS Air Pollution Control Cost Manual. The interest rate was based on the previous 6-month average interest rate on United States Treasury Securities (based on the life of the equipment) and addition of two percentage points and rounding up to the next higher integer rate.

NOx:

SCR System:
A cost effectiveness analysis was done to determine if an SCR system (with 2.5 ppm NOx @ 3% O_2 emissions) could be considered cost effective to control the NOx from a rental boiler and is calculated in Appendix A of this document. The baseline emissions are based on 9 ppm NOx @ 3% O_2 from SMAQMD Rule 411 standards. Emissions were calculated based on 24 hours per day, 365 days per year, and both a 20 and 100 MMBtu/hr boiler. For a rental boiler, it is assumed that the equipment life is 2 years.

For a 100 MMBTu/hr boiler
The total annualized cost for the SCR system is estimated to be $877,054. The total NOx controlled would be 3.46 tons/year at 2.5 ppmv. The analysis shows the cost effectiveness calculation to be $253,469 per ton of NOx reduced. Since the District's cost effectiveness threshold for NOx is $35,300 per ton, the addition of the SCR would not be considered cost effective.

Total Annualized Cost of SCR	Quantity of NOx Controlled (TPY)	Cost of SCR per ton removed	SMAQMD cost effective threshold for NOx	Cost effective
$877,054	3.46 @ 2.5 ppmv	$253,469 @ 2.5 ppmv of NOx	$35,300	No

For a 20 MMBTu/hr boiler

The total annualized cost for the SCR system is estimated to be $292,034. The total NOx controlled would be 0.69 tons/year at 2.5 ppmv. The analysis shows the cost effectiveness calculation to be $421,991 per ton of NOx reduced. Since the District's cost effectiveness threshold for NOx is $35,300 per ton, the addition of the SCR would not be considered cost effective.

Total Annualized Cost of SCR	Quantity of NOx Controlled (TPY)	Cost of SCR per ton removed	SMAQMD cost effective threshold for NOx	Cost effective
$292,034	0.69 @ 2.5 ppmv	$421,991 @ 2.5 ppmv of NOx	$35,300	No

Therefore, SCR is not cost effective for rental boilers at 2.5 ppm NOx.

C. SELECTION OF BACT:

Based on the above analysis, BACT for VOC, NOx, SOx, PM10, and CO will remain at what is currently achieved in practice and BACT for PM2.5 will be set to be the same as for PM10.

BACT #343 for Boiler/heater natural gas or LPG fired > 20 MMBtu/hr		
Pollutant	**Standard**	**Source**
VOC	PUC quality natural gas or propane with LPG backup	SJVUAPCD
NOx	2.5 ppm @ 3% O2 or 0.003 lb/MMBtu	SJVUAPCD
SOx	PUC quality natural gas or propane with LPG backup	SJVUAPCD
PM10	PUC quality natural gas or propane with LPG backup	SJVUAPCD
PM2.5	PUC quality natural gas or propane with LPG backup	SJVUAPCD
CO	50 ppm @ 3% O_2 or 0.037 lb/MMBtu	SJVUAPCD, BAAQMD

BACT #344 for Rental Boiler/heater natural gas or LPG fired > 20 MMBtu/hr		
Pollutant	**Standard**	**Source**
VOC	PUC quality natural gas or propane with LPG backup	SJVUAPCD
NOx	5 ppm @ 3% O_2 or 0.0062 lb/MMBtu	SCAQMD
SOx	PUC quality natural gas or propane with LPG backup	SJVUAPCD
PM10	PUC quality natural gas or propane with LPG backup	SJVUAPCD
PM2.5	PUC quality natural gas or propane with LPG backup	SJVUAPCD
CO	50 ppm @ 3% O_2 or 0.037 lb/MMBtu	SJVUAPCD, BAAQMD

APPROVED BY: *Brian F Krebs* **DATE:** **02-09-2024**

Attachment A

Review of BACT Determinations published by EPA

List of BACT determinations published in EPA's RACT/BACT/LAER Clearinghouse (RBLC) for Commercial/Institutional-Sized Boilers/Furnaces < 100 Million BTU/H - Natural Gas (includes propane & liquefied petroleum gas) (Process Code 13.310):

Boilers/Heaters > 20 MMBTU/hr							
RBLC#	**Permit Date(A)**	**Rating**	**Fuel**	**Pollutant**	**Standard**	**Control Technology**	**Case-By-Case Basis**
OH-0387	9/20/2022	29.4 MMBTU/hr	Natural gas	NOx	0.011 lb/MMbtu (9 ppm @ 3% O2)	Low NOx burner	BACT-PSD
				CO	0.037 lb/MMbtu	Good Combustion Practices	BACT-PSD
				PM10	0.0005 lb/MMbtu	Good Combustion Practices	BACT-PSD
				PM2.5	0.0004 lb/MMbtu	Good Combustion Practices	BACT-PSD
				VOC	0.005 lb/MMbtu	Good Combustion Practices	BACT-PSD
MI-0451	6/23/2022	61.5 MMBTU/hr	Natural gas	NOx	0.04 lb/MMbtu	Low NOx burner	BACT-PSD
				CO	0.08 lb/MMbtu	Good Combustion Practices	BACT-PSD
				PM10	0.46 lb/hr	Good Combustion Practices	BACT-PSD
				PM2.5	0.46 lb/hr	Good Combustion Practices	BACT-PSD
				VOC	0.004 lb/MMbtu	Good Combustion Practices	BACT-PSD
				SOx	0.6 gr/scf	Good Combustion Practices, pipeline quality natural gas	BACT-PSD

(A) Due to the large number of entries only determinations made (based on Permit Date) entered since 01/01/2013 are included in the above table.

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

Attachment B

Review of BACT Determinations published by CARB

List of BACT determinations published in CARB's BACT Clearinghouse for boilers ≥ 20 MMBtu/hr to 100 MMBtu/hr:

Capacity MMBtu/hr	Source	Date	Type	NOx ppmv @ 3% O_2	CO ppmv @ 3% O_2	VOC lbs/MMBtu	Filterable PM10 lbs/MMBtu	SO_2 lbs/MMBtu	Inorganic
26.50	SANTA BARBARA COUNTY APCD	1/3/06	Not Specified	14	27	7 ppm or 0.003 lb/MMBtu	NA	NA	
24.9	SANTA BARBARA COUNTY APCD	5/16/06	Not Specified	9	50	NA	NA	NA	
25.0	SANTA BARBARA COUNTY APCD	1/24/12	Not Specified	7	50	12 ppm or 0.0054 lb/MMBtu	NA	NA	
28.8	SOUTH COAST AQMD	6/7/21	Portable water tube	9	50	NA	NA	NA	
39.9	SOUTH COAST AQMD	3/22/16	Water tube with SCR	5	100	NA	NA	NA	5 ppmvd @ 3% O2 NH3 slip

= Selected as the most stringent BACT determination achieved in practice

Attachment C

R.F. MacDonald Rental Boiler Email

Jeffrey Quok

Subject: RE: R.F. MacDonald Co. - Sacramento Rendering Permit

From: Anthony Marino <Anthony.Marino@RFMacDonald.com>
Sent: Thursday, August 17, 2023 8:48 AM
To: Jeffrey Quok <JQuok@airquality.org>; Keith Clark <Keith.Clark@RFMacDonald.com>; Salvador Rodriguez <Salvador.Rodriguez@RFMacDonald.com>; Anthony Feliz <Anthony.Feliz@RFMacDonald.com>
Cc: Ali Othman <AOthman@airquality.org>; Tony Dalri <TDalri@airquality.org>; Angela Thompson <AThompson@airquality.org>; Brian Krebs <BKrebs@airquality.org>
Subject: RE: R.F. MacDonald Co. - Sacramento Rendering Permit

The system has an SCR system installed with it. The SCR system can us down to around 5PPM. No other technology is available on rental systems to get us down to below 2.5PPM that would be guaranteed. Not yet, atleast.

See attached spec sheet SCR-WT for reference.

Please advise as we need to setup source testing and Blue Sky needs direction for the ST plan.

Thanks,

Anthony Marino
R.F.MacDonald Co.
1016 North Market Blvrd
Sacramento, CA 95834
209.747.1817 cell
916.696.6758 Sacramento Office
anthony.marino@RFMacDonald.com

Attachment D

SCR Rental Boiler Cost Effectiveness Analysis

100 MMBtu/hr Rental 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 = $ 253,469.15 $/ton

Equipment

Boiler rating	100	mmBTU/hr
Boiler Operating hours	8760	hours
Boiler capacity factor	1	
SCR Operating Days	365	days
Total Capacity Factor	1	
Baseline NOx (9 ppm)	1.09E-02	lb/mmBTU
SCR NOx (2.5 ppm)	3.00E-03	lb/mmBTU
Ammonia Slip	10	ppm
Ammonia Stochiometric Ratio	1.05	
Stored Ammonia Conc	29	%
Amonnia 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	500	degrees F
Cost year	1998	
Equipment Life	2	years
Annual interest Rate	6	%
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	100	mmBTU/hr
$q_{flue\ gas}$	30817.50466	acfm
N_{NOx}	7.25E-01	

SCR Reactor Calculations

$Vol_{Catalyst}$	4.07E+02	ft3
$A_{Catalyst}$	32.10156735	ft2
A_{SCR}	36.91680245	ft2
l=w=	6.075919885	ft
n_{layer}	4	
h_{layer}	4.168837172	
n_{total}	5	
h_{SCR}	64.84418586	ft

Reagent Calculations

$m_{reagent}$	0.423621713	lb/hr
m_{sol}	1.460764526	lb/hr
q_{sol}	0.19514249	gph
Tank Volume	421.5077777	gal

Cost Estimation

Direct Costs

DC	$	1,074,807.36

Indirect Costs

General Facilites	$	53,740.37	
Engineering and home office fees	$	107,480.74	
Process Contingency	$	53,740.37	
Total Indirect Installation Costs	$	214,961.47	
Project Contingency	$	193,465.32	
Total Plant Cost	$	1,483,234.16	
Preproduction Cost	$	29,664.68	
Inventory Capital	$	318.68	
Total Capital Investment	$	1,513,217.52	

Direct Annual Costs

Maintenance Costs	$	22,698.26	per yr
Power		42.08295	KW
Annual Electricity	$	18,432.33	per yr
Reagent Solution Cost	$	1,292.43	per yr

Catalyst Replacement

FWF		0.314109813	
Annual Catalyst Replacement	$	9,266.29	per yr
Total Variable Direct Cost	$	28,991.04	per yr
Total Direct Annual Cost	$	51,689.31	per yr
CRF		0.545436893	
Indirect Annual Cost	$	825,364.66	per yr
Total annual Cost	$	877,053.97	per yr

NOx Removed	**3.46**	**tons per year**

Cost of NOx controlled per ton removal	**$ 253,469.15**	**per ton**

NOx emission factor without SCR (Based on 9 ppm NOx @ 3% O2)	10.9	NOx lb/MMft3
NOx emission factor with SCR (Based on 2.5 ppm NOx @ 3% O2)	3	NOx lb/MMft3
NOx emissions without SCR (Based on 9 ppm NOx @ 3% O2)	9548.40	lbs
NOx emissions with SCR (Based on 2.5 ppm NOx @ 3% O2)	2628.00	lbs
NOx emissions controlled with SCR	6920.40	lbs

20 MMBtu/hr Rental 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 = $ 421,990.77 $/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 (9 ppm)	1.09E-02	lb/mmBTU
SCR NOx (2.5 ppm)	3.00E-03	lb/mmBTU
Ammonia Slip	10	ppm
Ammonia Stochiometric Ratio	1.05	
Stored Ammonia Conc	29	%
Amonnia 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	500	degrees F
Cost year	1998	
Equipment Life	2	years
Annual interest Rate	6	%
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	20	mmBTU/hr
$q_{flue\ gas}$	6163.500931	acfm
N_{NOx}	7.25E-01	

SCR Reactor Calculations

$Vol_{Catalyst}$	8.14E+01	ft3
$A_{Catalyst}$	6.42031347	ft2
A_{SCR}	7.38336049	ft2
l=w=	2.717233978	ft
n_{layer}	4	
h_{layer}	4.168837172	
n_{total}	5	
h_{SCR}	64.84418586	ft

Reagent Calculations

$m_{reagent}$	0.084724343	lb/hr
m_{sol}	0.292152905	lb/hr
q_{sol}	0.039028498	gph
Tank Volume	84.30155554	gal

Cost Estimation

Direct Costs

DC	$	362,797.69

Indirect Costs

General Facilites	$	18,139.88	
Engineering and home office fees	$	36,279.77	
Process Contingency	$	18,139.88	
Total Indirect Installation Costs	$	72,559.54	
Project Contingency	$	65,303.58	
Total Plant Cost	$	500,660.81	
Preproduction Cost	$	10,013.22	
Inventory Capital	$	63.74	
Total Capital Investment	$	510,737.76	

Direct Annual Costs

Maintenance Costs	$	7,661.07	per yr
Power		8.41659	KW
Annual Electricity	$	3,686.47	per yr
Reagent Solution Cost	$	258.49	per yr

Catalyst Replacement

FWF		0.314109813	
Annual Catalyst Replacement	$	1,853.26	per yr
Total Variable Direct Cost	$	5,798.21	per yr
Total Direct Annual Cost	$	13,459.28	per yr
CRF		0.545436893	
Indirect Annual Cost	$	278,575.22	per yr
Total annual Cost	$	292,034.49	per yr
NOx Removed		0.69	tons per year
Cost of NOx controlled per ton removal	$	421,990.77	per ton

NOx emission factor without SCR (Based on 9 ppm NOx @ 3% O2)	10.9	NOx lb/MMft3
NOx emission factor with SCR (Based on 2.5 ppm NOx @ 3% O2)	3	NOx lb/MMft3
NOx emissions without SCR (Based on 9 ppm NOx @ 3% O2)	1909.68	lbs
NOx emissions with SCR (Based on 2.5 ppm NOx @ 3% O2)	525.60	lbs
NOx emissions controlled with SCR	1384.08	lbs