SMAQMD BACT CLEARINGHOUSE

ACTIVE

CATEGORY Type: **IC ENGINE SPARK-STANDBY**

BACT Category: Minor Source BACT

BACT Determination Number: 284	**BACT Determination Date:** **8/11/2021**

Equipment Information

Permit Number: N/A -- Generic BACT Determination

Equipment Description: IC ENGINE SPARK-STANDBY

Unit Size/Rating/Capacity: < 500 BHP

Equipment Location:

EXPIRED

BACT Determination Information

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

ROCs	**Standard:**	See Description
	Technology Description:	Rich Burn: 60 ppmvd @ 15% O2 as methane (0.29 g/bhp-hr); Lean Burn: 206 ppmvd @ 15% O2 as methane (1.0 g/bhp-hr)
	Basis:	Achieved in Practice
NOx	**Standard:**	See Description
	Technology Description:	Rich Burn: 25 ppmvd @ 15% O2 (0.44 g/bhp-hr) or 96% reduction by weight; Lean Burn: 1.0 g/bhp-hr
	Basis:	Achieved in Practice
SOx	**Standard:**	See Description
	Technology Description:	Use of natural gas fuel or equivalent
	Basis:	Achieved in Practice
PM10	**Standard:**	See Description
	Technology Description:	Use of natural gas fuel or equivalent
	Basis:	Achieved in Practice
PM2.5	**Standard:**	See Description
	Technology Description:	Use of natural gas fuel or equivalent
	Basis:	Achieved in Practice
CO	**Standard:**	See Description
	Technology Description:	2.0 g/bhp-hr
	Basis:	Achieved in Practice
LEAD	**Standard:**	
	Technology Description:	
	Basis:	

Comments: T-BACT is equivalent to BACT for VOC

Printed: 8/11/2021

SMAQMD BACT CLEARINGHOUSE

ACTIVE

CATEGORY Type: **IC ENGINE SPARK-STANDBY**

BACT Category: Minor Source BACT

BACT Determination Number: 285	**BACT Determination Date:** 8/11/2021

Equipment Information

Permit Number: N/A -- Generic BACT Determination

Equipment Description: IC ENGINE SPARK-STANDBY

Unit Size/Rating/Capacity: ≥ 500 BHP

Equipment Location:

EXPIRED

BACT Determination Information

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

ROCs	**Standard:**	See Description
	Technology Description:	Rich Burn: 60 ppmvd @ 15% O2 as methane (0.29 g/bhp-hr); Lean Burn: 206 ppmvd @ 15% O2 as methane (1.0 g/bhp-hr)
	Basis:	Achieved in Practice
NOx	**Standard:**	See Description
	Technology Description:	Rich Burn: 25 ppmvd @ 15% O2 (0.44 g/bhp-hr); Lean Burn: 0.5 g/bhp-hr
	Basis:	Achieved in Practice
SOx	**Standard:**	See Description
	Technology Description:	Use of natural gas fuel or equivalent
	Basis:	Achieved in Practice
PM10	**Standard:**	See Description
	Technology Description:	0.0099 lb/MMBtu
	Basis:	Achieved in Practice
PM2.5	**Standard:**	See Description
	Technology Description:	0.0099 lb/MMBtu
	Basis:	Achieved in Practice
CO	**Standard:**	See Description
	Technology Description:	1.5 g/bhp-hr
	Basis:	Achieved in Practice
LEAD	**Standard:**	
	Technology Description:	
	Basis:	

Comments: T-BACT is equivalent to BACT for VOC

777 12th Street, Suite 300 SACRAMENTO METROPOLITAN AIR QUALITY MANAGEMENT DISTRICT Sacramento, CA 95814

BEST AVAILABLE CONTROL TECHNOLOGY DETERMINATION

EXPIRED

DETERMINATION NOS.:	284 & 285
DATE:	August 11, 2021
ENGINEER:	J. Carle

Category/General Equip Description:	Internal Combustion (I.C.) Engine
Equipment Specific Description:	I.C. Engine Spark Ignited – Standby, Gaseous-fueled (Excluding Biogas)
Equipment Size/Rating:	Engines < 500 BHP (BACT #284) Engines ≥ 500 BHP (BACT #285)
Previous BACT Det. No.:	BACT #208 (Engines < 500 BHP) BACT #209 (Engines ≥ 500 BHP)

These Best Available Control Technology (BACT) determinations will update BACT Determination #208 & 209 for I.C. Engine Spark Ignited – Standby, Gaseous-fueled (Excluding Biogas) for engines rated < 500 bhp and ≥ 500 bhp respectively, which went into effect December 28, 2018.

Spark Ignited I.C. Engines – Standby use gaseous fuel to operate and provide emergency electrical power, emergency water pumping for flood control or firefighting, emergency potable water pumping, or emergency sewage pumping. Engines permitted as emergency standby are used in two ways: 1) as part of a generator system or 2) as a direct drive pump. As part of a generator, typical uses include providing power to life safety systems, building equipment, or computer equipment. As part of a direct drive pump, typical uses are for fire suppression, potable water supply or sewage pumping, the use of which is tied to an emergency event.

This determination will also include Best Available Control Technology for Toxics (T-BACT) for the hazardous air pollutants (HAP) associated with gaseous fuel combustion.

BACT/T-BACT ANALYSIS

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

The following control technologies are currently employed as BACT/T-BACT for standby, spark ignited, gaseous-fueled, I.C. engines by the following agencies and air pollution control districts:

Note: Tables 3.2-1, 3.2-2, and 3.2-3 of AP-42 list benzene, formaldehyde, PAHs, naphthalene, acetaldehyde, acrolein, propylene, toluene, xylenes, ethyl benzene, and hexane as the primary drivers for health risks associated with natural gas combustion. These HAPs/organic compounds are emitted as VOC and the same control technologies that control VOCs also control the listed HAPs.

US EPA

BACT
Source: EPA RACT/BACT/LAER Clearinghouse (See Attachment A)

Emergency Standby, Natural Gas-fired (including propane and LPG), < 500 BHP, IC Engines					
Pollutant	Standard	Control Technology	Engine Burn Type	Permit Date	RBLC ID
VOC	1.0 g/bhp-hr	None listed	Unknown	9/6/2018	WI-0267
NOx	0.5 g/bhp-hr	Good combustion practices	Unknown	4/16/2013	IN-0167
SOx	N/A (B)	Use of natural gas and good combustion practices	Unknown	4/16/2013	IN-0167
PM10	0.038 g/bhp-hr	None listed	Unknown	4/15/2014	CA-1225
PM2.5 (A)	0.038 g/bhp-hr	None listed	Unknown	4/15/2014	CA-1225
CO	Uncontrolled	None listed	Unknown	6/25/2018	IN-0288

(A) This standard is listed as a PM10 standard. The lowest PM2.5 determination listed in the EPA clearinghouse for this category is greater than this PM10 standard. As PM2.5 is a subset of PM10 this would this by default be the lowest PM2.5 standard as well.
(B) Although this lists an emission limit the control described is the use of natural gas with good combustion practices. It is unclear how the emission limit was calculated. Since SOx emissions are primarily based on the sulfur content of the fuel the standard will be considered using natural gas with good combustion practices.

Emergency Standby, Natural Gas-fired (including propane and LPG), ≥ 500 BHP, IC Engines					
Pollutant	Standard	Control Technology	Engine Burn Type	Permit Date	RBLC ID
VOC	0.5 g/bhp-hr	Oxidation catalyst	Lean	12/5/2016	MI-0424
NOx	0.5 g/bhp-hr	Lean burn combustion	Unknown	4/16/2013	IN-0167
SOx	N/A (A)	Use of natural gas and good combustion practices	Unknown	4/24/2014	IN-0185
PM10	0.00999 lb/MMBtu	Good combustion practices	Unknown	12/4/2017	MI-0401
PM2.5	0.00999 lb/MMBtu	Good combustion practices	Unknown	12/4/2017	MI-0401
CO	0.8 g/bhp-hr	Oxidation catalyst	Lean	12/5/2016	MI-0424

(A) Although this lists an emission limit the control described is the use of natural gas with good combustion practices. It is unclear how the emission limit was calculated. Because, SOx emissions are primarily based on the sulfur content of the fuel the standard will be considered using natural gas with good combustion practices.

T-BACT

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

RULE REQUIREMENTS:

40 CFR Part 60 Subpart JJJJ – Standards of Performance for Stationary Spark Ignition Internal Combustion Engines: This regulation applies to owners/operators of new stationary spark ignition engines (SI ICE) that commenced construction after June 12, 2006. [40 CFR §60.4230(a)(4)]

40 CFR §60.4233(d)

Owners and operators of stationary SI ICE with a maximum engine power greater than 19 KW (25 BHP) must comply with the emission standards of Table 1 to this subpart for their emergency stationary SI ICE (applies to both lean and rich burn engines).

40 CFR Subpart JJJJ Table 1: Emission Standards					
Engine Type and Fuel	Maximum Engine Power	Manufacture Date	Emission Standards (A) g/bhp-hr (ppmvd at 15% O_2)		
			NOx	CO	VOC (C)
Emergency (B)	25<HP<130	1/1/200	10	387	N/A
	HP≥130	-	2.0 (160)	4.0 (540)	1.0 (86)

(A) Owners and operators of stationary non-certified SI engines may choose to comply with the emission standards in units of either g/bhp-hr or ppmvd at 15% O2

(B) The emission standards applicable to emergency engines between 25 BHP and 130 BHP are in terms of NOx + HC. This category applies to both lean and rich burn engines

(C) For purposes of this subpart, when calculating emissions of VOC compounds, emissions of formaldehyde should not be included.

40 CFR Part 63 Subpart ZZZZ – National Emissions Standards for Hazardous Air Pollutants for Stationary Reciprocating Internal Combustion Engines: This regulation applies to owners/operators of stationary reciprocating internal combustion engines (RICE) located at both major and area sources of Hazardous Air Pollutant (HAP) emissions. [40 CFR §63.6585]

40 CFR §63.6590(c)

An affected source that meets any of the criteria in paragraphs (1) through (7) of this section must meet the requirements of this part by meeting the requirements of 40 CFR part 60 subpart IIII, for compression ignition engines or 40 CFR part 60 subpart JJJJ, for spark ignition engines. No further requirements apply for such engines under this part.

California Air Resource Board (CARB)

BACT
Source: CARB BACT Clearinghouse (See Attachment B)

Currently there are two BACT determinations in the CARB BACT Clearinghouse, which are summarized in Attachment B. The District has concluded that these determinations have not been achieved in practice for this equipment category for the reasons described below.

SCAQMD ID 361525: The unit detail on the CARB website for this determination is listed as backup/emergency, although it is categorized on the SCAQMD LAER/BACT webpage as non-emergency. The actual SCAQMD Determination A/N 361525 states that although the engine is used for backup purposes, it is permitted to operate over 200 hours per year. Under Sac Metro AQMD regulation this engine would be considered prime power and, therefore, would not fit under the equipment category of this BACT determination.

SCAQMD ID 359876: SCAQMD Determination A/N 359876 states that the AQMD is reconsidering the BACT requirement for future applications of this type. As shown later in this determination the SCAQMD BACT guidelines for non-major facilities category for emergency, spark-ignited, IC engines was updated in 2016 and the standards listed A/N 359876 were not listed to be achieved in practice. Additionally, determination A/N 359876 states that source testing was not required and, therefore, the standards were never verified in the field.

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

RULE REQUIREMENTS:
CARB does not have a statewide rule for control of stationary spark-ignited IC engines. However, the state develops, when necessary, guidelines that set Reasonable Available Control Technology (RACT) and Best Available Retrofit Technology (BARCT). These guidelines establish the minimum requirements for RACT and BARCT that Districts must consider when developing all feasible measures for attainment of the California Ambient Air Quality Standards.

CARB RACT/BARCT Guidelines for Stationary Spark-Ignited Internal Combustion Engines (11/2001):
This document presents the determination of reasonably available control technology (RACT) and best available retrofit control technology (BARCT) for controlling NOx, VOC, and CO from stationary, spark-ignited reciprocating internal combustion engines. On page IV-14 of the document, emergency standby engines are listed as exempt from the recommended emission limits. Therefore, this guideline is not applicable to this BACT determination.

Sacramento Metropolitan AQMD

BACT
Source: SMAQMD BACT Clearinghouse

BACT Determination #208 - IC Engine, Spark-ignited, Standby, < 500 BHP		
Pollutant	Rich Burn Standard	Lean Burn Standard
VOC	60 ppmv @ 15% O_2 as methane (0.29 g/bhp-hr)	206 ppmv @ 15% O_2 as methane (1.0 g/bhp-hr)
NOx	25 ppmvd @ 15% O_2 (0.44 g/bhp-hr); or 96% reduction by weight	1.0 g/bhp-hr
SOx	Natural gas fuel or equivalent	Natural gas fuel or equivalent
PM10	Natural gas fuel or equivalent	Natural gas fuel or equivalent
PM2.5	Natural gas fuel or equivalent	Natural gas fuel or equivalent
CO	2.0 g/bhp-hr	2.0 g/bhp-hr

BACT Determination #209 - IC Engine, Spark-ignited, Standby, ≥ 500 BHP		
Pollutant	Rich Burn Standard	Lean Burn Standard
VOC	60 ppmv @ 15% O_2 as methane (0.29 g/bhp-hr)	206 ppmv @ 15% O_2 as methane (1.0 g/bhp-hr)
NOx	25 ppmvd @ 15% O_2 (0.44 g/bhp-hr); or 96% reduction by weight	0.5 g/bhp-hr
SOx	Natural gas fuel or equivalent	Natural gas fuel or equivalent
PM10	0.0099 lb/MMBtu	0.0099 lb/MMBtu
PM2.5	0.0099 lb/MMBtu	0.0099 lb/MMBtu
CO	1.5 g/bhp-hr	1.5 g/bhp-hr

T-BACT
T-BACT is equivalent to BACT for VOC.

RULE REQUIREMENTS:
Rule 412 – Stationary Internal Combustion Engines Located at Major Stationary Sources of NOx (Adopted 6/1/1995)
This rule applies to any stationary internal combustion engine rated at more than 50 BHP located at a major stationary source of NOx. Section 110 of this rule states that operation of stationary internal combustion engines used for emergency standby are exempt from the standards of this rule. Therefore, this rule is not applicable to this BACT determination.

Rule 420 – Sulfur Content of Fuels (8/13/81)
No person shall burn any gaseous fuels containing sulfur compounds in excess of 50 grains per 100 cubic feet, calculated as hydrogen sulfide at standard conditions, or any liquid fuel or solid fuel having a sulfur content in excess of 0.5% by weight.

South Coast AQMD

BACT
Source: SCAQMD BACT Guidelines for Non-Major Polluting Facilities, page 76 (2/1/19)

I.C. Engine, Stationary, Emergency, Spark Ignition					
Rating/Size	VOC	NOx	SOx	CO	PM
< 130 HP	1.5 g/bhp-hr (10/20/2000)	1.5 g/bhp-hr (10/20/2000)	See Clean Fuels Policy (10/20/2000) (A)	2.0 g/bhp-hr (10/20/2000)	See Clean Fuels Policy (10/20/2000) (A)
≥ 130 HP	1.0 g/bhp-hr (12/02/2016)	1.5 g/bhp-hr (10/20/2000)	See Clean Fuels Policy (10/20/2000) (A)	2.0 g/bhp-hr (10/20/2000)	See Clean Fuels Policy (10/20/2000) (A)

(A) SCAQMD's Clean Fuels Policy defines a Clean Fuel as one that produces air emissions equivalent to or lower than natural gas. 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. SCAQMD's Clean Fuel Policy lists natural gas, methanol, liquid petroleum gas (LPG), and hydrogen as clean fuels.

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

RULE REQUIREMENTS:
Reg XI, Rule 1110.2 – Emissions from Gaseous- and Liquid-Fueled Engines (11/1/19)

Subdivision (i)(1)(B) exempts emergency engines with permit conditions that limit operation to 200 hours or less per year.

San Joaquin Valley APCD

BACT
Source: SJVAPCD BACT Guideline 3.1.5 (7/16/18)

Emergency Gas-Fired IC Engines (A)			
Pollutant	Engine Burn Type	Rating	Standard
VOC	Lean Burn	All	206 ppmv @ 15% O2 (1.0 g/bhp-hr)
	Rich Burn	All	60 ppmv @ 15% O2 (0.29 g/bhp-hr)

Emergency Gas-Fired IC Engines (A)			
Pollutant	Engine Burn Type	Rating	Standard
NOx	Lean Burn	< 500 BHP	1.0 g/bhp-hr
		≥ 500 BHP	0.5 g/bhp-hr
	Rich Burn	All	25 ppmv @ 15% O2 (0.44 g/bhp-hr)
SOx	All	All	Natural Gas, LPG, or Propane as fuel
PM10	All	All	Natural Gas, LPG, or Propane as fuel
PM2.5	All	All	Natural Gas, LPG, or Propane as fuel
CO	All	All	2.0 g/bhp-hr

(A) All standards are listed as achieved in practice. No standards were listed as technologically feasible.

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

RULE REQUIREMENTS:
Rule 4702 – INTERNAL COMBUSTION ENGINES (Amended 11/14/13)

Section 4.2 exempts emergency standby engines from the emission standards established in this rule.

San Diego County APCD

BACT
Source: NSR Requirements for BACT (June 2011)

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

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

RULE REQUIREMENTS:
Regulation 4, Rule 69.4 – Stationary Reciprocating Internal Combustion Engines – Reasonably Available Control Technology (7/30/03)
This rule applies to stationary I.C. Engines ≥ 50 BHP located at a stationary source which emits or has a potential to emit 50 tons per year or more of NOx.

Section (b)(2)(ii) of this rule exempts emergency standby engines that do not exceed 52 hours per year for non-emergency purposes.

Regulation 4, Rule 69.4.1 – Stationary Reciprocating Internal Combustion Engines – Best Available Retrofit Control Technology (7/8/20)
This rule applies to stationary I.C. Engines ≥ 50 BHP.

A person shall not operate a **new or replacement emergency standby** stationary internal combustion engine subject to this rule unless:

Uncontrolled NOx emissions are reduced with add-on control equipment by not less than the following:

Engine Category	Weight Percent Reduction
Rich-burn engines using fossil derived gaseous fuel or gasoline	96%
Lean-burn engines using fossil derived gaseous fuel	90%
Rich-burn engines used exclusively in agricultural operations	80%
Lean-burn engines used exclusively in agricultural operations	70%

OR

Emissions are not greater than the following:

Engine Category	Concentration of NOx (A)	Concentration of VOC (B)	Concentration of CO (C)
Rich-burn engines using gaseous fuel	25 ppmv	86 ppmv	540 ppmv
Lean-burn engines using gaseous fuel	2.0 g/bhp-hr or 160 ppmv	1.0 g/bhp-hr or 86 ppmv	4.0 g/bhp-hr or 540 ppmv
Black start engines using gaseous fuel	2.0 g/bhp-hr or 160 ppmv	1.0 g/bhp-hr or 86 ppmv	4.0 g/bhp-hr or 540 ppmv

(A) Calculated as nitrogen dioxide in ppmv corrected to 15% oxygen on a dry basis, or in grams of NOx per brake horsepower-hour, as indicated
(B) Calculated as methane in ppmv corrected to 15% oxygen on a dry basis, or in grams of VOC per break horsepower-hour, as indicated, excluding emissions of formaldehyde.
(C) Calculated as carbon monoxide in ppmv corrected to 15% oxygen on a dry basis, or in grams of CO per break horsepower-hour, as indicated.

Bay Area AQMD

BACT
Source: BAAQMD BACT Guideline 96.3.4 (5/7/03)

IC Engine – Spark Ignition, Natural Gas Fired, Emergency Engine, ≥ 50 bhp		
Pollutant	Standard (A)	Typical Technology
VOC	1.0 g/bhp-hr	Lean burn technology
NOx	1.0 g/bhp-hr	Lean burn technology
SOx	No standard	Natural gas
PM10	No standard	Natural gas
CO	2.75 g/bhp-hr	Lean burn technology

(A) All standards listed are achieved in practice. No standards were listed that are technologically feasible and cost effective.

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

RULE REQUIREMENTS:
Reg 9, Rule 8 – Nitrogen Oxides and Carbon Monoxide from Stationary Internal Combustion Engines (7/25/07)

Section 110.5 of this rule exempts emergency standby engines from the emissions standards in the rule.

Summary of Achieved in Practice Control Technologies

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

UNIT CONVERSION FOR NOx, VOC & CO

Depending on the agency, VOC, NOx, and CO emission standards were listed in either ppmvd @ 15% O_2 or in g/bhp-hr. For purposes of comparison standards have been converted to the units used in the current SMAQMD BACT standard. The factors used for the NOx and VOC conversion are based on the ppmvd @ 15% O_2 to g/bhp-hr equivalencies used in the previous SMAQMD BACT standard. The conversion factor for CO is based on Santa Barbara County APCD's Piston IC Engine Technical Reference Document for turbocharged natural gas engines.

$EF_{ppmvd} = (g/bhp\text{-}hr)_P * CF_P$

Where:

$(g/bhp\text{-}hr)_P$ = emission rate of pollutant in exhaust
CF_P = conversion factor of pollutant
CF_{VOC} = 206
CF_{NOx} = 57
CF_{CO} = 97

RICH BURN ENGINES – NOx, VOC & CO

The control method for all rich burn engine BACT determinations achieved in practice was through non-selective catalytic reduction (NSCR) or also commonly called a 3-way catalyst. NSCR reduces the emissions for NOx, VOC, and CO using one control device. The level of reduction for each pollutant depends on the air to fuel ratio that is driving the engine. As the air to fuel ratio gets more lean, NOx reduction goes down but VOC and CO reduction goes up. Due to each individual pollutant reduction being interdependent, determinations will be ranked for these three pollutants, with an emphasis on NOx reduction, rather than emission levels for individual pollutants. The table below shows the ranking for achieved in practice standards for both engines less than 500 bhp and engines 500 bhp and greater as the raking of achieved in practice standards is the same for both categories and there are minimal variations in the standards between the two brake horsepower categories.

Achieved in Practice Standards for NOx, VOC & CO for Rich Burn Engines			
Rank	Pollutant	Standard (A)	Source
1	NOx	25 ppmvd (0.44 g/bhp-hr) or 96% reduction by weight	SMAQMD BACT 12/28/2018
	VOC	60 ppmvd (0.29 g/bhp-hr)	
	CO	< 500 bhp: 2.0 g/bhp-hr ≥ 500 bhp: 1.5 g/bhp-hr	
2	NOx	25 ppmv (0.44 g/bhp-hr)	SJVAPCD BACT 7/16/2018
	VOC	60 ppmv (0.29 g/bhp-hr)	
	CO	2.0 g/bhp-hr	
3	NOx	25 ppmvd	SDCAPCD Rule 7/8/2020
	VOC	86 ppmvd	
	CO	5.6 g/bhp-hr (540 ppmvd)	
4	NOx	57 ppmvd (1.0 g/bhp-hr)	BAAQMD BACT 5/7/2003
	VOC	206 ppmvd (1.0 g/bhp-hr)	
	CO	2.75 g/bhp-hr	
5	NOx	85.5 ppmvd (1.5 g/bhp-hr)	SCAQMD BACT 2/1/2019
	VOC	< 130 bhp: 309 ppmvd (1.5 g/bhp-hr) ≥ 130 bhp: 206 ppmvd (1.0 g/bhp-hr)	
	CO	2.0 g/bhp-hr	
6	All	No determinations listed specifically for rich burn engines	EPA

(A) All PPM values are corrected to 15% oxygen. VOC PPM standards are calculated as methane.

<u>LEAN BURN ENGINES – NOx, VOC & CO</u>

NOx reduction in spark ignited engines can be reduced through leaning the air/fuel ratio of the engine and use of good combustion practices. Although, as the air/fuel ratio gets leaner and the NOx emissions decrease, the VOC and CO emissions will increase, and engine power decreases. Therefore, emission reduction when operating a lean burn engine is a balance between these three pollutant levels and the engine power. Due to each individual pollutant reduction being interdependent, determinations will be ranked for these three pollutants as a set, with an emphasis on NOx reduction, rather than emission levels for NOx, VOC, and CO individually.

Unlike for engines with a rich air/fuel ratio, NSCR cannot be used on engines with a lean air/fuel ratio due to the composition of the exhaust stream. In order to achieve further NOx reduction, the air/fuel ratio would need to be further leaned which increases other pollutants and compromises the performance of the engine or through add-on Selective Catalytic Reduction (SCR). There are currently no achieved in practice standards that require SCR. It is discussed later in this determination on the technological feasibility of SCR in this application.

Achieved in Practice Standards for NOx, VOC & CO for Lean Burn Engines < 500 BHP			
Rank	Pollutant	Standard (A)	Source
1	NOx	1.0 g/bhp-hr	SMAQMD BACT 12/28/2018
	VOC	206 ppmv (1.0 g/bhp-hr)	
	CO	2.0 g/bhp-hr	
2	NOx	1.0 g/bhp-hr	SJVAPCD BACT 7/16/2018
	VOC	206 ppmv (1.0 g/bhp-hr)	
	CO	2.0 g/bhp-hr	
3	NOx	1.0 g/bhp-hr	BAAQMD BACT 5/7/2003
	VOC	206 ppmvd (1.0 g/bhp-hr)	
	CO	2.75 g/bhp-hr	
4	NOx	1.5 g/bhp-hr	SCAQMD BACT 2/1/2019
	VOC	206 ppmvd (1.0 g/bhp-hr)	
	CO	2.0 g/bhp-hr	
5	NOx	2.0 g/bhp-hr or 160 ppmv	SDCAPCD Rule 7/8/2020
	VOC	86 ppmv or 1.0 g/bhp-hr	
	CO	4.0 g/bhp-hr or 540 ppmv	
6	All	No determinations listed specifically for lean burn engines < 500 bhp	EPA

(A) All PPM values are corrected to 15% oxygen. VOC PPM standards are calculated as methane.

Achieved in Practice Standards for NOx, VOC & CO for Lean Burn Engines ≥ 500 BHP			
Rank	Pollutant	Standard (A)	Source
1	NOx	0.5 g/bhp-hr	SMAQMD BACT 12/28/2018
	VOC	206 ppmv (1.0 g/bhp-hr)	
	CO	1.5 g/bhp-hr	
2	NOx	0.5 g/bhp-hr	SJVAPCD BACT 7/16/2018
	VOC	206 ppmv (1.0 g/bhp-hr)	
	CO	2.0 g/bhp-hr	
3	NOx	1.0 g/bhp-hr	BAAQMD BACT 5/7/2003
	VOC	206 ppmvd (1.0 g/bhp-hr)	
	CO	2.75 g/bhp-hr	

Achieved in Practice Standards for NOx, VOC & CO for Lean Burn Engines ≥ 500 BHP			
Rank	Pollutant	Standard (A)	Source
4	NOx	1.5 g/bhp-hr	SCAQMD BACT 2/1/2019
	VOC	206 ppmvd (1.0 g/bhp-hr)	
	CO	2.0 g/bhp-hr	
5	NOx	2.0 g/bhp-hr	EPA RBLC # MI-0424
	VOC	103 ppmv (0.5 g/bhp-hr)	
	CO	0.8 g/bhp-hr	
6	NOx	2.0 g/bhp-hr or 160 ppmv	SDCAPCD Rule 7/8/2020
	VOC	86 ppmv or 1.0 g/bhp-hr	
	CO	4.0 g/bhp-hr or 540 ppmv	

(A) All PPM values are corrected to 15% oxygen. VOC PPM standards are calculated as methane.

PM10 & PM2.5

Typically, PM control for spark ignited engines involve the use of clean fuels and good combustion practices. When permitting, the District assumes all PM emissions are PM2.5 and, therefore, PM10 and PM2.5 standards are equivalent.

Achieved in Practice Standards for PM for Engines < 500 bhp			
Rank	Standard/Control Method	Source	Comments
1	Use of natural gas fuel or equivalent	SMAQMD BACT 12/28/2018	
1	Follow SCAQMD Clean Fuels Policy (policy states use natural gas or equivalent fuel)	SCAQMD BACT 2/1/2019	
1	Use natural gas, LPG, or propane as fuel	SJVAPCD BACT 7/16/2018	
1	Use natural gas	BAAQMD BACT 5/7/2003	BACT only applies to natural gas fired engines
2	No standard	SDCAPCD Rule 7/8/2020	
N/A	0.038 g/bhp-hr	EPA RBLC ID: CA-1225	This determination does not specify if the engine is lean or rich burn and therefore it is unknown if the standard is more or less restrictive than just requiring the use of natural gas as a fuel.

Achieved in Practice Standards for PM for Engines ≥ 500 bhp			
Rank	Standard/Control Method	Source	Comments
1	0.0099 lb/MMBtu	SMAQMD BACT 12/28/2018	
2	Follow SCAQMD Clean Fuels Policy (policy states use natural gas or equivalent fuel)	SCAQMD BACT 2/1/2019	
2	Use natural gas, LPG, or propane as fuel	SJVAPCD BACT 7/16/2018	
2	Use natural gas	BAAQMD BACT 5/7/2003	BACT only applies to natural gas fired engines
3	0.00999 lb/MMBtu	EPA RBLC ID: MI-0401	The EPA Clearinghouse does not list the engine burn type (lean or rich burn). Because of this ambiguity, the standard is ranked below other achieved in practice standards.
4	No standard	SDCAPCD Rule 7/8/2020	

SOx

Typically, SOx control for spark ignited engines involve the use of clean fuels and good combustion practices.

Achieved in Practice Standards for SOx			
Rank	Standard	Source	Comments
1	Use of natural gas fuel or equivalent	SMAQMD BACT 12/28/2018	
1	Follow SCAQMD Clean Fuels Policy (policy states use natural gas or equivalent fuel)	SCAQMD BACT 2/1/2019	
1	Use natural gas, LPG, or propane as fuel	SJVAPCD BACT 7/16/2018	
1	Use natural gas	BAAQMD BACT 5/7/2003	BACT only applies to natural gas fired engines
1	Use of natural gas and good combustion practices	EPA RBLC ID: IN-0167 & IN-0185	

Achieved in Practice Standards for SOx			
Rank	Standard	Source	Comments
2	No standard	SDCAPCD Rule 7/8/2020	

Toxics

HAPs are emitted as VOC and the same control technologies that control VOCs also control the HAPs and, therefore, the achieved in practice standards for HAPs are the same as for VOC.

Summary Table

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

Best Control Technologies Achieved in Practice for Engines < 500 bhp			
Pollutant	Equipment/Operation Sub Category	Standard	Source
VOC	Rich Burn	60 ppmvd (0.29 g/bhp-hr)	SMAQMD BACT
	Lean Burn	206 ppmv (1.0 g/bhp-hr)	
NOx	Rich Burn	25 ppmvd (0.44 g/bhp-hr) or 96% reduction by weight	SMAQMD BACT
	Lean Burn	1.0 g/bhp-hr	
SOx	All Engines	Use of natural gas fuel or equivalent	SMAQMD BACT
PM10	All Engines	Use of natural gas fuel or equivalent	SMAQMD BACT
PM2.5	All Engines	Use of natural gas fuel or equivalent	SMAQMD BACT
CO	All Engines	2.0 g/bhp-hr	SMAQMD BACT
VHAPs (A) (T-BACT)	Rich Burn	60 ppmvd (0.29 g/bhp-hr)	SMAQMD BACT
	Lean Burn	206 ppmv (1.0 g/bhp-hr)	

(A) A full list of the volatile hazardous air pollutants (VHAP) from natural gas combustion can be found in AP-42, Section 3.2 Natural Gas-fired Reciprocating Engines, Tables 3.2-1, 3.2-2, and 3.2-3.

Best Control Technologies Achieved in Practice for Engines ≥ 500 bhp			
Pollutant	Equipment/Operation Sub Category	Standard	Source
VOC	Rich Burn	60 ppmvd (0.29 g/bhp-hr)	SMAQMD BACT
	Lean Burn	206 ppmv (1.0 g/bhp-hr)	
NOx	Rich Burn	25 ppmvd (0.44 g/bhp-hr) or 96% reduction by weight	SMAQMD BACT
	Lean Burn	0.5 g/bhp-hr	
SOx	All Engines	Use of natural gas fuel or equivalent	SMAQMD BACT
PM10	All Engines	0.0099 lb/MMBtu	SMAQMD BACT
PM2.5	All Engines	0.0099 lb/MMBtu	SMAQMD BACT
CO	All Engines	1.5 g/bhp-hr	SMAQMD BACT
VHAPs (A) (T-BACT)	Rich Burn	60 ppmvd (0.29 g/bhp-hr)	SMAQMD BACT
	Lean Burn	206 ppmv (1.0 g/bhp-hr)	

(A) A full list of the volatile hazardous air pollutants (VHAP) from natural gas combustion can be found in AP-42, Section 3.2 Natural Gas-fired Reciprocating Engines, Tables 3.2-1, 3.2-2, and 3.2-3.

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.

Technologically Feasible Alternatives			
Pollutant	**Emission Source Category**	**Standard**	**Source of Standard**
VOC	All Engines	No other technologically feasible option identified	N/A
NOx	Lean Burn Engines All Sizes	SCR	N/A
SOx	All Engines	No other technologically feasible option identified	N/A
PM10	All Engines	No other technologically feasible option identified	N/A
PM2.5	All Engines	No other technologically feasible option identified	N/A
CO	All Engines	No other technologically feasible option identified	N/A

The District's previous BACT Determination for this equipment category (BACT Determination #208 & 209) (Attachment C) found that installing SCR was not cost effective. The data and methodology for this cost effectiveness calculation came from the EPA Air Pollution Cost Control Manual, Sixth Edition (EPA/452/B-02-001, January 2002). Since the time this BACT Determination was approved, the EPA updated their Air Pollution Cost Manual for SCR control devices (Section 4, Chapter 2, updated 6/12/19). The revised section states, "The procedures for estimating costs presented in this report are based on cost data for SCR retrofits on existing coal-, oil-, and gas-fired boilers for electric generating units larger than 25 MWe (approximately 250 MMBtu/hr). Thus, this report's procedure estimates cost for typical retrofits of such boilers. The methodology for utility boilers also has been extended to large industrial boilers by modifying the capital cost equations and power consumption (electricity costs) equations to use the heat input capacity of the boiler instead of electrical generating capacity. The procedures to estimate capital costs are not directly applicable to other sources other than utility and industrial boilers."

As the new SCR section in the EPA Air Pollution Cost Manual for SCR control devices specifically states that the methodology for calculating capital costs are only applicable for utility and industrial boilers, the District will rely on the cost effectiveness calculations in the previous BACT Determination for this equipment category that found SCR to not be cost effective. Based on this information, the District has determined that SCR is not technically feasible and cost effective for standby, spark-ignited, gaseous-fueled, IC engines.

C. SELECTION OF BACT:

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

Volatile hazardous air pollutants (VHAP) are the primary driver for health risks associated with gaseous fueled engines. VHAPs are emitted as VOC, and the same control technologies that control VOC also control VHAPs. Therefore, the BACT for VOC and T-BACT for HAPs are the same. See the tables below for a summary of the BACT Determinations.:

BACT FOR I.C. ENGINES, STANDBY, SPARK IGNITED, GASEOUS-FUELED (EXCLUDING BIOGAS), < 500 BHP		
Pollutant	**Standard**	**Source**
VOC	Rich Burn Engines: 60 ppmvd @ 15% O_2 as methane (0.29 g/bhp-hr) Lean Burn Engines: 206 ppmvd @ 15% O_2 as methane (1.0 g/bhp-hr)	SMAQMD
NOx	Rich Burn Engines: 25 ppmvd @ 15% O_2 (0.44 g/bhp-hr) or 96% reduction by weight Lean Burn Engines: 1.0 g/bhp-hr	SMAQMD
SOx	Use of natural gas fuel or equivalent	SMAQMD
PM10	Use of natural gas fuel or equivalent	SMAQMD
PM2.5	Use of natural gas fuel or equivalent	SMAQMD
CO	2.0 g/bhp-hr	SMAQMD

T-BACT FOR I.C. ENGINES, STANDBY, SPARK IGNITED, GASEOUS-FUELED (EXCLUDING BIOGAS), < 500 BHP		
Pollutant	**Standard**	**Source**
HAP[(A)]	Rich Burn Engines: 60 ppmvd (0.29 g/bhp-hr) Lean Burn Engines: 206 ppmv (1.0 g/bhp-hr)	SMAQMD

(A) A full list of the hazardous air pollutants (HAP) from natural gas combustion can be found in AP-42, Section 3.2 Natural Gas-fired Reciprocating Engines, Tables 3.2-1, 3.2-2, and 3.2-3.

BACT FOR I.C. ENGINES, STANDBY, SPARK IGNITED, GASEOUS-FUELED (EXCLUDING BIOGAS), ≥ 500 BHP		
Pollutant	**Standard**	**Source**
VOC	Rich Burn Engines: 60 ppmvd @ 15% O_2 as methane (0.29 g/bhp-hr) Lean Burn Engines: 206 ppmvd @ 15% O_2 as methane (1.0 g/bhp-hr)	SMAQMD
NOx	Rich Burn Engines: 25 ppmvd @ 15% O_2 (0.44 g/bhp-hr) or 96% reduction by weight Lean Burn Engines: 0.5 g/bhp-hr	SMAQMD
SOx	Use of natural gas fuel or equivalent	SMAQMD
PM10	0.0099 lb/MMBtu	SMAQMD
PM2.5	0.0099 lb/MMBtu	SMAQMD
CO	1.5 g/bhp-hr	SMAQMD

T-BACT FOR I.C. ENGINES, STANDBY, SPARK IGNITED, GASEOUS-FUELED (EXCLUDING BIOGAS), ≥ 500 BHP		
Pollutant	**Standard**	**Source**
HAP[(A)]	Rich Burn Engines: 60 ppmvd @ 15% O_2 as methane (0.29 g/bhp-hr) Lean Burn Engines: 206 ppmvd @ 15% O_2 as methane (1.0 g/bhp-hr)	SMAQMD

(A) A full list of the hazardous air pollutants (HAP) from natural gas combustion can be found in AP-42, Section 3.2 Natural Gas-fired Reciprocating Engines, Tables 3.2-1, 3.2-2, and 3.2-3.

APPROVED BY: *Brian F Krebs* **DATE:** 08-11-2021

Attachment A

Review of BACT Determinations published by EPA

List of BACT determinations published in EPA's RACT/BACT/LAER Clearinghouse (RBLC) for Natural Gas (includes propane & liquefied petroleum gas) I.C. Engines:

Spark-Ignited, Emergency Standby, IC Engines < 500 BHP (Process Code: 17.230)								
RBLC#	**Permit Date (A)**	**Rating (B)**	**Fuel**	**Engine Burn Type**	**Pollutant**	**Standard (C)**	**Control Technology**	**Case-By-Case Basis**
CA-1225	4/25/2014	256 BHP	Natural Gas	Unknown	CO	4.0 g/hp-hr	None listed	BACT-PSD
					NOx	0.78 lb/hr (1.38 g/hp-hr)	None listed	BACT-PSD
					PM10	0.0216 lb/hr (0.038 g/hp-hr)	None listed	BACT-PSD
IA-0102	2/1/2012	225 KW (302 BHP)	Natural Gas	Unknown	VOC	0.66 lb/hr (1.0 g/hp-hr)	Good combustion practices	BACT-PSD
IN-0167	4/16/2013	300 BHP	Natural Gas	Unknown	NOx	0.5 g/hp-hr	Good combustion practices	BACT-PSD
					PM10	0.2 g/kw-hr (0.15 g/hp-hr)	Good combustion practices	BACT-PSD
					PM2.5	0.2 g/kw-hr (0.15 g/hp-hr)	Good combustion practices	BACT-PSD
					SO2	0.0015 g/kw-hr (0.0011 g/hp-hr)	Use of natural gas and good combustion practices	BACT-PSD
IN-0288	6/25/2018	100 KW (134 BHP)	Natural Gas	Unknown	CO	0.317 lb/MMBtu (D)	None listed	BACT-PSD
					VOC	0.36 lb/MMBtu	None listed	BACT-PSD
LA-0276	12/15/2016	150 KW (201 BHP)	Natural Gas	Unknown	VOC	1.0 g/hp-hr	None listed	BACT-PSD
LA-0311	7/15/2013	300 BHP	Natural Gas	Unknown	CO	3.31 lb/hr (5.0 g/hp-hr)	Good combustion practices	BACT-PSD
MI-0413	5/12/2014	250 BHP	Natural Gas	Unknown	CO	N/A	Good combustion practices	BACT-PSD
					SO2	0.002 g/hp-hr	None listed	BACT-PSD

Spark-Ignited, Emergency Standby, IC Engines < 500 BHP (Process Code: 17.230)								
RBLC#	**Permit Date (A)**	**Rating (B)**	**Fuel**	**Engine Burn Type**	**Pollutant**	**Standard (C)**	**Control Technology**	**Case-By-Case Basis**
SC-0182	10/31/2017	Unknown	LPG	Unknown	CO	4.0 g/hp-hr	Good combustion practices	BACT-PSD
					NOx	2.0 g/hp-hr	Good combustion practices	BACT-PSD
					PM10	N/A	Good combustion practices	BACT-PSD
					PM2.5	N/A	Good combustion practices	BACT-PSD
					VOC	1.0 g/hp-hr	Good combustion practices	BACT-PSD
VA-0321	3/12/2013	100 KW (134 BHP)	LPG	Unknown	CO	4.0 g/hp-hr	Good combustion practices	BACT-PSD
VA-0325	6/17/16	150 KW (201 BHP)	LPG	Unknown	CO	4.0 g/hp-hr	Good combustion practices	N/A
					NOx	2.0 g/hp-hr	Good combustion practices	N/A
					PM10	0.19 g/hp-hr	None listed	N/A
					PM2.5 (filterable)	0.019 g/hp-hr	Low sulfur fuel and good combustion practices	N/A
					VOC	1.0 g/hp-hr	None listed	N/A
WI-0267	9/6/2018	80 BHP	Natural Gas	Unknown	VOC	1.0 g/hp-hr	None listed	BACT-PSD

(A) Due to the large number of entries only determinations made (based on Permit Date) entered since 01/01/2011 are included in the above table.
(B) Break horsepower in parenthesis are converted from the listed kilowatt rating using a factor of 1.341 kw per hp.
(C) Standards in parenthesis are converted from the listed standard in some cases using the listed horsepower and/or a conversion factor of 1.341 kw per hp.
(D) This standard is equivalent to the EPA AP-42, Table 3.2-3 for 4-stroke, lean burn engines, uncontrolled emission standard for CO at a 90 – 105% Load (7/00).

[yellow] = Selected as the most stringent BACT determination achieved in practice. The most recent determination selected if multiple determinations are the most stringent.

Spark-Ignited, Emergency Standby, IC Engines ≥ 500 BHP (Process Code: 17.130)								
RBLC#	**Permit Date (A)**	**Rating (B)**	**Fuel**	**Engine Burn Type**	**Pollutant**	**Standard (C)**	**Control Technology**	**Case-By-Case Basis**
AL-0301	7/22/2014	400 KW (539 BHP)	Propane	Unknown	CO	7.5 lb/1000 gal	None listed	BACT-PSD
					NOx	13 lb/1000 gal	None listed	BACT-PSD
CA-1192 (F)	6/21/11	860 BHP	Natural Gas	Lean	CO	1.0 g/hp-hr	Oxidation catalyst	BACT-PSD
					NOx	0.21 g/hp-hr	SCR	BACT-PSD
					PM10	0.34 g/hp-hr	Use PUC pipeline natural gas	BACT-PSD
IN-0167	4/16/2013	620 BHP	Natural Gas	Unknown	NOx	0.5 g/hp-hr	Good combustion practices	BACT-PSD
					SO2	0.0015 g/kw-hr (0.0011 g/hp-hr)	Good combustion practices	BACT-PSD
					PM10	0.2 g/kw-hr (0.15 g/hp-hr)	Good combustion practices	BACT-PSD
					PM2.5	0.2 g/kw-hr (0.15 g/hp-hr)	Good combustion practices	BACT-PSD
IN-0185	4/24/2014	620 BHP	Natural Gas	Unknown	PM10	0.2 g/kw-hr (0.15 g/hp-hr)	None listed	BACT-PSD
					PM2.5	0.2 g/kw-hr (0.15 g/hp-hr)	None listed	BACT-PSD
					SO2	0.0015 g/kw-hr (0.0011 g/hp-hr)	Use of natural gas and good combustion practices	BACT-PSD
LA-0256	12/6/2011	1818 BHP	Natural Gas	Unknown	PM10	0.01 lb/hr (D) (0.0025 g/hp-hr)	Good combustion practices	BACT-PSD
					PM2.5	0.01 lb/hr (D) (0.0025 g/hp-hr)	Good combustion practices	BACT-PSD

Spark-Ignited, Emergency Standby, IC Engines ≥ 500 BHP (Process Code: 17.130)								
RBLC#	Permit Date (A)	Rating (B)	Fuel	Engine Burn Type	Pollutant	Standard (C)	Control Technology	Case-By-Case Basis
LA-0287	7/21/2014	1175 BHP	Natural Gas	Unknown	NOx	2.0 g/hp-hr	Good combustion practices	BACT-PSD
					PM10	0.004 lb/hr (E) (0.0015 g/hp-hr)	Good combustion practices	BACT-PSD
					PM2.5	0.005 lb/hr (E) (0.0019 g/hp-hr)	Good combustion practices	BACT-PSD
LA-0311	7/15/2013	2500 BHP	Natural Gas	Unknown	CO	27.56 lb/hr (5.0 g/hp-hr)	Good combustion practices	BACT-PSD
MI-0401	12/21/2011	1200 KW (1609 BHP)	Natural Gas	Unknown	NOx	0.5 g/hp-hr	None listed	BACT-PSD
					PM10	0.00999 lb/mmbtu	None listed	BACT-PSD
					PM2.5	0.00999 lb/mmbtu	None listed	BACT-PSD
MI-0412 (G)	12/4/2011	1000 KW (1341 BHP)	Natural Gas	Lean	CO	0.8 g/hp-hr	Oxidation catalyst	BACT-PSD
					NOx	2.0 g/hp-hr	Good combustion practices	BACT-PSD
					PM10	0.01 lb/mmbtu	Good combustion practices	BACT-PSD
					PM2.5	0.01 lb/mmbtu	Good combustion practices	BACT-PSD
					VOC	0.5 g/hp-hr	Oxidation catalyst	BACT-PSD
MI-0413	5/12/2014	530 BHP & 800 BHP	Natural Gas	Unknown	CO	N/A	Good combustion practices	BACT-PSD
					SO2	N/A	Good combustion practices	BACT-PSD
MI-0420	6/3/2016	1506 KW (2020 BHP)	Natural Gas	Unknown	CO	9.6 lb/hr (2.2 g/hp-hr)	Good combustion practices	BACT-PSD
					NOx	4.8 lb/hr (1.1 g/hp-hr)	Good combustion practices	BACT-PSD
					PM10	0.01 lb/mmbtu	Good combustion practices	BACT-PSD
					PM2.5	0.01 lb/mmbtu	Good combustion practices	BACT-PSD

Spark-Ignited, Emergency Standby, IC Engines ≥ 500 BHP (Process Code: 17.130)								
RBLC#	**Permit Date (A)**	**Rating (B)**	**Fuel**	**Engine Burn Type**	**Pollutant**	**Standard (C)**	**Control Technology**	**Case-By-Case Basis**
MI-0424	12/5/2016	1462 BHP	Natural Gas	Lean	CO	0.8 g/hp-hr	Oxidation catalyst	BACT-PSD
					NOx	2.0 g/hp-hr	Good combustion practices	BACT-PSD
					PM10	0.01 lb/mmbtu	Good combustion practices	BACT-PSD
					PM2.5	0.01 lb/mmbtu	Good combustion practices	BACT-PSD
					VOC	0.5 g/hp-hr	Oxidation catalyst	BACT-PSD
MI-0426	12/4/2017	1818 BHP	Natural Gas	Lean	CO	11.0 lb/hr (2.7 g/hp-hr)	Good combustion practices	BACT-PSD
					NOx	4.0 lb/hr (1.0 g/hp-hr)	Turbo charger & after cooler	BACT-PSD
					PM10	0.01 lb/mmbtu	Good combustion practices	BACT-PSD
					PM2.5	0.01 lb/mmbtu	Good combustion practices	BACT-PSD
OK-0153 (G)	3/1/2013	2889 BHP	Natural Gas	Lean	CO	0.43 g/hp-hr	Oxidation catalyst	BACT-PSD
					NOx	0.5 g/hp-hr	Lean burn combustion	BACT-PSD
					PM2.5	0.01 lb/mmbtu	Natural gas combustion	BACT-PSD
					VOC	0.44 g/hp-hr	Oxidation catalyst	BACT-PSD
TX-0642	12/20/2013	1328 BHP	Natural Gas	Lean	CO	1.3 g/hp-hr	None listed	BACT-PSD
					NOx	2.0 g/hp-hr	None listed	BACT-PSD

(A) Due to the large number of entries only determinations made (based on Permit Date) entered since 01/01/2011 are included in the above table.
(B) Break horsepower in parenthesis are converted from the listed kilowatt rating using a factor of 1.341 kw per hp.
(C) Standards in parenthesis are converted from the listed standard in some cases using the listed horsepower and/or a conversion factor of 1.341 kw per hp.
(D) BACT was determined to be use of natural gas fuel and good combustion practices. Emission limits for PM10, PM2.5, and PM (TSP) were determined to be <0.01 lb/hr and was established by Louisiana Department of Environmental Quality Permit PSD-LA-754 for Westlake Vinyls Company, LP.
(E) BACT was determined to be use of natural gas fuel and good combustion practices. There is no associated BACT emission standard listed on Permit PSD-LA-787 for Alexandria Compressor Station by Louisiana Department of Environmental Quality.
(F) The Ninth Circuit Court of Appeals issued a decision on 8/12/2014 that vacated the permit decision and remanded it to EPA. Therefore, this BACT determination has not yet been achieved in practice. Source: EPA Region IX, Avenal Energy Product.
(G) The engine in this determination powers an emergency generator but is allowed to operate more than 200 hours per year. Under Sac Metro AQMD regulation this engine would be considered prime power and, therefore, the standards will not be considered in this BACT determination.

[yellow] = Selected as the most stringent BACT determination achieved in practice. The most recent determination selected if multiple determinations are the most stringent.

Attachment B

Review of BACT Determinations published by ARB

List of BACT determinations published in ARB's BACT Clearinghouse for: IC Engine - Stationary, Natural Gas Fuel:

IC Engines – Stationary, Natural Gas Fueled, Emergency Standby, < 500 BHP						
Source	**Date**	**Rating**	**Function**	**Pollutant**	**Standard (A)**	**Control Technology**
SCAQMD (ID 361525)	1/17/2002	93.8 BHP	Driving an Electrical Generator	NOx	0.15 g/bhp-hr	Three-Way Catalytic Converter and Air/Fuel Ratio Controller
				CO	0.6 g/bhp-hr	Three-Way Catalytic Converter and Air/Fuel Ratio Controller
				VOC	0.15 g/bhp-hr	Three-Way Catalytic Converter and Air/Fuel Ratio Controller

IC Engines – Stationary, Natural Gas Fueled, Emergency Standby, ≥ 500 BHP						
Source	**Date**	**Rating**	**Function**	**Pollutant**	**Standard**	**Control Technology**
SCAQMD (ID 359876)	10/2/1999	750 BHP	Emergency Flood Control Pump	NOx	0.15 g/bhp-hr	Three-Way Catalytic Converter and Air/Fuel Ratio Controller
				CO	0.6 g/bhp-hr	Three-Way Catalytic Converter and Air/Fuel Ratio Controller
				VOC	0.15 g/bhp-hr	Three-Way Catalytic Converter and Air/Fuel Ratio Controller

Attachment C

SMAQMD BACT Determination #208 & 209

SMAQMD BACT CLEARINGHOUSE

EXPIRED

CATEGORY Type: **IC ENGINE SPARK - STANDBY**

BACT Category: MINOR SOURCE

BACT Determination Number: 208	**BACT Determination Date:** **12/28/2018**

Equipment Information

Permit Number: N/A -- Generic BACT Determination

Equipment Description: IC ENGINE STANDBY

Unit Size/Rating/Capacity: < 500 BHP

Equipment Location:

BACT Determination Information

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

ROCs	**Standard:**	See Description
	Technology Description:	Lean burn: 206 ppmv @ 15% O2 as methane (1.0 g/bhp-hr), Rich burn: 60 ppmv @ 15% O2 as methane (0.29 g/hp-hr)
	Basis:	Achieved in Practice
NOx	**Standard:**	See Description
	Technology Description:	Lean burn: 1.0 g/hp-hr, Rich burn: 25 ppmvd @ 15 O2 (0.44 g/hp-hr) OR 96% weight reduction
	Basis:	Achieved in Practice
SOx	**Standard:**	Natural gas fuel or equivalent fuel
	Technology Description:	
	Basis:	Achieved in Practice
PM10	**Standard:**	Natural gas fuel or equivalent fuel
	Technology Description:	
	Basis:	Achieved in Practice
PM2.5	**Standard:**	Natural gas fuel or equivalent fuel
	Technology Description:	
	Basis:	Achieved in Practice
CO	**Standard:**	2.0 g/hp-hr
	Technology Description:	
	Basis:	Achieved in Practice
LEAD	**Standard:**	
	Technology Description:	
	Basis:	

Comments: T-BACT is equivalent to BACT for VOC. This BACT was last reviewed on 12/28/2018, and amended on 8/9/2019.

EXPIRED

CATEGORY Type: **IC ENGINE SPARK - STANDBY**

BACT Category: MINOR SOURCE

BACT Determination Number: 209	**BACT Determination Date:** 12/28/2018

Equipment Information

Permit Number: N/A -- Generic BACT Determination

Equipment Description: IC ENGINE STANDBY

Unit Size/Rating/Capacity: ≥ 500 BHP

Equipment Location:

BACT Determination Information

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

ROCs	**Standard:**	See Description
	Technology Description:	Lean burn: 206 ppmv @ 15% O2 as methane (1.0 g/bhp-hr), Rich burn: 60 ppmv @ 15% O2 as methane (0.29 g/hp-hr)
	Basis:	Achieved in Practice
NOx	**Standard:**	See Description
	Technology Description:	Lean burn: 0.5 g/hp-hr, Rich burn: 25 ppmvd @ 15% O2 (0.44 g/hp-hr) OR 96% weight reduction
	Basis:	Achieved in Practice
SOx	**Standard:**	Natural gas fuel or equivalent fuel
	Technology Description:	
	Basis:	Achieved in Practice
PM10	**Standard:**	0.0099 lb/MMBtu
	Technology Description:	
	Basis:	Achieved in Practice
PM2.5	**Standard:**	0.0099 lb/MMBtu
	Technology Description:	
	Basis:	Achieved in Practice
CO	**Standard:**	1.5 g/bhp-hr
	Technology Description:	
	Basis:	Achieved in Practice
LEAD	**Standard:**	
	Technology Description:	
	Basis:	

Comments: T-BACT is equivalent to BACT for VOC. This BACT was last reviewed on 12/28/2018, and amended on 8/9/2019.

ADDENDUM TO BEST AVAILABLE CONTROL TECHNOLOGY DETERMINATION

DETERMINATION NO.: 208 & 209

DATE: July 8, 2019

ENGINEER: Jeffrey Quok

Category/General Equip Description:	Internal Combustion (I.C.) Engine
Equipment Specific Description:	I.C. Engine Spark – Standby, Gaseous-fueled (Excluding Biogas)
Equipment Size/Rating:	Engines < 500 BHP (BACT #208) Engines ≥ 500 BHP (BACT #209)
Previous BACT Det. No.:	No. 122 & 123

This BACT determination addendum will update BACT determinations #208 & #209 to update VOC emission standards that were based on SJVAPCD's BACT Guideline 3.1.5. This update will change the lean burn VOC emissions standard from 86 ppmv at 15% O_2 to 206 ppmv at 15% O_2 and add a rich burn VOC concentration standard of 60 ppmv at 15% O_2 to the original standard of 0.29 g/hp-hr.

SJVAPCD's VOC emission standard for lean burn engines was originally based on the EPA NSPS JJJJ VOC standard of 86 ppmv or 1.0 g/hp-hr (above 130 HP). SJVAPCD discovered that the NSPS standard is referenced as propane. SJVAPCD updated their BACT guideline to reference methane to be consistent with their rules. This change in reference switched the standard from 86 ppmv @ 15% O_2 (measured as propane) to 206 ppmv @ 15% O_2 (measured as methane). SJVAPCD also added a concentration standard of 60 ppmv at 15% O_2 (measured as methane) to the original standard of 0.29 g/hp-hr to be consistent with the lean burn VOC Standard.

BACT/T-BACT ANALYSIS

A. <u>ACHIEVED IN PRACTICE (Rule 202, §205.1a):</u>

The following control technologies are currently employed as BACT/T-BACT for gaseous-fueled and propane/LPG standby engines by the following agencies and air pollution control districts:

<table>
<tr>
<td>San Joaquin Valley Unified APCD</td>
<td>
<u>BACT</u>
Source: SJVUAPCD BACT
Guideline 3.1.5 – Emergency Gas-Fired IC Engine (7/16/18)
<table>
<tr><td colspan="2">Emergency Gas-Fired IC Engine</td></tr>
<tr><td>VOC</td><td><u>Lean Burn</u>: 206 ppmv @ 15% O_2 as methane (1.0 g/bhp-hr)

<u>Rich Burn</u>: 60 ppmv @ 15% O_2 as methane (0.29 g/hp-hr)</td></tr>
<tr><td>NOx</td><td><u>Lean Burn < 500 BHP</u>: 1.0 g/bhp-hr
<u>Lean Burn ≥ 500 BHP</u>: 0.5 g/bhp-hr

<u>Rich Burn</u>: 25 ppmvd @ 15% O_2 (0.44 g/bhp-hr)</td></tr>
<tr><td>SOx</td><td>Natural gas, LPG, or Propane fuel</td></tr>
<tr><td>PM10</td><td>Natural gas, LPG, or Propane fuel</td></tr>
<tr><td>PM2.5</td><td>No Standard</td></tr>
<tr><td>CO</td><td>2.0 g/bhp-hr</td></tr>
</table>
<u>T-BACT</u>
There are no T-BACT standards published in the clearinghouse for this category.

<u>RULE REQUIREMENTS:</u>
Rule 4702 – Internal Combustion Engines (Amended 11/14/13)

Standby Engines are exempt from the emission limitations of this rule.
</td>
</tr>
</table>

C. <u>SELECTION OF BACT/T-BACT:</u>

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.

Volatile hazardous air pollutants (VHAP) are the primary driver for health risks associated with gaseous fueled engines. VHAPs are emitted as VOC, and the same control technologies that control VOC also control VHAPs. Therefore, the BACT for VOC and T-BACT for VHAPs are the same.

Table 1: BACT #208 FOR SPARK IGNITED I.C. ENGINES, STANDBY, GASEOUS-FUELED (EXCLUDING BIOGAS) < 500 BHP		
Pollutant	**Standard**	**Source**
VOC	Lean Burn 206 ppmv @ 15% O_2 as methane (1.0 g/bhp-hr) Rich Burn 60 ppmv @ 15% O_2 as methane (0.29 g/hp-hr)	SJVAPCD
NOx	Lean-Burn: 1.0 g/bhp-hr Rich Burn: 25 ppmvd @ 15 O_2 (0.44 g/hp-hr) OR 96% weight reduction	SMAQMD & SJVAPCD
SOx	Natural gas fuel or equivalent fuel	SMAQMD, SCAQMD, SJVUAPCD, and BAAQMD
PM10	Natural gas fuel or equivalent fuel	SMAQMD, SCAQMD, SJVUAPCD, and BAAQMD
PM2.5	Natural gas fuel or equivalent fuel	SMAQMD, SCAQMD, SJVUAPCD, and BAAQMD
CO	2.0 g/bhp-hr	SMAQMD, SCAQMD, SJVAPCD

Table 2: T-BACT #208 FOR SPARK IGNITED I.C. ENGINES, STANDBY, GASEOUS-FUELED (EXCLUDING BIOGAS) < 500 BHP		
Pollutant	**Standard**	**Source**
VHAP(A)	Lean Burn 206 ppmv @ 15% O_2 as methane (1.0 g/bhp-hr) Rich Burn 60 ppmv @ 15% O_2 as methane (0.29 g/hp-hr)	SJVAPCD

(A) A full list of the volatile hazardous air pollutants (VHAP) from natural gas combustion can be found in AP-42, Section 3.2 Natural Gas-fired Reciprocating Engines, Tables 3.2-1, 3.2-2, and 3.2-3.

Table 3: BACT #209 FOR SPARK IGNITED I.C. ENGINES, STANDBY, GASEOUS-FUELED (EXCLUDING BIOGAS) ≥ 500 BHP		
Pollutant	**Standard**	**Source**
VOC	Lean Burn 206 ppmv @ 15% O_2 as methane (1.0 g/bhp-hr) Rich Burn 60 ppmv @ 15% O_2 as methane (0.29 g/hp-hr)	SJVAPCD
NOx	Lean-Burn: 0.5 g/bhp-hr Rich Burn: 25 ppmvd @ 15 O_2 (0.44 g/hp-hr) OR 96% weight reduction	SMAQMD & SJVAPCD
SOx	Natural gas fuel or equivalent fuel	BAAQMD
PM10	0.0099 lb/MMBtu	SMAQMD & EPA (MI-00401)
PM2.5	0.0099 lb/MMBtu	SMAQMD & EPA (MI-00401)
CO	1.5 g/p-hr	SMAQMD

Table 4: T-BACT #209 FOR SPARK IGNITED I.C. ENGINES, STANDBY, GASEOUS-FUELED (EXCLUDING BIOGAS) ≥ 500 BHP		
Pollutant	**Standard**	**Source**
VHAP[(A)]	Lean Burn 206 ppmv @ 15% O_2 as methane (1.0 g/bhp-hr) Rich Burn 60 ppmv @ 15% O_2 as methane (0.29 g/hp-hr)	SJVAPCD

(A) A full list of the volatile hazardous air pollutants (VHAP) from natural gas combustion can be found in AP-42, Section 3.2 Natural Gas-fired Reciprocating Engines, Tables 3.2-1, 3.2-2, and 3.2-3.

APPROVED BY: Brian F Kind (signature) **DATE:** 8-9-19

Attachment A

SJVAPCD BACT Determination and Email Contact

San Joaquin Valley
Unified Air Pollution Control District

Best Available Control Technology (BACT) Guideline 3.1.5*

Last Update: 07/16/2018

Emergency Gas-Fired IC Engine

Pollutant	Achieved in Practice or contained in the SIP	Technologically Feasible	Alternate Basic Equipment
VOC	1) LEAN BURN: 206 ppmv @ 15% O2 (1.0 g/bhp-hr) 2) RICH BURN: 60 ppmv @ 15% O2 (0.29 g/bhp-hr)		
SOx	Natural Gas, LPG, or Propane as fuel		
PM10	Natural Gas, LPG, or Propane as fuel		
NOx	1) LEAN BURN: < 500 BHP: 1.0 g/bhp-hr ≥ 500 BHP: 0.5 g/bhp-hr 2) RICH BURN: 25 ppmv @ 15% O2 (0.44 g/bhp-hr)		
CO	2.0 g/bhp-hr		

BACT is the most stringent control technique for the emissions unit and class of source. Control techniques that are not achieved in practice or contained in a State Implementation Plan must be cost effective as well as feasible. Economic analysis to demonstrate cost effectiveness is required for all determinations that are not achieved in practice or contained in an EPA approved State Implementation Plan.

***This is a Summary Page for this Class of Source**

Jeffrey Quok

From:	Matthew Baldwin
Sent:	Tuesday, May 07, 2019 4:47 PM
To:	Jeffrey Quok
Subject:	FW: Question on BACT 3.1.5
Categories:	Red Category

Jeff,

Here's a summary of what Silvana Procopio told me regarding BACT 3.1.5.

The lean burn VOC BACT was based on EPA NSPS JJJJ. This standard is 86 ppmv or 1.0 g/hp-hr (above 130 HP). However, not stated is the reference pollutant. San Joaquin investigated and discovered that it was referenced as propane. San Joaquin then updated their standard to reference methane, which is consistent with their rules. The change in reference switched the standard from 86 ppmv @ 15% oxygen to 206 ppmv @ 15% Oxygen. Likewise, they added a concentration standard to be consistent with the Lean Burn VOC standard, which is why they updated the original standard (0.29 g/hp-hr) to reference a 60 ppmv @ 15% Oxygen. Silvana stated that this is also referenced as methane.

Matt Baldwin
Sacramento Metropolitan AQMD
(916) 874-4858

From: Silvana Procopio [mailto:Silvana.Procopio@valleyair.org]
Sent: Tuesday, May 07, 2019 1:28 PM
To: Matthew Baldwin <MBaldwin@airquality.org>
Cc: Leonard Scandura <Leonard.Scandura@valleyair.org>; Errol Villegas <errol.villegas@valleyair.org>
Subject: RE: Question on BACT 3.1.5

Hi Matt,

It was a pleasure speaking with you earlier. Let me know if you have any further questions regarding the BACT Guideline Determination 3.1.5.

Kind regards,

Silvana Procopio
Air Quality Engineer
San Joaquin Valley APCD
34946 Flyover Ct.,
Bakersfield, CA 93308
Ph.: 661.392.5606
www.valleyair.org

San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT

From: Leonard Scandura <Leonard.Scandura@valleyair.org>
Sent: Tuesday, May 7, 2019 11:55 AM
To: Errol Villegas <errol.villegas@valleyair.org>
Cc: Silvana Procopio <Silvana.Procopio@valleyair.org>
Subject: RE: Question on BACT 3.1.5

Errol - Well give him a call back.

Thanks

Leonard

From: Errol Villegas <errol.villegas@valleyair.org>
Sent: Tuesday, May 7, 2019 10:20 AM
To: Leonard Scandura <Leonard.Scandura@valleyair.org>
Subject: FW: Question on BACT 3.1.5

Leonard – It looks like Sylvana did this proactive BACT update… Can you please assist with answering this question from Sac Metro?

Thanks,
Errol

From: Matthew Baldwin <MBaldwin@airquality.org>
Sent: Tuesday, May 7, 2019 9:34 AM
To: Errol Villegas <errol.villegas@valleyair.org>
Subject: Question on BACT 3.1.5

Errol,

Just had a question regarding one of your BACT determinations. During a review for a permit application, I noticed that the VOC standard for BACT 3.1.5 (Emergency Gas-fired engine) had been corrected or changed. When we did our BACT determination for this category, we referenced the following standards:

1) Lean burn: 86 ppmv @ 15% O2 (0.4 g/bhp-hr) 2) Rich burn: 0.29 g/hp-hr (SMAQMD BACT Determination 208 & 209)

When looking more recently at the same BACT, it looks like the standard changed to:

1) Lean Burn: 206 ppmv @ 15% O2 (1.0 g/bhp-hr) 2) Rich Burn: 60 ppmv @ 15% O2 (0.29 g/bhp-hr)

Could you please clarify? We just want to be sure we have referenced the correct standards, and update our BACT if necessary.

Thanks,

Matt Baldwin
Air Quality Engineer
Sacramento Metropolitan Air Quality Management District
777 12th Street, 3rd Floor | Sacramento, CA 95814
Tel: (916) 874-4858 | Front Desk: (916) 874-4800
www.airquality.org

Attachment B

Original BACTs #208 & #209 (12/18/2018)

CATEGORY: **IC ENGINE SPARK - STANDBY**

BACT Size: Minor Source BACT **IC ENGINE STANDBY**

BACT Determination Number: 208	**BACT Determination Date:** **12/18/2018**

Equipment Information

Permit Number: N/A -- Generic BACT Determination

Equipment Description: IC ENGINE STANDBY

Unit Size/Rating/Capacity: < 500 BHP

Equipment Location:

BACT Determination Information

ROCs	**Standard:**	See Description
	Technology Description:	Lean burn: 86 ppmv @ 15% O2 (0.4 g/bhp-hr), Rich burn: 0.29 g/hp-hr
	Basis:	Achieved in Practice
NOx	**Standard:**	See Description
	Technology Description:	Lean burn: 1.0 g/hp-hr, Rich burn: 25 ppmvd @ 15 O2 (0.44 g/hp-hr) OR 96% weight reduction
	Basis:	Achieved in Practice
SOx	**Standard:**	Natural gas fuel or equivalent fuel
	Technology Description:	
	Basis:	Achieved in Practice
PM10	**Standard:**	Natural gas fuel or equivalent fuel
	Technology Description:	
	Basis:	Achieved in Practice
PM2.5	**Standard:**	Natural gas fuel or equivalent fuel
	Technology Description:	
	Basis:	Achieved in Practice
CO	**Standard:**	2.0 g/hp-hr
	Technology Description:	
	Basis:	Achieved in Practice
LEAD	**Standard:**	
	Technology Description:	
	Basis:	

Comments: T-BACT is equivalent to BACT for VOC.

District Contact:

CATEGORY:

IC ENGINE SPARK - STANDBY

BACT Size: Minor Source BACT **IC ENGINE STANDBY**

BACT Determination Number: 209	**BACT Determination Date:** 12/18/2018

Equipment Information

Permit Number: N/A -- Generic BACT Determination

Equipment Description: IC ENGINE STANDBY

Unit Size/Rating/Capacity: ≥ 500 BHP

Equipment Location:

BACT Determination Information

ROCs	**Standard:**	See Description
	Technology Description:	Lean burn: 86 ppmv @ 15% O2 (0.4 g/bhp-hr), Rich burn: 0.29 g/hp-hr
	Basis:	Achieved in Practice
NOx	**Standard:**	See Description
	Technology Description:	Lean burn: 0.5 g/hp-hr, Rich burn: 25 ppmvd @ 15 O2 (0.44 g/hp-hr) OR 96% weight reduction
	Basis:	Achieved in Practice
SOx	**Standard:**	Natural gas fuel or equivalent fuel
	Technology Description:	
	Basis:	Achieved in Practice
PM10	**Standard:**	0.0099 lb/MMBtu
	Technology Description:	
	Basis:	Achieved in Practice
PM2.5	**Standard:**	0.0099 lb/MMBtu
	Technology Description:	
	Basis:	Achieved in Practice
CO	**Standard:**	1.5 g/bhp-hr
	Technology Description:	
	Basis:	Achieved in Practice
LEAD	**Standard:**	
	Technology Description:	
	Basis:	

Comments: T-BACT is equivalent to BACT for VOC.

District Contact:

BEST AVAILABLE CONTROL TECHNOLOGY DETERMINATION

DETERMINATION NO.: 208 & 209

DATE: December 18, 2018

ENGINEER: Jeffrey Quok

Category/General Equip Description:	Internal Combustion (I.C.) Engine
Equipment Specific Description:	I.C. Engine Spark – Standby, Gaseous-fueled (Excluding Biogas)
Equipment Size/Rating:	Engines < 500 BHP (BACT #208) Engines ≥ 500 BHP (BACT #209)
Previous BACT Det. No.:	No. 122 & 123

This BACT determination will update the following determinations:

#122 & #123 which were made on August 5, 2016 for I.C. Engine Spark - Standby, < 500 BHP and ≥ 500 BHP

BACT/T-BACT ANALYSIS

A. <u>ACHIEVED IN PRACTICE (Rule 202, §205.1a):</u>

The following control technologies are currently employed as BACT/T-BACT for gaseous-fueled and propane/LPG standby engines by the following agencies and air pollution control districts:

Note: Tables 3.2-1, 3.2-2, and 3.2-3 of AP-42 list benzene, formaldehyde, PAHs, naphthalene, acetaldehyde, acrolein, propylene, toluene, xylenes, ethyl benzene, and hexane as the primary drivers for health risks associated with natural gas combustion. These VHAPs/organic compounds are emitted as VOC and the same control technologies that control VOCs also control the listed VHAPs.

<table>
<tr><th>District/Agency</th><th>Best Available Control Technology (BACT)/Requirements</th></tr>
<tr><td>US EPA</td><td>
<u>BACT</u>
Source: EPA RACT/BACT/LAER Clearinghouse (See Attachment A)
RBLC ID: N/A IA-0102 (VOC) & CA-1225 (NOx, PM10, & CO)
<table>
<tr><td colspan="2">For standby natural gas (includes propane & LPG) units with a rating of < 500 BHP</td></tr>
<tr><td>VOC</td><td>0.66 lb/hr (IA-0102)[A]</td></tr>
<tr><td>NOx</td><td>0.78 lb/hr (CA-1225)[B]</td></tr>
<tr><td>SOx</td><td>N/A – No BACT determinations found in the < 500 BHP range</td></tr>
<tr><td>PM10</td><td>0.216 lb/hr (CA-1225)[B]</td></tr>
<tr><td>PM2.5</td><td>N/A – No BACT determinations found in the < 500 BHP range</td></tr>
<tr><td>CO</td><td>4.0 g/hp-hr (CA-1225)[B]</td></tr>
</table>
(A) IA-0102 was a BACT Determination for a 225 KW engine. This determination did not identify if the engine was lean or rich burn.
(B) CA-1225 was a BACT Determination for a 256 BHP engine. This determination did not identify if the engine was lean or rich burn.
Source: EPA RACT/BACT/LAER Clearinghouse (See Attachment A)
RBLC ID: OK-0153 (VOC, NOx, & CO), IN-0167 (SOx), & MI-0401 (PM10 & PM2.5)
<table>
<tr><td colspan="2">For standby natural gas (includes propane & LPG) units with a rating of ≥ 500 BHP</td></tr>
<tr><td>VOC</td><td>0.44 g/hp-hr (OK-0153)[A]</td></tr>
<tr><td>NOx</td><td>0.5 g/hp-hr (OK-0153)[A]</td></tr>
<tr><td>SOx</td><td>0.0015 g/kwh (0.0011 g/hp-hr) (IN-0167)[B]</td></tr>
<tr><td>PM10</td><td>0.0099 lb/MMBtu (MI-0401)[C]</td></tr>
<tr><td>PM2.5</td><td>0.0099 lb/MMBtu (MI-0401)[C]</td></tr>
<tr><td>CO</td><td>0.43 g/hp-hr (OK-0153)[A]</td></tr>
</table>
(A) OK-0153 was a BACT Determination for a 2,889 BHP engine. This determination did not identify if the engine was lean or rich burn.
(B) IN-0167 was a BACT Determination for a 620 BHP engine. This determination did not identify if the engine was lean or rich burn.
(C) MI-0401 was a BACT Determination for a 1,200 kW engine. This determination did not identify if the engine was lean or rich burn.
<u>T-BACT</u>
There are no T-BACT standards published in the clearinghouse for this category.
<u>RULE REQUIREMENTS:</u>
40 CFR Part 60 Subpart JJJJ – Standards of Performance for Stationary Spark Ignition Internal Combustion Engines: This regulation applies to owners/operators of new stationary spark ignition engines that commenced construction after June 12, 2006. [40 CFR §60.4230(a)(4)]
</td></tr>
</table>

District/Agency	Best Available Control Technology (BACT)/Requirements

US EPA

40 CFR §60.4233(d) & §60.4233(e)
Owners and operators of stationary SI ICE with a maximum engine power greater than 19 KW (25 BHP) must comply with the emission standards of Table 1 to this subpart for their emergency stationary SI ICE (applies to both lean and rich burn engines).

40 CFR Subpart JJJJ Table 1: Emission Standards (g/kW-hr)					
Engine Type and Fuel	Maximum Engine Power	Manufacture Date	Emission Standards[A] g/bhp-hr (ppmvd at 15% O_2)		
			NOx	CO	VOC[C]
Emergency[D]	25<BHP<130	1/1/2009	10[B] (N/A)	387 (N/A)	N/A
	BHP≥130		2.0 (160)	4.0 (540)	1.0 (86)

(A) Owners and operators of stationary non-certified SI engines may choose to comply with the emission standards in units of either g/bhp-hr or ppmvd at 15% O2
(B) The emission standards applicable to emergency engines between 25 BHP and 130 BHP are in terms of NOx + HC.
(C) For purposes of this subpart, when calculating emissions of VOC compounds, emissions of formaldehyde should not be included.
(D) Applies to both lean and rich burn emergency engines.

Air Resources Board (ARB)

BACT
Source: ARB BACT Clearinghouse (SCAQMD) (See Attachment B)

For standby spark ignition natural gas fired units[A]	
VOC	1.5 g/bhp-hr, 3-way catalyst converter with air/fuel ratio controller
NOx	1.5 g/bhp-hr, 3-way catalyst converter with air/fuel ratio controller
SOx	N/A – No BACT determinations found
PM10	N/A – No BACT determinations found
PM2.5	N/A – No BACT determinations found
CO	2.0 g/bhp-hr, 3-way catalyst converter with air/fuel ratio controller

(A) This BACT determination was for a 1334 bhp engine. The determination doesn't specify if the engine is rich or lean burn.

<table>
<tr><td>District/Agency</td><td>Best Available Control Technology (BACT)/Requirements</td></tr>
<tr><td>Air Resources Board (ARB)</td><td><u>T-BACT</u>
There are no T-BACT standards published in the clearinghouse for this category.

<u>RULE REQUIREMENTS:</u>
None

<u>CARB RACT/BARCT Guidelines for Stationary Spark-Ignited Internal Combustion Engines</u> (11/2001)
This document presents the determination of reasonably available control technology (RACT) and best available retrofit control technology (BARCT) for controlling NOx, VOC, and CO from stationary, spark-ignited reciprocating internal combustion engines. On page IV-14 of the document, emergency standby engines are listed as exempt from the recommended emission limits. Therefore, this guideline is not applicable to this BACT determination.</td></tr>
<tr><td>SMAQMD</td><td><u>BACT</u>
<u>Source: SMAQMD BACT Clearinghouse, BACT Determination #122 & #123</u> (8/5/16)

<table>
<tr><td colspan="2">For standby spark ignition units with a rating of < 500 BHP</td></tr>
<tr><td>VOC</td><td><u>Lean Burn</u>
1.0 g/bhp-hr

<u>Rich Burn</u>
50% Control efficiency, 3-way catalyst with air-to-fuel ratio controller</td></tr>
<tr><td>NOx</td><td><u>Lean-Burn:</u>
1.0 g/bhp-hr

<u>Rich Burn:</u>
25 ppmvd @ 15% O_2 OR 96% weight reduction</td></tr>
<tr><td>SOx</td><td>Natural gas or equivalent fuel</td></tr>
<tr><td>PM10</td><td>Natural gas or equivalent fuel</td></tr>
<tr><td>PM2.5</td><td>Natural gas or equivalent fuel</td></tr>
<tr><td>CO</td><td>2.0 g/bhp-hr</td></tr>
</table>
</td></tr>
</table>

<table>
<tr><th>District/Agency</th><th>Best Available Control Technology (BACT)/Requirements</th></tr>
<tr><td>SMAQMD</td><td>
<table>
<tr><th colspan="2">For standby spark ignition units with a rating of ≥ 500 BHP(A)</th></tr>
<tr><td>VOC</td><td><u>Lean Burn</u>
0.6 g/bhp-hr

<u>Rich Burn</u>
50% Control efficiency, 3-way catalyst with air-to-fuel ratio controller</td></tr>
<tr><td>NOx</td><td><u>Lean-Burn:</u>
0.5 g/bhp-hr

<u>Rich-Burn:</u>
25 ppmvd @ 15% O_2 OR 96% weight reduction</td></tr>
<tr><td>SOx</td><td>Natural gas or equivalent fuel</td></tr>
<tr><td>PM10</td><td>0.0099 lb/MMBtu</td></tr>
<tr><td>PM2.5</td><td>0.0099 lb/MMBtu</td></tr>
<tr><td>CO</td><td>1.5 g/p-hr</td></tr>
</table>

<u>T-BACT</u>
<u>Source: SMAQMD BACT Clearinghouse, BACT Determination #122 & #123</u> (8/5/16)
<table>
<tr><th colspan="2">For standby spark ignition units with a rating of < 500 BHP(A)</th></tr>
<tr><td>VHAP(A)</td><td>1.0 g/bhp-hr</td></tr>
</table>
(A) A full list of the volatile hazardous air pollutants (VHAP) from natural gas combustion can be found in AP-42, Section 3.2 Natural Gas-fired Reciprocating Engines, Tables 3.2-1, 3.2-2, and 3.2-3.
<table>
<tr><th colspan="2">For standby spark ignition units with a rating of ≥ 500 BHP(A)</th></tr>
<tr><td>VHAP(A)</td><td>0.6 g/bhp-hr</td></tr>
</table>
(A) A full list of the volatile hazardous air pollutants (VHAP) from natural gas combustion can be found in AP-42, Section 3.2 Natural Gas-fired Reciprocating Engines, Tables 3.2-1, 3.2-2, and 3.2-3.

<u>RULE REQUIREMENTS:</u>
<u>Rule 412 – Stationary Internal Combustion Engines Located at Major Stationary Sources of NOx (Adopted 6/1/1995)</u>
This rule applies to any stationary internal combustion engine rated at more than 50 BHP located at a major stationary source of NOx. Section 110 of this rule states that operation of stationary internal combustion engines used for emergency standby are exempt from the standards of this rule. Therefore, this rule is not applicable to this BACT determination.
</td></tr>
</table>

District/Agency	Best Available Control Technology (BACT)/Requirements

South Coast AQMD

BACT
Source: SCAQMD BACT Guidelines for Non-Major Polluting Facilities, page 74 (2/2/18)

BACT Guideline, I.C. Engine Spark Ignition, Stationary, Emergency – g/bhp-hr					
Rating/Size	VOC	NOx	SOx	CO	PM
< 130 HP	1.5 g/bhp-hr	1.5 g/bhp-hr	Use of clean fuels (A)	2.0 g/bhp-hr	Use of clean fuels (A)
≥ 130 HP	1.0 g/bhp-hr	1.5 g/bhp-hr	Use of clean fuels (A)	2.0 g/bhp-hr	Use of clean fuels (A)

(A) Clean fuel is defined as one that produces air emissions equivalent to or lower than natural gas for NOx, SOx, ROG, and fine particulate matter (PM10).

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

RULE REQUIREMENTS:
Reg IX, Rule 1110.2 – Emissions from Gaseous- and Liquid-Fueled Engines (Amended 6/3/16)

Emergency standby engines are exempt from this Rule.

San Joaquin Valley Unified APCD

BACT
Source: SJVUAPCD BACT
Guideline 3.1.5 – Emergency Gas-Fired IC Engine (7/16/18)

Emergency Gas-Fired IC engine	
VOC	Lean Burn: 86 ppmv @ 15% O2 (0.4 g/bhp-hr) Rich Burn: 0.29 g/hp-hr
NOx	Lean Burn < 500 BHP: 1.0 g/bhp-hr Lean Burn ≥ 500 BHP: 0.5 g/bhp-hr Rich Burn: 25 ppmvd @ 15% O2 (0.44 g/bhp-hr)
SOx	Natural gas, LPG, or Propane fuel
PM10	Natural gas, LPG, or Propane fuel
PM2.5	No Standard
CO	2.0 g/bhp-hr

<table>
<tr><th>District/Agency</th><th>Best Available Control Technology (BACT)/Requirements</th></tr>
<tr><td>San Joaquin Valley Unified APCD</td><td><u>T-BACT</u>
There are no T-BACT standards published in the clearinghouse for this category.

<u>RULE REQUIREMENTS:</u>
<u>Rule 4702 – Internal Combustion Engines</u> (Amended 11/14/13)

Standby Engines are exempt from the emission limitations of this rule.</td></tr>
<tr><td>San Diego APCD</td><td><u>BACT</u>
Source: <u>NSR Requirements for BACT</u>
The engine BACT determinations listed in the SDAPCD Clearinghouse do not apply to standby engines.

<u>T-BACT</u>
There are no T-BACT standards published in the clearinghouse for this category.

<u>RULE REQUIREMENTS:</u>
<u>Regulation 4, Rule 69.4 – Stationary Reciprocating Internal Combustion Engines – Reasonably Available Control Technology</u> (7/30/03)
This rule applies to stationary I.C. Engines ≥ 50 BHP located at a stationary source which emits or has a potential to emit 50 tons per year or more of NOx.

Standby Engines are exempt from the emission limitations of this rule.

<u>Regulation 4, Rule 69.4.1 – Stationary Reciprocating Internal Combustion Engines – Best Available Retrofit Control Technology</u> (11/15/00)
This rule applies to stationary I.C. Engines ≥ 50 BHP.

<table>
<tr><td colspan="4">New or replacement rich-burn engines using fossil derived gaseous fuel</td></tr>
<tr><td colspan="2">Published Value</td><td>Conversion for Naturally Aspirated Engines (g/bhp-hr)(A)</td><td>Conversion for Turbocharged Engines (g/bhp-hr)(B)</td></tr>
<tr><td>VOC</td><td>250 ppmvd @ 15% O_2</td><td>1.53</td><td>1.47</td></tr>
<tr><td>NOx</td><td>25 ppmvd @ 15% O_2 OR 96% weight reduction</td><td>0.44</td><td>0.42</td></tr>
<tr><td>SOx</td><td>No standard</td><td>-</td><td>-</td></tr>
<tr><td>PM10</td><td>No standard</td><td>-</td><td>-</td></tr>
<tr><td>PM2.5</td><td>No standard</td><td>-</td><td>-</td></tr>
<tr><td>CO</td><td>4,500 ppmvd @ 15% O_2</td><td>48.4</td><td>46.4</td></tr>
</table>
(A) Based on Santa Barbara County APCD Piston IC Engine Technical Reference Document (11/1/02) emission factor conversions, Section II(B)(B7)(e)(vi).
(B) Based on Santa Barbara County APCD Piston IC Engine Technical Reference Document (11/1/02) emission factor conversions, Section II(B)(B7)(e)(vii).</td></tr>
</table>

District/Agency	Best Available Control Technology (BACT)/Requirements
San Diego APCD	(see below)

San Diego APCD

New or replacement lean-burn engines using gaseous fuel			
Published Value		Conversion for Naturally Aspirated Engines (g/bhp-hr)[(A)]	Conversion for Turbocharged Engines (g/bhp-hr)[(B)]
VOC	250 ppmvd @ 15% O_2	1.53	1.47
NOx	65 ppmvd @ 15% O_2 OR 90% weight reduction	1.14	1.10
SOx	No standard	-	-
PM10	No standard	-	-
PM2.5	No standard	-	-
CO	4,500 ppmvd @ 15% O_2	48.4	46.4

(A) Based on *Santa Barbara County APCD Piston IC Engine Technical Reference Document* (11/1/02) emission factor conversions, Section II(B)(B7)(e)(vi).
(B) Based on *Santa Barbara County APCD Piston IC Engine Technical Reference Document* (11/1/02) emission factor conversions, Section II(B)(B7)(e)(vii).

Bay Area AQMD

BACT
Source: BAAQMD BACT
Guideline 96.3.4 (5/7/03)

IC Engine - Spark Ignition, Natural Gas Fired Emergency Engine ≥ 50 BHP	
VOC	1. 1.0 g/bhp-hr (Achieved in Practice) 2. Lean burn technology or equivalent (Achieved in Practice)
NOx	1. 1.0 g/bhp-hr (Achieved in Practice) 2. Lean burn technology or equivalent (Achieved in Practice)
SOx	1. Natural Gas Fuel (Achieved in Practice)
PM10	1. Natural Gas Fuel (Achieved in Practice)
PM2.5	No Standard
CO	1. 2.75 g/bhp-hr (Achieved in Practice) 2. Lean burn technology or equivalent (Achieved in Practice)

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

RULE REQUIREMENTS:
Reg 9, Rule 8 – Nitrogen Oxides and Carbon Monoxide from Stationary Internal Combustion Engines (7/25/07)

Standby Engines are exempt from the emission limitations of this rule.

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

SUMMARY OF ACHIEVED IN PRACTICE CONTROL TECHNOLOGIES	
VOC	For Spark Ignition, Emergency Standby Engines < 500 BHP 1. Lean burn: 86 ppmv @ 15% O_2 (0.4 g/bhp-hr) Rich burn: 0.29 g/hp-hr [SJVAPCD] 2. 0.66 g/bhp-hr (0.99 g/-bhp-hr)[(A)] [EPA, IA-0102] 3. Lean burn: 1.0 g/hp-hr Rich burn: 50% Control efficiency, 3-way catalyst with air-to-fuel ratio controller [SMAQMD] 4. 1.0 g/bhp-hr [BAAQMD] 5. 1.5 g/bhp-hr [SCAQMD] 6. 250 ppmvd @ 15% O_2 [SDAPCD] (1.53 g/bhp for naturally aspirated engines) (1.47 g/bhp for turbocharged engines) For Spark Ignition, Emergency Standby Engines ≥ 500 BHP 1. Lean burn: 86 ppmv @ 15% O_2 (0.4 g/bhp-hr) Rich burn: 0.29 g/hp-hr [SJVAPCD] 2. 0.44 g/bhp-hr [EPA, OK-0153] 3. Lean burn: 0.6 g/hp-hr Rich burn:50% Control efficiency, 3-way catalyst with air-to-fuel ratio controller [SMAQMD] 4. 1.0 g/bhp-hr [SCAQMD, BAAQMD] 5. 250 ppmvd @ 15% O_2 [SDAPCD] (1.53 g/bhp for naturally aspirated engines) (1.47 g/bhp for turbocharged engines)
NOx	For Spark Ignition, Emergency Standby Engines < 500 BHP 1. Lean burn: 1.0 g/hp-hr Rich burn: 25 ppmvd @ 15 O_2OR 96% weight reduction [SMAQMD] 2. Lean burn: 1.0 g/bhp-hr Rich Burn: 25 ppmvd @ 15% O_2 (0.44 g/bhp-hr) [SJVAPCD] 3. 1.0 g/bhp-hr [BAAQMD] 4. Rich Burn: 25 ppmvd @ 15% O_2 OR 96% NOx weight reduction [SDAPCD] (0.44 g/bhp-hr for naturally aspirated engines) (0.42 g/bhp-hr for turbocharged engines) Lean Burn:65 ppmvd @ 15% O_2 OR 90% NOx weight reduction (1.14 g/bhp-hr for naturally aspirated engines) (1.10 g/bhp-hr for turbocharged engines) 5. 0.78 lb/hr (1.35 g/bhp-hr)[(B)] [EPA, CA-1225] 6. 1.5 g/bhp-hr [SCAQMD]

SUMMARY OF ACHIEVED IN PRACTICE CONTROL TECHNOLOGIES	
NOx	For Spark Ignition, Emergency Standby Engines ≥ 500 BHP 1. Lean burn: 0.5 g/bhp-hr, Rich Burn: 25 ppmvd @ 15% O_2 (0.44 g/bhp-hr) [SJVAPCD] 2. Lean burn: 0.5 g/hp-hr, Rich burn: 25 ppmvd @ 15 O_2OR 96% weight reduction [SMAQMD] 3. Rich Burn: 25 ppmvd @ 15% O_2 OR 96% NOx weight reduction [SDAPCD] (0.44 g/bhp-hr for naturally aspirated engines) (0.42 g/bhp-hr for turbocharged engines) Lean Burn:65 ppmvd @ 15% O_2 OR 90% NOx weight reduction (1.14 g/bhp-hr for naturally aspirated engines) (1.10 g/bhp-hr for turbocharged engines) 4. 0.5 g/bhp-hr[(B)] [EPA, OK-0153] 5. 1.0 g/bhp-hr [BAAQMD] 6. 1.5 g/bhp-hr [SCAQMD]
SOx	For Spark Ignition, Emergency Standby Engines < 500 BHP 1. Natural gas fuel [BAAQMD] 2. Natural gas or equivalent fuel [SMAQMD] 3. Use of clean fuels[(C)] [SCAQMD] 4. Natural gas, LPG, or Propane fuel [EPA, SJVAPCD] 5. No standard [SDAPCD] For Spark Ignition, Emergency Standby Engines ≥ 500 BHP 1. 0.0015 g/kwh (0.0011 g/hp-hr) [EPA, IN-0167 & IN-0185][(E)] 2. Natural gas fuel [BAAQMD] 3. Natural gas or equivalent fuel [SMAQMD] 4. Use of clean fuels[(C)] [SCAQMD] 5. Natural gas, LPG, or Propane fuel [SJVAPCD] 6. No standard [SDAPCD]
PM10	For Spark Ignition, Emergency Standby Engines < 500 BHP 1. 0.0216 lb/hr [EPA, CA-1225][(F)] 2. Natural gas fuel [BAAQMD] 3. Natural gas or equivalent fuel [SMAQMD] 4. Use of clean fuels[(C)] [SCAQMD] 5. Natural gas, LPG, or Propane fuel [SJVAPCD] 6. No standard [SDAPCD] For Spark Ignition, Emergency Standby Engines ≥ 500 BHP 1. 0.0099 lb/MMBtu [EPA, MI-0401] 2. 0.0099 lb/MMBtu [SMAQMD] 3. Natural gas fuel [BAAQMD] 4. Use of clean fuels[(C)] [SCAQMD] 5. Natural gas, LPG, or Propane fuel [SJVAPCD] 6. No standard [SDAPCD]

SUMMARY OF ACHIEVED IN PRACTICE CONTROL TECHNOLOGIES	
PM2.5	For Spark Ignition, Emergency Standby Engines < 500 BHP 1. Natural gas or equivalent fuel [SMAQMD] 2. Use of clean fuels [SCAQMD] 3. No standard [EPA, SJVAPCD, SDACPD, BAAQMD] For Spark Ignition, Emergency Standby Engines ≥ 500 BHP 1. 0.0099 lb/MMBtu [EPA, MI-0401] 2. 0.0099 lb/MMBtu [SMAQMD] 3. Use of clean fuels(c) [SCAQMD] 4. No Standard [SJVAPCD, SDAPCD, BAAQMD]
CO	For Spark Ignition, Emergency Standby Engines < 500 BHP 1. 2.0 g/hp-hr [SMAQMD, SCAQMD, SJVAPCD] 2. 2.75 g/bhp-hr [BAAQMD] 3. 4.0 g/bhp-hr [EPA, CA-1225] 4. 4,500 ppmvd @ 15% O_2 [SDAPCD] (48.4 g/bhp-hr for naturally aspirated engines) (46.4 g/bhp-hr for turbocharged engines) For Spark Ignition, Emergency Standby Engines ≥ 500 BHP 1. 0.43 g/bhp-hr [EPA, OK-0153](G) 2. 1.5 g/bhp-hr [SMAQMD] 3. 2.0 g/bhp-hr [SCAQMD, SJVAPCD] 4. 2.75 g/bhp-hr [BAAMQD] 5. 4,500 ppmvd @ 15% O_2 [SDAPCD] (48.4 g/bhp-hr for naturally aspirated engines) (46.4 g/bhp-hr for turbocharged engines)
VHAP(D) (T-BACT)	For Spark Ignition, Emergency Standby Engines < 500 BHP 1. 1.0 g/bhp-hr [SMAQMD] 2. No standard [EPA, ARB, SCAQMD, BAAQMD, SDAPVD, SJVAPCD] For Spark Ignition, Emergency Standby Engines ≥ 500 BHP 1. 0.6 g/bhp-hr [SMAQMD] 2. No standard [EPA, ARB, SCAQMD, BAAQMD, SDAPVD, SJVAPCD]

(A) Conversion from lb/hr to g/bhp-hr based on a 225 KW engine and a conversion factor of 0.7457 kw/hp.
(B) Conversion from lb/hr to g/bhp-hr based on a 256 BHP engine.
(C) Clean fuels is defined as one that produces air emissions equivalent to or lower than natural gas for NOx, SOx, ROG, and fine particulate matter (PM10).
(D) A full list of the volatile hazardous air pollutants (VHAP) from natural gas combustion can be found in AP-42, Section 3.2 Natural Gas-fired Reciprocating Engines, Tables 3.2-1, 3.2-2, and 3.2-3.
(E) This BACT Determination did not specify if this was for a rich or lean burn engine. Compliance verification is listed as not verified. Therefore, this limit will not be considered achieved in practice.
(F) This BACT Determination did not specify if this was for a rich or lean burn engine. Compliance verification is listed as unknown. Therefore, this limit will not be considered achieved in practice.
(G) This BACT Determination did not specify if this was for a rich or lean burn engine. Compliance verification is listed as unknown. Therefore, this limit will not be considered achieved in practice.

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

BEST CONTROL TECHNOLOGIES ACHIEVED		
Pollutant	**Standard**	**Source**
VOC	**For gaseous or propane/LPG fired emergency IC Engines < 500 BHP (excluding biogas)** Lean burn: 86 ppmv @ 15% O_2 (0.4 g/bhp-hr) Rich burn: 0.29 g/hp-hr **For gaseous or propane/LPG fired emergency IC Engines ≥ 500 BHP (excluding biogas)** Lean burn: 86 ppmv @ 15% O_2 (0.4 g/bhp-hr) Rich burn: 0.29 g/hp-hr	SJVAPCD SJVAPCD
NOx	**For gaseous or propane/LPG fired emergency IC Engines < 500 BHP (excluding biogas)** Lean burn: 1.0 g/hp-hr Rich burn: 25 ppmvd @ 15 O_2 (0.44 g/hp-hr) OR 96% weight reduction **For gaseous or propane/LPG fired emergency IC Engines ≥ 500 BHP (excluding biogas)** Lean burn: 0.5 g/hp-hr Rich burn: 25 ppmvd @ 15 O_2 (0.44 g/hp-hr) OR 96% weight reduction	SMAQMD & SJVAPCD SJVAPCD
SOx	**For gaseous or propane/LPG fired emergency IC Engines < 500 BHP (excluding biogas)** Natural gas fuel or equivalent fuel **For gaseous or propane/LPG fired emergency IC Engines ≥ 500 BHP (excluding biogas)** Natural gas fuel or equivalent fuel	SMAQMD, SCAQMD, SJVUAPCD, and BAAQMD
PM10	**For gaseous or propane/LPG fired emergency IC Engines < 500 BHP (excluding biogas)** Natural gas fuel or equivalent fuel **For gaseous or propane/LPG fired emergency IC Engines ≥ 500 BHP (excluding biogas)** 0.0099 lb/MMBtu	SMAQMD, SCAQMD, SJVUAPCD, and BAAQMD SMAQMD, EPA MI-0401

BEST CONTROL TECHNOLOGIES ACHIEVED		
Pollutant	**Standard**	**Source**
PM2.5[(A)]	**For gaseous or propane/LPG fired emergency IC Engines < 500 BHP (excluding biogas)** Natural gas fuel or equivalent fuel **For gaseous or propane/LPG fired emergency IC Engines ≥ 500 BHP (excluding biogas)** 0.0099 lb/MMBtu	BAAQMD SMAQMD, EPA MI-0401
CO	**For gaseous or propane/LPG fired emergency IC Engines < 500 BHP (excluding biogas)** 2.0 g/hp-hr **For gaseous or propane/LPG fired emergency IC Engines ≥ 500 BHP (excluding biogas)** 1.5 g/bhp-hr	SMAQMD, SCAQMD, SJVAPCD SMAQMD
VHAP	**For gaseous or propane/LPG fired emergency IC Engines < 500 BHP (excluding biogas)** Lean burn: 86 ppmv @ 15% O_2 (0.4 g/bhp-hr) Rich burn: 0.29 g/hp-hr **For gaseous or propane/LPG fired emergency IC Engines ≥ 500 BHP (excluding biogas)** Lean burn: 86 ppmv @ 15% O_2 (0.4 g/bhp-hr) Rich burn: 0.29 g/hp-hr	SJVAPCD SJVAPCD

(A) All PM is expected to be less than 1.0 micrometer in diameter and therefore PM10 BACT is equivalent to PM2.5 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.

During the most recent rulemaking for updates to the Airborne Toxic Control Measure for Stationary Compression Ignition Engines (Title 17, Cal. Code. Regs., §93115 to §93115.15), ARB conducted a cost effectiveness analysis to determine if selective catalytic reduction (SCR) was technologically feasible and cost effective for emergency use applications. (Initial Statement of Reasons for Proposed Rulemaking: Proposed Amendments to the Airborne Toxic Control Measure for Stationary Compression Ignition Engines, Appendix B, September 2010). Although the analysis was for stationary compression ignition engines, the listed SCR challenges due to the operational nature of emergency standby engines is also applicable for stationary spark ignition engines.

The analysis concluded that SCR may be technologically feasible, but had some additional challenges. Because standby engines routinely operate only for scheduled maintenance and testing, the engines do not operate more than 15-30 minutes, and do operate at no or low load. Because of this the exhaust would not likely reach the temperature (260 °C to 540 °C) required for the catalyst to operate. To circumvent this problem, the engine would need to be operated with higher loads and in many cases for longer periods of time. This could be a challenge for most emergency standby applications as most businesses do not have load banks in house and would have to create a larger load on the engine to get the catalyst up to operational temperature.
Urea handling and maintenance is also an important consideration. Urea crystallization in the lines can cause damage to the SCR system and to the engine itself. Crystallization in the lines is more likely in emergency standby engines due to their periodic and low hours of usage. Urea also has a shelf life of approximately two years. This could increase the cost of operating a SCR for emergency standby engines since the low number of annual hours of operation experienced by most emergency standby engines could lead to urea expiration. The urea would then have to be drained and replaced, creating an extra maintenance step and an increased cost to the end user.

ARB staff determined that while, SCR systems may be technically feasible, there are significant operational hurdles to overcome before routine use of SCR on emergency standby engines is practical. This is because the majority of operating hours for emergency standby engines occur during short 15 to 30 minute maintenance and testing checks are at low engine loads. In most cases, the temperature needed for the SCR catalyst to function will not be reached during this operation and the SCR will not provide the expected NOx reductions.

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	For lean burn engines: Selective Catalytic Reduction
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

<u>Cost Effective Determination:</u>
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)
ROG	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 C, the cost effectiveness for the add on SCR system to control NOx to a 96% weight reduction was calculated to be **$181,576.47/ton** for a 499 bhp engine and **$152,555.04/ton** for a 1000 bhp engine (see attached Engine Cost Effectiveness Analysis). Since the cost per ton of NOx removal increases as engine size decreases and a 499 bhp engine was found to not be cost effective, the lower bound cost of a 50 bhp engine was not calculated. The following basic parameters were used in the analysis.

499 BHP Engine

NOx Control Level = 0.02356 lb/MMBtu (96% weight reduction)

NOx Baseline Level = 0.589 lb/MMBtu (160 ppmv @ 15% O2 per Subpart JJJJ)

Engine Rating = 499 BHP (4.8 MMBtu/hr)

Engine Operating Hours = 100 hours/year (maximum maintenance hours)

Equipment Life = 20 years

Direct Cost = $139,848.01

Direct Annual Cost = $8,778.86 per year

Indirect Annual Cost = $15,862.08 per year

Total Annual Cost = $24,640.94 per year

NOx Removed = 0.14 tons per year

Cost of NOx Removal = $181,576.47 per ton reduced

1,000 BHP Engine

NOx Control Level = 0.02356 lb/MMBtu (96% weight reduction)

NOx Baseline Level = 0.589 lb/MMBtu (160 ppmv @ 15% O2 per Subpart JJJJ)

Engine Rating = 1,000 BHP (9.6 MMBtu/hr)

Engine Operating Hours = 100 hours/year (maximum maintenance hours)

Equipment Life = 20 years

Direct Cost = $220,942.20

Direct Annual Cost = $16,317.19 per year

Indirect Annual Cost = $25,087.96 per year

Total Annual Cost = $41,405.15 per year

NOx Removed = 0.27 tons per year

Cost of NOx Removal = $152,555.04 per ton reduced

Therefore, the add-on SCR system is considered not cost effective for either engine size and is eliminated.

C. SELECTION OF BACT/T-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.

Volatile hazardous air pollutants (VHAP) are the primary driver for health risks associated with gaseous fueled engines. VHAPs are emitted as VOC, and the same control technologies that control VOC also control VHAPs. Therefore, the BACT for VOC and T-BACT for VHAPs are the same.

Table 1: BACT #208 FOR SPARK IGNITED I.C. ENGINES, STANDBY, GASEOUS-FUELED (EXCLUDING BIOGAS) < 500 BHP

Pollutant	Standard	Source
VOC	Lean Burn 86 ppmv @ 15% O_2 (0.4 g/bhp-hr) Rich Burn 0.29 g/hp-hr	SJVAPCD
NOx	Lean-Burn: 1.0 g/bhp-hr Rich Burn: 25 ppmvd @ 15 O_2 (0.44 g/hp-hr) OR 96% weight reduction	SMAQMD & SJVAPCD
SOx	Natural gas fuel or equivalent fuel	SMAQMD, SCAQMD, SJVUAPCD, and BAAQMD
PM10	Natural gas fuel or equivalent fuel	SMAQMD, SCAQMD, SJVUAPCD, and BAAQMD
PM2.5	Natural gas fuel or equivalent fuel	SMAQMD, SCAQMD, SJVUAPCD, and BAAQMD
CO	2.0 g/bhp-hr	SMAQMD, SCAQMD, SJVAPCD

Table 2: T-BACT #208 FOR SPARK IGNITED I.C. ENGINES, STANDBY, GASEOUS-FUELED (EXCLUDING BIOGAS) < 500 BHP

Pollutant	Standard	Source
VHAP[(A)]	Lean Burn 86 ppmv @ 15% O_2 (0.4 g/bhp-hr) Rich Burn 0.29 g/hp-hr	SJVAPCD

(A) A full list of the volatile hazardous air pollutants (VHAP) from natural gas combustion can be found in AP-42, Section 3.2 Natural Gas-fired Reciprocating Engines, Tables 3.2-1, 3.2-2, and 3.2-3.

Table 3: BACT #209 FOR SPARK IGNITED I.C. ENGINES, STANDBY, GASEOUS-FUELED (EXCLUDING BIOGAS) ≥ 500 BHP		
Pollutant	**Standard**	**Source**
VOC	Lean Burn 86 ppmv @ 15% O_2 (0.4 g/bhp-hr) Rich Burn 0.29 g/hp-hr	SJVAPCD
NOx	Lean-Burn: 0.5 g/bhp-hr Rich Burn: 25 ppmvd @ 15 O_2 (0.44 g/hp-hr) OR 96% weight reduction	SMAQMD & SJVAPCD
SOx	Natural gas fuel or equivalent fuel	BAAQMD
PM10	0.0099 lb/MMBtu	SMAQMD, EPA (MI-00401)
PM2.5	0.0099 lb/MMBtu	SMAQMD, EPA (MI-00401)
CO	1.5 g/p-hr	SMAQMD

Table 4: T-BACT #209 FOR SPARK IGNITED I.C. ENGINES, STANDBY, GASEOUS-FUELED (EXCLUDING BIOGAS) ≥ 500 BHP		
Pollutant	**Standard**	**Source**
VHAP[(A)]	Lean Burn 86 ppmv @ 15% O_2 (0.4 g/bhp-hr) Rich Burn 0.29 g/hp-hr	SJVAPCD

(A) A full list of the volatile hazardous air pollutants (VHAP) from natural gas combustion can be found in AP-42, Section 3.2 Natural Gas-fired Reciprocating Engines, Tables 3.2-1, 3.2-2, and 3.2-3.

APPROVED BY: [signature] **DATE:** 12/18/18

Attachment A

Review of BACT Determinations published by EPA

List of BACT determinations published in EPA's RACT/BACT/LAER Clearinghouse (RBLC) for Natural Gas (includes propane & liquefied petroleum gas) I.C. Engines ≤ 500 BHP & > 500 BHP

RBLC#	Permit Date[A]	Process Code [B], [C]	Engine Burn Type	Rating	Pollutant	Standard	Case-By-Case Basis
MI-0426	3/24/17	17.130	Not Listed	1,818 BHP	CO	11.0 lb/hr	BACT-PSD
MI-0426	3/24/17	17.130	Not Listed	1,818 BHP	NOx	4.0 lb/hr & 2.0 g/hp-hr	BACT-PSD
MI-0426	3/24/17	17.130	Not Listed	1,818 BHP	PM10	0.01 lb/mmBtu	BACT-PSD
MI-0426	3/24/17	17.130	Not Listed	1,818 BHP	PM2.5	0.01 lb/mmBtu	BACT-PSD
CA-1240	3/17/17	17.130	Not Listed	881 BHP	VOC	25 ppmvd @ 15% O2	Other Case-By-Case
CA-1240	3/17/17	17.130	Not Listed	881 BHP	CO	54 ppmvd @ 15% O2	Other Case-By-Case
CA-1240	3/17/17	17.130	Not Listed	881 BHP	NOx	5 ppmvd @ 15% O2	Other Case-By-Case
CA-1240	3/17/17	17.130	Not Listed	881 BHP	NH3	5 ppmvd @ 15% O2	Other Case-By-Case
MI-0424	12/5/16	17.130	Not Listed	1,462 BHP	CO	0.8 g/hp-hr	BACT-PSD
MI-0424	12/5/16	17.130	Not Listed	1,462 BHP	NOx	2.0 g/hp-hr	BACT-PSD
MI-0424	12/5/16	17.130	Not Listed	1,462 BHP	PM10	0.01 lb/mmBtu	BACT-PSD
MI-0424	12/5/16	17.130	Not Listed	1,462 BHP	PM2.5	0.01 lb/mmBtu	BACT-PSD
MI-0424	12/5/16	17.130	Not Listed	1,462 BHP	VOC	0.5 g/hp-hr	BACT-PSD
MI-0420	6/3/16	17.130	Not Listed	1,506 kW	CO	9.6 lb/hr & 4.0 g/hp-hr	BACT-PSD
MI-0420	6/3/16	17.130	Not Listed	1,506 kW	NOx	4.8 lb/hr & 2.0 g/hp-hr	BACT-PSD
MI-0420	6/3/16	17.130	Not Listed	1,506 kW	PM10	0.01 lb/mmBtu	BACT-PSD
MI-0420	6/3/16	17.130	Not Listed	1,506 kW	PM2.5	0.01 lb/mmBtu	BACT-PSD

RBLC#	Permit Date[A]	Process Code [B], [C]	Engine Burn Type	Rating	Pollutant	Standard	Case-By-Case Basis
SC-0170	11/7/14	17.130	Not Listed	500 kW	CO	Tier 3 emission standards	BACT-PSD
SC-0170	11/7/14	17.130	Not Listed	500 kW	VOC	Tier 3 emission standards	BACT-PSD
LA-0287	7/21/14	17.130	Not Listed	1175 BHP	NOx	2.0 g/hp-hr	BACT-PSD
LA-0287	7/21/14	17.130	Not Listed	1175 BHP	PM10	0.004 lb/hr	BACT-PSD
LA-0287	7/21/14	17.130	Not Listed	1175 BHP	PM2.5	0.004 lb/hr	BACT-PSD
IN-0185	4/24/14	17.130	Not Listed	620 BHP	PM10	0.2 g/kWh	BACT-PSD
IN-0185	4/24/14	17.130	Not Listed	620 BHP	PM2.5	0.2 g/kWh	BACT-PSD
IN-0185	4/24/14	17.130	Not Listed	620 BHP	SO2	0.0015 g/kWh	BACT-PSD
MI-0412	12/4/13	17.130	Not Listed	1,000 kW	CO	0.8 g/hp-hr	BACT-PSD
MI-0412	12/4/13	17.130	Not Listed	1,000 kW	NOx	2.0 g/hp-hr	BACT-PSD
MI-0412	12/4/13	17.130	Not Listed	1,000 kW	PM10	0.01 lb/mmBtu	BACT-PSD
MI-0412	12/4/13	17.130	Not Listed	1,000 kW	PM2.5	0.01 lb/mmBtu	BACT-PSD
MI-0412	12/4/13	17.130	Not Listed	1,000 kW	VOC	0.5 g/hp-hr	BACT-PSD
LA-0311	7/15/13	17.130	Not Listed	2,500 BHP	CO	27.56 lb/hr	BACT-PSD
IN-0167	4/16/13	17.130	Not Listed	620 BHP	NOx	0.5 g/hp-hr	BACT-PSD
IN-0167	4/16/13	17.130	Not Listed	620 BHP	PM10	0.2 g/kw-hr	BACT-PSD
IN-0167	4/16/13	17.130	Not Listed	620 BHP	PM2.5	0.2 g/kw-hr	BACT-PSD
IN-0167	4/16/13	17.130	Not Listed	620 BHP	SO2	0.0015 g/kw-hr	BACT-PSD
OK-0153	3/1/13	17.130	Not Listed	2,889 BHP	CO	0.43 g/hp-hr	BACT-PSD
OK-0153	3/1/13	17.130	Not Listed	2,889 BHP	NOx	0.5 g/hp-hr	BACT-PSD
OK-0153	3/1/13	17.130	Not Listed	2,889 BHP	PM2.5	0.01 lb/mmBtu	BACT-PSD
OK-0153	3/1/13	17.130	Not Listed	2,889 BHP	VOC	0.44 g/hp-hr	BACT-PSD
MI-0401	12/21/11	17.130	Not Listed	1,200 kW	NOx	0.5 g/hp-hr	BACT-PSD

RBLC#	Permit Date[A]	Process Code [B], [C]	Engine Burn Type	Rating	Pollutant	Standard	Case-By-Case Basis
MI-0401	12/21/11	17.130	Not Listed	1,200 kW	PM10	0.00999 lb/mmBtu	BACT-PSD
MI-0401	12/21/11	17.130	Not Listed	1,200 kW	PM2.5	0.00999 lb/mmBtu	BACT-PSD
LA-0256	12/06/2011	17.130	Not Listed	1,818 BHP	PM10	0.01 lb/hr	BACT-PSD, Operating Permit[D]
LA-0256	12/06/2011	17.130	Not Listed	1,818 BHP	PM2.5	0.01 lb/hr	BACT-PSD, Operating Permit[D]
LA-0256	12/06/2011	17.130	Not Listed	1,818 BHP	PM (TSP)	0.01 lb/hr	BACT-PSD, Operating Permit[D]
LA-0257	12/06/2011	17.130	Not Listed	2,012 BHP	CO	4.0 lb/bhp-r	BACT-PSD[E]
LA-0257	12/06/2011	17.130	Not Listed	2,012 BHP	NOx	2.0 g/bhp-hr	BACT-PSD[E]
LA-0257	12/06/2011	17.130	Not Listed	2,012 BHP	PM (TPM)	N/A	BACT-PSD
LA-0257	12/06/2011	17.130	Not Listed	2,012 BHP	VOC	1.0 g/bhp-r	BACT-PSD[E]
CA-1192	6/21/2011	17.130	Not Listed	860 BHP (550.0 KW)	CO	N/A	BACT-PSD[F]
CA-1192	6/21/2011	17.130	Not Listed	860 BHP (550.0 KW)	NOx	N/A	BACT-PSD[F]
CA-1192	6/21/2011	17.130	Not Listed	860 BHP (550.0 KW)	PM (TPM)	N/A	BACT-PSD[F]
CA-1192	6/21/2011	17.130	Not Listed	860 BHP (550.0 KW)	PM (PM10)	N/A	BACT-PSD[F]
MI-0390	10/14/2010	17.130	Not Listed	1818 BHP	NOx	0.5 g/bhp-hr	BACT-PSD, NSPS, NESHAP
LA-0232	6/24/2008	17.130	Not Listed	838 BHP	NOx	4.8 lb/hr	BACT-PSD, Operating Permit
LA-0232	6/24/2008	17.130	Not Listed	838 BHP	VOC	1.39 lb/hr	BACT-PSD, Operating Permit
MD-0036	3/10/2006	17.130	Not Listed	1,085 BHP (770KW)	CO	1.5 g/bhp-hr	BACT-PSD
MD-0036	3/10/2006	17.130	Not Listed	1,085 BHP (770KW)	NOx	2.0 g/bhp-hr	BACT-PSD
MD-0036	3/10/2006	17.130	Not Listed	1,085 BHP (770KW)	PM (FPM10)	0.0099 lb/MMBtu	BACT-PSD[G]

RBLC#	Permit Date[A]	Process Code [B], [C]	Engine Burn Type	Rating	Pollutant	Standard	Case-By-Case Basis
MD-0036	3/10/2006	17.130	Not Listed	1,085 BHP (770 KW)	VOC	0.6 g/hp-hr	LAER
LA-0276	12/15/16	17.230	Not Listed	150 kW	VOC	Comply with NSPS Subpart JJJJ	BACT-PSD
FL-0356	3/9/16	17.230	Not Listed	25 kW	CO	387 g/hp-hr	BACT-PSD
CA-1225	4/25/14	17.230	Not Listed	256 BHP	CO	4.0 g/hp-hr	BACT-PSD
CA-1225	4/25/14	17.230	Not Listed	256 BHP	NOx	0.78 lb/hr	BACT-PSD
CA-1225	4/25/14	17.230	Not Listed	256 BHP	FPM	0.0216 lb/hr	BACT-PSD
CA-1225	4/25/14	17.230	Not Listed	256 BHP	PM10	0.0216 lb/hr	BACT-PSD
LA-0311	7/15/13	17.230	Not Listed	300 BHP	CO	3.31 lb/hr	BACT-PSD
IA-0102	2/1/2012	17.230	Not Listed	225 KW	VOC	0.66 lb/hr	BACT-PSD[H]
WA-0316	6/14/2006	17.230	Not Listed	450 KW	NOx	82 g/hr	BACT-PSD[I]
NV-0048	5/16/2006	17.230	Not Listed	771 BHP (575 KW)	CO	2.0 g/bhp-hr	Other Case-by-Case, SIP, Operating Permit
NV-0048	5/16/2006	17.230	Not Listed	771 BHP (575 KW)	NOx	21.5 g/bhp-hr	Other Case-by-Case, SIP, Operating Permit
NV-0048	5/16/2006	17.230	Not Listed	771 BHP (575 KW)	PM (FPM10)	0.0410 g/bhp-hr	Other Case-by-Case, SIP, Operating Permit
NV-0048	5/16/2006	17.230	Not Listed	771 BHP (575 KW)	SOx	0.0052 g/bhp-hr	Other Case-by-Case, SIP, Operating Permit
NV-0048	5/16/2006	17.230	Not Listed	771 BHP (575 KW)	VOC	0.23 g/bhp-hr	Other Case-by-Case, SIP, Operating Permit

(A) Due to the large number of entries only determinations made (based on Permit Date) entered since 01/01/2005 are included in the above table.
(B) Process Code 17.130 includes Large Internal Combustion Engines (> 500 BHP) fueled using natural gas (includes propane and liquid petroleum gas).
(C) Process Code 17.230 includes Small Internal Combustion Engines (≤ 500 BHP) fueled using natural gas (includes propane and liquid petroleum gas).
(D) BACT was determined to be use of natural gas fuel and good combustion practices. Emission limits for PM10, PM2.5, and PM (TSP) were determined to be <0.01 lb/hr and was established by Louisiana Department of Environmental Quality Permit PSD-LA-754 for Westlake Vinyls

Company, LP.

(E) Emission Limits are based on 40 CFR Part 60 Subpart JJJJ – Standards of Performance for Stationary Spark Ignition Internal Combustion Engines. (NSPS, Subpart IIII)

(F) The Ninth Circuit Court of Appeals issued a decision on 8/12/2014 that vacated the permit decision and remanded it to EPA. Therefore, this BACT determination has not yet been achieved in practice. Source: EPA Region IX, Avenal Energy Product.

(G) Emission limit for PM is based on AP-42 PM condensable emission factor for natural gas-fired reciprocating engines.

(H) BACT was determined to be good combustion practices. Emission limit for VOC was determined to be 0.66 lb/hr and was established by Iowa Department of Natural Resources; Air Quality Bureau, Title V Permit 03-TV-025R2 (page 133) for Alcoa, Inc.

(I) BACT was determined to be non-selective catalytic reduction. Emission limit for NOx was determined to be ≤82 g/hr and was established by Washington State Department of Ecology; Air Quality Program, Permit PSD-01-09 Amendment 6 for Northwest Pipeline Corporation

[pink box] = Not applicable to this determination. Equipment has not yet been achieved in practice or is for a specific purpose outside of the scope of this determination.

[yellow box] = 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 ICE: Spark Ignition, Natural Gas & ICE: Emergency, Spark Ignition:

Capacity	Source	Date	Engine Burn Type	NOx	VOC	CO	PM10	SOx
528 BHP	MBUAPCD	10/13/2005	Rich Burn	0.07 g/bhp-hr(A)	N/A	N/A	N/A	N/A
93 BHP	SCAQMD	10/06/2000	Rich Burn	0.15 g/bhp-hr(B)	0.15 g/bhp-hr	0.6 g/bhp-hr	N/A	N/A
1334 BHP	SCAQMD	12/7/1999	Rich Burn	1.5 g/bhp-hr(B)	1.5 g/bhp-hr(B)	2.0 g/bhp-hr(B)	N/A	N/A
750 BHP	SCAQMD(C)	N/A	Rich Burn	0.15 g/bhp-hr(B)	0.15 g/bhp-hr(B)	0.6 g/bhp-hr(B)	N/A	N/A
310 BHP	SMAQMD(D)	10/22/2004	Rich Burn	2.13 g/bhp-hr(A)	0.0449(A)	1.6 g/bhp-hr(A)	0.152 g/bhp-hr	0.002 g/bhp-hr

(A) Add-on control – 3-way catalytic converter,
(B) Add-on control – 3-way catalytic converter and air/fuel ratio controller
(C) SCAQMD is reconsidering the BACT requirement for future applications of this type. Source: SCAQMD Application No. 359876
(D) Emission limits are based on emissions for the specific engine and is not a standard for gaseous emergency standby engines

[light blue] = Not enough information to determine if engine is for standby purposes

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

Attachment C
Cost Effectiveness Calculations

ENGINE 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 = $ 181,576.47 $/ton

Equipment

Engine rating (499 BHP)	4.8	mmBTU/hr
Engine Operating hours	100	hours
Engine capacity factor	1	
SCR Operating Days	365	days
Total Capacity Factor	1	
Baseline NOx (30 ppm)	0.589	lb/mmBTU
SCR NOx (5 ppm)	0.02356	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
Equipment Life	20	years
Annual interest Rate	5	%
Catalyst cost, Initial	240	$/ft2
Catalyst cost, replacement	290	$/ft2
Electrical Power cost	0.1124	$/KWh
Ammonia Cost	0.101	$/lb
Catalyst Life	24000	hr
Catalyst Layers	2 full, 1 empty	

Engine Calculations

Q_B	4.8		mmBTU/hr
$q_{flue\ gas}$		1710.371508	acfm

N_{NOx}	0.96	

SCR Reactor Calculations

$Vol_{Catalyst}$	14.47935815	ft3
$A_{Catalyst}$	1.781636988	ft2
A_{SCR}	2.048882536	ft2
l=w=	1.431391818	ft
n_{layer}	3	
h_{layer}	3.708998943	
n_{total}	4	
h_{SCR}	51.83599577	ft

Reagent Calculations

$m_{reagent}$	1.098773675	lb/hr
m_{sol}	3.788874742	lb/hr
q_{sol}	0.50615307	gph
Tank Volume	1093.290632	gal

Cost Estimation

Direct Costs

DC	$139,848.01

Indirect Costs

General Facilities	$6,992.40
Engineering and home office fees	$13,984.80
Process Contingency	$6,992.40
Total Indirect Installation Costs	$27,969.60
Project Contingency	$25,172.64
Total Plant Cost	$192,990.25
Preproduction Cost	$3,859.80
Inventory Capital	$826.58
Total Capital Investment	$197,676.63

Direct Annual Costs

Maintenance Costs	$2,965.15	per yr
Power	2.04898176	KW
Annual Electricity	$2,017.48	per yr

Reagent Solution Cost	$3,352.24	per yr

Catalyst Replacement

FWF	0.317208565	
Annual Catalyst Replacement	$443.99	per yr
Total Variable Direct Cost	$5,813.71	per yr
Total Direct Annual Cost	$8,778.86	per yr
CRF	0.080242587	
Indirect Annual Cost	$15,862.08	per yr
Total annual Cost	$24,640.94	per yr
NOx Removed	0.14	tons
Cost of NOx removal	$181,576.47	per ton

ENGINE 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 = $ 152,555.04 $/ton

Equipment

Engine rating (1000 HP)	9.6	mmBTU/hr
Engine Operating hours	100	hours
Engine capacity factor	1	
SCR Operating Days	365	days
Total Capacity Factor	1	
Baseline NOx (30 ppm)	0.589	lb/mmBTU
SCR NOx (5 ppm)	0.02356	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
Equipment Life	20	years
Annual interest Rate	5	%
Catalyst cost, Initial	240	$/ft2
Catalyst cost, replacement	290	$/ft2
Electrical Power cost	0.1124	$/KWh
Ammonia Cost	0.101	$/lb
Catalyst Life	24000	hr
Catalyst Layers	2 full, 1 empty	

Boiler Calculations

Q_B	9.6	mmBTU/hr
$q_{flue\ gas}$	3420.743017	acfm

N_{NOx}	0.96	

SCR Reactor Calculations

$Vol_{Catalyst}$	28.9587163	ft3
$A_{Catalyst}$	3.563273976	ft2
A_{SCR}	4.097765072	ft2
l=w=	2.024293722	ft
n_{layer}	3	
h_{layer}	3.708998943	
n_{total}	4	
h_{SCR}	51.83599577	ft

Reagent Calculations

$m_{reagent}$	2.197547351	lb/hr
m_{sol}	7.577749485	lb/hr
q_{sol}	1.012306141	gph
Tank Volume	2186.581265	gal

Cost Estimation

Direct Costs

DC	$	220,942.20

Indirect Costs

General Facilities	$	11,047.11
Engineering and home office fees	$	22,094.22
Process Contingency	$	11,047.11
Total Indirect Installation Costs	$	44,188.44
Project Contingency	$	39,769.60
Total Plant Cost	$	304,900.24
Preproduction Cost	$	6,098.00
Inventory Capital	$	1,653.16
Total Capital Investment	$	312,651.41

Direct Annual Costs

Maintenance Costs	$	4,689.77	per yr
Power		4.09796352	KW
Annual Electricity	$	4,034.95	per yr

Reagent Solution Cost	$	6,704.49	per yr

Catalyst Replacement

FWF		0.317208565	
Annual Catalyst Replacement	$	887.98	per yr
Total Variable Direct Cost	$	11,627.42	per yr
Total Direct Annual Cost	$	16,317.19	per yr
CRF		0.080242587	
Indirect Annual Cost	$	25,087.96	per yr
Total annual Cost	$	41,405.15	per yr
NOx Removed		0.27	tons
Cost of NOx removal	$	152,555.04	per ton