CATEGORY: **LANDFILL GAS FLARE**

BACT Size: Minor Source BACT **LANDFILL GAS FLARE**

BACT Determination Number: 198	**BACT Determination Date:**

Equipment Information

Permit Number: 25596
Equipment Description: LANDFILL GAS FLARE
Unit Size/Rating/Capacity: 167 MMBtu/hr
Equipment Location: CITY OF SACRAMENTO SOLID WASTE PUBLIC WORKS
20 28TH ST
SACRAMENTO, CA

BACT Determination Information

ROCs	**Standard:**	See Comment Section
	Technology Description:	
	Basis:	Achieved in Practice
NOx	**Standard:**	0.05 lb/MMBtu
	Technology Description:	
	Basis:	Achieved in Practice
SOx	**Standard:**	0.04 lb/MMBtu
	Technology Description:	
	Basis:	Achieved in Practice
PM10	**Standard:**	6.1 lb/MMcf
	Technology Description:	
	Basis:	Achieved in Practice
PM2.5	**Standard:**	6.1 lb/MMcf
	Technology Description:	
	Basis:	Achieved in Practice
CO	**Standard:**	0.15 lb/MMBtu
	Technology Description:	
	Basis:	Achieved in Practice
LEAD	**Standard:**	
	Technology Description:	
	Basis:	

Comments: This BACT is for a non-hazardous landfill. T-BACT is equivalent to BACT. BACT for the pilot is the use of natural gas or LPG/Propane.

VOC BACT Standard: 98% NMOC destruction efficiency or 20 ppmvd NMOC @ 3% O2 as Hexane.

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

777 12th Street, Third Floor

SACRAMENTO METROPOLITAN AIR QUALITY MANAGEMENT DISTRICT

Sacramento, CA 95814

BEST AVAILABLE CONTROL TECHNOLOGY AND TOXIC BEST AVAILABLE CONTROL TECHNOLOGY DETERMINATION

DETERMINATION NO.:	198
DATE:	November 7, 2018
ENGINEER:	Felix Trujillo, Jr.

Category/General Equip Description:	Flare
Equipment Specific Description:	Non-Hazardous Landfill Gas Flare
Equipment Size/Rating:	Minor Source
Previous BACT Det. No.:	102

SMAQMD's BACT Clearinghouse does not have a current BACT guideline for non-hazardous landfill gas flares. The last BACT determination (BACT # 102) for this type of operation was determined on 3/16/15 and expired on 3/16/17. Since more than two years has passed since the last determination, a new BACT determination had to be determined. Therefore, a new BACT determination was performed under the project for A/C 25596 (28th Street Landfill, Solid Waste Division, City of Sacramento).

BACT ANALYSIS

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

The following control technologies are currently employed as BACT for non-hazardous landfill gas flares:

<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
<table>
<tr><th colspan="2">Non-Hazardous Landfill Gas Flare (A)</th></tr>
<tr><td>VOC</td><td>20 ppmvd as Hexane @ 3% O2</td></tr>
<tr><td>NOx</td><td>0.06 lb/MMBtu</td></tr>
<tr><td>SOx</td><td>No standard</td></tr>
<tr><td>PM10</td><td>17 lb/MMcf</td></tr>
<tr><td>PM2.5</td><td>No standard</td></tr>
<tr><td>CO</td><td>0.2 lb/MMBtu</td></tr>
</table>
(A) See Appendix A for EPA BACT Clearinghouse listing for landfill flares.

<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 WWW – Standards of Performance for Municipal Solid Waste Landfills

This subpart is applicable to municipal solid waste landfills with a design capacity of equal to or greater than 2.5 million megarams and 2.5 million cubic meters and with non-methane organic compound (NMOC) emissions greater than 50 megagrams/year that commenced construction, reconstruction or modification after May 30, 1991.

This regulation requires an enclosed flare to reduce NMOC by 98% by weight or reduce the outlet NMOC concentration to less than 20 ppmvd as hexane @ 3% O_2.

40 CFR Part 60 Subpart Cc – Emission Guidelines and Compliance Times for Municipal Solid Waste Landfills

This subpart is applicable to municipal solid waste landfills with a design capacity of equal to or greater than 2.5 million megarams and 2.5 million cubic meters and with non-methane organic compound (NMOC) emissions greater than 50 megagrams/year that commenced construction, reconstruction or modification before May 30, 1991.

This regulation requires an enclosed flare to reduce NMOC by 98% by weight or reduce the outlet NMOC concentration to less than 20 ppmvd as hexane @ 3% O_2.

40 CFR Part 60 Subpart Cf – Emission Guidelines and Compliance Time for Municipal Solid Waste Landfill

This subpart is applicable to existing municipal solid waste landfills for which construction, reconstruction or modification was commenced on or before July 17, 2014.
</td></tr>
</table>

<table>
<tr><th>District/Agency</th><th>Best Available Control Technology (BACT)/Requirements</th></tr>
<tr><td></td><td>
This regulation requires an enclosed flare to reduce NMOC by 98% by weight or reduce the outlet NMOC concentration to less than 20 ppmvd as hexane @ 3% O_2.

40 CFR Part 60 Subpart XXX – Standards of Performance for Municipal Solid Waste Landfills

This subpart is applicable to municipal solid waste landfills that commenced construction, reconstruction or modification after July 17, 2014.

This regulation requires an enclosed flare to reduce NMOC by 98% by weight or reduce the outlet NMOC concentration to less than 20 ppmvd as hexane @ 3% O_2.

40 CFR Part 63 Subpart AAAA – National Emission Standards for Hazardous Air Pollutants: Municipal Solid Waste Landfills

This subpart establishes national emission standards for hazardous air pollutants for exsiting and new municipal solid waste (MSW) landfills. Pursuant to Section 63.1955(a)(1), compliance with this regulation is shown by meeting the requirements of 40 CFR 60 Subpart WWW.
</td></tr>
<tr><td>ARB</td><td>
<u>BACT</u>
Source: ARB BACT Clearinghouse

(A) See Appendix A for CARB BACT Clearinghouse listing for landfill flares.
<table>
<tr><th colspan="2">Non-Hazardous Landfill Gas Flare (A)</th></tr>
<tr><td>VOC</td><td>20 ppmvd NMOC as hexane @ 3% O_2</td></tr>
<tr><td>NOx</td><td>0.05 lb/MMBtu</td></tr>
<tr><td>SOx</td><td>No standard</td></tr>
<tr><td>PM10</td><td>No standard</td></tr>
<tr><td>PM2.5</td><td>No standard</td></tr>
<tr><td>CO</td><td>0.4 lb MMBtu</td></tr>
</table>
<u>T-BACT:</u>
There are no T-BACT standards published in the clearinghouse for this category.

<u>RULE REQUIREMENTS</u>:
California Code of Regulations Title 17, Subchapter 10, Article 4, Subarticle 6, Sections 95460 through 65476: Methane Emissions from Municipal Solid Waste Landfills.

The purpose of this rule is to reduce methane emissions from MSW landfills pursuant to the California Global Warming Solutions Act of 2006. This regulation is applicable to MSW landfills that received solid waste after January 1, 1977. This facility received solid waste after January 1, 1977, therefore it is subject to the requirements
</td></tr>
</table>

<table>
<tr><th>District/Agency</th><th>Best Available Control Technology (BACT)/Requirements</th></tr>
<tr><td>ARB</td><td>of this regulation.

Section 95464(b)(2)(A) requires enclosed flares to achieve a methane destruction efficiency of at least 99% by weight.</td></tr>
<tr><td>SMAQMD</td><td><u>BACT</u>
<u>Source: SMAQMD BACT Clearinghouse; BACT #102</u>
<table><tr><th colspan="2">Non-Hazardous Landfill Gas Flare</th></tr><tr><td>VOC</td><td>98% control efficiency or 20 ppmvd @ 3% O2 as Hexane</td></tr><tr><td>NOx</td><td>0.05 lb/MMBtu</td></tr><tr><td>SOx</td><td>0.04 lb/MMBtu</td></tr><tr><td>PM10</td><td>6.1 lb/MMcf</td></tr><tr><td>PM2.5</td><td>6.1 lb/MMcf</td></tr><tr><td>CO</td><td>0.15 lb/MMBtu</td></tr></table><u>T-BACT:</u>
T-BACT was determined to be equivalent to BACT.

<u>RULE REQUIREMENTS</u>:
Rule 485 – Municipal Landfill Gas

The purpose of this rule is to limit NMOC emissions from existing MSW landfills by implementing the provisions of 40 CFR Part 60 Subpart Cc – Emission Guidelines and Compliance times for MSW Landfills.

40 CFR Part 60 Subpart Cc requires a control device to reduce NMOC by 98% by weight or reduce the outlet NMOC concentration to less than 20 ppmvd as hexane @ 3% O_2.</td></tr>
</table>

<table>
<tr><th>District/Agency</th><th>Best Available Control Technology (BACT)/Requirements</th></tr>
<tr><td>South Coast AQMD</td><td>
<u>BACT</u>
Source: SCAQMD BACT Guidelines for Non-Major Sources, Page 53
<table>
<tr><th colspan="2">Non-Hazardous Landfill Gas Flare</th></tr>
<tr><td>VOC</td><td>Ground level, shrouded, ≥ 0.6 second retention time at 1400 °F, auto combustion air control, automatic shutoff gas valve and automatic re-start system</td></tr>
<tr><td>NOx</td><td>0.06 lb/MMBtu</td></tr>
<tr><td>SOx</td><td>No standard</td></tr>
<tr><td>PM10</td><td>Knockout vessel</td></tr>
<tr><td>PM2.5</td><td>No standard</td></tr>
<tr><td>CO</td><td>Ground level, shrouded, ≥ 0.6 second retention time at 1400 °F, auto combustion air control</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 1150.1 Control of Gaseous Emissions from Municipal Solid Waste Landfills

This rule requires a flare serving a MSW landfill to reduce NMOC by at least 98 percent by weight or reduce the outlet NMOC concentration to less than 20 ppmvd @ 3% O_2 as hexane.
</td></tr>
<tr><td>San Diego County APCD</td><td>
<u>BACT</u>
Source: NSR Requirements for BACT

The SDCAPCD does not have a BACT determination for this source category.

The SDCAPCD has a BACT trigger level of 10 lb/day.

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

<u>RULE REQUIREMENTS</u>:
None
</td></tr>
</table>

<table>
<tr><th>District/Agency</th><th>Best Available Control Technology (BACT)/Requirements</th></tr>
<tr><td>Bay Area AQMD</td><td>
<u>BACT</u>
Source: BAAQMD BACT Guideline, Document 80.1 (12/16/91)

<table>
<tr><td colspan="2">Non-Hazardous Landfill Gas Flare</td></tr>
<tr><td>VOC</td><td>Ground level, enclosed, ≥ 0.6 second retention time at 1400 °F, auto combustion air control, automatic shutoff gas valve and automatic re-start system</td></tr>
<tr><td>NOx</td><td>0.06 lb/MMBtu</td></tr>
<tr><td>SOx</td><td>No standard</td></tr>
<tr><td>PM10</td><td>No standard</td></tr>
<tr><td>PM2.5</td><td>No standard</td></tr>
<tr><td>CO</td><td>Same as VOC</td></tr>
</table>

The BAAQMD has a BACT trigger level of 10 lb/day.

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

<u>RULE REQUIREMENTS</u>:
None.
</td></tr>
<tr><td>San Joaquin Valley APCD</td><td>
<u>BACT</u>
Source: SJVUAPCD BACT Guideline 1.4.3

The SJVAPCD does not have a BACT determination for this source category. BACT Guideline 1.4.3 was rescinded by the SJVAPCD on 11/7/16.

The SJVAPCD BACT trigger level is 2 lb/day.

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

<u>RULE REQUIREMENTS</u>:
None
</td></tr>
</table>

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

SUMMARY OF ACHIEVED IN PRACTICE CONTROL TECHNOLOGIES		
Pollutant	**Standard**	**Source**
VOC	98% NMOC destruction efficiency or 20 ppmvd NMOC @ 3% O2 measured as Hexane	EPA, CARB, SMAQMD,
NOx	1. 0.05 lb/MMBtu 2. 0.06 lb/MMBtu	CARB, SMAQMD EPA, SCAQMD, BAAQMD
SOx	0.04 lb/MMBtu	SMAQMD
PM10	1. 6.1 lb/MMcf 2. 17 lb/MMcf	SMAQMD, EPA
PM2.5	1. 6.1 lb/MMcf	SMAQMD
CO	1. 0.15 lb/MMBtu 2. 0.2 lb/MMBtu 3. 0.4 lb/MMBtu	SMAQMD EPA CARB

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

BEST CONTROL TECHNOLOGIES ACHIEVED		
Pollutant	**Standard**	**Source**
VOC	98% NMOC destruction efficiency or 20 ppmvd NMOC @ 3% O_2 measured as Hexane	EPA, CARB, SMAQMD,
NOx	0.05 lb/MMBtu	CARB, SMAQMD
SOx	0.04 lb/MMBtu	SMAQMD
PM10	6.1 lb/MMcf	SMAQMD
PM2.5	6.1 lb/MMcf	SMAQMD
CO	0.15 lb/MMBtu	SMAQMD

Pilot Burner:

The EPA and CARB BACT Clearinghouses did not address the pilot burner. The Districts referenced under this BACT determination also did not address the pilot, since these Districts would consider the pilot as an insignificant source of emissions and would exempt it from permitting requirements. However, SMAQMD permits these types of emissions units as they are part of a process that requires a permit. The use of natural gas or LPG/propane is what is

used to fire these types of units. Therefore, the use of natural gas or LPG/propane on the pilot will be included as achieved in practice BACT under this determination to cover the use of a pilot.

B. TECHNOLOGICALLY FEASIBLE AND COST EFFECTIVE (Rule 202, §205.1.b.):

Technologically Feasible Alternatives:

Any alternative basic equipment, fuel, process, emission control device or technique, singly or in combination, determined to be technologically feasible by the Air Pollution Control Officer. The table below shows the technologically feasible alternatives identified as capable of reducing emissions beyond the levels determined to be "Achieved in Practice" as per Rule 202, §205.1.a.

Pollutant	Technologically Feasible Alternatives
VOC	None identified
NOx	0.025 lb/MMBtu
SOx	Scrubbing and/or carbon adsorption for hydrogen sulfide removal
PM10	None identified
PM2.5	None identified
CO	None identified

NOx Cost Effectiveness Analysis Summary:

The cost analysis was processed in accordance with the EPA OAQPS Air Pollution Control Cost Manual (Sixth Edition) Chapter 1 Flares (5/17). The sales tax rate was based on the District's standard rate of 8.5% as approved on 10/17/16. The life (15 years) of the equipment was based on the EPA cost manual recommendation. The interest rate (5%) was based on the previous 6-month (April – August/2018) average interest rate on United States Treasury Securities (based on the life of the equipment) and addition of two percentage points and rounding up the next higher integer rate. The labor (Occupation Code 51-8099: Plant & System Operators/All Other) and maintenance (Occupation Code 49-9099: Installation, maintenance, and repair workers, all others) rates were based on data from the Bureau of Labor Statistics (May 2017 for California). The cost of the ZULE flare was provided by John Zink, as requested by the facility. John Zink also stated the cost of a Zule flare is about 2.2 to 2.6 times the price of a standard enclose flare. The lowest factor was used to determine the price of a standard flare.

Background:

John Zink (Aron Katz - Aron.Katz@johnzink.com) was contacted by the District to determine if they provide flares that meet a NOx standard of 0.025 lb/MMBtu for small flares (9.6 MMBtu/hr). John Zink stated they guarantee this standard for flares in the size range from 2 MMBt/hr to 160 MMBtu/hr. The facility was asked to provide cost information for a 9.6 MMBtu/hr ZULE flare. The cost information provided by John Zink is included in the spreadsheet of Appendix B. According to the District's Procedures for Making BACT and T-BACT Determinations for New and Modified Emission Units (10/16) guidance document, the emissions reduced are the difference between the post-BACT and pre-BACT emissions. The document states if there are no local, State or

Federal emission standards, that emissions can be based on EPA's Compilation of Air Pollutant Emission Factors (AP-42). Therefore, an emission factor of 0.068 lb/MMBtu will be used for a standard flare (AP-42 Section 13.5 Industrial Flares Table 13.5-1 (2/18)). The cost analysis will determine if it is cost effective to install a 0.025 lb NOx/MMBtu flare. The cost analysis will be based on the difference in NOx reductions from a standard flare (0.068 lb/MMBtu) and a Zule flare (0.025 lb/MMBtu) and the cost of a zule flare. A cost analysis will be performed on a 9.6 MMBtu/hr flare and a 167 MMBtu/hr flare. A capital cost of $1,400,000 for a 167 MMBtu/hr ZULE flare is being used in the SCAQMD's proposed Rule 1118.1 cost-effectiveness analysis for that rule (http://www.aqmd.gov/home/rules-compliance/rules/scaqmd-rule-book/proposed-rules#1118.1). The District will use the aforementioned information to determine the maximum size flare rating for this BACT determination.

9.6 MMBtu/hr Flare:

Equipment Life = 15 years

Total Annual Cost = 273,849.91 per year

NOx Removed = 1.8 tons per year

Cost of NOx Removal = $151,460.29 per ton reduced

A detailed calculation of the cost effectiveness for NOx is shown in Appendix B. As shown above, the cost of installing a 0.025 lb NOx/MMBtu flare is greater than $24,500 per ton of NOx reduced and therefore not cost effective.

167 MMBtu/hr Flare:

Equipment Life = 15 years

Total Annual Cost = $904,867.27 per year

NOx Removed = 31.5 tons per year

Cost of NOx Removal = $28,769.07 per ton reduced

A detailed calculation of the cost effectiveness for NOx is shown in Appendix B. As shown above, the cost of installing a 0.025 lb NOx/MMBtu flare is greater than $24,500 per ton of NOx reduced and therefore not cost effective.

SOx Cost Effectiveness Analysis Summary:

The District has no specific rules for flares that address SOx emissions. Emissions of SO_2 generally result from the combustion of hydrogen sulfide (H_2S) in landfill gas. AP-42 Section 2.4 Municipal Solid Waste Landfills (11/98) Table 2.4-1 lists an H_2S concentration of 35.5 ppmv for landfills. The Draft Version (10/08) of the amendment to this section includes additional information on SOx emissions. According to this draft document, H_2S can vary greatly between landfills. The document states the H_2S is normally present in LFG at levels ranging from 0 to 90 ppm, with an average concentration of 33 ppm. The H_2S concentration will depend on the gypsum (wall-board) content of material in the landfill from construction and demolition waste. The proposed H_2S content for this project is above the aforementioned concentrations. In order to determine a standard for landfill gas, a research of other district's requirments was conducted.

SCAQMD District Rule 431.1 has a specific sulfur content requirement for landfill gas of 150 ppmv as H_2S. The proposed uncontrolled H_2S limit for this project and uncontrolled H_2S tested for the existing permitted landfills within the District's jurisdiction are under this concentration. Therefore, this standard shall be used as the uncontrolled standard in the cost analysis.

Under the District's cost analysis for NOx, the District determined that the maximum rating of a flare that would be subject to this BACT as being 167 MMBtu/hr. In order to determine the flowrate associated with a flare of this size, a landfill gas higher heating value (HHV) of 500 Btu/scf will be used. The flowrate determined for this size of flare is equal to 5,567 cfm[1].

Carbon Adsorption:

The cost analysis was processed in accordance with the EPA OAQPS Air Pollution Control Cost Manual (Sixth Edition) Chapter 1 Carbon Adsorbers (9/99). The sales tax rate was based on the District's standard rate of 8.5% as approved on 10/17/16. The life (10 years) of the equipment was based on the EPA cost manual recommendation. The interest rate (5%) was based on the previous 6-month (April – August/2018) average interest rate on United States Treasury Securities (based on the life of the equipment) and addition of two percentage points and rounding up the next higher integer rate. The labor (Occupation Code 51-8099: Plant & System Operators/All Other) and maintenance (Occupation Code 49-9099: Installation, maintenance, and repair workers, all others) rates were based on data from the Bureau of Labor Statistics (May 2017 for California). The capital cost for a carbon adsorption system at a flowrate of 5,000 cfm was provided by SCS Engineers. This cost will be used for the 167 MMBtu/hr flare as the flowrates are similar. SCS engineers also provided a cost of a carbon system associated with this project with a flowrate of 400 cfm. The annual cost of the carbon replacement was also provided by SCS Engineers.

H_2S Control for 9.6 MMBtu/hr Flare:

Equipment Life = 10 years

Total Annual Cost = $74,578.23 per year

SOx Removed = 0.4 tons per year

Cost of SOx Removal = $177,364.52 per ton reduced

A detailed calculation of the cost effectiveness for SOx is shown in Appendix B. As shown above, the cost of installing a carbon adsorption system for H_2S control is greater than $18,500 per ton of SOx reduced and therefore not cost effective.

H_2S Control for 167 MMBtu/hr Flare:

Equipment Life = 10 years

Total Annual Cost = $554,429.34 per year

SOx Removed = 7.3 tons per year

Cost of SOx Removal = $75,797.63 per ton reduced

[1] Fuel Flowrate (cfm) = 167,000,000 Btu/hr/(500 Btu/cf x 60 min/hr)

A detailed calculation of the cost effectiveness for SOx is shown in Appendix B. As shown above, the cost of installing a carbon adsorption system for H_2S control is greater than $18,500 per ton of SOx reduced and therefore not cost effective.

Wet Scrubber:

The cost analysis was processed in accordance with the EPA OAQPS Air Pollution Control Cost Manual (Sixth Edition) Chapter 1 Wet Scrubbers for Acid Gas (12/95). The sales tax rate was based on the District's standard rate of 8.5% as approved on 10/17/16. The life (15 years) of the equipment was based on the EPA cost manual recommendation. The interest rate (5%) was based on the previous 6-month (April – August/2018) average interest rate on United States Treasury Securities (based on the life of the equipment) and addition of two percentage points and rounding up the next higher integer rate. The labor (Occupation Code 51-8099: Plant & System Operators/All Other) and maintenance (Occupation Code 49-9099: Installation, maintenance, and repair workers, all others) rates were based on data from the Bureau of Labor Statistics (May 2017 for California). The capital cost for a wet scrubber system (LO-CAT) at a flowrate of 1,388 cfm was provided by SCS Engineers for a similar project. The cost for a higher flowrate system would be higher. SCS engineers also provided a cost for a scrubbing system associated with this project with a flowrate of 400 cfm. The annual cost of the media replacement was also provided by SCS Engineers.

H_2S Control for 9.6 MMBtu/hr Flare:

Equipment Life = 15 years

Total Annual Cost = $588,914.08 per year

SOx Removed = 0.2 tons per year

Cost of SOx Removal = $2,801,151.43 per ton reduced

A detailed calculation of the cost effectiveness for SOx is shown in Appendix B. As shown above, the cost of installing a wet scrubber system for H_2S control is greater than $18,500 per ton of SOx reduced and therefore not cost effective.

H_2S Control for 167 MMBtu/hr Flare:

Equipment Life = 15 years

Total Annual Cost = $733,850.35 per year

SOx Removed = 3.7 tons per year

Cost of SOx Removal = $200,653.58 per ton reduced

A detailed calculation of the cost effectiveness for SOx is shown in Appendix B. As shown above, the cost of installing a wet scrubber system for H_2S control is greater than $18,500 per ton of SOx reduced and therefore not cost effective.

C. SELECTION OF BACT:

Minor Source BACT for a non-hazardous landfill gas flare is the following:

BACT FOR NON-HAZARDOUS LANDFILL GAS FLARE		
Pollutant	**Standard**	**Source**
VOC	98% NMOC destruction efficiency or 20 ppmvd NMOC @ 3% O_2 as Hexane and use of a natural gas or LPG/propane fired pilot	EPA, CARB, SMAQMD,
NOx	0.05 lb/MMBtu and use of a natural gas or LPG/propane fired pilot	CARB, SMAQMD
SOx	0.04 lb/MMBtu and use of a natural gas or LPG/propane fired pilot	SMAQMD
PM10	6.1 lb/MMcf and use of a natural gas or LPG/propane fired pilot	SMAQMD
PM2.5	6.1 lb/MMcf and use of a natural gas or LPG/propane fired pilot	SMAQMD
CO	0.15 lb/MMBtu and use of a natural gas or LPG/propane fired pilot	SMAQMD

D. SELECTION OF T-BACT:

As referenced in Section A of this document, the applicable Federal NSPS (40 CFR Part 60 Subpart WWW) and NESHAP (40 CFR Part 63 Subpart AAAA) require the use of a control device to reduce NMOC by 98% by weight or reduce the outlet NMOC concentration to less than 20 ppmvd as hexane @ 3% O2. There are no State ATCM's for this source category. None of the sources surveyed have any toxic T-BACT determinations published. Therefore, T-BACT standards will be considered as meeting the BACT standards identified above.

APPROVED BY: _____ **DATE:** _____

Appendix A

Review of BACT Determinations

List of applicable BACT determinations published in EPA's RBLC Clearinghouse for **Process Code 19.320 (Digester and Landfill Gas Flares)**:

Process Code 19.320 – Digester and Landfill Gas Flares								
Description and Capacity	**RBLC ID**	**Date**	**Case-By-Case Basis**	**VOC**	**NOx**	**SOx**	**PM10/2.5**	**CO**
Open Landfill Flare	NY-0110	1/10/17	BACT-PSD	N/A	0.068 lb/MMBtu	N/A	N/A	0.31 lb/MMBtu
Enclosed Landfill Flare	NY-0110	1/10/17	BACT-PSD	N/A	0.06 lb/MMBtu	N/A	0.017 lb/MMBtu	0.2 lb/MMBtu
Enclosed Landfill Flare	NY-0111	12/02/16	BACT-PSD	N/A	0.06 lb/MMBtu	N/A	N/A	0.2 lb/MMBtu
Landfill Flare	IN-0246	10/22/15	BACT-PSD	N/A	0.068 lb/MMBtu	N/A	17 lb/MMcf	0.37 lb/MMBtu
Landfill Flare	FL-0339	9/15/14	BACT-PSD	N/A	N/A	N/A	N/A	N/A
Landfill Flare	OR-0052	6/21/13	BACT-PSD	20 ppm @ 3% O2	N/A	N/A	N/A	N/A
Enclosed Landfill Flare	CA-1234	1/1/10	BACT-PSD	20 ppm @ 3% O2	N/A	N/A	N/A	N/A
Flare	RI-0023	1/1/10	BACT-PSD	N/A	0.06 lb/MMBtu	N/A	N/A	0.2 lb/MMBtu

CALIFORNIA AIR RESOURCES BOARD

BACT Determination Detail

Category

Source Category:	Landfill: Flare-Digester Gas or Landfill Gas from Non-Hazardous Waste Landfill
SIC Code	4953
NAICS Code	562212

Emission Unit Information

Manufacturer:	Perennial Energy
Type:	enclosed
Model:	FL-120-30-E
Equipment Description:	landfill gas flare
Capacity / Dimentions	1,800 scfm, 54 MM Btu/hr
Fuel Type	Landfill Gas
Multiple Fuel Types	

Operating Schedule (hours/day)/(days/week)/ (weeks/year)e	Variable (/ /)
Function of Equipment	control landfill gas
VOC Limit	20
VOC Limit Units	ppmvd@3%O2
VOC Average Time	
VOC Control Method	Add-on
VOC Control Method Desc	Enclosed flare
VOC Percent Control Efficiency	
VOC Cost Effectiveness (%/ton)	
VOC Incremental Cost Effectiveness (%/ton)	
VOC Cost Verified (Y/N)	
VOC Dollar Year	

Project / Permit Information

Application/Permit No.:	980163
Application Completeness Date:	

New Construction/Modification:	Modification
ATC Date:	
PTO Date:	
Startup Date:	
Technology Status:	BACT Determination
Source Test Available:	Yes
Source Test Results:	

Facility / District Information

Facility Name:	Sycamore Landfill, Inc.
Facility Zip Code:	
Facility County:	San Diego
District Name:	San Diego County APCD
District Contact:	Alta Stengel
Contact Phone No.:	858-650-4611
Contact E-Mail:	Alta.Stengel@sdcounty.ca.gov

Notes

New Construction/Modification:	Modification
ATC Date:	
PTO Date:	
Startup Date:	
Technology Status:	BACT Determination
Source Test Available:	Yes
Source Test Results:	

Facility / District Information

Facility Name:	Sycamore Landfill, Inc.
Facility Zip Code:	
Facility County:	San Diego
District Name:	San Diego County APCD
District Contact:	Alta Stengel
Contact Phone No.:	858-650-4611
Contact E-Mail:	Alta.Stengel@sdcounty.ca.gov

Notes

BACT Determination Detail

Category

Source Category:	Landfill: Flare-Digester Gas or Landfill Gas from Non-Hazardous Waste Landfill
SIC Code	4953
NAICS Code	562212

Emission Unit Information

Manufacturer:	Perennial Energy, Inc.
Type:	Landfill Gas Flare
Model:	FL-90-26-E
Equipment Description:	Enclosed landfill gas flare
Capacity / Dimentions	20 MMBtu/hr
Fuel Type	Landfill Gas
Multiple Fuel Types	No

Operating Schedule (hours/day)/(days/week)/ (weeks/year)e	Continuous (24/7/52)
Function of Equipment	combust landfill gas

Bact Information

NOx Limit	0.05
NOx Limit Units	lb/MMBtu
NOx Average Time	40 minutes
NOx Control Method	Pollution Prevention
NOx Control Method Desc	landfill gas flare
NOx Percent Control Efficiency	
NOx Cost Effectiveness (%/ton)	
NOx Incremental Cost Effectiveness (%/ton)	
NOx Cost Verified (Y/N)	
NOx Dollar Year	
CO Limit	0.4
CO Limit Units	lb/MMBtu
CO Average Time	40 minutes

CO Control Method	Pollution Prevention
CO Control Method Desc	landfill gas flare
CO Percent Control Efficiency	
CO Cost Effectiveness (%/ton)	
CO Incremental Cost Effectiveness (%/ton)	
CO Cost Verified (Y/N)	
CO Dollar Year	

VOC Limit	20
VOC Limit Units	ppmvd NMOC @ 3% O2
VOC Average Time	40
VOC Control Method	Pollution Prevention
VOC Control Method Desc	ppm as hexane
VOC Percent Control Efficiency	
VOC Cost Effectiveness (%/ton)	
VOC Incremental Cost Effectiveness (%/ton)	
VOC Cost Verified (Y/N)	

VOC Dollar Year

Project / Permit Information

Application/Permit No.:	ATC 12037
Application Completeness Date:	
New Construction/Modification:	New Construction
ATC Date:	03-07-2007
PTO Date:	11-05-2008
Startup Date:	08-08-2007
Technology Status:	BACT Determination
Source Test Available:	Yes
Source Test Results:	0.048 lb NOx/MMBtu, 0.377 lb NOx/hr, 0.165 lb CO/MMbtu, 1.293 lb CO/hr, 4.8 ppm NMOC as hexane @ 3% O2

Facility / District Information

Facility Name:	Santa Maria Regional Landfill
Facility Zip Code:	93454
Facility County:	Santa Barbara
District Name:	Santa Barbara County APCD

District Contact:	Ben Ellenberger
Contact Phone No.:	(805) 961-8800
Contact E-Mail:	cbe@sbcapcd.org

Notes

Notes:	Three in-stack thermocouples to measure combustion temperature, landfill gas blower with variable frequency drive, automatic temperature control system using louvers to regulate excess air

Report Error In Determination

REPLACED

SMAQMD BACT CLEARINGHOUSE

CATEGORY: **FLARE**

BACT Size: Minor Source BACT **FLARE**

BACT Determination Number: 102	**BACT Determination Date:** 3/16/2015

Equipment Information

Permit Number: 24341
Equipment Description: FLARE
Unit Size/Rating/Capacity: 18 MMBtu/hr
Equipment Location: CITY OF SACRAMENTO SOLID WASTE PUBLIC WORKS
20 28TH ST
SACRAMENTO, CA

BACT Determination Information

ROCs	**Standard:**	98% control efficiency or 20 ppmv @ 3%O2 as Hexane
	Technology Description:	
	Basis:	Achieved in Practice
NOx	**Standard:**	0.05 lb/MMBtu
	Technology Description:	
	Basis:	Achieved in Practice
SOx	**Standard:**	0.04 lb/MMBtu
	Technology Description:	
	Basis:	Achieved in Practice
PM10	**Standard:**	6.1 lb/MMcf
	Technology Description:	
	Basis:	Achieved in Practice
PM2.5	**Standard:**	6.1 lb/MMcf
	Technology Description:	
	Basis:	Achieved in Practice
CO	**Standard:**	0.15 lb/MMBtu
	Technology Description:	
	Basis:	Achieved in Practice
LEAD	**Standard:**	
	Technology Description:	
	Basis:	

Comments: Landfill gas flare.

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

Printed: 7/24/2018

San Joaquin Valley
Unified Air Pollution Control District

Best Available Control Technology (BACT) Guideline 1.4.3*

Last Update: 11/07/2016

Landfill Gas Vapor Collection System *RESCINDED*

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 s 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**

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
Best Available Control Technology (BACT) Guidelines for Non-Major Polluting Facilities*

10-20-2000 Rev. 0

Equipment or Process: Flare

	Criteria Pollutants					
Rating/Size	**VOC**	**NOx**	**SOx**	**CO**	**PM_{10}**	**Inorganic**
Digester Gas or Landfill Gas from Non-Hazardous Waste Landfill	Ground Level, Shrouded, ≥ 0.6 Sec. Retention Time at ≥ 1400 °F, Auto Combustion Air Control, Automatic Shutoff Gas Valve and Automatic Re-Start System (1988)	0.06 lbs/MM Btu (1988)		Ground Level, Shrouded, ≥ 0.6 Sec. Retention Time at ≥ 1400 °F, and Auto Combustion Air Control (1988)	Knockout Vessel (1988)	
Landfill Gas from Hazardous Waste Landfill	Ground Level, Shrouded, ≥ 0.6 Sec. Retention Time at ≥ 1500 °F, Auto Combustion Air Control, Automatic Shutoff Gas Valve and Automatic Re-Start System (1988)	0.06 lbs/MM Btu (1988)		Ground Level, Shrouded, ≥ 0.6 Sec. Retention Time at ≥ 1500 °F, and Auto Combustion Air Control (1988)	Knockout Vessel (1988)	

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

BAY AREA AIR QUALITY MANAGEMENT DISTRICT
Best Available Control Technology (BACT) Guideline

Source Category

Source:	*Flare - Digester Gas or Landfill Gas from Non-Hazardous Waste landfill*	Revision:	*1*
		Document #:	*80.1*
Class:	*All*	Date:	*12/16/91*

Determination

POLLUTANT	BACT 1. Technologically Feasible/ Cost Effective 2. Achieved in Practice	TYPICAL TECHNOLOGY
POC	1. *n/d* 2. *Ground level, enclosed, $\geq$0.6 sec. retention time at $\geq$1400^{o}F, auto combustion air control, automatic shoutoff gas valve and automatic re-start system*[b]	1. *n/d* 2. *BAAQMD Approved Design and Operation*[b]
NOx	1. *$\leq$0.06 lb/MMBtu* 2. *0.06 lb/MMBtu*	1. *n/s* 2. *n/s*
SO_2	1. *Scrubbing and/or carbon adsorption for hydrogen sulfide removal*[c] 2. *n/d*	1. *BAAQMD Approved Design and Operation*[b] 2. *n/d*
CO	1. *n/d* 2. *Same as for POC above*[b]	1. *n/a* 2. *BAAQMD Approved Design and Operation*[b]
PM_{10}	1. *n/s* 2. *n/s*	1. *Fuel Gas Filter* 2. *Knockout Vessel*
NPOC	1. *n/a* 2. *n/a*	1. *n/a* 2. *n/a*

References

b. BAAQMD
c. CARB/CAPCOA Clearinghouse

Appendix A

NOx Cost-Effectiveness Analysis

ULTRA LOW EMISSIONS FLARE COST EFFECTIVENESS CALCULATION

EPA AIR POLLUTION CONTROL COST MANUAL, Sixth Edition, EPA/452/B-02-001, September 2000
Section 3.2 - VOC Destruction Controls, Chapter 1 - Flares

Equipment

Flare Rating	9.6	MMBTU/hr
Flare Operating Hours	8760	hours
Standard Flare	0.068	lb/MMBTU
ZULE Flare	0.025	lb/MMBTU
Standard Flare NOx (lbs/year)	5718.528	
Zule Flare NOx (lbs/year)	2102.4	
NOx Reduction (tons/year)	1.8	

Cost Estimation

Direct Costs	**Flare (0.025 lb/MMBtu)**	
Flare System (A)	$	374,300.00
Instrumentation (0.10 A)	$	37,430.00
Sales Tax (8.5%)	$	31,815.50
Freight (0.05 A)	$	18,715.00
PEC (B)	$	462,260.50
Direct Installation Costs		
Foundation & Support (0.12 B)	$	55,471.26
Handling & Erection (0.40 B)	$	184,904.20
Electrical (0.01 B)	$	4,622.61
Piping (0.02 B)	$	9,245.21
Insulation (0.01 B)	$	4,622.61
Painting (0.01 B)	$	4,622.61
Total Direct Installation Costs	$	263,488.49
Total Direct Costs (DC)	**$**	**725,748.99**
Indirect Costs		
Engineering (0.10 B)	$	46,226.05
Construction and Field Expenses (0.10 B)	$	46,226.05
Contractor Fees (0 B)	$	-
Start-up (0.01 B)		$4,622.61
Performancd Test (0.01 B)		$4,622.61
Contingencies (0.03 B)	$	13,867.82
Total Indirect Costs (IC)	**$**	**115,565.13**
Total Capital Investment (DC + IC)	**$**	**841,314.11**
Direct Annual Costs		
Operating Labor (630 hr/yr x $31.72/hr)	$	19,983.60
Supervisor (15% of operator)	$	2,997.54
Maintenance Labor		
Labor (0.5 hr/shift x shift/8 hr x 8,760 hr/yr x $18.81/hr)	$	10,298.48
Materials (100% of labor)	$	10,298.48
Total Direct Annual Costs	**$**	**43,578.09**
Indirect Annual Costs		
Overhead (60% of total labor & material costs)	$	115,565.13
Administration Charges (2% of TCI)	$	16,826.28
Property Tax (1% of TCI)	$	8,413.14
Insurance (1% of TCI)	$	8,413.14
Annual Interest Rate		5%
Capital Recovery Factor (CRF)		0.0963
Capital Recovery (CRF x TCI)	$	81,054.13
Total Indirect Annual Costs	**$**	**230,271.82**
Total Annual Costs	**$**	**273,849.91**
NOx Removed (ton/yr)		1.8
Annual Cost	$	273,849.91
Cost of NOx removal ($/ton)		**151,460.29**

ULTRA LOW EMISSIONS FLARE COST EFFECTIVENESS CALCULATION

EPA AIR POLLUTION CONTROL COST MANUAL, Sixth Edition, EPA/452/B-02-001, September 2000
Section 3.2 - VOC Destruction Controls, Chapter 1 - Flares

Equipment

Flare Rating	167	MMBTU/hr
Flare Operating Hours	8760	hours
Standard Flare	0.068	lb/MMBTU
ZULE Flare	0.025	lb/MMBTU
Standard Flare NOx (lbs/year)	99478.56	
Zule Flare NOx (lbs/year)	36573	
NOx Reduction (tons/year)	31.5	

Cost Estimation

Direct Costs	**Flare (0.025 lb/MMBtu)**	
Flare System (A)	$	1,400,000.00
Instrumentation (0.10 A)	$	140,000.00
Sales Tax (8.5%)	$	119,000.00
Freight (0.05 A)	$	70,000.00
PEC (B)	$	1,729,000.00
Direct Installation Costs		
Foundation & Support (0.12 B)	$	207,480.00
Handling & Erection (0.40 B)	$	691,600.00
Electrical (0.01 B)	$	17,290.00
Piping (0.02 B)	$	34,580.00
Insulation (0.01 B)	$	17,290.00
Painting (0.01 B)	$	17,290.00
Total Direct Installation Costs	$	985,530.00
Total Direct Costs (DC)	**$**	**2,714,530.00**
Indirect Costs		
Engineering (0.10 B)	$	172,900.00
Construction and Field Expenses (0.10 B)	$	172,900.00
Contractor Fees (0 B)	$	-
Start-up (0.01 B)		$17,290.00
Performancd Test (0.01 B)		$17,290.00
Contingencies (0.03 B)	$	51,870.00
Total Indirect Costs (IC)	**$**	**432,250.00**
Total Capital Investment (DC + IC)	**$**	**3,146,780.00**
Direct Annual Costs		
Operating Labor (630 hr/yr x $31.72/hr)	$	19,983.60
Supervisor (15% of operator)	$	2,997.54
Maintenance Labor		
Labor (0.5 hr/shift x shift/8 hr x 8,760 hr/yr x $18.81/hr)	$	10,298.48
Materials (100% of labor)	$	10,298.48
Total Direct Annual Costs	**$**	**43,578.09**
Indirect Annual Costs		
Overhead (60% of total labor & material costs)	$	432,250.00
Administration Charges (2% of TCI)	$	62,935.60
Property Tax (1% of TCI)	$	31,467.80
Insurance (1% of TCI)	$	31,467.80
Annual Interest Rate		5%
Capital Recovery Factor (CRF)		0.0963
Capital Recovery (CRF x TCI)	$	303,167.98
Total Indirect Annual Costs	**$**	**861,289.18**
Total Annual Costs	**$**	**904,867.27**
NOx Removed (ton/yr)		31.5
Annual Cost	$	904,867.27
Cost of NOx removal ($/ton)		**28,769.07**

CARBON ADSORPTION SYSTEM COST EFFECTIVENESS CALCULATION

EPA AIR POLLUTION CONTROL COST MANUAL, Sixth Edition, EPA/452/B-02-001, September 1999
Section 3.1 - VOC Recapture Controls, Chapter 1 - Carbon Adsorbers

Equipment

Flare Rating	9.6	MMBTU/hr
Flare Operating Hours	8760	hours
Standard Flare	0.05	lb/MMBTU
80% Control	0.04	lb/MMBTU
Standard Flare SO2 (lbs/year)	4204.8	
Controlled SO2 (lbs/year)	3363.84	
NOx Reduction (tons/year)	0.4	

Cost Estimation

Direct Costs		**Carbon Adsorption System**
Carbon Adsorption System (A)	$	45,120.00
Instrumentation (0.10 A)	$	4,512.00
Sales Tax (8.5%)	$	3,835.20
Freight (0.05 A)	$	2,256.00
PEC (B)	$	55,723.20
Direct Installation Costs		
Foundation & Support (0.12 B)	$	6,686.78
Handling & Erection (0.40 B)	$	22,289.28
Electrical (0.01 B)	$	557.23
Piping (0.02 B)	$	1,114.46
Insulation (0.01 B)	$	557.23
Painting (0.01 B)	$	557.23
Total Direct Installation Costs	$	31,762.22
Total Direct Costs (DC)	**$**	**87,485.42**
Indirect Costs		
Engineering (0.10 B)	$	5,572.32
Construction and Field Expenses (0.10 B)	$	5,572.32
Contractor Fees (0 B)	$	-
Start-up (0.01 B)		$557.23
Performancd Test (0.01 B)		$557.23
Contingencies (0.03 B)	$	1,671.70
Total Indirect Costs (IC)	**$**	**13,930.80**
Total Capital Investment (DC + IC)	**$**	**101,416.22**
Direct Annual Costs		
Operating Labor (0.5 hr/shift x 3 shift/day x 360 days/yr x $31.72/hr)	$	17,128.80
Supervisor (15% of operator)	$	2,569.32
Maintenance Labor		
Labor (0.5 hr/shift x 3 shift/day x 360 days/yr x $18.81/hr)	$	10,157.40
Materials (100% of labor)	$	10,157.40
Carbon replacement	$	3,444.00
Total Direct Annual Costs	**$**	**43,456.92**
Indirect Annual Costs		
Overhead (60% of total labor & material costs)	$	13,930.80
Administration Charges (2% of TCI)	$	2,028.32
Property Tax (1% of TCI)	$	1,014.16
Insurance (1% of TCI)	$	1,014.16
Annual Interest Rate		5%
Capital Recovery Factor (CRF)		0.1295
Capital Recovery (CRF x TCI)	$	13,133.86
Total Indirect Annual Costs	**$**	**31,121.31**
Total Annual Costs	**$**	**74,578.23**
NOx Removed (ton/yr)		0.4
Annual Cost	$	74,578.23
Cost of NOx removal ($/ton)		**177,364.52**

CARBON ADSORPTION SYSTEM COST EFFECTIVENESS CALCULATION

EPA AIR POLLUTION CONTROL COST MANUAL, Sixth Edition, EPA/452/B-02-001, September 1999
Section 3.1 - VOC Recapture Controls, Chapter 1 - Carbon Adsorbers

Equipment

Flare Rating	167	MMBTU/hr
Flare Operating Hours	8760	hours
Standard Flare	0.05	lb/MMBTU
80% Control	0.04	lb/MMBTU
Standard Flare SO2 (lbs/year)	73146	
Controlled SO2 (lbs/year)	58516.8	
NOx Reduction (tons/year)	7.3	

Cost Estimation

Direct Costs		**Carbon Adsorption System**
Carbon Adsorption System (A)	$	564,000.00
Instrumentation (0.10 A)	$	56,400.00
Sales Tax (8.5%)	$	47,940.00
Freight (0.05 A)	$	28,200.00
PEC (B)	$	696,540.00
Direct Installation Costs		
Foundation & Support (0.12 B)	$	83,584.80
Handling & Erection (0.40 B)	$	278,616.00
Electrical (0.01 B)	$	6,965.40
Piping (0.02 B)	$	13,930.80
Insulation (0.01 B)	$	6,965.40
Painting (0.01 B)	$	6,965.40
Total Direct Installation Costs	$	397,027.80
Total Direct Costs (DC)	**$**	**1,093,567.80**
Indirect Costs		
Engineering (0.10 B)	$	69,654.00
Construction and Field Expenses (0.10 B)	$	69,654.00
Contractor Fees (0 B)	$	-
Start-up (0.01 B)		$6,965.40
Performancd Test (0.01 B)		$6,965.40
Contingencies (0.03 B)	$	20,896.20
Total Indirect Costs (IC)	**$**	**174,135.00**
Total Capital Investment (DC + IC)	**$**	**1,267,702.80**
Direct Annual Costs		
Operating Labor (0.5 hr/shift x 3 shift/day x 360 days/yr x $31.72/hr)	$	17,128.80
Supervisor (15% of operator)	$	2,569.32
Maintenance Labor		
Labor (0.5 hr/shift x 3 shift/day x 360 days/yr x $18.81/hr)	$	10,157.40
Materials (100% of labor)	$	10,157.40
Carbon replacement	$	125,400.00
Total Direct Annual Costs	**$**	**165,412.92**
Indirect Annual Costs		
Overhead (60% of total labor & material costs)	$	174,135.00
Administration Charges (2% of TCI)	$	25,354.06
Property Tax (1% of TCI)	$	12,677.03
Insurance (1% of TCI)	$	12,677.03
Annual Interest Rate		5%
Capital Recovery Factor (CRF)		0.1295
Capital Recovery (CRF x TCI)	$	164,173.31
Total Indirect Annual Costs	**$**	**389,016.42**
Total Annual Costs	**$**	**554,429.34**
NOx Removed (ton/yr)		7.3
Annual Cost	$	554,429.34
Cost of NOx removal ($/ton)		**75,797.63**

WET SCRUBBER SYSTEM COST EFFECTIVENESS CALCULATION

EPA AIR POLLUTION CONTROL COST MANUAL, Sixth Edition, EPA/452/B-02-001, December 1995
Section 5.2 - Post-Combustion Controls, Chapter 1 - Wet Scrubbers for Acid Gas

Equipment

Flare Rating	9.6	MMBTU/hr
Flare Operating Hours	8760	hours
Standard Flare	0.05	lb/MMBTU
90% Control	0.045	lb/MMBTU
Standard Flare SO2 (lbs/year)	4204.8	
Controlled SO2 (lbs/year)	3784.32	
SOx Reduction (tons/year)	0.2	

Cost Estimation

Direct Costs	**Wet Scrubber System**
Wet Scrubber System (A)	$ 896,000.00
Instrumentation (0.10 A)	$ 89,600.00
Sales Tax (8.5%)	$ 76,160.00
Freight (0.05 A)	$ 44,800.00
PEC (B)	$ 1,106,560.00

Direct Installation Costs

Foundation & Support (0.12 B)	$ 132,787.20
Handling & Erection (0.40 B)	$ 442,624.00
Electrical (0.01 B)	$ 11,065.60
Piping (0.02 B)	$ 22,131.20
Insulation (0.01 B)	$ 11,065.60
Painting (0.01 B)	$ 11,065.60
Total Direct Installation Costs	$ 630,739.20
Total Direct Costs (DC)	**$ 1,737,299.20**

Indirect Costs

Engineering (0.10 B)	$ 110,656.00
Construction and Field Expenses (0.10 B)	$ 110,656.00
Contractor Fees (0 B)	$ -
Start-up (0.01 B)	$11,065.60
Performancd Test (0.01 B)	$11,065.60
Contingencies (0.03 B)	$ 33,196.80
Total Indirect Costs (IC)	**$ 276,640.00**
Total Capital Investment (DC + IC)	**$ 2,013,939.20**

Direct Annual Costs

Operating Labor (0.5 hr/shift x shift/8 hr x 8,000 hr/yr x $31.72/hr)	$ 15,860.00
Supervisor (15% of operator)	$ 2,379.00
Maintenance Labor	
Labor (0.5 hr/shift x shift/8 hr x 8,000 hr/yr x $18.81/hr)	$ 9,405.00
Materials (100% of labor)	$ 9,405.00
Chemical Cost	$ 640.00
Total Direct Annual Costs	**$ 37,689.00**

Indirect Annual Costs

Overhead (60% of total labor & material costs)	$ 276,640.00
Administration Charges (2% of TCI)	$ 40,278.78
Property Tax (1% of TCI)	$ 20,139.39
Insurance (1% of TCI)	$ 20,139.39
Annual Interest Rate	5%
Capital Recovery Factor (CRF)	0.0963
Capital Recovery (CRF x TCI)	$ 194,027.51
Total Indirect Annual Costs	**$ 551,225.08**
Total Annual Costs	**$ 588,914.08**
SOx Removed (ton/yr)	0.2
Annual Cost	$ 588,914.08
Cost of SOx removal ($/ton)	**2,801,151.43**

WET SCRUBBER SYSTEM COST EFFECTIVENESS CALCULATION

EPA AIR POLLUTION CONTROL COST MANUAL, Sixth Edition, EPA/452/B-02-001, December 1995
Section 5.2 - Post-Combustion Controls, Chapter 1 - Wet Scrubbers for Acid Gas

Equipment

Flare Rating	167	MMBTU/hr
Flare Operating Hours	8760	hours
Standard Flare	0.05	lb/MMBTU
90% Control	0.045	lb/MMBTU
Standard Flare SO2 (lbs/year)	73146	
Controlled SO2 (lbs/year)	65831.4	
SOx Reduction (tons/year)	3.7	

Cost Estimation

Direct Costs	**Wet Scrubber System**	
Wet Scrubber System (A)	$	1,120,000.00
Instrumentation (0.10 A)	$	112,000.00
Sales Tax (8.5%)	$	95,200.00
Freight (0.05 A)	$	56,000.00
PEC (B)	$	1,383,200.00

Direct Installation Costs

Foundation & Support (0.12 B)	$	165,984.00
Handling & Erection (0.40 B)	$	553,280.00
Electrical (0.01 B)	$	13,832.00
Piping (0.02 B)	$	27,664.00
Insulation (0.01 B)	$	13,832.00
Painting (0.01 B)	$	13,832.00
Total Direct Installation Costs	$	788,424.00
Total Direct Costs (DC)	**$**	**2,171,624.00**

Indirect Costs

Engineering (0.10 B)	$	138,320.00
Construction and Field Expenses (0.10 B)	$	138,320.00
Contractor Fees (0 B)	$	-
Start-up (0.01 B)		$13,832.00
Performancd Test (0.01 B)		$13,832.00
Contingencies (0.03 B)	$	41,496.00
Total Indirect Costs (IC)	**$**	**345,800.00**
Total Capital Investment (DC + IC)	**$**	**2,517,424.00**

Direct Annual Costs

Operating Labor (0.5 hr/shift x shift/8 hr x 8,000 hr/yr x $31.72/hr)	$	15,860.00
Supervisor (15% of operator)	$	2,379.00
Maintenance Labor		
Labor (0.5 hr/shift x shift/8 hr x 8,000 hr/yr x $18.81/hr)	$	9,405.00
Materials (100% of labor)	$	9,405.00
Chemical Cost	$	7,770.00
Total Direct Annual Costs	**$**	**44,819.00**

Indirect Annual Costs

Overhead (60% of total labor & material costs)	$	345,800.00
Administration Charges (2% of TCI)	$	50,348.48
Property Tax (1% of TCI)	$	25,174.24
Insurance (1% of TCI)	$	25,174.24
Annual Interest Rate		5%
Capital Recovery Factor (CRF)		0.0963
Capital Recovery (CRF x TCI)	$	242,534.39
Total Indirect Annual Costs	**$**	**689,031.35**
Total Annual Costs	**$**	**733,850.35**
SOx Removed (ton/yr)		3.7
Annual Cost	$	733,850.35
Cost of SOx removal ($/ton)		**200,653.58**