

**Evaluation of Existing Limits and Preliminary Determination of Possible BACT Emission Limits
 For the Purpose of Modeling Six IC Engines Combusting Landfill Gas**

VOC	Source of Information	Emission Factors Per Engine - Original Application (except as noted)	Notes Based on Original Application	Potential to Emit for 6 IC Engines - Original Application (tpy)	May 19, 2011 Response Letter - Appendix B (per engine)	Notes Based on Application Addendum	PTE 6 engines Based on Application Addendum (tpy)	RBL/C Review	Initial EPD BACT Limit
Applicant	<p>1.31 lb/hr</p> <p><i>0.081 lb/MMBtu</i></p> <p><i>0.233 g/bhp-hr</i></p> <p>20 ppmvd as hexane at 3% oxygen</p> <p>Does not include formaldehyde</p>	<p>SIP Application</p> <p>40 CFR 60.752(2)(iii)(B) (In Subpart WWW) from collection and control device for LFG</p> <p>Does not include formaldehyde</p>	34.42	<p>3.21 lb/hr</p> <p><i>0.179 lb/MMBtu</i></p> <p><i>0.52 g/bhp-hr</i></p> <p>Includes Formaldehyde</p>	SIP Application	84.358	<p>Range 0.16 – 0.8 g/bhp-hr</p> <p>Range 0.77 – 1.77 lb/hr</p> <p>Does not include formaldehyde</p>	<p><i>0.52 g/bhp-hr</i></p> <p>Based on 3.21 lb/hr</p> <p>BACT limit includes formaldehyde</p> <p>3-hr averaging period</p> <p>Basis: Application Addendum dated 5/19/2011.</p>	
Applicant – Technical Specification Sheet for IC Engine	<p>0.88 g/bhp-hr at 100% load</p> <p><i>4.33 lb/hr</i></p> <p><i>0.29 lb/MMBtu</i></p> <p>Do not know if values include formaldehyde</p>	<p>2,233 bhp</p> <p>242,216 Btu/min</p>	113.85	<p>0.88 g/bhp-hr at 100% load</p> <p><i>4.33 lb/hr</i></p> <p><i>0.29 lb/MMBtu</i></p> <p>Do not know if values include formaldehyde</p>	2,233 bhp	242,216 Btu/min	<p>113.792</p> <p>Do not know if this value includes formaldehyde</p>		

Note: Emission rates that are **bolded** indicate original proposed emission rates. Emission rates that are *italicized* indicate derived values.

VOC	Source of Information	Emission Factors Per Engine - Original Application (except as noted)	Notes Based on Original Application	Potential to Emit for 6 IC Engines - Original Application (tpy)	May 19, 2011 Response Letter - Appendix B (per engine)	Notes Based on Application Addendum	PTE 6 engines Based on Application Addendum (tpy)	RBLC Review	Initial EPD BACT Limit
	AP-42 Section 3.2.2 4-Stroke Lean-Burn Engine burning natural gas	0.118 lb/MMBtu with a "C" rating 1.90 lb/hr Do not know if this value includes formaldehyde		49.93 Do not know if this value includes formaldehyde	0.118 lb/MMBtu with a "C" rating 2.1 lb/hr		55.188 Do not know if this value includes formaldehyde		
	40 CFR 60 Subpart JJJJ	1 g/hp-hr 80 ppmvd at 15% oxygen 0.347 lb/MMBtu Does not include formaldehyde	From Part 60 Subpart JJJJ 60.4233(e) which references Table 1. From Part 60 Subpart JJJJ 60.4233(e) which references Table 1. Based on 6,354 Btu/bhp-hr NSPS JJJJ compliance methods include Methods 25, 25A, or 18 or Method 320 of Part 63	129.38 Does not include formaldehyde	1 g/hp-hr 80 ppmvd at 15% oxygen 0.347 lb/MMBtu Does not include formaldehyde	From Part 60 Subpart JJJJ 60.4233(e) which references Table 1. From Part 60 Subpart JJJJ 60.4233(e) which references Table 1. Based on 6,354 Btu/bhp-hr NSPS JJJJ compliance methods include Methods 25, 25A, or 18 or Method 320 of Part 63	129.38 Does not include formaldehyde		

Note: Emission rates that are **bolded** indicate original proposed emission rates. Emission rates that are *italicized* indicate derived values.

VOC Source of Information	Emission Factors Per Engine - Original Application (except as noted)	Notes Based on Original Application	Potential to Emit for 6 IC Engines - Original Application (tpy)	May 19, 2011 Response Letter - Appendix B (per engine)	Notes Based on Application Addendum	PTE 6 engines Based on Application Addendum (tpy)	RBLC Review	Initial EPD BACT Limit
Title V Application	HCOH = 20.81 tpy VOC = 14.34 tpy (For 6 engines)	Section E	35.15 Includes formaldehyde					
Title V Application	HCOH = 8.32 tpy VOC = 20 ppm @3 % Oxygen 5.74 tpy	Section E: VOC concentration does not include formaldehyde Max Actual Emissions	84.36 Includes formaldehyde					

Note A:

VOC (including formaldehyde): If limit is kept below 100 tons per year for PSD air impact assessment, then no air impact assessment is needed.

$$\text{VOC} = 3.80 \text{ lb/hr/engine} = (99.9 \text{ tons/yr-total}) * (2000 \text{ lb/ton}) * (1 \text{ yr}/8760 \text{ hrs}) * (1/6)$$

$$\text{VOC} = 0.2127 \text{ lb/MMBtu} = (3.80 \text{ lb/hr}) * (\text{hr}/17.87 \text{ MMBtu})$$

$$\text{VOC} = 0.6129 \text{ g/bhp-hr} = (0.006354 \text{ MMBtu/bhp-hr}) * (0.2127 \text{ lb/MMBtu}) * (1000 \text{ g}/2.205 \text{ lb})$$

Note: Emission rates that are **bolded** indicate original proposed emission rates. Emission rates that are *italicized* indicate derived values.

Particulate Matter (PM, PM10, PM2.5) Filterable Plus Condensable Particulate Matter (CPM)									
Source of Information	Emission Factor Per Engine: Original Application	Notes: Original Application	Potential to Emit for 6 IC Engines Original Application (tpy)	May 19, 2011 Response Letter Appendix B (per engine, except as noted)	Notes Based on Application Addendum	PTE 6 engines Application Addendum (tpy)	RBLC Review	Initial EPD BACT Limit	
SIP Application				22.291 tpy (For 6 engines) <i>0.848 lb/hr</i> <i>0.047 lb/MMBtu</i> <i>0.135 g/bhp-hr</i> Note A	Section 13 of Application Assume 17.87 MMBtu/hr/engine Assume 6,354 Btu/bhp-hr	22.29 tpy	Range 0.1 – 0.2 g/bhp-hr Range 0.05 – 0.24 lb/MMBtu Range 0.2 – 0.71 lb/hr	<i>0.135 g/bhp-hr</i> Includes CPM For PM, PM10, and PM2.5 3-hr averaging period Modeling emission rate is <i>0.848 lb/hr</i>	
SIP Application				0.93 lb/hr <i>0.052 lb/MMBtu</i> <i>0.15 g/bhp-hr</i> Note B	Form 4.00 of SIP Application for Hourly PTE Per SIP Application 17.87 MMBtu/hr/engine Per SIP Application 6354 Btu/bhp-hr	24.44			

Note: Emission rates that are **bolded** indicate original proposed emission rates. Emission rates that are *italicized* indicate derived values.

Particulate Matter (PM, PM10, PM2.5) Filterable Plus Condensable Particulate Matter (CPM)								
Source of Information	Emission Factor Per Engine: Original Application	Notes: Original Application	Potential to Emit for 6 IC Engines Original Application (tpy)	May 19, 2011 Response Letter Appendix B (per engine, except as noted)	Notes Based on Application Addendum	PTE 6 engines Application Addendum (tpy)	RBLC Review	Initial EPD BACT Limit
Applicant (from AP-42 Table 2.4-5) Application page 3-4	48 lb PM/MMdscf methane Do not know if this value includes CPM 0.048 lb PM/MMBtu 0.773 lb/hr based on 16.12 MMBtu/hr/engine	Methane is about 1000 Btu/dscf Emission factor has "E" rating PM=PM10=PM2.5 per AP-42	20.31	48 lb PM/MMdscf methane 0.048 lb PM/MMBtu 0.857 lb/hr based on 17.87 MMBtu/hr/engine 0.1383 g/bhp-hr Note C	Methane is about 1000 Btu/dscf Emission factor has "E" rating PM=PM10=PM2.5 per AP-42 Applicant remained silent on whether these emission rates include CPM	22.52 App. Proposing 22.29 tpy for PM and PM10; 22.26 for PM2.5 ASSUME that values include CPM; applicant did not answer question in the May 19 response.		
AP-42 Section 3.2.2 4-Stroke Lean-Burn Engine burning natural gas	0.00991 lb/MMBtu with a "D" rating 0.160 lb/hr based on 16.12 MMBtu/hr/engine	Includes CPM PM=PM10=PM2.5 per AP-42	4.2	0.00991 lb/MMBtu with a "D" rating 0.163 lb/hr based on 17.87 MMBtu/hr/engine 0.02855 g/bhp-hr Note D	Includes CPM PM=PM10=PM2.5 per AP-42	4.28		

Note A:
 $0.848 \text{ lb/hr} = (22.29 \text{ tons/yr}) * (1 \text{ yr}/8760 \text{ hr}) * (2000 \text{ lb}/1 \text{ ton}) * (1/6 \text{ engines})$
 $0.047 \text{ lb/MMBtu} = (0.848 \text{ lb/hr}) * (\text{hr}/17.87 \text{ MMBtu})$
 $0.135 \text{ g/bhp-hr} = (0.006354 \text{ MMBtu/bhp-hr}) * (0.047 \text{ lb/MMBtu}) * (1000 \text{ g}/2.205 \text{ lb})$

Note: Emission rates that are **bolded** indicate original proposed emission rates. Emission rates that are *italicized* indicate derived values.

Note B:

$$0.052 \text{ lb/MMBtu} = (0.93 \text{ lb/hr}) * (\text{hr}/17.87 \text{ MMBtu})$$

$$0.15 \text{ g/bhp} = (0.006354 \text{ MMBtu/bhp-hr}) * (0.052 \text{ lb/MMBtu}) * (1000 \text{ g}/2.205 \text{ lb})$$

Note C:

$$0.1383 \text{ g/bhp-hr} = (0.006354 \text{ MMBtu/bhp-hr}) * (0.048 \text{ lb/MMBtu}) * (1000 \text{ g}/2.205 \text{ lb})$$

Note D:

$$0.02885 \text{ g/bhp-hr} = (0.006354 \text{ MMBtu/bhp-hr}) * (0.0091 \text{ lb/MMBtu}) * (1000 \text{ g}/2.205 \text{ lb})$$

Nitrogen Oxides (NOx)								
Source of Information	Emission Factor Per Engine Original Application	Notes form Original Application	Potential to Emit for 6 IC Engines Original Application (tpy)	May 19, 2011 Response Letter Appendix B (per engine)	Notes Application Addendum	PTE 6 engines Application Addendum (tpy)	RBLC Review	Initial EPD BACT Limit
Application page 3-1 and Form 4.00	0.6 g/bhp-hr	2,233 bhp	77.62	0.6 g/bhp-hr	Pg. 3-8 WM EF	77.526	Range 0.5 – 0.6 g/bhp-hr	0.5 g/bhp-hr 3-hr averaging period
	<i>0.202 lb/MMBtu</i>	242,216 Btu/min		<i>0.202 lb/MMBtu</i>	2,233 bhp		Range 1.94 – 4.9 lb/hr	
	<i>2.95 lb/hr</i>			<i>2.95 lb/hr</i>	242,216 Btu/min			
Application – Technical Specification Sheet	0.5 g/bhp-hr	2,233 bhp	64.68	0.5 g/bhp-hr	2,233 bhp	64.68	Range 0.36 – 2.1 lb/MMBtu	Modeling emission rate <i>2.95 lb/hr</i>
	<i>0.169 lb/MMBtu</i>	242,216 Btu/min		<i>0.169 lb/MMBtu</i>	242,216 Btu/min			
	<i>2.46 lb/hr</i>			<i>2.46 lb/hr</i>				

Note: Emission rates that are **bolded** indicate original proposed emission rates. Emission rates that are *italicized* indicate derived values.

Nitrogen Oxides (NO _x)								
Source of Information	Emission Factor Per Engine Original Application	Notes form Original Application	Potential to Emit for 6 IC Engines Original Application (tpy)	May 19, 2011 Response Letter Appendix B (per engine)	Notes Application Addendum	PTE 6 engines Application Addendum (tpy)	RBLC Review	Initial EPD BACT Limit
AP-42 Table 2.4-5	250 lb/MMdscf methane 0.254 lb/MMBtu 4.09 lb/hr	Methane is about 1000 Btu/dscf Emission factor has "D" rating	107.60	250 lb/MMdscf methane 0.254 lb/MMBtu 4.09 lb/hr 0.731 g/bhp-hr Note A	Methane is about 1000 Btu/dscf Emission factor has "D" rating Assume 6,354 Btu/bhp-hr	107.60		
40 CFR 60 Subpart JJJJ	2.0 g/hp-hr 150 ppmvd at 15% oxygen		258.75	2.0 g/hp-hr 150 ppmvd at 15% oxygen		258.75		
Rule 391-3-1-.02(2)(mmm)	80 ppm @15% oxygen, dry basis 0.29 lb/MMBtu	Applicable Regulation for each IC engine	110.76	80 ppm @15% oxygen, dry basis 0.29 lb/MMBtu 0.835 g/bhp-hr – Note B	Applicable Regulation for each IC engine	110.76		
Title V Application				0.6 g bhp-hr 80 ppm @ 15% oxygen	Section E Section E			

Note: Emission rates that are **bolded** indicate original proposed emission rates. Emission rates that are *italicized* indicate derived values.

Note A:
 $0.731 \text{ g/bhp-hr} = (0.006354 \text{ MMBtu/bhp-hr}) * (0.254 \text{ lb/MMBtu}) * (1000 \text{ g/2.205 lb})$

Note B
 $0.835 \text{ g/bhp-hr} = (0.006354 \text{ MMBtu/bhp-hr}) * (0.29 \text{ lb/MMBtu}) * (1000 \text{ g/2.205 lb})$

Sulfur Dioxide									
Source of Information	Emission Factor Per Engine Original Application	Notes from Original Application	Potential to Emit for 6 IC Engines Original Application (tpy)	May 19, 2011 Response Letter Appendix B (per engine)	Notes from Application Addendum	PTE 6 engines Application Addendum (tpy)	RBLC Review	Initial EPD Permit Limit to Avoid PSD	
Application Page 3-1	maximum sulfur concentration of 275 ppmv 5.76 tpy per engine <i>0.267 g/bhp-hr</i> <i>1.32 lb/hr</i>		34.56	maximum sulfur concentration of 275 ppmv 6.33 tpy per engine – Note A <i>0.322 g/bhp-hr</i> <i>1.44 lb/hr – Note A</i>	Pg. 3-5 thru 3-8 of app. Equation 7 on page 3-6 does not include control efficiency. Application assumed 100% TRS control.	37.98	NA	SM limit of 1.52 lb/hr Note C	
SIP Application				1.59 lb/hr	Form 4.00 Note B – Applicant assumed approximately 89.6% control of TRS rather than 100% as found on page 3.-6 of application.	41.78			

Note: Emission rates that are **bolded** indicate original proposed emission rates. Emission rates that are *italicized* indicate derived values.

Sulfur Dioxide									
Source of Information	Emission Factor Per Engine Original Application	Notes from Original Application	Potential to Emit for 6 IC Engines Original Application (tpy)	May 19, 2011 Response Letter Appendix B (per engine)	Notes from Application Addendum	PTE 6 engines Application Addendum (tpy)	RBLC Review	Initial EPD Permit Limit to Avoid PSD	
Title V Application				6.33 tpy/engine	Section E	37.98			

Note A:
 Page 3-6 of Application Addendum
 $6.33 \text{ tpy/engine} = (5,744 \text{ kg/yr}) * (2.205 \text{ lb/kg}) * (1 \text{ ton}/2000 \text{ lb})$
 $1.44 \text{ lb/hr} * (6.33 \text{ ton/yr}) * (1 \text{ yr}/8760 \text{ hr}) * (2000 \text{ lb}/1 \text{ ton})$

Note B:
 $\% \text{ Difference} = [(1.59 \text{ lb/hr} - 1.44 \text{ lb/hr}) / (1.44 \text{ lb/hr})] * 100\% = 10.4\%$
 $100\% - 10.4\% = 89.6\% \text{ control of TRS}$

Note C:
 $1.518 \text{ lb/hr} = (39.9 \text{ ton/yr}) * (2000 \text{ lb}/1 \text{ ton}) * (1 \text{ yr}/8760 \text{ hrs}) * (1/6)$

Note: Emission rates that are **bolded** indicate original proposed emission rates. Emission rates that are *italicized* indicate derived values.

Carbon Monoxide

Source of Information	Emission Factor Per Engine Original Application	Notes from Original Application	Potential to Emit for 6 IC Engines Original Application (tpy)	May 19, 2011 Response Letter Appendix B (per engine)	Notes from Application Addendum	PTE 6 engines Application Addendum (tpy)	RBL/C	Initial EPD BACT Limit
Application Page 3-1	4.13 g/bhp-hr <i>1.39 lb/MMBtu</i> <i>20.33 lb/hr</i>		534.31	4.13 g/bhp-hr <i>1.39 lb/MMBtu</i> <i>24.839 lb/hr</i>	Pg. 3-1 of app. 17.87 MMBtu/hr/eng Pg 3-9 of app. Lists hourly emission rate as 20.33 lb/hr	652.769 534.272	Range 2.5 – 3 g/bhp-hr Range 7.28 – 15.5 lb/hr 3.2 lb/MMBtu	2.75 g/bhp-hr with a modeling emission rate of <i>17.05lb/hr/engine</i> 3-hr averaging period Note B
Application Page 3-5	4.31 g/bhp-hr <i>1.45 lb/MMBtu</i> <i>21.21 lb/hr</i>		557.6	N/A	N/A	N/A		
Application-Technical Specification Sheet	Nominal CO 2.5 g/bhp-hr 0.846 lb/MMBtu 12.30 lb/hr	Only for first 100 hours of operation of unit.	323.43	2.5 g/bhp-hr 0.846 lb/MMBtu 12.30 lb/hr	Only for first 100 hours of operation of unit.	323.43		
	NTE CO 4.13 g/bhp-hr 1.39 lb/MMBtu 20.33 lb/hr	NTE CO values are "Not to Exceed"	534.31	4.13 g/bhp-hr 1.39 lb/MMBtu 24.839 lb/hr		652.769		

Note: Emission rates that are **bolded** indicate original proposed emission rates. Emission rates that are *italicized* indicate derived values.

Source of Information	Emission Factor Per Engine Original Application	Notes from Original Application	Potential to Emit for 6 IC Engines Original Application (tpy)	May 19, 2011 Response Letter Appendix B (per engine)	Notes from Application Addendum	PIE 6 engines Application Addendum (tpy)	RBLC	Initial EPD BACT Limit
AP-42 Table 2.4-5	470 lb/MMdscf 0.47 lb/MMBtu 7.58 lb/hr	Methane is about 1000 Btu/dscf	199	470 lb/MMdscf 0.47 lb/MMBtu 7.58 lb/hr 1.35 g/bhp-hr	Methane is about 1000 Btu/dscf Note A	199		
40 CFR 60 Subpart JJJJ	5.0 g/hp-hr 610 ppmvd at 15% oxygen	NSPS JJJJ emission std is 60.4233(e) which references Table 1. NSPS JJJJ compliance method per 60.4244 using Method 10	646.88	5.0 g/hp-hr 610 ppmvd at 15% oxygen		646.88		

White Paper - Revisiting BACT for Lean Burn Landfill Gas Fired Internal Combustion Engines, Bay Area Air Quality Management District, February 26, 2009, suggests the following:

- a) Initial startup BACT limit of 2.5 g/bhp-hr
- b) Allow emissions to float up to Not to Exceed (NTE) emission limits between 3.0 and 4.2 g/bhp-hr
- c) Bay Area Air Quality Management District Guideline NTE limit of 3.9 g/bhp-hr

Review of current draft permits from other states indicates CO limits are in line with the higher NTE emission limits

Note A:

$$1.35 \text{ g/bhp-hr} = (0.006354 \text{ MMBtu/bhp-hr}) * (0.47 \text{ lb/MMBtu}) * (1000 \text{ g}/2.205 \text{ lb})$$

Note B:

$$0.954 \text{ lb/MMBtu} = (2.75 \text{ g/bhp-hr}) * (\text{bhp-hr}/0.006354 \text{ MMBtu}) * (2.205 \text{ lb}/1000 \text{ g})$$

$$17.05 \text{ lb/hr} = (0.954 \text{ lb/MMBtu}) * (17.87 \text{ MMBtu/hr})$$

Note: Emission rates that are **bolded** indicate original proposed emission rates. Emission rates that are *italicized* indicate derived values.