

ATTACHMENT C
EMISSION CALCULATIONS

EMISSION SUMMARIES:

- CRITERIA POLLUTANTS - Controlled Emissions Summary
- HAZARDOUS AIR POLLUTANTS (HAP) - Controlled Emissions Summary
- GREENHOUSE GASES (GHG) - Controlled Emissions Summary
- PRE-Controlled Emissions Summary

UNIT SPECIFIC EMISSIONS:

- Compressor Engine Emissions – 1,380 BHP CAT G3516B (CE-04 and -05)
- Compressor Rod Packing and Engine Crankcase Emissions (RPC)
- Startup, Shutdown, and Maintenance (Including Blowdown) Emissions (SSM)
- Dehydrator Emissions – 25.0 MMscfd (DEHY-01)
- Reboiler Emissions – 0.25 MMBtu/hr (BLR-01)
- Dehydrator Emissions – 40.0 MMscfd (DEHY-02)
- Reboiler Emissions – 0.75 MMBtu/hr (BLR-02)
- Produced Water Storage Tank Emissions – Four (4) Tanks (424 bbl Total) (TKS)
- Produced Water Truck Load-Out Emissions – (11,000 bbl/yr) (TLO)
- Process Piping and Equipment Fugitive Emissions (FUG)

EMISSION FACTORS

- AP-42 Emission Factors – Internal and External Combustion
- 40 CFR 98 – Default Greenhouse Gas Emission Factors
- Useful Conversion Factors

CRITERIA POLLUTANTS - Controlled Emissions Summary

ID No	Emission Unit	Description	NOX		CO		VOC		SO2		PM10/2.5	
			lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy	lb/hr	tpy
CE-01	Engine 01	Electric Motor Driven Compressor	Zero Emissions from the Electric Motor									
CE-02	Engine 02	CAT G3516B (4SLB) (AFRC/OxCat)	Remove and Replace CE-02 w/ CE-04 - 1,380 bhp CAT G3516B Engine 04									
CE-03	Engine 03	CAT G3516B (4SLB) (AFRC/OxCat)	Remove and Replace CE-03 w/ CE-05 - 1,380 bhp CAT G3516B Engine 05									
CE-04	Engine 04	NEW - CAT G3516B (4SLB) (AFRC/OxCat)	1.52	6.66	0.52	2.27	0.85	3.73	0.01	0.03	0.11	0.50
CE-05	Engine 05	NEW - CAT G3516B (4SLB) (AFRC/OxCat)	1.52	6.66	0.52	2.27	0.85	3.73	0.01	0.03	0.11	0.50
RPC	RPC	Compressor Rod Packing/Engine Crankcase	---	---	---	---	0.09	0.39	---	---	---	---
SSM	SSM/BD	Startup/Shutdown/Maintenance (Blowdown)	---	---	---	---	---	0.32	---	---	---	---
DEHY-01	Dehydrator 01	Dehydrator (Regenerator)	---	---	---	---	2.26	9.90	---	---	---	---
BLR-01	Reboiler 01	Reboiler	0.03	0.12	0.02	0.10	1.5E-03	0.01	1.6E-04	7.1E-04	2.1E-03	0.01
DEHY-02	Dehydrator 02	NEW - Dehydrator (Flash Tank/Regenerator)	---	---	---	---	1.12	4.90	---	---	---	---
BLR-02	Reboiler 02	NEW - Reboiler	0.08	0.36	0.07	0.30	4.6E-03	0.02	4.9E-04	2.1E-03	0.01	0.03
TKS	TK 01 thru 04	Produced Water Storage Tanks	---	---	---	---	0.21	0.94	---	---	---	---
TLO	Truck Load-Out	Produced Water Load-Out	---	---	---	---	---	0.37	---	---	---	---
FUG	Fugitives	Pipe and Fitting Fugitives - Gas	---	---	---	---	0.03	0.15	---	---	---	---
TOTAL CRITERIA PTE:			3.15	13.80	1.13	4.93	5.42	24.45	0.01	0.06	0.24	1.03
TVOP Major Source Threshold:				100		100		50		100		100
PSD Major Source Threshold:				250		250		250		250		250

Notes: 1 - Emissions are based on operation at 100% of rated load for 8,760 hrs/yr; except TLO and SSM emissions are intermittent (and infrequent).
 2 - VOC is volatile organic compounds, as defined by EPA, and includes HCHO (formaldehyde).
 3 - PM10/2.5 is filterable and condensable particulate matter; including PM10 and PM2.5.

HAZARDOUS AIR POLLUTANTS (HAP) - Controlled Emissions Summary

ID No	Emission Unit	Benzene lb/hr tpy	Ethylbenzene lb/hr tpy	Formaldehyde lb/hr tpy	n-Hexane lb/hr tpy	Methanol lb/hr tpy	Toluene lb/hr tpy	2,2,4-TMP lb/hr tpy	Xylenes lb/hr tpy	Other HAP lb/hr tpy	Total HAP lb/hr tpy
Zero Emissions from the Electric Motor											
CE-01	Engine 01 1,500 bhp										
CE-02	Engine 02 4,340 bhp										
CE-03	Engine 03 4,340 bhp										
CE-04	Engine 04 1,380 bhp	2.6E-03	2.4E-04	0.09	0.01	0.06	2.4E-03	0.01	1.5E-03	0.09	0.37
CE-05	Engine 05 1,380 bhp	2.6E-03	2.4E-04	0.09	0.01	0.06	2.4E-03	0.01	1.5E-03	0.09	0.37
RPC	2,760 bhp	8.5E-04	8.5E-04	0.02	8.5E-04	3.7E-03	8.5E-04	3.7E-03	8.5E-04	3.7E-03	0.03
SSM	SSM/BD 4,260 bhp	---	1.6E-03	---	---	---	---	1.6E-03	---	---	---
DEHY-01	Dehydrator 01 25 MMBscfd	0.21	0.90	---	2.3E-02	0.10	0.14	0.60	0.02	0.10	0.23
BLR-01	Reboiler 01 0.25 MMBtu/hr	5.7E-07	2.5E-06	---	4.9E-04	2.1E-03	---	9.2E-07	4.0E-06	---	5.2E-07
DEHY-02	Dehydrator 02 40 MMBscfd	0.21	0.90	---	2.3E-02	0.10	0.18	0.80	0.02	0.10	0.32
BLR-02	Reboiler 02 0.75 MMBtu/hr	1.7E-06	7.5E-06	---	1.5E-03	0.01	---	2.8E-06	1.2E-05	---	---
TKS	TK 01 thru 04 424 bbl (total)	4.3E-03	0.02	---	4.3E-03	0.02	4.3E-03	0.02	4.3E-03	0.02	---
TLO	Truck Load-Out 11,000 bbl/yr	---	0.01	---	---	---	---	0.01	---	---	---
FUG	Fugitives 2,316 Fittings	1.7E-04	7.3E-04	---	1.7E-04	7.3E-04	1.7E-04	7.3E-04	1.7E-04	7.3E-04	---

TOTAL CRITERIA PTE:
TVOP Major Source Threshold:
PSD Major Source Threshold:

0.42	1.86	0.44	1.93	0.21	0.90	0.07	0.30	0.20	0.86	0.33	1.45	0.05	0.25	0.56	2.44	0.17	0.75	2.44	10.80
10	na	10	na	10	na	10	na	10	na	10	na	10	na	10	na	10	na	10	na

- Notes:
- 1 - Emissions are based on operation at 100% of rated load for 8,760 hrs/yr, except TLO and SSM emissions are intermittent (and infrequent).
 - 2 - HCHO is Formaldehyde.
 - 3 - Other HAP includes Acetaldehyde, Acrolein, and traces of other hazardous pollutants.

Laurel Mountain Midstream Operating, LLC
SPRINGHILL COMPRESSOR STATION
Application for Authorization to Use General Permit GP-5
Attachment C - Emission Calculations

GREENHOUSE GASES (GHG) - Controlled Emissions Summary

ID No	Emission Unit	Description	Heat Input MMBtu/hr (HHV)	kg/MMBtu: GWP: CO2 tpy	53.06 1 CO2e tpy	kg/MMBtu: GWP: CH4 tpy	1.00E-03 25 CO2e tpy	kg/MMBtu: GWP: N2O tpy	1.00E-04 298 CO2e tpy	TOTAL CO2e tpy
CE-01	Engine 01	Electric Motor Driven Compressor								
CE-02	Engine 02	CAT G3516LE (4SLB) (AFRC/OxCat)								
CE-03	Engine 03	CAT G3516LE (4SLB) (AFRC/OxCat)								
CE-04	Engine 04	NEW - CAT G3516B (4SLB) (AFRC/OxCat)	11.40	6,290	6,290	54	1,346	0.01	3	7,639
CE-05	Engine 05	NEW - CAT G3516B (4SLB) (AFRC/OxCat)	11.40	6,290	6,290	54	1,346	0.01	3	7,639
RPC	RPC	Compressor Rod Packing/Engine Crankcase	---	110	110	39	982	---	---	1,092
SSM	SSM/BD	Startup/Shutdown/Maintenance (Blowdown)	---	1	1	68	1,693	---	---	1,694
DEHY-01	Dehydrator 01	Dehydrator (Regenerator)	---	---	---	590	14,750	---	---	14,750
BLR-01	Reboiler 01	Reboiler	0.28	143	143	2.7E-03	0.07	2.6E-03	1	144
DEHY-02	Dehydrator 02	NEW - Dehydrator (Flash Tank/Regenerator)	---	---	---	595	14,875	---	---	14,875
BLR-02	Reboiler 02	NEW - Reboiler	0.83	428	428	8.2E-03	0.21	7.9E-03	2	431
TKS	TK 01 thru 04	Produced Water Storage Tanks	---	---	---	3	68	---	---	68
TLO	Truck Load-Out	Produced Water Load-Out	---	---	---	---	---	---	---	---
FUG	Fugitives	Pipe and Fitting Fugitives - Gas	---	0.58	0.58	32	793	---	---	793

TOTAL POINT SOURCE EMISSIONS:

TVOP Major Source Threshold:

PSD Major Source Threshold:

23.92	13,263	13,263	1,434	35,853	0.03	10	49,125
na	na	na	na	(OR)	na	(AND)	na
na	na	na	na	(OR)	na	(AND)	na

- Notes:
- 1 - Emissions are based on operation at 100% of rated load for 8,760 hrs/yr; except TLO and SSM emissions are intermittent (and infrequent).
 - 2 - Engine CO2 and CH4 emissions are based on vendor specifications.
 - 3 - Dehydrator CH4 emissions are based on "Worst Case" GRI-GLYCalc Model Output.
 - 4 - SSM CH4 emissions are based on vendor specifications and operational experience.
 - 5 - Fugitive CH4 emissions are based on EPA Fugitive Emission Factors for Oil and Gas Production Operations.
 - 6 - All other GHG emissions are based on default values in 40CFR98, Subpart C, Table C-1.
 - 7 - CO2e is aggregated Greenhouse Gas (GHG), comprised of carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O), as adjusted for Global Warming Potential (GWP).
 - 8 - GHG TVOP and PSD Major Source Thresholds are applicable only if other regulated air pollutants exceed the corresponding Thresholds.

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PRE-Controlled Emissions Summary

ID No	Emission Unit	Description	NOX lb/hr	CO lb/hr	VOC lb/hr	Benzene lb/hr	HCHO lb/hr	Total HAP lb/hr	CO2e lb/hr
CE-01	Engine 01	Electric Motor Driven Compressor							
CE-02	Engine-02	GAT-G3516LE (4SLB) (AFRC/OxCat)							
CE-03	Engine-03	GAT-G3516LE (4SLB) (AFRC/OxCat)							
CE-04	Engine 04	NEW - CAT G3516B (4SLB) (AFRC/OxCat)	1.52	7.39	2.77	0.01	1.31	1.53	1,744
CE-05	Engine 05	NEW - CAT G3516B (4SLB) (AFRC/OxCat)	1.52	7.39	2.77	0.01	1.31	1.53	1,744
RPC	2,760 bhp	Compressor Rod Packing/Engine Crankcase	---	---	0.09	8.5E-04	0.02	0.03	249
SSM	SSM/BD	Startup/Shutdown/Maintenance (Blowdown)	---	---	---	---	---	---	---
DEHY-01	Dehydrator 01	Dehydrator (Regenerator)	---	---	2.26	0.21	---	---	---
BLR-01	Reboiler 01	Reboiler	0.03	0.12	1.5E-03	5.7E-07	2.0E-05	5.1E-04	33
DEHY-02	Dehydrator 02	NEW - Dehydrator (Flash Tank/Regenerator)	---	---	1.12	0.21	---	---	---
BLR-02	Reboiler 02	NEW - Reboiler	0.08	0.36	4.6E-03	1.7E-06	6.1E-05	1.5E-03	98
TKS	TK 01 thru 04	Produced Water Storage Tanks	---	---	0.21	4.3E-03	---	0.19	1
TLO	Truck Load-Out	Produced Water Load-Out	---	---	---	---	---	---	---
FUG	Fugitives	Pipe and Fitting Fugitives - Gas	---	---	0.03	1.7E-04	---	1.0E-03	181
TOTAL PRE-Controlled PTE:			13.80	65.16	37.49	1.88	11.56	22.39	49,125

- Notes:
- 1 - Emissions are based on operation at 100% of rated load for 8,760 hrs/yr; except TLO and SSM emissions are intermittent (and infrequent).
 - 2 - VOC is volatile organic compounds, as defined by EPA, and includes HCHO (formaldehyde).
 - 3 - PM10/2.5 is filterable and condensable particulate matter; including PM10 and PM2.5.
 - 4 - HCHO is Formaldehyde.
 - 5 - Other HAP includes Acetaldehyde, Acrolein, and traces of other hazardous pollutants.
 - 6 - CO2e is aggregated Greenhouse Gas (GHG), comprised of carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O), as adjusted for Global Warming Potential (GWP).
 - 7 - GHG TVOP and PSD Major Source Thresholds are applicable only if other regulated air pollutants exceed the corresponding Thresholds.

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Compressor Engine Emissions – 1,380 bhp CAT G3516B (4SLB) w/ OxCat

Unit	Description	Reference	Pollutant	Pre-Controlled Emissions		Control Efficiency %	Controlled Emissions	
		Vendor Data	NOX	g/bhp-hr	lb/hr	tpy	g/bhp-hr	lb/hr
		Vendor Data	CO	0.50	1.52	6.66	0.50	1.52
		Vendor Data	THC	2.43	7.39	32.38	0.17	0.52
		Vendor Data	NMHC	4.75	14.45	63.30	4.52	13.75
		Vendor Data	NMNEHC	0.71	2.16	9.46	0.48	1.46
		Vendor Data	VOC	0.48	1.46	6.40	0.25	0.76
		NMNEHC+HCHO	SO2	0.91	2.77	12.13	0.28	0.85
		AP-42 Table 3.2-3	PM10/2.5	2.2E-03	0.01	0.03	2.2E-03	0.01
		AP-42 Table 3.2-3	Benzene	0.04	0.11	0.50	0.04	0.11
		AP-42 Table 3.2-3	Ethylbenzene	1.6E-03	0.01	0.02	8.6E-04	2.6E-03
		AP-42 Table 3.2-3	HCHO	1.5E-04	4.5E-04	2.0E-03	7.7E-05	2.4E-04
		Vendor Data	n-Hexane	0.43	1.31	5.73	0.03	0.09
		AP-42 Table 3.2-3	Methanol	4.2E-03	0.01	0.06	2.2E-03	0.01
		AP-42 Table 3.2-3	Toluene	0.01	0.03	0.12	4.9E-03	0.01
		AP-42 Table 3.2-3	2,2,4-TMP	1.5E-03	4.7E-03	0.02	8.0E-04	2.4E-03
		AP-42 Table 3.2-3	Xylene	9.4E-04	2.9E-03	0.01	4.9E-04	1.5E-03
		AP-42 Table 3.2-3	Other HAP	6.9E-04	2.1E-03	0.01	3.6E-04	1.1E-03
		SUM	Total HAP	0.05	0.16	0.72	0.03	0.09
		Vendor Data	CO2	0.50	1.53	6.70	0.07	0.21
		THC-NMHC	CH4	472	1,436	6,290	472	1,436
		40CFR98 - Table C-2	N2O	4.04	12.29	53.84	4	12
		40CFR98 - Table A-1	CO2e	8.3E-04	2.5E-03	0.01	8.3E-04	2.5E-03
				573	1,744	7,639	573	1,744

- Notes:
- The emissions estimates are based on operation at 100% of rated load for 8,760 hrs/yr.
 - As per vendor specifications, NMNEHC (non-methane non-ethane hydrocarbon) does not include HCHO. VOC is the sum of NMNEHC and HCHO.
 - PM10/2.5 is filterable and condensable particulate matter, including PM10 and PM2.5
 - HCHO is Formaldehyde.
 - Other HAP includes Acetaldehyde, Acrolein, 1,3-Butadiene, Chloride, Methylene Chloride, and traces of other HAP.
 - The control efficiency (CE) for each HAP is assumed to be the same as the CE for NMNEHC, except for HCHO where the vendor provides specific data.
 - The fuel heating value will vary, 920 Btu/scf (LHV) is at the low end of the range and results in a high (conservative) fuel consumption estimate.

Compressor Rod Packing Leaks and Engine Crankcase Emissions (RPC)

Unit Description	No. of Recip Compressors	Cylinders per Recip Compressor	scfh per Cylinder	Contingency	Total Leak Rate MMscf/yr	VOC lb/MMscf	Formaldehyde na lb/MMscf	Hex, BTEX, TMP lb/MMscf	Total HAP lb/MMscf	CO2 lb/MMscf	CH4 lb/MMscf	CO2e lb/MMscf
Compressor Rod Packing	3	4	15.00	15%	1.81	0.04	0.18	2.1E-04	1.2E-03	0.17	0.73	219
						0.04	0.18	2.1E-04	1.2E-03	0.17	0.73	219
						0.04	0.18	2.1E-04	1.2E-03	0.17	0.73	219

Unit Description	Total Recip Engine Horsepower (bhp)	Leak Rate scf/bhp-hr	Safety Factor	VOC lb/MMscf	Formaldehyde lb/MMscf	Hex, BTEX, TMP lb/MMscf	Total HAP lb/MMscf	CO2 lb/MMscf	CH4 lb/MMscf	CO2e lb/MMscf
Engine Crankcase	2,760	12.09	250%	13.94	6.59	0.19	7.70	7,229	62	8,779
				13.94	6.59	0.19	7.70	7,229	62	8,779
				13.94	6.59	0.19	7.70	7,229	62	8,779

Operating hr/yr: **8,760**

Total RPC Emissions:

VOC	Formaldehyde	Hex, BTEX, TMP	Total HAP	CO2	CH4	CO2e
lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr	lb/hr
0.09	0.02	0.00	0.03	25.10	39.26	249
0.39	0.10	0.00	0.12	109.96	249	1,092

Notes:

- 1 - Fugitive equipment leaks from misc. equipment is a broad category covering leaks of natural gas from sealed surfaces, such as packing and gaskets, resulting from the wear of mechanical joints, seals, and rotating surfaces over time. It also includes the crankcase emissions from reciprocating engines.
- 2 - Emission estimates are based on 40CFR98, Subpart W and manufacturer's data.
- 3 - To be conservative, and to account for potential future changes, the following "worst-case" gas characteristics were assumed:

Pollutant	Representative Gas Analysis	Worst-Case Assumption
CO2	385.03 lb/MMscf	800 lb/MMscf
CH4	41,156 lb/MMscf	42,275 lb/MMscf
VOC	91 lb/MMscf	200.00 lb/MMscf
n-Hex, BTEX, 2,2,4-TMP (ea)	Varies lb/MMscf	1.00 lb/MMscf
Total HAP	2 lb/MMscf	6.00 lb/MMscf

- 4 - Total Reciprocating Compressor Rod Packing Leak Rate:
 $\text{scf/yr} = \text{No. of Compressors} * \text{Cylinders/Compressor} * \text{scfh/Cylinder} * \text{Operating hr/yr} * (1 + \text{Contingency})$

- 5 - Engine crankcase emissions are based on vendor data: "As a general rule, blow-by (i.e., crankcase emissions) on a new engine is approximately 0.5 scf/bhp-hr." A "safety factor" is used to account for increasing blow-by as the engine "wears".

6 - Crankcase emissions are estimated as follows:

(Data from CAT G3516B Data Sheet and Emissions Calculation Spreadsheet.)

Total Engine Exhaust (TEEx) (Volume):

9,105 ft³/min (acfm/min)

1,740 MMscf/yr TEEx*

Pollutant	Crankcase VOC emissions (Mass)	Crankcase HCHO emissions (Mass)	Crankcase BTEX (ea) emissions (Mass)	Crankcase HAP emissions (Mass)	Crankcase CO2 emissions (Mass)	Crankcase CH4 emissions (Mass)	Crankcase CO2e emissions (Mass)
	12.13 tpy VOC	5.73 tpy HCHO	0.16 tpy BTEX (ea)	6.70 tpy HAP	6,290 tpy CO2	53.84 tpy CH4	7,639 tpy CO2e
	13.94 lb VOC / MMscf TEEx	6.59 lb HCHO / MMscf TEEx	0.19 lb BTEX (ea) / MMscf TEEx	7.70 lb HAP / MMscf TEEx	7,229 lb CO2 / MMscf TEEx	62 lb CH4 / MMscf TEEx	8,779 lb CO2e / MMscf TEEx

* Conversion from acfm/min to scf/yr based on 8,760 hr/yr, 992 of exhaust temp, and 68 of sid temp.

** Crankcase Emission Factor = PTE (tpy) from a G3516B Engine ÷ Total Engine Exhaust (TEEx) (MMscf/yr).

Startup, Shutdown and Maintenance (including Blowdown (BD) and Piggings Emissions (SSM))

Unit ID	Description	No of Units	Total bhp	a. "Cold-Start" Gas scf/Unit	b. Blowdown (BD) Gas scf/bhp	Site-Wide SSM Events Events/wk
SSM (Start/Stop/Maintenance)	a. Cold-Start Engine	2	na	700 1,400	na	4.0 208
	b. Compressor Blowdown	3	4,260	na	26,477	2.0 104
	c. Piggings	1	na	na	3,061	1.0 52

Unit ID	Description	Total Gas Vented MMscf/yr	VOC 200.00 lb/MMscf	Hex, BTEX, TMP 1.00 lb/MMscf	Total HAP 6.00 lb/MMscf	CO2 800 lb/MMscf	CH4 42,275 lb/MMscf	CO2e 1,057,675 lb/MMscf
SSM (Start/Stop/Maintenance)	a. Cold-Start Engine	0.29	0.03	1.5E-04	8.7E-04	0.12	6	154
	b. Compressor Blowdown	2.75	0.28	1.4E-03	0.01	1.10	58	1,456
	c. Piggings	0.16	0.02	8.0E-05	4.8E-04	0.06	3	84

0.32	1.6E-03	0.01	1.28	68	1,694
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Notes: 1 - SSM Emissions are the sum of:

- a. Unburned fuel resulting from "cold-start" of idle gas-fired engines; and
- b. Natural gas that is purged (aka blowdown) from the compressor and associated piping and equipment.

2 - Starting gas quantity and blowdown (BD) gas quantity as per engineering department. (e.g., 8,577 scf/BD of a compressor with a 1,380 bhp engine equals 6.22 scf/bhp/BD.)

3 - To be conservative, and to account for potential future changes, the following "worst-case" gas characteristics were assumed:

Pollutant	Representative Gas Analysis	Worst-Case Assumption
CO2	385 lb/MMscf	800 lb/MMscf
CH4	41,156 lb/MMscf	42,275 lb/MMscf
VOC	91.01 lb/MMscf	200.00 lb/MMscf
n-Hex, BTEX, 2,2,4-TMP (ea)	Varies lb/MMscf	1.00 lb/MMscf
Total HAP	1.54 lb/MMscf	6.00 lb/MMscf

4 - This estimate of SSM emissions is sufficient to account for other infrequent and (often) de-minimis emissions from various activities (e.g., pig launching) at the facility that are not necessarily associated with compressor blowdowns.

5 - Piggings calculations based on 52 events per year and 3,061 scf/event (assuming 50 scf of gas blowdown at 900 psig).

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Dehydrator Emissions - 25.0 MMscfd

Unit ID	Description	Reference	Pollutant	Emission Factor lb/MMscf	lb/MMBtu	Pre-Controlled Emissions lb/hr	tpy	Control Eff %	Controlled Emissions lb/hr	tpy
DEHY-01	Dehydrator 01	---	NOX	---	---	---	---	---	---	---
		---	CO	---	---	---	---	---	---	---
		GRI-GLYCalc 4.0	VOC	---	---	2.26	9.90	0.0%	2.26	9.90
		---	SO2	---	---	---	---	---	---	---
	25.0 MMscfd	---	PM10/2.5	---	---	---	---	---	---	---
		GRI-GLYCalc 4.0	Benzene	---	---	0.21	0.90	0.0%	0.21	0.90
		GRI-GLYCalc 4.0	Ethylbenzene	---	---	0.18	0.80	0.0%	0.18	0.80
		---	HCHO	---	---	---	---	---	---	---
	8,760 Hr/yr	GRI-GLYCalc 4.0	n-Hexane	---	---	2.3E-02	0.10	0.0%	2.3E-02	0.10
		GRI-GLYCalc 4.0	Methanol	---	---	---	---	---	---	---
		GRI-GLYCalc 4.0	Toluene	---	---	0.14	0.60	0.0%	0.14	0.60
		GRI-GLYCalc 4.0	2,2,4-TMP	---	---	0.02	0.10	0.0%	0.02	0.10
	9,125 MMscf/yr 1.04 MMscf/hr NESHAP HH - Exempt	GRI-GLYCalc 4.0	Xylenes	---	---	0.23	1.00	0.0%	0.23	1.00
		GRI-GLYCalc 4.0	Other HAP	---	---	---	---	---	---	---
		GRI-GLYCalc 4.0	Total HAP	---	---	0.80	3.50	0.0%	0.80	3.50
		---	CO2	---	---	---	---	---	---	---
	GRI-GLYCalc 4.0	---	CH4	---	---	135	590	0.0%	135	590
		---	N2O	---	---	---	---	---	---	---
		40CFR98 - Table A-1	CO2e	---	---	3,368	14,750	0.0%	3,368	14,750

Notes: 1 - To be conservative, and to account for potential future changes in gas quality, the following worst-case emissions were assumed:

25.0 MMscfd Dehydrator 01	GRI-GLYCalc 4.0* Model Results		Worst-Case Assumption	*Dehydrator Operating Parameters (See Attachments D-2 - GRI-GLYCalc Model and D-3 - Extended Gas Analysis)	
	PRE-Control	Controlled		PRE-Control	Controlled
THC	273.45 tpy	273.45 tpy	600.00 tpy	Dry Gas Flow Rate: 25.0 MMscfd	Extended Gas Analysis: 02/13/14
NMNEHC = VOC	2.04 tpy	2.04 tpy	9.90 tpy	Wet Gas Temperature: 70 oF	Flash Tank Temperature: na
Benzene	0.15 tpy	0.15 tpy	0.90 tpy	Wet Gas Pressure: 1,000 psig	Flash Tank Pressure: na
Ethylbenzene	0.36 tpy	0.36 tpy	0.80 tpy	Wet Gas Water Content: Saturated	Flash Tank Off-Gas: na
HCHO	---	---	---	Dry Gas Water Content: 7.0 lb H2O/MMscf	Stripping Gas: na
n-Hexane	0.01 tpy	0.01 tpy	0.10 tpy	Lean Glycol Water Content: 1.5 wt% H2O	Stripping Gas Flow Rate: na
Methanol	---	---	---	Glycol Pump Type: Gas Injection	Regen Overhead Control: na
Toluene	0.26 tpy	0.26 tpy	0.60 tpy	Glycol Pump Model: Kimray 21020PV	Condenser Temperature: na
2,2,4-TMP	0.01 tpy	0.01 tpy	0.10 tpy	Lean Glycol Circulation Rate: 3.50 gpm	Condenser Pressure: na
Xylenes	0.47 tpy	0.47 tpy	1.00 tpy	Additional GRI-GLYCalc 4.0 Model Results:	
Other HAP	---	---	---	Flash Tank Off-Gas Flow: na	Wet Gas Water Content: 0.049 Vol%
Total HAP	1.24 tpy	1.24 tpy	3.50 tpy	Regen Overhead Stream: 1,940 scfh	Dry Gas Water Content: 0.002 Vol%
CH4	259.08 tpy	259.08 tpy	590.00 tpy	Lean Glycol Recirc Ratio: 9.0 gal/lb-H2O	Rich Glycol Water Content: 2.57 wt%

Reboiler Emissions - 0.25 MMBtu/hr

Unit ID	Description	Reference	Pollutant	Emission Factor		Pre-Controlled		Control %	Controlled	
				lb/MMscf	lb/MMBtu	lb/hr	tpy	%	lb/hr	tpy
BLR-01	Reboiler 01	EPA AP-42 Table 1.4-1	NOX	100.00	9.80E-02	0.03	0.12	na	0.03	0.12
		EPA AP-42 Table 1.4-1	CO	84.00	8.24E-02	0.02	0.10	na	0.02	0.10
		EPA AP-42 Table 1.4-2	VOC	5.68	5.56E-03	1.5E-03	0.01	na	1.5E-03	0.01
		EPA AP-42 Table 1.4-2	SO2	0.60	5.88E-04	1.6E-04	7.1E-04	na	1.6E-04	7.1E-04
		EPA AP-42 Table 1.4-2	PM10/2.5	7.60	0.01	2.1E-03	0.01	na	2.1E-03	0.01
		EPA AP-42 Table 1.4-3	Benzene	2.1E-03	2.06E-06	5.7E-07	2.5E-06	na	5.7E-07	2.5E-06
	8,760 hr/yr	EPA AP-42 Table 1.4-3	Ethylbenzene	---	---	---	---	---	---	---
		EPA AP-42 Table 1.4-3	HCHO	0.08	7.35E-05	2.0E-05	8.9E-05	na	2.0E-05	8.9E-05
		EPA AP-42 Table 1.4-3	n-Hexane	1.80	1.76E-03	4.9E-04	2.1E-03	na	4.9E-04	2.1E-03
		EPA AP-42 Table 1.4-3	Methanol	---	---	---	---	---	---	---
		EPA AP-42 Table 1.4-3	Toluene	---	---	---	---	---	---	---
		EPA AP-42 Table 1.4-3	2,2,4-TMP	3.4E-03	3.33E-06	9.2E-07	4.0E-06	na	9.2E-07	4.0E-06
	920 Btu/scf (LHV) 1,020 Btu/scf (HHV)	EPA AP-42 Table 1.4-3	Xylenes	---	---	---	---	---	---	---
		EPA AP-42 Table 1.4-3	Other HAP	1.9E-03	1.86E-06	5.2E-07	2.3E-06	na	5.2E-07	2.3E-06
		EPA AP-42 Table 1.4-3	Total HAP	1.88	1.86E-03	5.1E-04	2.2E-03	na	5.1E-04	2.2E-03
		EPA AP-42 Table 1.4-3	CO2	120,000	118	33	143	na	33	143
		EPA AP-42 Table 1.4-2	CH4	2.30	2.25E-03	6.3E-04	2.7E-03	na	6.3E-04	2.7E-03
		EPA AP-42 Table 1.4-2	N2O	2.20	2.16E-03	6.0E-04	2.6E-03	na	6.0E-04	2.6E-03
	40CFR98 - Table A-1		CO2e	120,713	118	33	144	na	33	144

Notes: PM10/2.5 is filterable and condensable particulate matter, including PM10 and PM2.5.

Laurel Mountain Midstream Operating, LLC
SPRINGHILL COMPRESSOR STATION
Application for Authorization to Use General Permit GP-5
Attachment C - Emission Calculations

Dehydrator Emissions - 40.0 MMscfd

Unit ID	Description	Reference	Pollutant	Emission Factor lb/MMscf	Pre-Controlled Emissions lb/hr	Control Eff %	Controlled Emissions lb/hr	tpy
DEHY-02	Dehydrator 02	---	NOX	---	---	---	---	---
		---	CO	---	---	---	---	---
		GRI-GLYCalc 4.0	VOC	---	1.12	0.0%	1.12	4.90
		---	SO2	---	---	---	---	---
	40.0 MMscfd	---	PM10/2.5	---	---	---	---	---
		GRI-GLYCalc 4.0	Benzene	---	0.21	0.0%	0.21	0.90
		GRI-GLYCalc 4.0	Ethylbenzene	---	0.25	0.0%	0.25	1.10
		---	HCHO	---	2.3E-02	0.0%	2.3E-02	0.10
	8,760 Hr/yr	GRI-GLYCalc 4.0	n-Hexane	---	---	---	---	---
		GRI-GLYCalc 4.0	Methanol	---	---	---	---	---
		GRI-GLYCalc 4.0	Toluene	---	0.18	0.0%	0.18	0.80
		GRI-GLYCalc 4.0	2,2,4-TMP	---	0.02	0.0%	0.02	0.10
	14,600 MMscf/yr 1.67 MMscf/hr NESHAP HH - Exempt	GRI-GLYCalc 4.0	Xylenes	---	0.32	0.0%	0.32	1.40
		GRI-GLYCalc 4.0	Other HAP	---	---	---	---	---
		GRI-GLYCalc 4.0	Total HAP	---	1.00	0.0%	1.00	4.40
		---	CO2	---	---	---	---	---
	40CFR98 - Table A-1	GRI-GLYCalc 4.0	CH4	---	136	0.0%	136	595
		---	N2O	---	---	---	---	---
		---	CO2e	---	3,396	0.0%	3,396	14,875

Notes: 1 - To be conservative, and to account for potential future changes in gas quality, the following worst-case emissions were assumed:

40.0 MMscfd Dehydrator 02	GRI-GLYCalc 4.0* Model Results		Worst-Case Assumption	*Dehydrator Operating Parameters (See Attachments D-2 - GRI-GLYCalc Model and D-3 - Extended Gas Analysis)	
	PRE-Control	Controlled		PRE-Control	Controlled
THC	411.13 tpy	411.13 tpy	600.00 tpy	Dry Gas Flow Rate: 40.0 MMscfd	Extended Gas Analysis: 02/13/14
NMNEHC = VOC	3.65 tpy	3.65 tpy	4.90 tpy	Wet Gas Temperature: 70 oF	Flash Tank Temperature: 120 oF
Benzene	0.29 tpy	0.29 tpy	0.90 tpy	Wet Gas Pressure: 1,000 psig	Flash Tank Pressure: 40 psig
Ethylbenzene	0.71 tpy	0.71 tpy	1.10 tpy	Wet Gas Water Content: Saturated	Flash Tank Off-Gas: 30% Recycle
HCHO	---	---	---	Dry Gas Water Content: 7.0 lb H2O/MMscf	Stripping Gas: na
n-Hexane	0.01 tpy	0.01 tpy	0.10 tpy	Lean Glycol Water Content: 1.5 wt% H2O	Stripping Gas Flow Rate: na
Methanol	---	---	---	Glycol Pump Type: Gas Injection	Regen Overhead Control: na
Toluene	0.51 tpy	0.51 tpy	0.80 tpy	Glycol Pump Model: Kinray 45020PV	Condenser Temperature: na
2,2,4-TMP	0.01 tpy	0.01 tpy	0.10 tpy	Lean Glycol Circulation Rate: 7.50 gpm	Condenser Pressure: na
Xylenes	0.91 tpy	0.91 tpy	1.40 tpy	Additional GRI-GLYCalc 4.0 Model Results:	
Other HAP	---	---	---	Flash Tank Off-Gas Flow: 3,090 scfh	Wet Gas Water Content: 0.049 Vol%
Total HAP	2.44 tpy	2.44 tpy	4.40 tpy	Regen Overhead Stream: 807 scfh	Dry Gas Water Content: 0.002 Vol%
CH4	388.79 tpy	388.79 tpy	595.00 tpy	Lean Glycol Recirc Ratio: 12.1 gal/lb-H2O	Rich Glycol Water Content: 2.29 wt%

Laurel Mountain Midstream Operating, LLC
SPRINGHILL COMPRESSOR STATION
Application for Authorization to Use General Permit GP-5
Attachment C - Emission Calculations
Reboiler Emissions - 0.75 MMBtu/hr

Unit ID	Description	Reference	Pollutant	Emission Factor		Pre-Controlled		Control	Controlled	
				lb/MMscf	lb/MMBtu	lb/hr	tpy	%	lb/hr	tpy
BLR-02	Reboiler 02	EPA AP-42 Table 1.4-1	NOX	100.00	9.80E-02	0.08	0.36	na	0.08	0.36
		EPA AP-42 Table 1.4-1	CO	84.00	8.24E-02	0.07	0.30	na	0.07	0.30
		EPA AP-42 Table 1.4-2	VOC	5.68	5.56E-03	4.6E-03	0.02	na	4.6E-03	0.02
		EPA AP-42 Table 1.4-2	SO2	0.60	5.88E-04	4.9E-04	2.1E-03	na	4.9E-04	2.1E-03
	0.75 MMBtu/hr (LHV) 0.83 MMBtu/hr (HHV)	EPA AP-42 Table 1.4-2	PM10/2.5	7.60	0.01	6.2E-03	0.03	na	0.01	0.03
		EPA AP-42 Table 1.4-3	Benzene	2.1E-03	2.06E-06	1.7E-06	7.5E-06	na	1.7E-06	7.5E-06
		EPA AP-42 Table 1.4-3	Ethylbenzene	---	---	---	---	---	---	---
		EPA AP-42 Table 1.4-3	HCHO	0.08	7.35E-05	6.1E-05	2.7E-04	na	6.1E-05	2.7E-04
	8,760 hr/yr	EPA AP-42 Table 1.4-3	n-Hexane	1.80	1.76E-03	1.5E-03	0.01	na	1.5E-03	0.01
		EPA AP-42 Table 1.4-3	Methanol	---	---	---	---	---	---	---
		EPA AP-42 Table 1.4-3	Toluene	---	---	---	---	---	---	---
		EPA AP-42 Table 1.4-3	2,2,4-TMP	3.4E-03	3.33E-06	2.8E-06	1.2E-05	na	2.8E-06	1.2E-05
	920 Btu/scf (LHV) 1,020 Btu/scf (HHV)	EPA AP-42 Table 1.4-3	Xylenes	---	---	---	---	---	---	---
		EPA AP-42 Table 1.4-3	Other HAP	1.9E-03	1.86E-06	1.5E-06	6.8E-06	na	1.5E-06	6.8E-06
		EPA AP-42 Table 1.4-3	Total HAP	1.88	1.85E-03	1.5E-03	0.01	na	1.5E-03	0.01
		EPA AP-42 Table 1.4-2	CO2	120,000	118	98	428	na	98	428
	815 scf/hr 19.57 Mscf/d 7.14 MMscl/yr	EPA AP-42 Table 1.4-2	CH4	2.30	2.25E-03	1.9E-03	0.01	na	1.9E-03	0.01
		EPA AP-42 Table 1.4-2	N2O	2.20	2.16E-03	1.8E-03	0.01	na	1.8E-03	0.01
		40CFR98 - Table A-1	CO2e	120,713	118	98	431	na	98	431

Notes: PM10/2.5 is filterable and condensable particulate matter, including PM10 and PM2.5.

Laurel Mountain Midstream Operating, LLC
SPRINGHILL COMPRESSOR STATION
 Application for Authorization to Use General Permit GP-5
Attachment C - Emission Calculations

Produced Water Storage Tank Emissions

Unit No	Tank ID	Material Stored	Capacity gal	Turn- overs per Year	Throughput gall/yr	VOC Emission Factor	CH ₄ Emission Factor	Total VOC lb/hr	Methane (CH ₄) lb/hr	Methanol (CH ₃ OH) lb/hr	n-Hex, BTEX, and TMP (Ea) 2.00% of VOC lb/hr	Total HAP lb/hr
TKS	Tank 01	Produced Water	1,000	24	25,200	0.039 lb/bbl	0.494 lb/bbl	0.01	0.03	0.01	2.3E-04	0.01
	Tank 02	Produced Water	4,200	100	109,200	0.039 lb/bbl	0.494 lb/bbl	0.05	0.15	0.04	1.0E-03	0.05
	Tank 03	Produced Water	6,300	150	163,800	0.039 lb/bbl	0.494 lb/bbl	0.08	0.22	0.06	1.5E-03	0.07
	Tank 04	Produced Water	6,300	150	163,800	0.039 lb/bbl	0.494 lb/bbl	0.08	0.22	0.06	1.5E-03	0.07

TOTAL VOLUME: 17,800 424 26 462,000 11,000

TOTAL: 0.21 0.94 0.62 2.72 0.17 0.73 4.3E-03 0.02 0.19 0.84

- Notes:
- 1 - Total VOC emissions are based on the total liquid throughput multiplied by an EPA emission factor.
 - 2 - Methane emissions are based on laboratory-staged flash analysis factor from the Cherry Compressor Station GP5 Application of June 2014.
 - 3 - EPA-450/3-85-001a - "Volatile Organic Compound Emissions from Petroleum Refinery Wastewater Systems - Background Information for Proposed Standards" is a reasonable protocol for estimating potential produced water storage tank emissions. EPA-450/3-85-001a, page 3-39, gives a VOC emission factor of 420 kg/MMgal wastewater produced in an oil-water separator. (0.420 g/gal * 0.0022 lb/g * 42 gal/bbl = 0.039 lb/bbl)
 - 4 - These emission estimates are nearly 4X more conservative than emission factors required by the TCEQ on the Barnett Shale produced water tanks at gas-only sites. (<http://www.tceq.texas.gov/assets/public/implementation/air/le/pseiforms/producedwaterstorage tank.pdf>).

Table 1. Produced Water Storage Tank Flash Loss Emissions Factors for Barnett Shale Special Inventory Purposes ONLY

Pollutant	Average Produced Water Emission Factor (lb/bbl)	
	Gas Production Only Sites	Liquid Hydrocarbon and Gas Production Sites
VOC	0.01	0.0402
Benzene	0.0001	0.000054
Toluene	0.0003	0.000139
Ethylbenzene	0.000006	0.000003
Xylene(s)	0.00006	0.000049
n-Hexane	NA	0.000987

- 5 - n-Hexane, each BTEX, and 2,2,4-TMP components are estimated at 5% of VOC emissions and Total HAP is estimated at 30% of VOC emissions. These are very conservative estimates, as exemplified above:
 - 0.01 lb-VOC/bbl / 350 lb-Total/bbl = 0.003% VOC (vs. 5%)
 - (0.0001+0.0003+0.000006+0.00006) lb-HAP/bbl / 0.01 lb-VOC/bbl = 4.7% of VOC (vs. 50%).

Produced Water Truck Load-Out Emissions

Unit ID	Description	S	P	M	T	CE	L _L	T-Put	VOC	n-Hexane, BTEX, and 2,2,4-TMP (Ea)	Total HAP
		sat. fac.	psia	lb/lb-mol	°R	%	lb/Mgal	Mgal/yr	AP-42 Sect 5.2 tpy	5.00% of VOC tpy	30.00% of VOC tpy
TLO	Truck Load-Out	1.45	1.50	30.00	510	0.0%	1.59	462	0.37	0.02	0.11

TOTAL TLO:	0.37	0.02	0.11
------------	------	------	------

Notes: 1 - Emission factors and formulas are from AP-42 Section 5.2 "Transportation and Marketing of Petroleum Liquids";
$$L_L = 12.46 \times S \times P \times M / T \times (1 - CE)$$
where:
 L_L = Loading loss, lb/1000 gal of liquid loaded.
 S = Saturation factor, used 0.60 for "splash loading".
 P = true vapor pressure of liquid loaded, psia. (Conservative estimate = 1.5 psia. Measured RVP (100 °F) ranges from 1.0 to 1.3 psia; so the actual TVP is expected to be less than 0.7 psia at common storage temperature.)
 M = molecular weight of vapors, lb/lb-mol (Conservative estimate.)
 T = Temperature of bulk liquid loaded, °R = °F + 460. (Conservatively assumed 50 °F.)
 CE = Overall emission reduction efficiency (collection efficiency x control efficiency).
2 - Molecular weight and vapor pressure are based on operator experience and sampling data at various locations in the Marcellus Shale basin.
3 - It is estimated that each tank will be emptied up to:

26	times per year.
424	bbl = 17,800 gal.

4 - The total storage tank capacity at the facility is:
5 - n-Hexane, each BTEX, and 2,2,4-TMP components are estimated at 5% of VOC emissions and Total HAP is estimated at 30% of VOC emissions. □

Process Piping and Equipment Fugitive Emissions

Unit	Description	Component (Unit) Type	Unit Count	THC Factor lb/hr/Unit	Tot Hydrocarbons (THC)	VOC 0.46 Wgt%	Hex,BTEX,TMP-ea 2.3E-03 Wgt%	Total HAP 0.01 Wgt%	CO2 1.84 Wgt%	CH4 100.00 Wgt%	CO2e CH4 GWP = 25							
FUG	Process Piping and Equipment Fugitives (Gas)	(Gas)																
		Valves	514	9.9E-03	5.10	22.33	---	---	---	---	---	---						
		Pump Seals	---	---	---	---	---	---	---	---	---	---						
		Other	60	1.9E-02	1.16	5.10	5.4E-03	0.02	1.8E-04	0.02	1.16	29						
		Connectors	1,474	4.4E-04	0.65	2.85	3.0E-03	0.01	1.5E-05	0.01	0.65	16						
		Flanges	240	8.6E-04	0.21	0.90	9.5E-04	4.2E-03	2.9E-05	3.8E-03	0.21	5						
		Open-ended lines	28	4.4E-03	0.12	0.54	5.7E-04	2.5E-03	1.7E-05	2.3E-03	0.12	3						
		Total:	2,316		7.24	31.72	0.03	0.15	1.7E-04	7.35E-04	1.0E-03	4.4E-03	0.13	0.58	7.24	31.72	181	793

- Notes: 1 - Assumed 8,760 hours per year of fugitive emissions.
2 - Component counts are based on the default counts for compressor stations (GRI-HAPCalc model) multiplied by:

200%

3 - Gas emissions calculated using EPA Protocol for Equipment Leak Emission Estimates, EPA-453/R-95-017, Nov 1995.

TABLE 2.4 O&G PROD (AVE)		Gas	
		kg/hr	lb/hr
Valves		4.5E-03	9.9E-03
Pump Seals	na	na	na
Others		8.8E-03	1.9E-02
Connectors		2.0E-04	4.4E-04
Flanges		3.9E-04	8.6E-04
Open-Ended Lines		2.0E-03	4.4E-03

- 4 - "Other" components include compressor seals, relief valves, diaphragms, drains, meters, etc.
5 - To be conservative, the following gas characteristics were assumed:

Pollutant	Gas (Inlet)	
	Analysis	Estimated
Carbon Dioxide	0.89 Wgt%	1.84 Wgt%
Methane	94.85 Wgt%	100.00 Wgt%
VOC	0.21 Wgt%	0.46 Wgt%
n-Hex, BTEX, TMP (ea)	Varies	2.3E-03 Wgt%
Total HAP	3.5E-03 Wgt%	0.01 Wgt%