Appendix A- Phillips 66 Fuel Gas System under Rodeo Renewed Project

Overview

The Fuel Gas System (Unit 233) (BAAQMD Source S-338) is existing. S-338 treats the majority of the refinery fuel gas at the refinery.

The current refinery fuel gas system collects most of the fuel gas and processes it at S-338 Fuel Gas Center which removes sulfur using an amine contactor. S-338 is not a direct source of emissions other than emissions associated with equipment fugitive leaks. There are no physical changes being made at the unit and no LDAR equipment (valves, pumps, etc.) is being added. Therefore, there is no increase in the potential to emit from this unit and it is considered altered.

Once the Rodeo Renewed Project is complete, the existing Fuel Gas system also includes gases recovered from the Vapor Recovery system (A-7) which includes tank vapors (from S-135, S-137, S-139, S-140, S-168, S-173, S-174, S-175, S-182, S-188, S-189, S-190, S-253, S-360, S-433 (idle), S-445, S-446, S-447, S-449, and S-506) and vapors from S-70. The fuel gas is sent to fuel gas users such as furnaces and boilers throughout the refinery. Every combustion source at the refinery (with the exception of U200 B102 (S-36), U250 B701 (S-461), U246 B-801 (S-45)) uses fuel gas from S-338, either 100% or a mixture of S-338 fuel gas and natural gas or other gases.

Proposed Changes

There are no piping or equipment changes at S-338, and no feed lines or process lines will be added, removed, or changed. Several units feeding Unit 233 will not be operating post-project. These units will be idled post-project, and Phillips 66 will retain permits for these sources. See Figure A-1 for a Block Flow Diagram of the proposed fuel gas system. The anticipated composition of fuel gas is shown in Table A-1 and compared to historical refinery fuel gas. Based on the anticipated composition, the properties of fuel gas will be comparable to refinery fuel gas.

Appendix A, Table A-1: Fuel Gas Analysis

FG Component	NSR 3-Yr Baseline	Rodeo Renewed
Nitrogen (Mole %)	1.90	0.49
Hydrogen (Mole%)	26.47	24.47
Methane (Mole %)	42.26	47.69
C2-C5 (Mole %)	27.55	23.28
C6+ (Mole %)	0.57	0.55
HHV_{70F}	1198	1186
Fd $Factor_{70F}$	8530	8553
Carbon Content	0.745	0.76

Refinery Fuel Gas basis and analysis points:

1) Refinery historical analysis was based on daily fuel gas samples
2) Fuel gas constituents after the completion of the Rodeo Renewed project are engineering estimates
3) Carbon Monoxide and Carbon Dioxide are both <1% in both the pre/post project cases
4) Nitrogen <2% in both the pre/post-project cases
5) C6+ components comprise <1% in both the pre/post-project cases
6) H_2S content in fuel gas will be approximately the same, H_2S < 15-ppm average
7) Total Sulfur in the fuel gas will directionally decrease on an annual average
8) March 26, 2020 was only outlier removed from the data set due to an unusually low Btu content in sample gas

Conclusions from Fuel Gas Analysis:

1) Comparison between baseline refinery fuel gas and post-project fuel gas indicates no change in fundamental combustion properties that would affect performance
2) No modifications to the fuel gas system or any combustion equipment is necessary as part of the Rodeo Renewed project

Appendix A, Figure A-1: Proposed Fuel Gas System Process Flow Diagram REDACTED

REDACTED

Appendix A. Table A.2 | Refinery Fuel Gas (RFG) Data

Appendix A, Table A-2: Refinery Fuel Gas (RFG) Data

		MW	2.016	28.014	100	44.1	42.08	34.08	58.123	58.123	56.106
		HHV	319.00	0.00	4743.00	2524.00	2336.00		3271.00	3370.00	3076.00
			233:Fuel Gas Hydrogen	233:Fuel Gas Nitrogen	233:Fuel Gas C5+/C6+	233:Fuel Gas Propane	233:Fuel Gas Propene	233:Fuel Gas H2S	233:Fuel Gas i-Butane	233:Fuel Gas n-Butane	233:Fuel Gas 1-Butene
Outlier			R233:1:Hydrogen.L	R233:1:Nitrogen.L	R233:1:C5+/C6+.L	R233:1:Propane.L	R233:1:Propene.L	R233:1:H2S.L	R233:1:i-Butane.L	R233:1:n-Butane.L	R233:1:1-Butene.L
	03/10/19	100.00	25.20	1.40	0.59	9.57	1.30	17444.00	2.19	2.99	0.29
	03/11/19	99.80	24.07	1.90	0.52	9.30	1.31	17444.00	2.11	2.85	0.29
	03/12/19	99.73	22.96	1.26	0.63	9.12	1.27	17444.00	2.22	3.17	0.29
	03/13/19	99.72	24.26	0.82	0.65	9.90	1.30	17444.00	2.64	4.76	0.29
	03/14/19	99.74	24.96	0.95	0.67	10.12	1.35	17444.00	2.70	4.15	0.29
	03/15/19	99.62	23.81	0.93	0.54	10.27	1.30	17444.00	3.04	5.19	0.29
	03/16/19	99.72	19.70	11.08	0.37	9.08	1.18	17444.00	2.58	4.52	0.29
	03/17/19	99.93	21.64	4.84	0.44	9.74	1.26	17444.00	2.68	4.22	0.29
	03/18/19	99.79	24.72	1.75	0.72	10.78	1.28	17444.00	3.22	5.16	0.29
	03/19/19	99.77	26.38	1.31	0.93	10.81	1.19	17444.00	3.16	5.07	0.29
	03/20/19	99.83	24.30	1.88	0.81	10.16	1.29	17444.00	2.96	4.72	0.29
	03/21/19	99.86	23.56	1.24	0.70	9.86	1.31	17444.00	2.94	5.12	0.29
	03/22/19	99.83	24.94	0.83	0.75	11.87	1.28	17444.00	3.19	5.11	0.29
	03/23/19	99.79	24.52	1.15	1.06	11.07	1.35	17444.00	3.28	5.75	0.29
	03/24/19	99.80	24.79	0.83	1.06	11.13	1.21	17444.00	3.37	5.94	0.29
	03/25/19	99.68	23.33	1.73	2.98	11.84	1.21	17444.00	4.34	8.88	0.29
	03/26/19	99.84	26.12	1.61	1.01	11.88	1.42	17444.00	3.64	5.95	0.29
	03/27/19	99.86	23.69	2.13	0.70	11.32	1.28	17444.00	3.01	3.85	0.29
	03/28/19	99.87	25.15	1.84	0.74	11.98	1.29	17444.00	3.24	4.34	0.29
	03/29/19	99.82	24.34	1.40	0.71	12.40	1.34	17444.00	3.15	4.40	0.29
	03/30/19	99.88	22.33	2.10	0.59	11.74	1.24	17444.00	2.94	4.11	0.29
	03/31/19	99.79	26.97	1.10	0.74	13.11	1.46	17444.00	3.28	4.40	0.29
	04/01/19	99.80	27.02	1.02	0.80	12.65	1.38	17444.00	3.36	4.14	0.29
	04/02/19	99.83	27.62	0.94	0.82	13.18	1.25	17444.00	3.69	5.01	0.29
	04/03/19	99.84	25.49	1.72	0.74	12.15	1.26	11951.50	3.31	4.63	0.29
	04/04/19	99.87	22.91	0.93	0.75	11.57	1.19	10853.00	3.29	4.55	0.29

Appendix A. Table A.2 | Refinery Fuel Gas (RFG) Data

Appendix A, Table A-2: Refinery Fuel Gas (RFG) Data

		MW	2.016	28.014	100	44.1	42.08	34.08	58.123	58.123	56.106	56.106	56.106	56.106	72.149	72.149	44.01	28.053	30.069	16.043	32	28.01	40.064	54.09	26.037	
		HHV	319.00	0.00	4743.00	2524.00	2336.00		3271.00	3370.00	3076.00	3076.00	3076.00	3076.00	4008.00	4016.00	0.00	1614.00	1773.00	1012.00	0.00	321.00	2600.00	3080.00	1499.00	
			233:Fuel Gas Hydrogen	233:Fuel Gas Nitrogen	233:Fuel Gas C5+/C6+	233:Fuel Gas Propane	233:Fuel Gas Propene	233:Fuel Gas H2S	233:Fuel Gas i-Butane	233:Fuel Gas n-Butane	233:Fuel Gas 1-Butene	233:Fuel Gas i-Butylene	233:Fuel Gas t-2-Butene	233:Fuel Gas c-2 Butene	233:Fuel Gas i-Pentane	233:Fuel Gas n-Pentane	233:Fuel Gas CO2	233:Fuel Gas Ethylene	233:Fuel Gas Ethane	233:Fuel Gas Methane	233:Fuel Gas Oxygen	233:Fuel Gas CO	233:Fuel Gas Propadiene	233:Fuel Gas 1,3-Butadiene	233:Fuel Gas Acetylene	
Outlier			R233:1:Hydrogen.L	R233:1:Nitrogen.L	R233:1:C5+/C6+.L	R233:1:Propane.L	R233:1:Propene.L	R233:1:H2S.L	R233:1:i-Butane.L	R233:1:n-Butane.L	R233:1:1-Butene.L	R233:1:i-Butylene.L	R233:1:t-2-Butene.L	R233:1:c-2Butene.L	R233:1:i-Pentane.L	R233:1:n-Pentane.L	R233:1:CO2.L	R233:1:Ethylene.L	R233:1:Ethane.L	R233:1:Methane.L	R233:1:Oxygen.L	R233:1:CO.L	R233:1:Propadiene.L	R233:1:1,3-Butadiene.L	R233:1:Acetylene.L	R233:1:HHV.L
	09/28/20	99.60	25.19	1.41	0.54	9.09	1.32	11340.00	2.31	3.59	0.29	0.41	0.19	0.13	0.57	0.44	0.09	0.62	9.78	42.85	0.20	0.59	0.00	0.00	0.00	1262.534476
	09/29/20	99.64	23.33	1.27	0.57	8.32	1.21	11340.00	1.98	3.12	0.29	0.37	0.17	0.11	0.44	0.32	0.15	0.58	9.73	46.90	0.19	0.60	0.00	0.00	0.00	1235.806525
	09/30/20	99.65	24.20	1.82	0.64	8.82	1.18	11340.00	2.18	3.38	0.29	0.35	0.16	0.11	0.50	0.38	0.11	0.55	9.90	44.15	0.31	0.59	0.00	0.00	0.00	1248.391085
	10/01/20	99.52	24.35	1.76	0.62	9.11	1.29	11340.00	2.33	3.85	0.29	0.41	0.19	0.13	0.60	0.47	0.09	0.59	10.05	42.49	0.31	0.61	0.00	0.00	0.00	1279.205361
	10/02/20	99.55	24.08	1.21	0.61	8.81	1.17	11340.00	2.28	3.82	0.29	0.38	0.18	0.12	0.74	0.60	0.13	0.53	9.86	43.99	0.19	0.55	0.00	0.00	0.00	1284.52125
	10/03/20	99.64	23.77	1.59	0.55	9.49	1.19	11340.00	2.43	3.75	0.29	0.37	0.18	0.12	0.59	0.46	0.12	0.54	9.88	43.47	0.26	0.59	0.00	0.00	0.00	1280.290755
	10/04/20	99.73	21.96	1.31	0.49	8.28	1.10	11340.00	2.07	3.25	0.29	0.36	0.16	0.11	0.45	0.35	0.15	0.51	9.31	48.82	0.19	0.57	0.00	0.00	0.00	1240.084998
	10/05/20	99.73	21.18	1.10	0.45	7.93	1.10	7048.24	1.96	3.08	0.29	0.36	0.15	0.10	0.47	0.35	0.16	0.51	9.04	50.79	0.13	0.57	0.00	0.00	0.00	1232.986558
	10/06/20	99.71	20.64	1.47	0.48	7.95	1.11	6266.00	2.01	3.11	0.29	0.36	0.16	0.11	0.46	0.35	0.19	0.51	9.58	50.13	0.22	0.58	0.00	0.00	0.00	1239.656926
	10/07/20	99.76	19.74	1.96	0.40	8.54	1.09	6266.00	2.06	2.95	0.29	0.34	0.15	0.10	0.40	0.30	0.19	0.51	9.75	50.06	0.34	0.60	0.00	0.00	0.00	1238.631071
	10/08/20	99.82	18.94	1.87	0.31	8.23	0.96	6266.00	2.02	2.80	0.29	0.32	0.14	0.09	0.34	0.28	0.22	0.45	9.24	52.47	0.31	0.55	0.00	0.00	0.00	1222.449924
	10/09/20	99.79	19.65	1.21	0.36	8.42	1.00	6266.00	2.16	2.88	0.29	0.32	0.14	0.09	0.34	0.28	0.22	0.47	9.56	51.66	0.17	0.55	0.00	0.00	0.00	1239.737208
	10/10/20	99.72	22.09	2.09	0.51	9.24	1.08	6266.00	2.50	3.37	0.29	0.38	0.17	0.11	0.45	0.35	0.13	0.49	9.70	45.89	0.31	0.57	0.00	0.00	0.00	1261.086899
	10/11/20	99.71	23.73	1.27	0.49	9.58	1.11	6266.00	2.52	3.46	0.29	0.38	0.17	0.11	0.48	0.36	0.12	0.49	10.21	44.18	0.18	0.57	0.00	0.00	0.00	1272.483019
	10/12/20	99.66	23.25	1.32	0.48	9.84	1.22	6266.00	2.48	3.47	0.29	0.40	0.18	0.12	0.49	0.37	0.12	0.57	10.41	43.83	0.20	0.63	0.00	0.00	0.00	1283.065709
	10/13/20	99.61	23.60	1.56	0.52	9.68	1.27	6266.00	2.41	3.61	0.29	0.45	0.18	0.12	0.52	0.38	0.10	0.61	10.22	43.14	0.26	0.69	0.00	0.00	0.00	1281.373591
	10/14/20	99.76	21.33	2.21	0.43	8.78	1.07	6266.00	2.12	2.94	0.29	0.35	0.15	0.10	0.44	0.31	0.20	0.52	9.64	47.81	0.39	0.68	0.00	0.00	0.00	1230.985167
	10/15/20	99.70	22.87	2.98	0.64	9.29	1.13	6266.00	2.38	3.41	0.29	0.39	0.17	0.12	0.61	0.41	0.14	0.54	9.93	43.20	0.52	0.69	0.00	0.00	0.00	1257.599175
	10/16/20	99.64	24.89	1.72	0.58	9.42	1.23	6266.00	2.37	3.57	0.29	0.42	0.19	0.13	0.61	0.42	0.09	0.58	10.42	41.67	0.30	0.72	0.00	0.00	0.00	1270.811261
	10/17/20	99.87	43.84	1.15	0.58	6.65	0.95	6266.00	1.85	3.56	0.29	0.32	0.15	0.10	0.70	0.46	0.01	0.45	8.09	29.99	0.22	0.49	0.00	0.00	0.00	1068.591179

Appendix A, Table A-3: Refinery Fuel Gas (RFG) Data without Outliers

Note: This sheet only pulls in data not shown as outlier in RFG Data tab. Identify outliers in RFG Data tab.

	233:Fuel Gas Hydrogen	233:Fuel Gas Nitrogen	233:Fuel Gas C5=/C6+	233:Fuel Gas Propane	233:Fuel Gas Propene	233:Fuel Gas H2S PPB	233:Fuel Gas i-Butane	233:Fuel Gas n-Butane	233:Fuel Gas 1-Butene	233:Fuel Gas i-Butylene	233:Fuel Gas t-2-Butene	233:Fuel Gas c-2 Butene	233:Fuel Gas i-Pentane
Min	0.00	0.30	0.00	0.00	0.00	3533	0.02	0.00	0.00	0.00	0.00	0.00	0.00
Max	63.12	16.79	2.98	25.57	1.60	35780	11.70	12.33	0.43	0.59	0.34	0.89	1.68
MW	2.016	28.014	100	44.1	42.08	42	58.123	58.123	56.106	56.106	56.106	56.106	72.149
HHV	319.00	0.00	4743.00	2524.00	2336.00	2336	3271.00	3270.00	3076.00	3076.00	3076.00	3076.00	4008.00

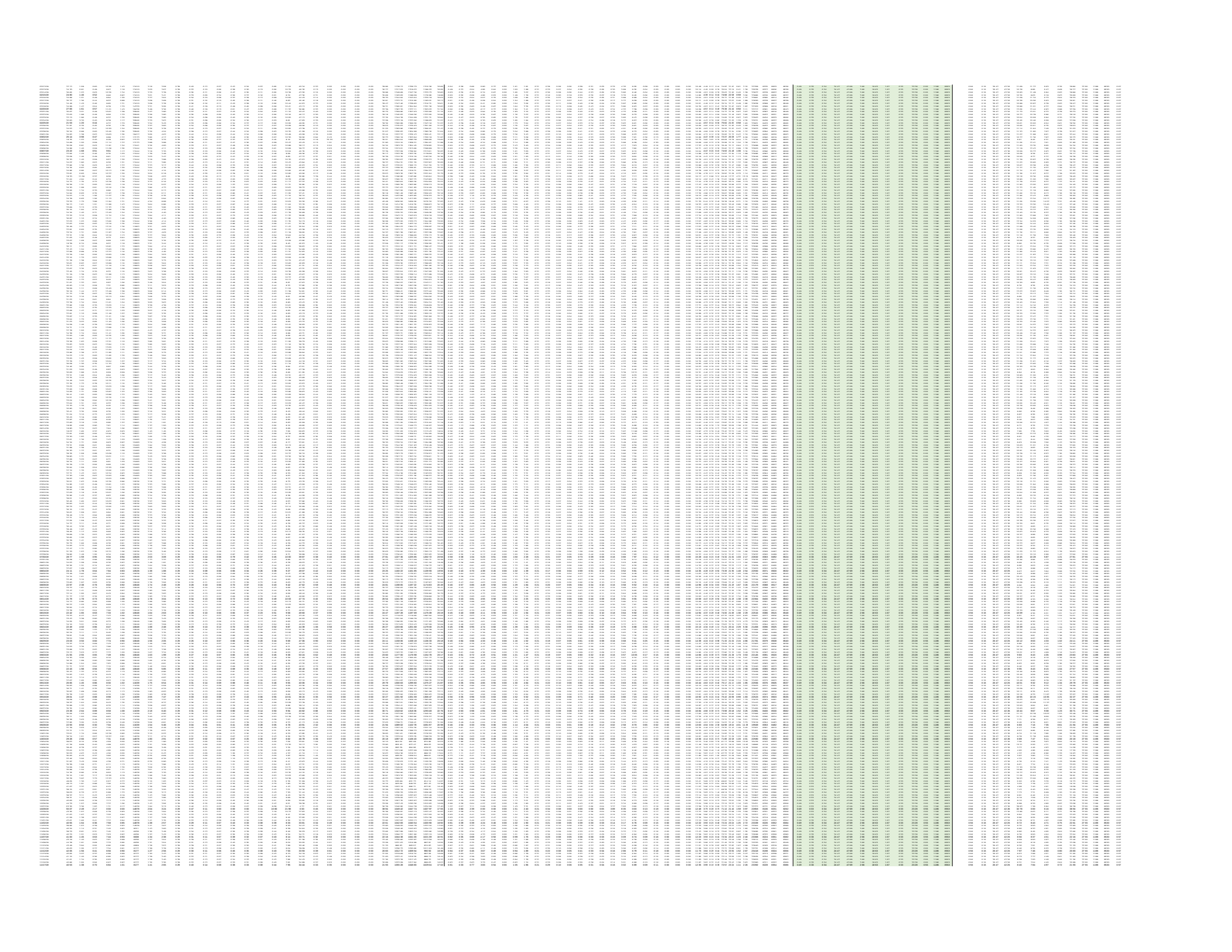
Baseline Hydrogen Mole %

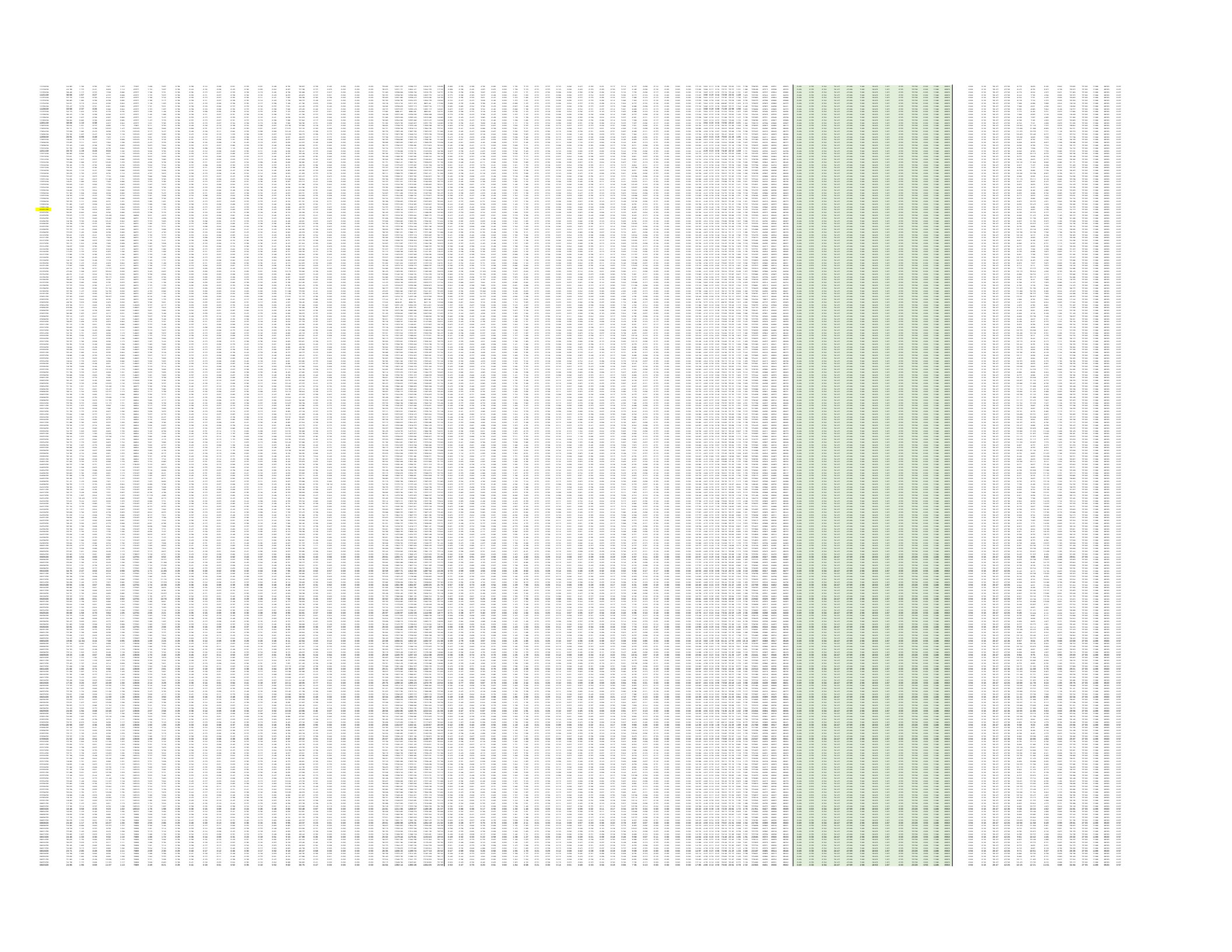
Outlier | Total % | R233:1:Hydrogen | R233:1:Nitrogen | R233:1:C5=/C6+ | R233:1:Propane | R233:1:Propene | R233:1:H2S | R233:1:i-Butane | R233:1:n-Butane | R233:1:1-Butene | R233:1:i-Butylene | R233:1:t-2-Butene | R233:1:c-2Butene | R233:1:i-Pentane

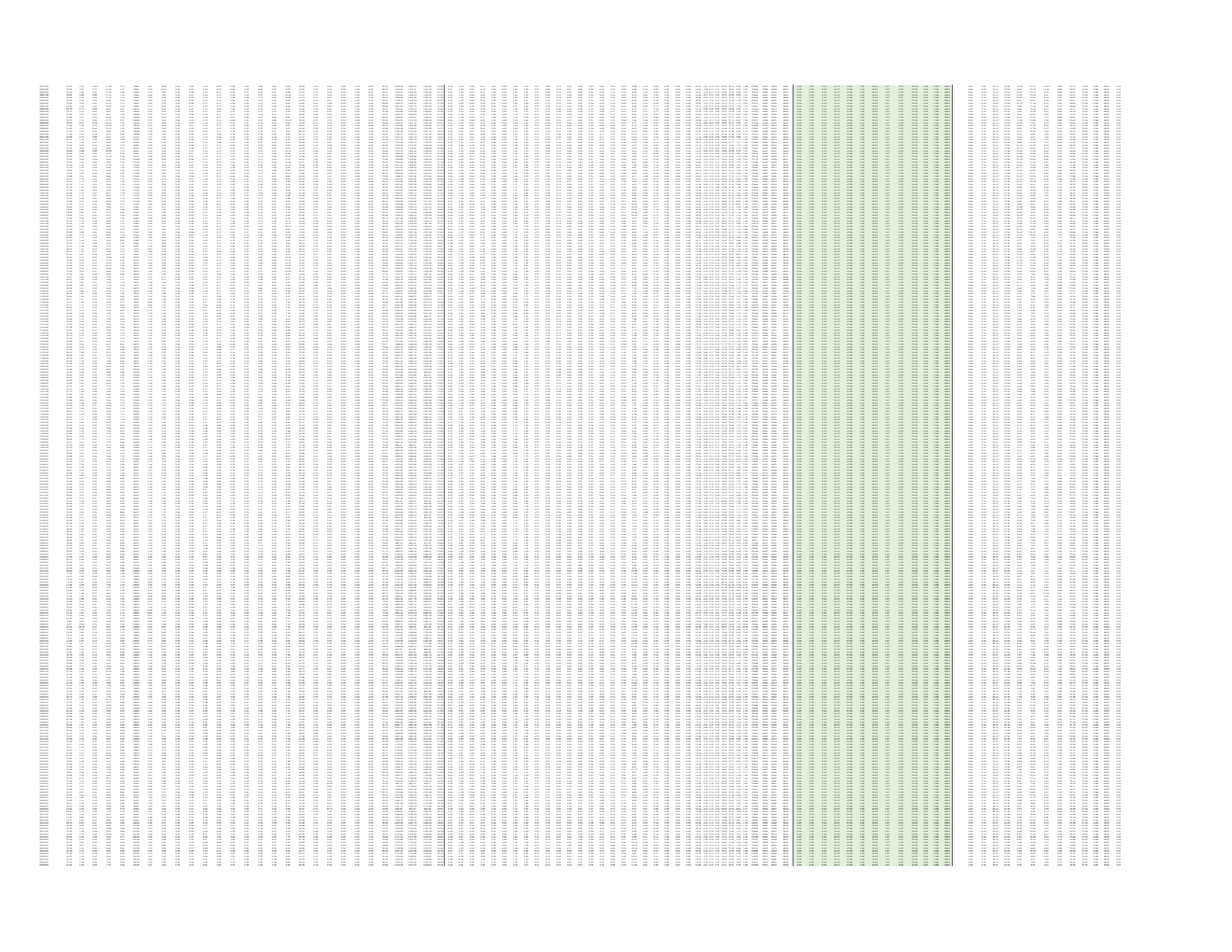
Mol% (daily data rows [illegible])

Rodeo Removed Fuel Gas

Rodeo RI Baseline 3 Yr Average







Appendix A, Table A-4: Rodeo Renewed (Post-Project) Fuel Gas Composition : Carbon and F-Factor Calculations

	Mol%																			
	H2O	N2	CO	CO2	H2	C1 Methane	C2= Ethylene	C2 Ethane	C3 =Propene	C3 Propane	C4 =i-butene	iC4 - butane	nC4 n-butane	C5= Pentene	iC5 i-Pentane	nC5 n-Pentane	C6+	TOTAL (mole%)	Carbon Content	MW
Rodeo Renewed	2.960	0.485	0.240	0.330	24.465	47.690		2.660		18.625		0.890	0.775		0.155	0.175	0.550	100.0	0.000	0.000
Rodeo Renewed (normalized for H_2O content)	-	0.500	0.247	0.340	25.211	49.145		2.741		19.193		0.917	0.799		0.160	0.180	0.567	100.0	0.758	19.770

Fuel F-Factor Rodeo Renewed Fuel Composition

ATOMS / MOLE												
C	H	O	N	SPECIES	MW	HHV	MOLE %	C	H	O	N
0.00	2.00	0.00	0.00	H_2	2	319.00	25.21	0.00	0.50	0.00	0.00
6.00	14.00	0.00	0.00	C_{6+}	86	4743.00	0.57	0.41	0.08	0.00	0.00
1.00	4.00	0.00	0.00	Methane	16	1012.00	49.14	5.90	1.97	0.00	0.00
2.00	6.00	0.00	0.00	Ethane	30	1773.00	2.74	0.66	0.16	0.00	0.00
3.00	8.00	0.00	0.00	Propane	44	2524.00	19.19	6.91	1.54	0.00	0.00
1.00	0.00	2.00	0.00	CO_2	44	--	0.34	0.04	0.00	0.11	0.00
4.00	10.00	0.00	0.00	Isobutane	58	3271.00	0.92	0.44	0.09	0.00	0.00
4.00	10.00	0.00	0.00	n-Butane	58	3370.00	0.80	0.38	0.08	0.00	0.00
0.00	0.00	0.00	2.00	N_2	28	--	0.50	0.00	0.00	0.00	0.14
5.00	12.00	0.00	0.00	Isopentane	72	4008.00	0.16	0.10	0.02	0.00	0.00
5.00	12.00	0.00	0.00	n-Pentane	72	4016.00	0.18	0.11	0.02	0.00	0.00
1.00	0.00	1.00	0.00	CO	28	321.00	0.25	0.03	0.00	0.04	0.00
				Ave. / Total			100.00	14.97	4.46	0.15	0.14
				Weight, %			99.79	75.75	22.58	0.75	0.71

Gas MW = 19.76
Btu/scf = 1,209 @ 60 F
Btu/scf = 1,186 @ 70 F
Btu/lb. = 23,217
lb./scf = 0.05

Fd"(60) = 8,392 (O_2 Based)
Fd"(68) = 8,521
Fd"(70) = 8,553

Note: RR fuel composition linked from "RR Carbon Content Calculation" tab

Calculations:

Fd"(68) = 10^6 * [3.64 * (H%) + 1.53 * (C%) + 0.14 * (N%) - 0.46 * (O%)] / HHV, Btu/lb
Fd"(60) = Fd"(68) * 520 R / 528 R
Fd"(60) = Fd"(68) * 520 R / 528 R
Fd"(60) = Fd"(68) * 520 R / 528 R
Fd"(70) = Fd"(68) * 530 R / 528 R

Appendix A, Table A-5: Rodeo Renewed (Post-Project) Carbon Content Calculation

Atomic mass	
Carbon	12.0107
Hydrogen	1.00794
Oxygen	15.9994
Nitrogen	14.0067

Carbon Count =		0	1	1	0	1	2	2	3	3	4	4	4	5	5	5	6
Hydrogen Count =		0	0	0	2	4	4	6	6	8	8	10	10	10	12	12	14
Oxygen Count =		0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Nitrogen Count =		2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MW, Kg/kgmol =		28.01	28.01	44.01	2.02	16.04	28.05	30.07	42.08	44.10	56.11	58.12	58.12	70.13	72.15	72.15	86.18
Carbon ratio		0.00	0.43	0.27	0.00	0.75	0.86	0.80	0.86	0.82	0.86	0.83	0.83	0.86	0.83	0.83	0.84

Mol%

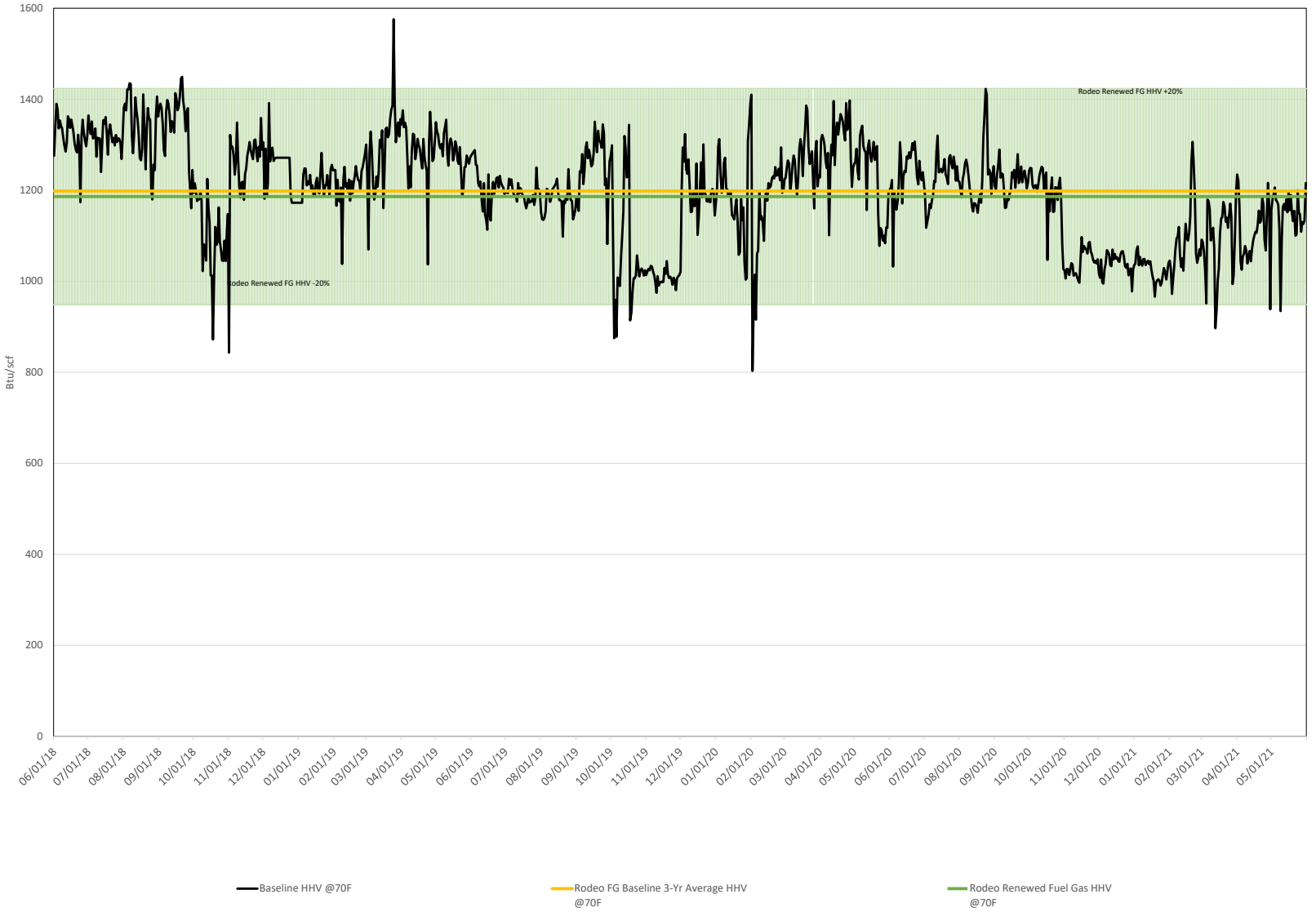
	H2O	N2	CO	CO2	H2	C1 Methane	C2= Ethylene	C2 Ethane	C3 =Propene	C3 Propane	C4 =i-butene	iC4 -butane	nC4 n-butane	C5=Pentene	iC5 i-Pentane	nC5 n-Pentane	C6+	TOTAL (mole%)	Carbon Content	MW
Rodeo Renewed	2.96	0.485	0.24	0.33	24.465	47.69	-	2.66	-	18.625	-	0.89	0.775	-	0.155	0.175	0.55	100.00		
Rodeo Renewed - (normalized for H2O content)	-	0.50	0.25	0.34	25.21	49.14	-	2.74	-	19.19	-	0.92	0.80	-	0.16	0.18	0.57	100.00	**0.758**	19.8
Rodeo Refinery 3-Yr Average		**1.897**	**0.558**	**0.146**	**26.469**	**42.261**	**0.490**	**9.399**	**1.001**	**9.577**	**0.767**	**2.310**	**3.177**		**0.520**	**0.338**	**0.565**		**0.745**	

R233:1:1-Butene.L	**0.28**
R233:1:i-Butylene.L	**0.31**
R233:1:t-2-Butene.L	**0.12**
R233:1:c-2Butene.L	**0.06**
Total Butenes:	**0.7670**

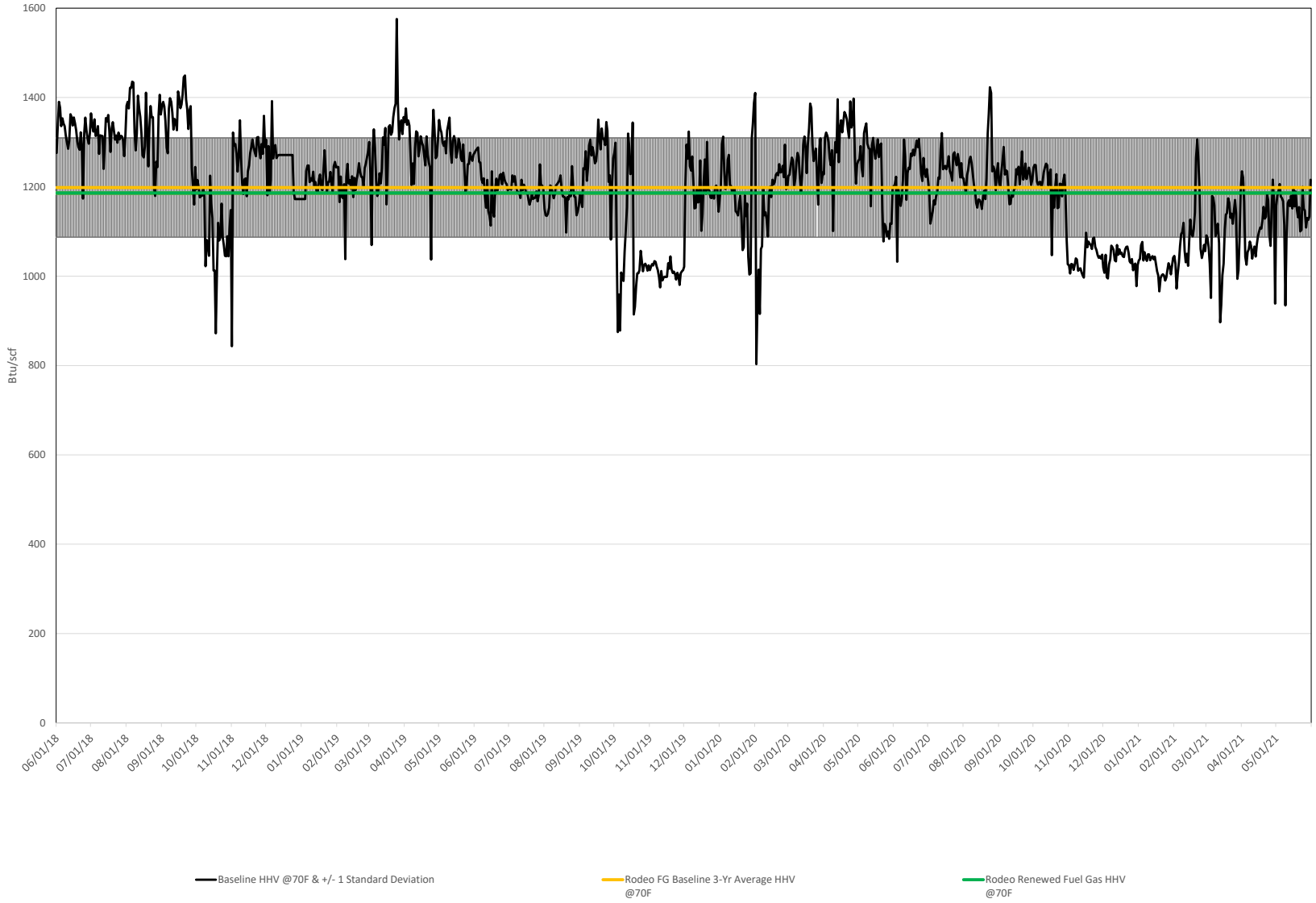
3-yr avg data was copied from the "RFG Data wo Outliers" tab and then transferred above into the CC calculation above.

R233:1:Hydrogen.L	R233:1:Nitrogen.L	R233:1:CS=/C6+.L	R233:1:Propane.L	R233:1:Propene.L	R233:1:i-Butane.L	R233:1:n-Butane.L	R233:1:1-Butene.L	R233:1:i-Butylene.L	R233:1:t-2-Butene.L	R233:1:c-2Butene.L	R233:1:i-Pentane.L	R233:1:n-Pentane.L	R233:1:CO2.L	R233:1:Ethylene.L	R233:1:Ethane.L	R233:1:Methane.L	R233:1:Oxygen.L	R233:1:CO.L	R233:1:Propadiene.L	R233:1:1,3-Butadiene.L	R233:1:Acetylene.L
							0.28051	0.30752	0.11535	0.06364							0.361033		0.012621	0.001110	0.000000
																	O2		C3H4	C4H6	C2H2
																Carbon atoms	0		3	4	2
																CC	0		0.899	0.888	0.923
																MW	32		40.07	54.1	26.04

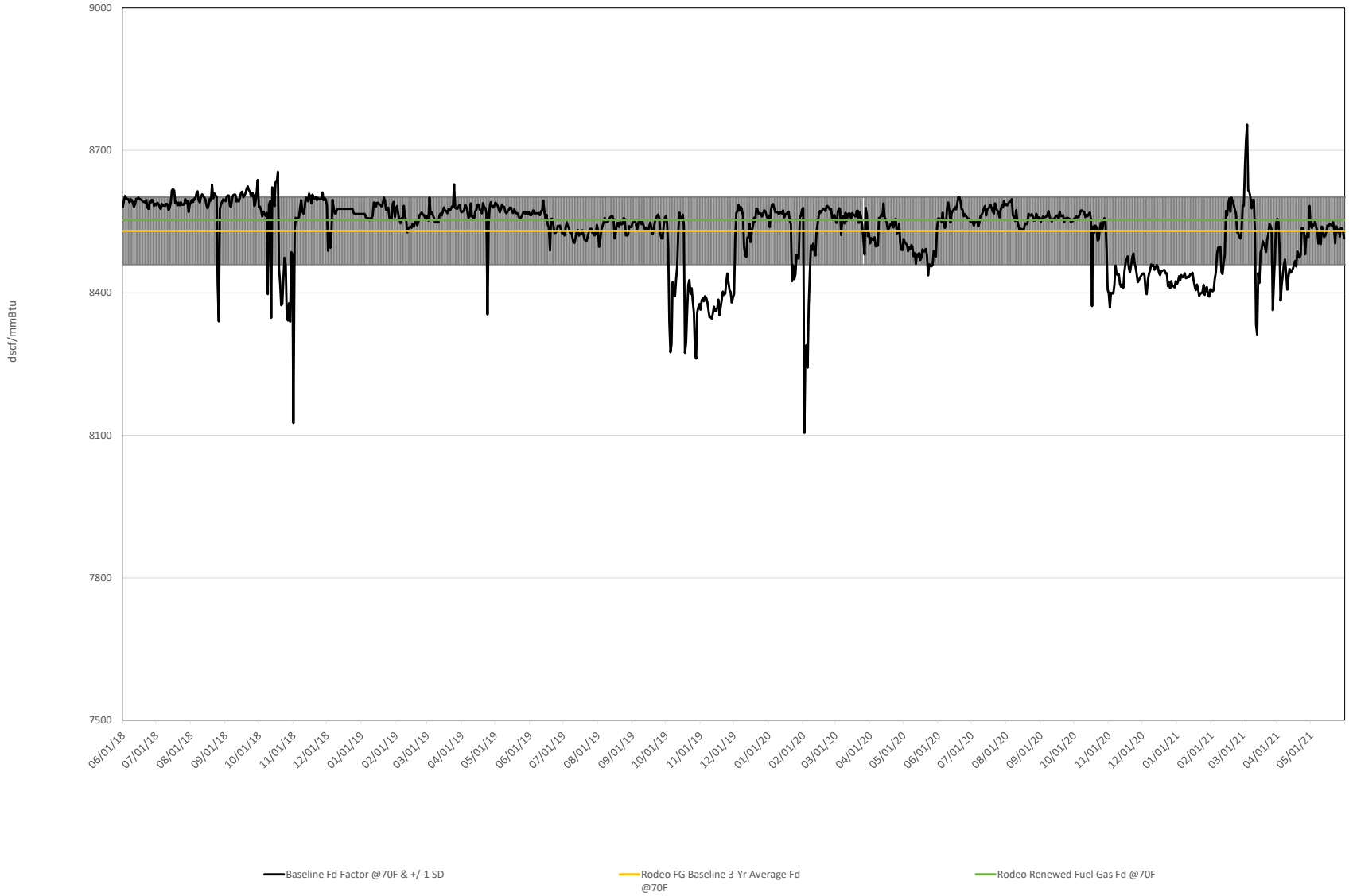
Appendix A, Figure A-2: Fuel Gas Heat Content



Appendix A, Figure A-3: Fuel Gas Heat Content +/- 1 Standard Deviation



Appendix A, Figure A-4: Fd Factor



Appendix B – Process Heaters Emissions Calculation

The following process heaters will continue to operate within the permitted design parameters and there will be no physical changes to the heaters. The properties of the fuel gas will change from the production of renewable fuels, but the new fuel gas combusted in the heaters will have a similar or lower heat content on a volumetric basis (Btu/scf) and less sulfur due to changes in facility operations. See Appendix A for more details on Phillips 66's fuel gas system and new fuel gas properties. Phillips 66 will provide fuel gas analysis to demonstrate that firing fuel gas is similar to refinery fuel gas per permit condition requirements.

Table B-1 – Overview of Process Heaters at Phillips 66

Source No.	Source Description	Fuel Type	Change Description	Firm Limit
S-11	U240_B-201 Heater	NG/RFG	Change in the Method of Operation	108 MMBtu/hour 946,080 MMBtu/year
S-12	U240 B-202 Heater	NG/RFG	Change in the Method of Operation	42 MMBtu/hour 367,920 MMBtu/year
S-13	U240_B-301 Heater	NG/RFG	Change in the Method of Operation	194 MMBtu/hour 1,699,440 MMBtu/year
S-22	U248_B-606 HEATER	NG/RFG	Change in the Method of Operation	31 MMBtu/hour 271,560 MMBtu/year
S-45	Heavy Gas Oil Feed Heater U246, B-801 A/B Heater	NG/RFG	Change in the Method of Operation	85 MMBtu/hour 744,600 MMBtu/year
S-438	U110_H-1 Furnace (H2 Plant Reforming)	NG/RFG	Change in the Method of Operation	175 MMBtu/hour 1,533,000 MMBtu/year

Appendix B, Table B-2
Potential to Emit (PTE) Emissions for U240 B-201 Heater (S-11)
Pre-Project PTE = Post-Project PTE

Parameter	Value	Units	Reference
Max Firing Rate	108	MMBtu/hour	Facility permit, Table II A
Fuel HHV	1576	BTU/SCF	Max daily between 2018-2021 (U233 RFG)
Fuel Sulfur (daily)	792	PPMV	Max daily between 2018-2021
Fuel Sulfur (annual)	432	PPMV	Max annual average between 2018-2021
MVC	386.9	SCF @70 degF/lb-mol	BAAQMD Guidelines, Table 5.4-1
Hours per day	24	Hours	
Days per year	365	Days	

Pollutant	Emission Factor	Units	PTE Emissions		Reference
Criteria			**lb/day**	**ton/yr**	
PM10	4.82E-03	lb/MMBtu	12.50	2.28	AP 42 Table 1.4-2
PM2.5	4.82E-03	lb/MMBtu	12.50	2.28	AP 42 Table 1.4-2
NOX	4.91E-02	lb/MMBtu	127.27	23.23	2019 U240 B-201 Source Test
CO	2.84E-01	lb/MMBtu	735.97	134.31	BAAQMD 9-10-305[1]
SO2	8.31E-02	lb/MMBtu	215.47	21.45	Total Sulfur mass balance[2]
POC	3.49E-03	lb/MMBtu	9.05	1.65	AP 42 Table 1.4-2
Greenhouse Gases			**MT/day**	**MT/yr**	
CO2	5.90E+01	kg/MMBtu	152.93	55,818.72	CARB default EF for fuel gas
CH4	3.00E-03	kg/MMBtu	0.0078	2.84	CARB default EF for fuel gas
N2O	6.00E-04	kg/MMBtu	0.0016	0.57	CARB default EF for fuel gas
CO2e			153.57	56,054.29	CARB GWP factors
Toxic Air Contaminants			**lb/day**	**lb/yr**	
Acetaldehyde	5.18E-02	lb/MMcf	0.0852	31.10	CATEF
Arsenic	1.25E-06	lb/MMBtu	0.0032	1.18	2018 U240 B-201 Source Test
Benzene	4.76E-02	lb/MMcf	0.0783	28.57	CATEF
Beryllium	1.46E-05	lb/MMcf	0.0000	0.01	CATEF
Cadmium	9.32E-09	lb/MMBtu	0.0000	0.01	2018 U240 B-201 Source Test
Chromium (hexavalent)	2.70E-09	lb/MMBtu	0.0000	0.00	2018 U240 B-201 Source Test
Copper	5.71E-03	lb/MMcf	0.0094	3.43	CATEF
Ethylbenzene	1.77E-02	lb/MMcf	0.0291	10.63	CATEF
Formaldehyde	9.93E-02	lb/MMcf	0.1633	59.61	CATEF
Hexane (n-)	1.80E-03	lb/MMBtu	4.6656	1,702.94	ICR Protocol, Table 4-3
Hydrogen chloride	8.13E-01	lb/MMcf	1.3371	488.05	CATEF
Hydrogen cyanide	2.66E-03	lb/MMcf	0.0044	1.59	CATEF
Hydrogen sulfide	8.05E-02	lb/MMcf	0.1324	48.32	CATEF
Lead	2.47E-03	lb/MMcf	0.0041	1.48	CATEF
Manganese	4.63E-03	lb/MMcf	0.0076	2.78	CATEF
Mercury	2.41E-04	lb/MMcf	0.0004	0.14	CATEF
Naphthalene	4.74E-04	lb/MMcf	0.0008	0.28	CATEF
Nickel	6.75E-07	lb/MMBtu	0.0017	0.64	2018 U240 B-201 Source Test
PAHs (as B[a]P equiv)	6.42E-05	lb/MMcf	0.0001	0.04	CATEF (as B[a]P equiv)
Phenol	4.63E-03	lb/MMcf	0.0076	2.78	CATEF
Propylene	2.05E-03	lb/MMcf	0.0034	1.23	CATEF
Selenium	4.95E-03	lb/MMcf	0.0081	2.97	CATEF
Sulfuric acid	6.15E-03	lb/MMBtu	15.9318	3,171.87	2002 Oil & Gas Journal[3]
Toluene	8.39E-02	lb/MMcf	0.1380	50.37	CATEF
Vanadium	2.30E-06	lb/MMBtu	0.0060	2.18	ICR Protocol, Table 4-3
Xylene (o-)	8.80E-03	lb/MMcf	0.0145	5.28	CATEF
Xylene (mixed isomers)	4.16E-02	lb/MMcf	0.0684	24.97	CATEF

1. CO EF (lb/MMBtu) = PPMV / 10^6 x (20.9% / 20.9% - %O2) x Fd (dscf/MMBtu) x MW (lb/lb-mol) / MVC (scf/lb-mol)
2. SO2 EF (lb/MMBtu) = Total S PPMV / 10^6 x MW SO2 (lb/lb-mol) / MVC (scf/lb-mol) / HHV (Btu/scf) * 1,000,000
3. Full calculation method for Sulfuric acid (H2SO4) is documented with the facility's Regulation 12-15 calculations.

Fuel Type	U233 RFG
Fuel factor (dscf/ MMBTU)	8400.66

Molecular weights (lb/lb-mol)

CO	28
NOX	46
SO2	64

Permit Condition

CO	400	ppmv @	3%	O2
NOX		ppmv @		O2

CARB GHG GWP

CO2	1
CH4	21
N2O	310

PAH as B[a]P equiv calculation

PEF	PAH or derivative		
0.1	benz(a)anthracene	2.02E-05	lb/MMcf
0.1	benzo(b)fluoranthene	2.51E-05	lb/MMcf
0.1	benzo(j)fluoranthene	-	
0.1	benzo(k)fluoranthene	1.47E-05	lb/MMcf
1	benzo(a)pyrene	5.19E-05	lb/MMcf
0.01	chrysene	1.88E-06	lb/MMcf
0.1	dibenz(a,j)acridine	-	
0.1	dibenz(a,h)acridine	-	
1.05	dibenz(a,h)anthracene	1.79E-07	lb/MMcf
1	7H-dibenzo(c,g)carbazole	-	
1	dibenzo(a,e)pyrene	-	
10	dibenzo(a,h)pyrene	-	
10	dibenzo(a,i)pyrene	-	
10	dibenzo(a,l)pyrene	-	
64	7,12-dimethylbenz(a)anthrac	-	
0.1	indeno(1,2,3-cd)pyrene	6.06E-05	lb/MMcf
1	5-methylchrysene	-	
5.7	3-methylcholanthrene	-	
0.03	5-nitroacenaphthene	-	
0.1	1-nitropyrene	-	
0.1	4-nitropyrene	-	
10	1,6-dinitropyrene	-	
1	1,8-dinitropyrene	-	
10	6-nitrocrysene	-	
0.01	2-nitrofluorene	-	

Appendix B, Table B-3
Potential to Emit (PTE) Emissions for U240 B-202 Heater (S-12)
Pre-Project PTE = Post-Project PTE

Parameter	Value	Units	Reference
Max Firing Rate	42	MMBtu/hour	Facility permit, Table II A
Fuel HHV	1576	BTU/SCF	Max daily between 2018-2021 (U233 RFG)
Fuel Sulfur (daily)	792	PPMV	Max daily between 2018-2021
Fuel Sulfur (annual)	432	PPMV	Max annual average between 2018-2021
MVC	386.9	SCF @70 degF/lb-mol	BAAQMD Guidelines, Table 5.4-1
Hours per day	24	Hours	
Days per year	365	Days	

Pollutant	Emission Factor	Units	PTE Emissions		Reference
Criteria			**lb/day**	**ton/yr**	
PM10	4.82E-03	lb/MMBtu	4.86	0.89	AP 42 Table 1.4-2
PM2.5	4.82E-03	lb/MMBtu	4.86	0.89	AP 42 Table 1.4-2
NOX	2.42E-02	lb/MMBtu	24.39	4.45	2017 U240 B-202 Source Test
CO	2.84E-01	lb/MMBtu	286.21	52.23	BAAQMD 9-10-305[1]
SO2	8.31E-02	lb/MMBtu	83.79	8.34	Total Sulfur mass balance[2]
POC	3.49E-03	lb/MMBtu	3.52	0.64	AP 42 Table 1.4-2
Greenhouse Gases			**MT/day**	**MT/yr**	
CO2	5.90E+01	kg/MMBtu	59.47	21,707.28	CARB default EF for fuel gas
CH4	3.00E-03	kg/MMBtu	0.0030	1.10	CARB default EF for fuel gas
N2O	6.00E-04	kg/MMBtu	0.0006	0.22	CARB default EF for fuel gas
CO2e			59.72	21,798.89	CARB GWP factors
Toxic Air Contaminants			**lb/day**	**lb/yr**	
Acetaldehyde	5.18E-02	lb/MMcf	0.0331	12.09	CATEF
Arsenic	1.25E-06	lb/MMBtu	0.0013	0.46	2018 U240 B-201 Source Test
Benzene	4.76E-02	lb/MMcf	0.0304	11.11	CATEF
Beryllium	1.46E-05	lb/MMcf	0.0000	0.00	CATEF
Cadmium	9.32E-09	lb/MMBtu	0.0000	0.00	2018 U240 B-201 Source Test
Chromium (hexavalent)	2.70E-09	lb/MMBtu	0.0000	0.00	2018 U240 B-201 Source Test
Copper	5.71E-03	lb/MMcf	0.0037	1.33	CATEF
Ethylbenzene	1.77E-02	lb/MMcf	0.0113	4.13	CATEF
Formaldehyde	9.93E-02	lb/MMcf	0.0635	23.18	CATEF
Hexane (n-)	1.80E-03	lb/MMBtu	1.8144	662.26	ICR Protocol, Table 4-3
Hydrogen chloride	8.13E-01	lb/MMcf	0.5200	189.80	CATEF
Hydrogen cyanide	2.66E-03	lb/MMcf	0.0017	0.62	CATEF
Hydrogen sulfide	8.05E-02	lb/MMcf	0.0515	18.79	CATEF
Lead	2.47E-03	lb/MMcf	0.0016	0.58	CATEF
Manganese	4.63E-03	lb/MMcf	0.0030	1.08	CATEF
Mercury	2.41E-04	lb/MMcf	0.0002	0.06	CATEF
Naphthalene	4.74E-04	lb/MMcf	0.0003	0.11	CATEF
Nickel	6.75E-07	lb/MMBtu	0.0007	0.25	2018 U240 B-201 Source Test
PAHs (as B[a]P equiv)	6.42E-05	lb/MMcf	0.0000	0.01	CATEF (as B[a]P equiv)
Phenol	4.63E-03	lb/MMcf	0.0030	1.08	CATEF
Propylene	2.05E-03	lb/MMcf	0.0013	0.48	CATEF
Selenium	4.95E-03	lb/MMcf	0.0032	1.16	CATEF
Sulfuric acid	6.15E-03	lb/MMBtu	6.1957	1,233.51	2002 Oil & Gas Journal[3]
Toluene	8.39E-02	lb/MMcf	0.0537	19.59	CATEF
Vanadium	2.30E-06	lb/MMBtu	0.0023	0.85	ICR Protocol, Table 4-3
Xylene (o-)	8.80E-03	lb/MMcf	0.0056	2.05	CATEF
Xylene (mixed isomers)	4.16E-02	lb/MMcf	0.0266	9.71	CATEF

1. CO EF (lb/MMBtu) = PPMV / 10^6 x (20.9% / 20.9% - %O2) x Fd (dscf/MMBtu) x MW (lb/lb-mol) / MVC (scf/lb-mol)
2. SO2 EF (lb/MMBtu) = Total S PPMV / 10^6 x MW SO2 (lb/lb-mol) / MVC (scf/lb-mol) / HHV (Btu/scf) * 1,000,000
3. Full calculation method for Sulfuric acid (H2SO4) is documented with the facility's Regulation 12-15 calculations.

Fuel Type	U233 RFG
Fuel factor (dscf/ MMBTU)	8400.66

Molecular weights (lb/lb-mol)

CO	28
NOX	46
SO2	64

Permit Condition

CO	400	ppmv @	3%	O2
NOX		ppmv @		O2

CARB GHG GWP

CO2	1
CH4	21
N2O	310

PAH as B[a]P equiv calculation

PEF	PAH or derivative		
0.1	benz(a)anthracene	2.02E-05	lb/MMcf
0.1	benzo(b)fluoranthene	2.51E-05	lb/MMcf
0.1	benzo(j)fluoranthene	-	
0.1	benzo(k)fluoranthene	1.47E-05	lb/MMcf
1	benzo(a)pyrene	5.19E-05	lb/MMcf
0.01	chrysene	1.88E-06	lb/MMcf
0.1	dibenz(a,j)acridine	-	
0.1	dibenz(a,h)acridine	-	
1.05	dibenz(a,h)anthracene	1.79E-07	lb/MMcf
1	7H-dibenzo(c,g)carbazole	-	
1	dibenzo(a,e)pyrene	-	
10	dibenzo(a,h)pyrene	-	
10	dibenzo(a,i)pyrene	-	
10	dibenzo(a,l)pyrene	-	
64	7,12-dimethylbenz(a)anthrac	-	
0.1	indeno(1,2,3-cd)pyrene	6.06E-05	lb/MMcf
1	5-methylchrysene	-	
5.7	3-methylcholanthrene	-	
0.03	5-nitroacenaphthene	-	
0.1	1-nitropyrene	-	
0.1	4-nitropyrene	-	
10	1,6-dinitropyrene	-	
1	1,8-dinitropyrene	-	
10	6-nitrocrysene	-	
0.01	2-nitrofluorene	-	

Appendix B, Table B-4
Potential to Emit (PTE) Emissions for U240 B-301 Heater (S-13)
Pre-Project PTE = Post-Project PTE

Parameter	Value	Units	Reference
Max Firing Rate	194	MMBtu/hour	Facility permit, Table II A
Fuel HHV	1576	BTU/SCF	Max daily between 2018-2021 (U233 RFG)
Fuel Sulfur (daily)	792	PPMV	Max daily between 2018-2021
Fuel Sulfur (annual)	432	PPMV	Max annual average between 2018-2021
MVC	386.9	SCF @70 degF/lb-mol	BAAQMD Guidelines, Table 5.4-1
Hours per day	24	Hours	
Days per year	365	Days	

Pollutant	Emission Factor	Units	PTE Emissions		Reference
Criteria			**lb/day**	**ton/yr**	
PM10	4.82E-03	lb/MMBtu	22.45	4.10	AP 42 Table 1.4-2
PM2.5	4.82E-03	lb/MMBtu	22.45	4.10	AP 42 Table 1.4-2
NOX	1.50E-02	lb/MMBtu	69.84	12.75	BAAQMD Condition 1694, Part F.4b
CO	2.84E-01	lb/MMBtu	1,322.02	241.27	BAAQMD 9-10-305[1]
SO2	8.31E-02	lb/MMBtu	387.05	38.53	Total Sulfur mass balance[2]
POC	3.49E-03	lb/MMBtu	16.25	2.97	AP 42 Table 1.4-2
Greenhouse Gases			**MT/day**	**MT/yr**	
CO2	5.90E+01	kg/MMBtu	274.70	100,266.96	CARB default EF for fuel gas
CH4	3.00E-03	kg/MMBtu	0.0140	5.10	CARB default EF for fuel gas
N2O	6.00E-04	kg/MMBtu	0.0028	1.02	CARB default EF for fuel gas
CO2e			275.86	100,690.12	CARB GWP factors
Toxic Air Contaminants			**lb/day**	**lb/yr**	
Acetaldehyde	5.18E-02	lb/MMcf	0.1530	55.86	CATEF
Ammonia	4.31E-03	lb/MMBtu	20.0664	7,324.24	10 ppmv @ 3% O2
Arsenic	1.25E-06	lb/MMBtu	0.0058	2.12	2018 U240 B-201 Source Test
Benzene	4.76E-02	lb/MMcf	0.1406	51.33	CATEF
Beryllium	1.46E-05	lb/MMcf	0.0000	0.02	CATEF
Cadmium	9.32E-09	lb/MMBtu	0.0000	0.02	2018 U240 B-201 Source Test
Chromium (hexavalent)	2.70E-09	lb/MMBtu	0.0000	0.00	2018 U240 B-201 Source Test
Copper	5.71E-03	lb/MMcf	0.0169	6.16	CATEF
Ethylbenzene	1.77E-02	lb/MMcf	0.0523	19.09	CATEF
Formaldehyde	9.93E-02	lb/MMcf	0.2934	107.08	CATEF
Hexane (n-)	1.80E-03	lb/MMBtu	8.3808	3,058.99	ICR Protocol, Table 4-3
Hydrogen chloride	8.13E-01	lb/MMcf	2.4019	876.68	CATEF
Hydrogen cyanide	2.66E-03	lb/MMcf	0.0078	2.86	CATEF
Hydrogen sulfide	8.05E-02	lb/MMcf	0.2378	86.81	CATEF
Lead	2.47E-03	lb/MMcf	0.0073	2.66	CATEF
Manganese	4.63E-03	lb/MMcf	0.0137	4.99	CATEF
Mercury	2.41E-04	lb/MMcf	0.0007	0.26	CATEF
Naphthalene	4.74E-04	lb/MMcf	0.0014	0.51	CATEF
Nickel	6.75E-07	lb/MMBtu	0.0031	1.15	2018 U240 B-201 Source Test
PAHs (as B[a]P equiv)	6.42E-05	lb/MMcf	0.0002	0.07	CATEF (as B[a]P equiv)
Phenol	4.63E-03	lb/MMcf	0.0137	4.99	CATEF
Propylene	2.05E-03	lb/MMcf	0.0061	2.21	CATEF
Selenium	4.95E-03	lb/MMcf	0.0146	5.34	CATEF
Sulfuric acid	6.15E-03	lb/MMBtu	28.6182	5,697.62	2002 Oil & Gas Journal[3]
Toluene	8.39E-02	lb/MMcf	0.2479	90.47	CATEF
Vanadium	2.30E-06	lb/MMBtu	0.0107	3.91	ICR Protocol, Table 4-3
Xylene (o-)	8.80E-03	lb/MMcf	0.0260	9.49	CATEF
Xylene (mixed isomers)	4.16E-02	lb/MMcf	0.1229	44.86	CATEF

1. CO EF (lb/MMBtu) = PPMV / 10^6 x (20.9% / 20.9% - %O2) x Fd (dscf/MMBtu) x MW (lb/lb-mol) / MVC (scf/lb-mol)
2. SO2 EF (lb/MMBtu) = Total S PPMV / 10^6 x MW SO2 (lb/lb-mol) / MVC (scf/lb-mol) / HHV (Btu/scf) * 1,000,000
3. Full calculation method for Sulfuric acid (H2SO4) is documented with the facility's Regulation 12-15 calculations.

Fuel Type	U233 RFG
Fuel factor (dscf/ MMBTU)	8400.66

Molecular weights (lb/lb-mol)

CO	28
NOX	46
SO2	64
NH3	17

Permit Condition

CO	400	ppmv @	3%	O2
NOX		ppmv @		O2
NH3	10	ppmv @	3%	O2

CARB GHG GWP

CO2	1
CH4	21
N2O	310

PAH as B[a]P equiv calculation

PEF		PAH or derivative		
0.1		benz(a)anthracene	2.02E-05	lb/MMcf
0.1		benzo(b)fluoranthene	2.51E-05	lb/MMcf
0.1		benzo(j)fluoranthene	-	
0.1		benzo(k)fluoranthene	1.47E-05	lb/MMcf
1		benzo(a)pyrene	5.19E-05	lb/MMcf
0.01		chrysene	1.88E-06	lb/MMcf
0.1		dibenz(a,j)acridine	-	
0.1		dibenz(a,h)acridine	-	
1.05		dibenz(a,h)anthracene	1.79E-07	lb/MMcf
1		7H-dibenzo(c,g)carbazole	-	
1		dibenzo(a,e)pyrene	-	
10		dibenzo(a,h)pyrene	-	
10		dibenzo(a,i)pyrene	-	
10		dibenzo(a,l)pyrene	-	
64		7,12-dimethylbenz(a)anthrac	-	
0.1		indeno(1,2,3-cd)pyrene	6.06E-05	lb/MMcf
1		5-methylchrysene	-	
5.7		3-methylcholanthrene	-	
0.03		5-nitroacenaphthene	-	
0.1		1-nitropyrene	-	
0.1		4-nitropyrene	-	
10		1,6-dinitropyrene	-	
1		1,8-dinitropyrene	-	
10		6-nitrocrysene	-	
0.01		2-nitrofluorene	-	

Appendix B, Table B-5
Potential to Emit (PTE) Emissions for U248 B-606 Heater (S-22)
Pre-Project PTE = Post-Project PTE

Parameter	Value	Units	Reference
Max Firing Rate	31	MMBtu/hour	Facility permit, Table II A
Fuel HHV	1576	BTU/SCF	Max daily between 2018-2021 (U233 RFG)
Fuel Sulfur (daily)	792	PPMV	Max daily between 2018-2021
Fuel Sulfur (annual)	432	PPMV	Max annual average between 2018-2021
MVC	386.9	SCF @70 degF/lb-mol	BAAQMD Guidelines, Table 5.4-1
Hours per day	24	Hours	
Days per year	365	Days	

Pollutant	Emission Factor	Units	PTE Emissions		Reference
Criteria			**lb/day**	**ton/yr**	
PM10	4.82E-03	lb/MMBtu	3.59	0.65	AP 42 Table 1.4-2
PM2.5	4.82E-03	lb/MMBtu	3.59	0.65	AP 42 Table 1.4-2
NOX	2.44E-02	lb/MMBtu	18.15	3.31	2019 U248 B-606 Source Test
CO	2.84E-01	lb/MMBtu	211.25	38.55	BAAQMD 9-10-305[1]
SO2	8.31E-02	lb/MMBtu	61.85	6.16	Total Sulfur mass balance[2]
POC	3.49E-03	lb/MMBtu	2.60	0.47	AP 42 Table 1.4-2
Greenhouse Gases			**MT/day**	**MT/yr**	
CO2	5.90E+01	kg/MMBtu	43.90	16,022.04	CARB default EF for fuel gas
CH4	3.00E-03	kg/MMBtu	0.0022	0.81	CARB default EF for fuel gas
N2O	6.00E-04	kg/MMBtu	0.0004	0.16	CARB default EF for fuel gas
CO2e			44.08	16,089.66	CARB GWP factors
Toxic Air Contaminants			**lb/day**	**lb/yr**	
Acetaldehyde	5.18E-02	lb/MMcf	0.0245	8.93	CATEF
Arsenic	1.25E-06	lb/MMBtu	0.0009	0.34	2018 U240 B-201 Source Test
Benzene	4.76E-02	lb/MMcf	0.0225	8.20	CATEF
Beryllium	1.46E-05	lb/MMcf	0.0000	0.00	CATEF
Cadmium	9.32E-09	lb/MMBtu	0.0000	0.00	2018 U240 B-201 Source Test
Chromium (hexavalent)	2.70E-09	lb/MMBtu	0.0000	0.00	2018 U240 B-201 Source Test
Copper	5.71E-03	lb/MMcf	0.0027	0.98	CATEF
Ethylbenzene	1.77E-02	lb/MMcf	0.0084	3.05	CATEF
Formaldehyde	9.93E-02	lb/MMcf	0.0469	17.11	CATEF
Hexane (n-)	1.80E-03	lb/MMBtu	1.3392	488.81	ICR Protocol, Table 4-3
Hydrogen chloride	8.13E-01	lb/MMcf	0.3838	140.09	CATEF
Hydrogen cyanide	2.66E-03	lb/MMcf	0.0013	0.46	CATEF
Hydrogen sulfide	8.05E-02	lb/MMcf	0.0380	13.87	CATEF
Lead	2.47E-03	lb/MMcf	0.0012	0.43	CATEF
Manganese	4.63E-03	lb/MMcf	0.0022	0.80	CATEF
Mercury	2.41E-04	lb/MMcf	0.0001	0.04	CATEF
Naphthalene	4.74E-04	lb/MMcf	0.0002	0.08	CATEF
Nickel	6.75E-07	lb/MMBtu	0.0005	0.18	2018 U240 B-201 Source Test
PAHs (as B[a]P equiv)	6.42E-05	lb/MMcf	0.0000	0.01	CATEF (as B[a]P equiv)
Phenol	4.63E-03	lb/MMcf	0.0022	0.80	CATEF
Propylene	2.05E-03	lb/MMcf	0.0010	0.35	CATEF
Selenium	4.95E-03	lb/MMcf	0.0023	0.85	CATEF
Sulfuric acid	6.15E-03	lb/MMBtu	4.5730	910.44	2002 Oil & Gas Journal[3]
Toluene	8.39E-02	lb/MMcf	0.0396	14.46	CATEF
Vanadium	2.30E-06	lb/MMBtu	0.0017	0.62	ICR Protocol, Table 4-3
Xylene (o-)	8.80E-03	lb/MMcf	0.0042	1.52	CATEF
Xylene (mixed isomers)	4.16E-02	lb/MMcf	0.0196	7.17	CATEF

1. CO EF (lb/MMBtu) = PPMV / 10^6 x (20.9% / 20.9% - %O2) x Fd (dscf/MMBtu) x MW (lb/lb-mol) / MVC (scf/lb-mol)
2. SO2 EF (lb/MMBtu) = Total S PPMV / 10^6 x MW SO2 (lb/lb-mol) / MVC (scf/lb-mol) / HHV (Btu/scf) * 1,000,000
3. Full calculation method for Sulfuric acid (H2SO4) is documented with the facility's Regulation 12-15 calculations.

Fuel Type	U233 RFG
Fuel factor (dscf/ MMBTU)	8400.66

Molecular weights (lb/lb-mol)

CO	28
NOX	46
SO2	64

Permit Condition

CO	400	ppmv @	3%	O2
NOX		ppmv @		O2

CARB GHG GWP

CO2	1
CH4	21
N2O	310

PAH as B[a]P equiv calculation

PEF	PAH or derivative		
0.1	benz(a)anthracene	2.02E-05	lb/MMcf
0.1	benzo(b)fluoranthene	2.51E-05	lb/MMcf
0.1	benzo(j)fluoranthene	-	
0.1	benzo(k)fluoranthene	1.47E-05	lb/MMcf
1	benzo(a)pyrene	5.19E-05	lb/MMcf
0.01	chrysene	1.88E-06	lb/MMcf
0.1	dibenz(a,j)acridine	-	
0.1	dibenz(a,h)acridine	-	
1.05	dibenz(a,h)anthracene	1.79E-07	lb/MMcf
1	7H-dibenzo(c,g)carbazole	-	
1	dibenzo(a,e)pyrene	-	
10	dibenzo(a,h)pyrene	-	
10	dibenzo(a,i)pyrene	-	
10	dibenzo(a,l)pyrene	-	
64	7,12-dimethylbenz(a)anthrac	-	
0.1	indeno(1,2,3-cd)pyrene	6.06E-05	lb/MMcf
1	5-methylchrysene	-	
5.7	3-methylcholanthrene	-	
0.03	5-nitroacenaphthene	-	
0.1	1-nitropyrene	-	
0.1	4-nitropyrene	-	
10	1,6-dinitropyrene	-	
1	1,8-dinitropyrene	-	
10	6-nitrocrysene	-	
0.01	2-nitrofluorene	-	

Appendix B, Table B-6
Potential to Emit (PTE) Emissions for U246 B-801 A/B Heater (S-45)
Pre-Project PTE = Post-Project PTE

Parameter	Value	Units	Reference
Max Firing Rate	85.00	MMBtu/hour	BAAQMD Condition 22962, Part 2a
Fuel HHV	1576	BTU/SCF	Max daily between 2018-2021 (U233 RFG)
MVC	386.9	SCF @70 degF/lb-mol	BAAQMD Guidelines, Table 5.4-1
Hours per day	24	Hours	
Days per year	365.00	Days	

Pollutant	Emission Factor	Units	PTE Emissions		Reference
Criteria			**lb/day**	**ton/yr**	
PM10	NA	NA	10.41	1.90	BAAQMD Condition 22962, Part 6d
PM2.5	NA	NA	10.41	1.90	Assumed to be equal to PM10
NOX	NA	NA	12.60	2.30	BAAQMD Condition 22962, Part 6a
CO	NA	NA	15.34	2.80	BAAQMD Condition 22962, Part 6b
SO2	NA	NA	25.75	4.70	BAAQMD Condition 22962, Part 6e
POC	NA	NA	8.22	1.50	BAAQMD Condition 22962, Part 6c
Greenhouse Gases			**MT/day**	**MT/yr**	
CO2	5.90E+01	kg/MMBtu	120.36	43,931.40	CARB default EF for fuel gas
CH4	3.00E-03	kg/MMBtu	0.0061	2.23	CARB default EF for fuel gas
N2O	6.00E-04	kg/MMBtu	0.0012	0.45	CARB default EF for fuel gas
CO2e			120.87	44,116.81	CARB GWP factors
Toxic Air Contaminants			**lb/day**	**lb/yr**	
Acetaldehyde	NA	NA	0.0312	11.40	BAAQMD Application #13424
Ammonia	NA	NA	9.3840	3,430.00	BAAQMD Application #13424
Antimony	NA	NA	0.0011	0.39	BAAQMD Application #13424
Arsenic	NA	NA	0.0017	0.63	BAAQMD Application #13424
Benzene	NA	NA	0.1320	48.20	BAAQMD Application #13424
Cadmium	NA	NA	0.0020	0.74	BAAQMD Application #13424
Chromium (total)	NA	NA	0.0022	0.80	BAAQMD Application #13424
Copper	NA	NA	0.0086	3.13	BAAQMD Application #13424
Ethylbenzene	NA	NA	0.0617	22.50	BAAQMD Application #13424
Formaldehyde	NA	NA	0.2266	82.70	BAAQMD Application #13424
Lead	NA	NA	0.0100	3.64	BAAQMD Application #13424
Manganese	NA	NA	0.0139	5.07	BAAQMD Application #13424
Mercury	NA	NA	0.0004	0.13	BAAQMD Application #13424
Naphthalene	NA	NA	0.0006	0.23	BAAQMD Application #13424
Nickel	NA	NA	0.0192	7.01	BAAQMD Application #13424
PAHs (as B[a]P equiv)	NA	NA	0.0002	0.08	BAAQMD Application #13424
Phenol	NA	NA	0.0115	4.19	BAAQMD Application #13424
Propylene	NA	NA	0.0044	1.62	BAAQMD Application #13424
Selenium	NA	NA	0.0000	0.01	BAAQMD Application #13424
Silver	NA	NA	0.0033	1.20	BAAQMD Application #13424
Toluene	NA	NA	0.2184	79.70	BAAQMD Application #13424
Xylene (mixed isomers)	NA	NA	0.0761	27.80	BAAQMD Application #13424
Zinc	NA	NA	0.0425	15.50	BAAQMD Application #13424

CARB GHG GWP

CO2	1
CH4	21
N2O	310

PAH as B[a]P equiv calculation

PAH or derivative					
benz(a)anthracene	2.02E-05	lb/MMcf	0.00006552	0.0239	BAAQMD Application #13424
benzo(b)fluoranthene	2.51E-05	lb/MMcf	0.00008232	0.0301	BAAQMD Application #13424
benzo(j)fluoranthene	-				
benzo(k)fluoranthene	1.47E-05	lb/MMcf	0.0000492	0.0179	BAAQMD Application #13424
benzo(a)pyrene	5.19E-05	lb/MMcf	0.00018288	0.0667	BAAQMD Application #13424
chrysene	1.88E-06	lb/MMcf	0.000003336	0.00121	BAAQMD Application #13424
dibenz(a,j)acridine	-				
dibenz(a,h)acridine	-				
dibenz(a,h)anthracene	1.79E-07	lb/MMcf			
7H-dibenzo(c,g)carbazole	-				
dibenzo(a,e)pyrene	-				
dibenzo(a,h)pyrene	-				
dibenzo(a,i)pyrene	-				
dibenzo(a,l)pyrene	-				
7,12-dimethylbenz(a)anthrac	-				
indeno(1,2,3-cd)pyrene	6.06E-05	lb/MMcf	0.00021024	0.0767	BAAQMD Application #13424
5-methylchrysene	-				
3-methylcholanthrene	-				
5-nitroacenaphthene	-				
1-nitropyrene	-				
4-nitropyrene	-				
1,6-dinitropyrene	-				
1,8-dinitropyrene	-				
6-nitrocrysene	-				
2-nitrofluorene	-				

Appendix B, Table B-7
Potential to Emit (PTE) Emissions for U110 H-1 Furnace (S-438)
Pre-Project PTE = Post-Project PTE

Parameter	Value	Units	Reference
Max Firing Rate	250	MMBtu/hour	Facility permit, Table II A
Fuel HHV	1590	BTU/SCF	Max daily between 2018-2021 (SPP/U110 RFG)
Fuel Sulfur (daily)	624	PPMV	Max daily between 2018-2021
Fuel Sulfur (annual)	258	PPMV	Max annual average between 2018-2021
MVC	386.9	SCF @70 degF/lb-mol	BAAQMD Guidelines, Table 5.4-1
Hours per day	24	Hours	
Days per year	365	Days	

Pollutant	Emission Factor	Units	PTE Emissions		Reference
Criteria			**lb/day**	**ton/yr**	
PM10	4.00E-03	lb/MMBtu	24.00	4.380	BAAQMD Application #11293
PM2.5	4.00E-03	lb/MMBtu	24.00	4.380	BAAQMD Application #11293
NOX	8.30E-03	lb/MMBtu	49.80	9.089	BAAQMD Application #11293
CO	2.30E-02	lb/MMBtu	138.00	25.185	BAAQMD Application #11293
SO2	1.60E-03	lb/MMBtu	9.60	1.752	BAAQMD Application #11293
POC	2.30E-03	lb/MMBtu	13.80	2.519	BAAQMD Application #11293
Greenhouse Gases			**MT/day**	**MT/yr**	
CO2	5.90E+01	kg/MMBtu	354.00	129,210.00	CARB default EF for fuel gas
CH4	3.00E-03	kg/MMBtu	0.0180	6.57	CARB default EF for fuel gas
N2O	6.00E-04	kg/MMBtu	0.0036	1.31	CARB default EF for fuel gas
CO2e			355.49	129,755.31	CARB GWP factors
Toxic Air Contaminants			**lb/day**	**lb/yr**	
Acetaldehyde	5.18E-02	lb/MMcf	0.1955	71.35	CATEF
Ammonia	4.33E-03	lb/MMBtu	25.9783	9,482.07	10 ppmv @ 3% O2
Arsenic	1.25E-06	lb/MMBtu	0.0075	2.74	2018 U240 B-201 Source Test
Benzene	4.76E-02	lb/MMcf	0.1796	65.56	CATEF
Beryllium	1.46E-05	lb/MMcf	0.0001	0.02	CATEF
Cadmium	9.32E-09	lb/MMBtu	0.0001	0.02	2018 U240 B-201 Source Test
Chromium (hexavalent)	2.70E-09	lb/MMBtu	0.0000	0.01	2018 U240 B-201 Source Test
Copper	5.71E-03	lb/MMcf	0.0215	7.86	CATEF
Ethylbenzene	1.77E-02	lb/MMcf	0.0668	24.38	CATEF
Formaldehyde	9.93E-02	lb/MMcf	0.3747	136.77	CATEF
Hexane (n-)	1.80E-03	lb/MMBtu	10.8000	3,942.00	ICR Protocol, Table 4-3
Hydrogen chloride	8.13E-01	lb/MMcf	3.0679	1,119.79	CATEF
Hydrogen cyanide	2.66E-03	lb/MMcf	0.0100	3.66	CATEF
Hydrogen sulfide	8.05E-02	lb/MMcf	0.3038	110.88	CATEF
Lead	2.47E-03	lb/MMcf	0.0093	3.40	CATEF
Manganese	4.63E-03	lb/MMcf	0.0175	6.38	CATEF
Mercury	2.41E-04	lb/MMcf	0.0009	0.33	CATEF
Naphthalene	4.74E-04	lb/MMcf	0.0018	0.65	CATEF
Nickel	6.75E-07	lb/MMBtu	0.0041	1.48	2018 U240 B-201 Source Test
PAHs (as B[a]P equiv)	6.42E-05	lb/MMcf	0.0002	0.09	CATEF (as B[a]P equiv)
Phenol	4.63E-03	lb/MMcf	0.0175	6.38	CATEF
Propylene	2.05E-03	lb/MMcf	0.0077	2.82	CATEF
Selenium	4.95E-03	lb/MMcf	0.0187	6.82	CATEF
Sulfuric acid	1.18E-04	lb/MMBtu	0.7098	107.12	2002 Oil & Gas Journal[1]
Toluene	8.39E-02	lb/MMcf	0.3166	115.56	CATEF
Vanadium	2.30E-06	lb/MMBtu	0.0138	5.04	ICR Protocol, Table 4-3
Xylene (o-)	8.80E-03	lb/MMcf	0.0332	12.12	CATEF
Xylene (mixed isomers)	4.16E-02	lb/MMcf	0.1570	57.30	CATEF

1. Full calculation method for Sulfuric acid (H2SO4) is documented with the facility's Regulation 12-15 calculations.

CARB GHG GWP

CO2	1
CH4	21
N2O	310

PAH as B[a]P equiv calculation

PEF		PAH or derivative		
0.1		benz(a)anthracene	2.02E-05	lb/MMcf
0.1		benzo(b)fluoranthene	2.51E-05	lb/MMcf
0.1		benzo(j)fluoranthene	-	
0.1		benzo(k)fluoranthene	1.47E-05	lb/MMcf
1		benzo(a)pyrene	5.19E-05	lb/MMcf
0.01		chrysene	1.88E-06	lb/MMcf
0.1		dibenz(a,j)acridine	-	
0.1		dibenz(a,h)acridine	-	
1.05		dibenz(a,h)anthracene	1.79E-07	lb/MMcf
1		7H-dibenzo(c,g)carbazole	-	
1		dibenzo(a,e)pyrene	-	
10		dibenzo(a,h)pyrene	-	
10		dibenzo(a,i)pyrene	-	
10		dibenzo(a,l)pyrene	-	
64		7,12-dimethylbenz(a)anthrac	-	
0.1		indeno(1,2,3-cd)pyrene	6.06E-05	lb/MMcf
1		5-methylchrysene	-	
5.7		3-methylcholanthrene	-	
0.03		5-nitroacenaphthene	-	
0.1		1-nitropyrene	-	
0.1		4-nitropyrene	-	
10		1,6-dinitropyrene	-	
1		1,8-dinitropyrene	-	
10		6-nitrocrysene	-	
0.01		2-nitrofluorene	-	

Appendix B, Table B-8
Potential to Emit (PTE) Emissions for Turbines (S-352 through S-354)
Pre-Project PTE = Post-Project PTE

Parameter	Value	Units	Reference
Max Firing Rate (daily)	777	MMBtu/hour (combined for all sources S-352 through S-354; each turbine is 259 MMBtu/hr)	Application #30810
Max Firing Rate (annual)	1048	MMBtu/hour	BAAQMD Condition 18629, Part D.3, combined for turbines and duct burners S-352 through S-357
Fuel HHV	1321	BTU/SCF	Max daily between 2018-2021 (Turbine blend)
MVC	386.9	SCF @70 degF/lb-mol	BAAQMD Guidelines, Table 5.4-1
Hours per day	24	Hours	
Days per year	365	Days	

Pollutant	Emission Factor	Units	PTE Emissions		Reference
Criteria (Combined for turbines and duct burners S-352 through S-357)[1]			**lb/day**	**ton/yr**	
PM10	NA	NA	120.00	19.00	BAAQMD Application #30810
PM2.5	NA	NA	120.00	19.00	Assumed to be equal to PM10
NOX	NA	NA	1,584.00	79.80	BAAQMD Condition 12122, Part 9b
CO	NA	NA	1,096.00	200.00	BAAQMD Condition 12122, Part 10a
SO2	NA	NA	617.00	111.00	BAAQMD Application #30810
POC	NA	NA	199.00	30.50	BAAQMD Condition 12122, Part 11
Greenhouse Gases			**MT/day (combined for turbines S-352 through S-354)**	**MT/yr (combined for all turbines and duct burners S-352 through S-357)**	
CO2	5.90E+01	kg/MMBtu	1,100.23	541,648.32	CARB default EF for fuel gas
CH4	3.00E-03	kg/MMBtu	0.0559	27.54	CARB default EF for fuel gas
N2O	6.00E-04	kg/MMBtu	0.0112	5.51	CARB default EF for fuel gas
CO2e			1,104.88	403,279.50	CARB GWP factors
Toxic Air Contaminants			**lb/day (combined for turbines S-352 through S-354)**	**lb/yr (combined for all turbines and duct burners S-352 through S-357)**	**Reference**
Acetaldehyde	1.56E-02	lb/MMcf	0.2202	108.41	CATEF
Ammonia	4.47E-03	lb/MMBtu	83.2846	41,001.31	10 ppmv @ 3% O2
Arsenic	1.25E-06	lb/MMBtu	0.0233	11.48	2018 U240 B-201 Source Test
Benzene	1.92E-03	lb/MMcf	0.0270	13.31	CATEF
Cadmium	9.32E-09	lb/MMBtu	0.0002	0.09	2018 U240 B-201 Source Test
Chromium (hexavalent)	2.70E-09	lb/MMBtu	0.0001	0.02	2018 U240 B-201 Source Test
Formaldehyde	2.95E-02	lb/MMcf	0.4164	205.01	CATEF
Hexane (n-)	1.80E-03	lb/MMBtu	33.5664	16,524.86	ICR Protocol, Table 4-3
Nickel	6.75E-07	lb/MMBtu	0.0126	6.20	2018 U240 B-201 Source Test
Propylene	5.45E-02	lb/MMcf	0.7694	378.76	CATEF
Sulfuric acid	4.55E-03	lb/MMBtu	84.7618	30,497.77	2002 Oil & Gas Journal[4]
Toluene	5.95E-03	lb/MMcf	0.0840	41.35	CATEF
Vanadium	2.30E-06	lb/MMBtu	0.0429	21.12	ICR Protocol, Table 4-3
Xylene (mixed isomers)	1.37E-02	lb/MMcf	0.1934	95.21	CATEF

1. Permit limits (each turbine/duct burner set): NOX = 528 lb/day, SO2 = 15.6 lb/hr, POC = 8.3 lb/hr
2. Permit limits (sum of all turbine/duct burner sets): NOX = 79.8 ton/yr, SO2 = 153 ton/yr, POC = 30.5 ton/yr
3. CO EF (lb/MMBtu) = PPMV / 10^6 x (20.9% / 20.9% - %O2) x Fd (dscf/MMBtu) x MW (lb/lb-mol) / MVC (scf/lb-mol)
4. Full calculation method for Sulfuric acid (H2SO4) is documented with the facility's Regulation 12-15 calculations.

CARB GHG GWP

CO2	1
CH4	21
N2O	310

PAH as B[a]P equiv calculation

PEF		PAH or derivative		
0.1		benz(a)anthracene	6.24E-06	lb/MMcf
0.1		benzo(b)fluoranthene	9.88E-06	lb/MMcf
0.1		benzo(j)fluoranthene	-	
0.1		benzo(k)fluoranthene	4.68E-07	lb/MMcf
1		benzo(a)pyrene	4.68E-07	lb/MMcf
0.01		chrysene	3.94E-05	lb/MMcf
0.1		dibenz(a,j)acridine	-	
0.1		dibenz(a,h)acridine	-	
1.05		dibenz(a,h)anthracene	4.68E-07	lb/MMcf
1		7H-dibenzo(c,g)carbazole	-	
1		dibenzo(a,e)pyrene	-	
10		dibenzo(a,h)pyrene	-	
10		dibenzo(a,i)pyrene	-	
10		dibenzo(a,l)pyrene	-	
64		7,12-dimethylbenz(a)anthrac	-	
0.1		indeno(1,2,3-cd)pyrene	4.68E-07	lb/MMcf
1		5-methylchrysene	-	
5.7		3-methylcholanthrene	-	
0.03		5-nitroacenaphthene	-	
0.1		1-nitropyrene	-	
0.1		4-nitropyrene	-	
10		1,6-dinitropyrene	-	
1		1,8-dinitropyrene	-	
10		6-nitrocrysene	-	
0.01		2-nitrofluorene	-	

Appendix B, Table B-9
Potential to Emit (PTE) Emissions for Duct Burners (S-355 through S-357)
Pre-Project PTE = Post-Project PTE

Parameter	Value	Units	Reference
Max Firing Rate (daily)	525	MMBtu/hour (combined for all sources S-355 through S-357; each duct burner is 175 MMBtu/hr)	Application #30810
Max Firing Rate (annual)	1048	MMBtu/hour	BAAQMD Condition 18629, Part D.3, combined for turbines and duct burners S-352 through S-357
Fuel HHV	1321	BTU/SCF	Max daily between 2018-2021 (Turbine blend)
MVC	386.9	SCF @70 degF/lb-mol	BAAQMD Guidelines, Table 5.4-1
Hours per day	24	Hours	
Days per year	365	Days	

Pollutant	Emission Factor	Units	PTE Emissions		Reference
Criteria (Combined for turbines and duct burners S-352 through S-357)			**lb/day**	**ton/yr**	
PM10	**See Table B-8**				
PM2.5					
NOX					
CO					
SO2					
POC					
Greenhouse Gases			**MT/day (combined for all duct burners S-355 through S-357**	**MT/yr (combined for all turbines and duct burners S-352 through S-357)**	
CO2	5.90E+01	kg/MMBtu	743.40	**See Table B-8**	CARB default EF for fuel gas
CH4	3.00E-03	kg/MMBtu	0.0378		CARB default EF for fuel gas
N2O	6.00E-04	kg/MMBtu	0.0076		CARB default EF for fuel gas
CO2e			746.54		CARB GWP factors
Toxic Air Contaminants			**lb/day (combined for all sources S-355 through S-357)**	**lb/yr (combined for all turbines and duct burners S-352 through S-357)**	**Reference**
Acetaldehyde	1.56E-02	lb/MMcf	0.1488	**See Table B-8**	CATEF
Ammonia	4.47E-03	lb/MMBtu	56.2734		10 ppmv @ 3% O2
Arsenic	1.25E-06	lb/MMBtu	0.0158		2018 U240 B-201 Source Test
Benzene	1.92E-03	lb/MMcf	0.0183		CATEF
Cadmium	9.32E-09	lb/MMBtu	0.0001		2018 U240 B-201 Source Test
Chromium (hexavalent)	2.70E-09	lb/MMBtu	0.0000		2018 U240 B-201 Source Test
Formaldehyde	2.95E-02	lb/MMcf	0.2814		CATEF
Hexane (n-)	1.80E-03	lb/MMBtu	22.6800		ICR Protocol, Table 4-3
Nickel	6.75E-07	lb/MMBtu	0.0085		2018 U240 B-201 Source Test
Propylene	5.45E-02	lb/MMcf	0.5198		CATEF
Sulfuric acid	**See Table B-8**				2002 Oil & Gas Journal[4]
Toluene	5.95E-03	lb/MMcf	0.0568		CATEF
Vanadium	2.30E-06	lb/MMBtu	0.0290		ICR Protocol, Table 4-3
Xylene (mixed isomers)	1.37E-02	lb/MMcf	0.1307		CATEF

1. CATEF emission factors are Appendix A of BAAQMD Petroleum Refinery Emissions Inventory Guidelines.