

Attachment 4

Supplemental Project and BACT information-E-mails/E-mail dated November 30, 2011, from Energy Answers Consultant (Kevin Scott) to EPA (Viorica Petriman): information related to the GHG emissions, AR I.B.6.7



GHG Tables
Scott, Kevin

to:

Viorica Petriman

11/30/2011 01:46 PM

Hide Details

From: "Scott, Kevin" <Kevin.Scott@arcadis-us.com>

To: Viorica Petriman/R2/USEPA/US@EPA

2 Attachments



PR GHG Emissions data - Annual.pdf PR GHG Emissions data - Short-term.pdf

Viorica,

Here are the revised GHG emission tables. One set is for the annual emissions, and the second is the maximum short-term emissions (110% load). I also added in the emissions from the propane pilot at the RSCR.

I will call as soon as I get a chance.

Thanks,

Kevin

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ENERGY ANSWERS ARECIBO
GHG BACT Emission Calculations - Short Term Maximum Operations

1. GHG from ENERGY ANSWERS power generation:

Firing PRF with Supplemental Fuels:

OPERATING SCENARIO	Fuel	mmBTU/ton	GHG	kg/mmBtu (1)	kg/ton	lb/ton	MAX FUEL USE FACTOR ⁽²⁾	MAX TPD Used	LB/HR GHG EMISSIONS 110% capacity
PRF Primary Fuel	PRF	11.4	CO2	90.7	1034	2280	1	2316	219,973
		11.4	CH4	0.032	0.36	0.80	1	2316	78
		11.4	N2O	0.0042	0.048	0.11	1	2316	10
	PRF							2316	220,061
AOS 1	TDF	26.87	CO2	85.97	2310	5,093	0.37	364	77,138
PRF + TDF	(20%) ⁽³⁾	26.87	CH4	0.032	0.860	1.90	0.37	364	29
		26.87	N2O	0.0042	0.113	0.25	0.37	364	4
PRF + TDF	PRF (80%) ⁽³⁾	11.4	CO2	90.7	1034	2,280	0.63	1459	138,583
		11.4	CH4	0.032	0.36	0.80	0.63	1459	49
		11.4	N2O	0.0042	0.048	0.11	0.63	1459	6
	PRF + TDF							1823	215,809
AOS 2	ASR	38.0	CO2	75	2850	6,283	0.455	316	82,755
PRF + ASR	(20%) ⁽³⁾	38.0	CH4	0.032	1.216	2.68	0.455	316	35
		38.0	N2O	0.0042	0.160	0.35	0.455	316	5
PRF + ASR	PRF (80%) ⁽³⁾	11.4	CO2	90.7	1034	2,280	0.545	1262	119,885
		11.4	CH4	0.032	0.3648	0.80	0.545	1262	42
		11.4	N2O	0.0042	0.04788	0.11	0.545	1262	6
	PRF + ASR							1578	202,728
AOS 3	UWW	15.38	CO2	93.8	1443	3,180	0.574	986	130,659
PRF + UWW	(50%) ⁽³⁾	15.38	CH4	0.032	0.49	1.09	0.574	986	45
		15.38	N2O	0.0042	0.06	0.14	0.574	986	6
PRF + UWW	PRF (50%) ⁽³⁾	11.4	CO2	90.7	1034	2,280	0.426	986	93,620
		11.4	CH4	0.032	0.36	0.80	0.426	986	33
		11.4	N2O	0.0042	0.05	0.11	0.426	986	4
	PRF + UWW							1972	224,367

Notes:

- (1) Emission factors taken from 40 CFR 98 Subpart C Table C-1 for CO2, and Table C-2 for CH4 and N2O
- (2) Fuel Use factor adjusts the usage rate after considering higher heat values of the fuel and its weight (density) to maintain a total energy input of 1100 mmbtu/hr (2 x 550 mmbtu/hr each boiler) and the weight based usage ratio.
- (3) Represents weight-based fraction in the total fuel mix

ENERGY ANSWERS ARECIBO
GHG BACT Emission Calculations - Short Term Maximum Operations

Firing No. 2 Fuel Oil / Propane Combustion - 100% Non-biogenic GHG emissions

Emission factors taken from 40 CFR 98 Tables C-1 and C-2.

2 x 500 mmbtu/hr boilers (combusting approximately 7142 gph and 424,000 gpy) Assumes 8% operating factor for startup and shutdown

	kg/mmbtu	lb/hr	Mass ton/year	GWP	CO2e lb/hr	CO2e ton/year
CO2	73.96	162712	4,830	1	162712	4,830
Methane	0.003	6.6	0.196	23	151.8	4.51
N2O	0.0006	1.32	0.039	310	409.2	12.15
Total		162,720	4,830		163,273	4,847

Emission factors taken from 40 CFR 98 Tables C-1 and C-2.

670 hp Emergency Diesel Generator for 500 hours (32.4 gph and 16,200 gpy)

	kg/mmbtu	lb/hr	Mass ton/year	GWP	CO2e lb/hr	CO2e ton/year
CO2	73.96	728	182	1	728	182
Methane	0.003	0.030	0.00738	23	0.68	0.17
N2O	0.0006	0.0059	0.00148	310	1.8	0.46
Total	73.96	728	182		730	183

Emission factors taken from 40 CFR 98 Tables C-1 and C-2.

335 hp Diesel Fire Pump for 500 hours (16.2 gph and 8,100 gpy)

	kg/mmbtu	lb/hr	Mass ton/year	GWP	CO2e lb/hr	CO2e ton/year
CO2	73.96	363.8	91	1	364	91
Methane	0.003	0.015	0.00369	23	0.34	0.08
N2O	0.0006	0.0030	0.00074	310	0.915	0.23
Total	73.96	363.8	90.9		365	91.3

Emission factors taken from 40 CFR 98 Tables C-1 and C-2.

4.5 mmbtu/hr per RSCR burner. Calculations are for both RSCR units.

	kg/mmbtu	lb/hr	Mass ton/year	GWP	CO2e lb/hr	CO2e ton/year
CO2	73.96	1464.4	6,414	1	1464	6,414
Methane	0.003	0.0594	0.260	23	1.37	5.98
N2O	6.00E-04	0.01188	0.052	310	3.683	16.13
Total		1,464	6,414		1469	6,436

Total for Fuel Oil :	165,276	11,517	165,837	11,557
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RSCR PROPANE PILOT FLAME

Emission factors taken from 40 CFR 98 Tables C-1 and C-2.

0.3 mmbtu/hr per RSCR burner. Calculations are for both RSCR units.

	kg/mmbtu	lb/hr	Mass ton/year	GWP	CO2e lb/hr	CO2e ton/year
CO2	61.46	81.1	355	1	81	355
Methane	0.003	0.00396	0.017	23	0.09	0.40
N2O	6.00E-04	0.000792	0.003	310	0.246	1.08
Total		81	355		81	357

Total for Propane :	81	355	81	357
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ENERGY ANSWERS ARECIBO
GHG BACT Emission Calculations - Short Term Maximum Operations

GHG SUMMARY - MAXIMUMS FOR PROPOSED FUEL BLENDS

Short-Term Max Steam Rate = 782,358 lb/hr steam

	Mass GHG LB/HR	LB/HR AS CO ₂ e	MAX LB/HR BIOGENIC CO ₂ e	MAX LB/HR NONBIOGENIC CO ₂ e	Proposed BACT (Non Biogenic CO ₂ e Emission Rate)*		Total CO ₂ e	
						lb CO ₂ e / lb steam		lb CO ₂ e / lb steam
BOILERS - SOLID FUELS:	224,367	229,222	191,686	114,185	0.15	lb CO ₂ e / lb steam	0.29	lb CO ₂ e / lb steam
RSCR w/ PILOT FLAME:	1,546	1,551	0	1,551				
BOILERS - FUEL OIL:	162,720	163,273	0	163,273	163,273	lb/hr		
EDG:	728	730	0	730	730	lb/hr		
FWP:	363.8	365	0	365	365	lb/hr		
TOTAL	389,724	395,141	191,686	280,103				

* Based on emission factors taken from 40 CFR 98 Subpart C Table C-1 for CO₂, and Table C-2 for CH₄ and N₂O

**ENERGY ANSWERS ARECIBO
GHG BACT Emission Calculations - Annualized Operations**

1. GHG from ENERGY ANSWERS power generation:

Firing PRF with Supplemental Fuels:

OPERATING SCENARIO	Fuel	mmBTU/ton	GHG	kg/mmBtu (1)	kg/ton	lb/ton	MAX FUEL USE FACTOR ⁽²⁾	MAX TPD Used	TPY GHG EMISSIONS 100% capacity
PRF Primary Fuel	PRF	11.4	CO2	90.7	1034	2280	1	2106	876,119
		11.4	CH4	0.032	0.36	0.80	1	2106	309
		11.4	N2O	0.0042	0.048	0.11	1	2106	41
	PRF							2106	876,469
AOS 1 PRF + TDF	TDF (20%) ⁽³⁾	26.87	CO2	85.97	2310	5,093	0.37	330	307,151
		26.87	CH4	0.032	0.860	1.90	0.37	330	114.3
		26.87	N2O	0.0042	0.113	0.25	0.37	330	15.0
	PRF (80%) ⁽³⁾	11.4	CO2	90.7	1034	2,280	0.63	1327	551,955
		11.4	CH4	0.032	0.36	0.80	0.63	1327	195
		11.4	N2O	0.0042	0.048	0.11	0.63	1327	26
	PRF + TDF							1657	859,456
AOS 2 PRF + ASR	ASR (20%) ⁽³⁾	38.0	CO2	75	2850	6,283	0.455	287	329,516
		38.0	CH4	0.032	1.216	2.68	0.455	287	140.6
		38.0	N2O	0.0042	0.160	0.35	0.455	287	18.5
	PRF (80%) ⁽³⁾	11.4	CO2	90.7	1034	2,280	0.545	1148	477,485
		11.4	CH4	0.032	0.3648	0.80	0.545	1148	168
		11.4	N2O	0.0042	0.04788	0.11	0.545	1148	22
	PRF + ASR							1435	807,351
AOS 3 PRF + UWW	UWW (50%) ⁽³⁾	15.38	CO2	93.8	1443	3,180	0.575	897	520,804
		15.38	CH4	0.032	0.49	1.09	0.575	897	178
		15.38	N2O	0.0042	0.06	0.14	0.575	897	23
	PRF (50%) ⁽³⁾	11.4	CO2	90.7	1034	2,280	0.425	895	372,351
		11.4	CH4	0.032	0.36	0.80	0.425	895	131
		11.4	N2O	0.0042	0.05	0.11	0.425	895	17
	PRF + UWW							1792	893,505

Notes:

(1) Emission factors taken from 40 CFR 98 Subpart C Table C-1 for CO2, and Table C-2 for CH4 and N2O

(2) Fuel Use factor adjusts the usage rate after considering higher heat values of the fuel and its weight (density) to maintain a total energy input of 1000 mmbtu/hr (2 x 500 mmbtu/hr each boiler) and the weight based usage ratio.

(3) Represents weight-based fraction in the total fuel mix

ENERGY ANSWERS ARECIBO
GHG BACT Emission Calculations - Annualized Operations

1. GHG from ENERGY ANSWERS power generation:

Firing PRF with Supplemental Fuels:

OPERATING SCENARIO	Fuel	TPY GHG EMISSIONS 100% capacity	GWP	TPY CO ₂ e 100% capacity	BOGENIC FRACTION	MAX BIOGENIC TPY CO ₂ e	NONBIOGENIC FRACTION	MAX NONBIOGENIC TPY CO ₂	MAX NONBIOGENIC TPY CO ₂ e
PRF Primary Fuel	PRF	876,119	1	876,119	0.670	587,000	0.330	289,119	289,119
		309	23	7,109					7,109
		41	310	12,577					12,577
	PRF	876,469		895,805	0.655	587,000	0.345	289,119	308,805
AOS 1	TDF	307,151	1	307,151	0.2	61,430	0.8	245,721	245,721
PRF + TDF	(20%) ⁽³⁾	114.3	23	2,630					2,630
		15.0	310	4,652					4,652
	PRF	551,955	1	551,955	0.670	369,810	0.330	182,145	182,145
	(80%) ⁽³⁾	195	23	4,479					4,479
		26	310	7,923					7,923
	PRF + TDF	859,456		878,790	0.491	431,240	0.509	427,866	447,550
AOS 2	ASR	329,516	1	329,516	0.158	52,064	0.842	277,453	277,453
PRF + ASR	(20%) ⁽³⁾	140.6	23	3,234					3,234
		18.5	310	5,720					5,720
	PRF	477,485	1	477,485	0.670	319,915	0.330	157,570	157,570
	(80%) ⁽³⁾	168	23	3,875					3,875
		22	310	6,854					6,854
	PRF + ASR	807,351		826,684	0.450	371,978	0.550	435,023	454,706
AOS 3	UWW	520,804	1	520,804	0.987	514,034	0.013	6,770	6,770
PRF + UWW	(50%) ⁽³⁾	178	23	4,086					4,086
		23	310	7,229					7,229
	PRF	372,351	1	372,351	0.670	249,475	0.330	122,876	122,876
	(50%) ⁽³⁾	131	23	3,022					3,022
		17	310	5,345					5,345
	PRF + UWW	893,505		912,837	0.836	763,509	0.164	129,646	149,328

**ENERGY ANSWERS ARECIBO
GHG BACT Emission Calculations - Annualized Operations**

Firing No. 2 Fuel Oil / Propane Combustion - 100% Non-biogenic GHG emissions

Emission factors taken from 40 CFR 98 Tables C-1 and C-2.

2 x 500 mmbtu/hr boilers (combusting approximately 7142 gph and 424,000 gpy) Assumes 8% operating factor for startup and shutdown

	kg/mmbtu	lb/hr	Mass ton/year	GWP	CO2e lb/hr	CO2e ton/year
CO2	73.96	162712	4,830	1	162712	4,830
Methane	0.003	6.6	0.196	23	151.8	4.51
N2O	0.0006	1.32	0.039	310	409.2	12.15
Total		162,720	4,830		163,273	4,847

Emission factors taken from 40 CFR 98 Tables C-1 and C-2.

670 hp Emergency Diesel Generator for 500 hours (32.4 gph and 16,200 gpy)

	kg/mmbtu	lb/hr	Mass ton/year	GWP	CO2e lb/hr	CO2e ton/year
CO2	73.96	728	182	1	728	182
Methane	0.003	0.030	0.00738	23	0.68	0.17
N2O	0.0006	0.0059	0.00148	310	1.8	0.46
Total	73.96	728	182		730	183

Emission factors taken from 40 CFR 98 Tables C-1 and C-2.

335 hp Diesel Fire Pump for 500 hours (16.2 gph and 8,100 gpy)

	kg/mmbtu	lb/hr	Mass ton/year	GWP	CO2e lb/hr	CO2e ton/year
CO2	73.96	363.8	91	1	364	91
Methane	0.003	0.015	0.00369	23	0.34	0.08
N2O	0.0006	0.0030	0.00074	310	0.915	0.23
Total	73.96	363.8	90.9		365	91.3

Emission factors taken from 40 CFR 98 Tables C-1 and C-2.

4.5 mmbtu/hr per RSCR burner. Calculations are for both RSCR units.

	kg/mmbtu	lb/hr	Mass ton/year	GWP	CO2e lb/hr	CO2e ton/year
CO2	73.96	1464.4	6,414	1	1464	6,414
Methane	0.003	0.0594	0.260	23	1.37	5.98
N2O	6.00E-04	0.01188	0.052	310	3.683	16.13
Total		1,464	6,414		1469	6,436

Total for Fuel Oil :			11,517		165,837	11,557
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RSCR PROPANE PILOT FLAME

Emission factors taken from 40 CFR 98 Tables C-1 and C-2.

0.3 mmbtu/hr per RSCR burner. Calculations are for both RSCR units.

	kg/mmbtu	lb/hr	Mass ton/year	GWP	CO2e lb/hr	CO2e ton/year
CO2	61.46	81.1	355	1	81	355
Methane	0.003	0.00396	0.017	23	0.09	0.40
N2O	6.00E-04	0.000792	0.003	310	0.246	1.08
Total		81	355		81	357

Total for Propane :			355		81	357
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ENERGY ANSWERS ARECIBO
GHG BACT Emission Calculations - Annualized Operations
TABLE 12

GHG SUMMARY - MAXIMUMS FOR PROPOSED FUEL BLENDS

Annual Steam Rate = 6,264 million lb/yr

	Mass GHG TPY	TPY AS CO2e	MAX TPY BIOGENIC CO2	MAX TPY NONBIOGENIC CO2e	Proposed BACT (Non Biogenic CO2e Emission Rate)*		Total CO2e	
BOILERS - SOLID FUELS:	893,505	912,837	763,509	454,706	74	ton/million lb steam	147	ton/million lb steam
RSCR w/ PILOT FLAME:	6,770	6,793	0	6,793				
BOILERS - FUEL OIL:	4,830	4,847	0	4,847	163,273	lbs/hr		
EDG:	182	183	0	183	730	lbs/hr		
FWP:	90.9	91.3	0	91	365	lbs/hr		
TOTAL	905,377	924,750	763,509	466,619				

* Based on emission factors taken from 40 CFR 98 Subpart C Table C-1 for CO2, and Table C-2 for CH4 and N2O