APPENDIX A
COLD-START ADJUSTMENT FACTORS

DIESEL GENERATOR COLD-START ADJUSTMENT FACTORS
ICF INTERNATIONAL, APRIL-2011

Short-term concentration trends for VOC, CO and NOx immediately following a cold start by a large diesel backup generator were measured by the California Energy Commission for their document :Air Quality Implications of Backup Generators in California" dated July 2005. They used continuous monitors to measure the following trends, which are shown in the attached figure:

During the first 14 seconds after cold-start, the VOC concentration spiked up to a maximum value of 900 ppm before dropping back to the steady state value of 30 ppm. The area under the concentration-vs-time curve represents a "VOC spike" of 6,300 ppm-sec..

It took 8 seconds for the NOx concentration to ramp up to its steady state value of 38 ppm. The area under the concentration-vs-time curve represents the "NOx deficit" of 160 ppm-sec.

The Cold Start Adjustment Factor for DPM was estimated by assuming the concentration trend for DPM should be similar to the trend for VOC. In that case, for any generator operating period after a cold start, the adjustment factor is the area under the VOC Spike divided by the area under the 30 ppm steady state concentration profile.

<u>**Example: DPM emissions for 1-hour Generator Runtime After Cold Start**</u>

The steady state VOC concentration is 30 ppm. For a 1-hour runtime the VOC emission is the area under the concentration-vs-time curve, or 30 pppm x 3600 seconds = 108,000 ppm-sec.

The "cold start factor" is the VOC spike area divided by the steady state area:

(6300 ppm-sec) / (108,000 ppm-sec) = 0.058.

So during the 1-hour period following a cold start the overall DPM emission factor is adjusted by the "cold start factor" of 1.058.

<u>**Example: NOx Emissions During 1-Hour Runtime Following Cold Start**</u>

NOx Deficit = 160 ppm-sec

Steady-state NOx profile = 38 ppm x 3600 sec = 137,000 ppm-sec

NOx Cold Start Factor = 1 - (160/137,000) = 0.999 x Steady State Emission Factor

Table B-1. Emission Factor Adjustments for Cold Start

Runtime Following Cold Start	DPM	NOx
10-minutes	1.35	0.999
30-minutes	1.12	0.999
1-hour	1.058	0.999
8-hours	1.007	0.999

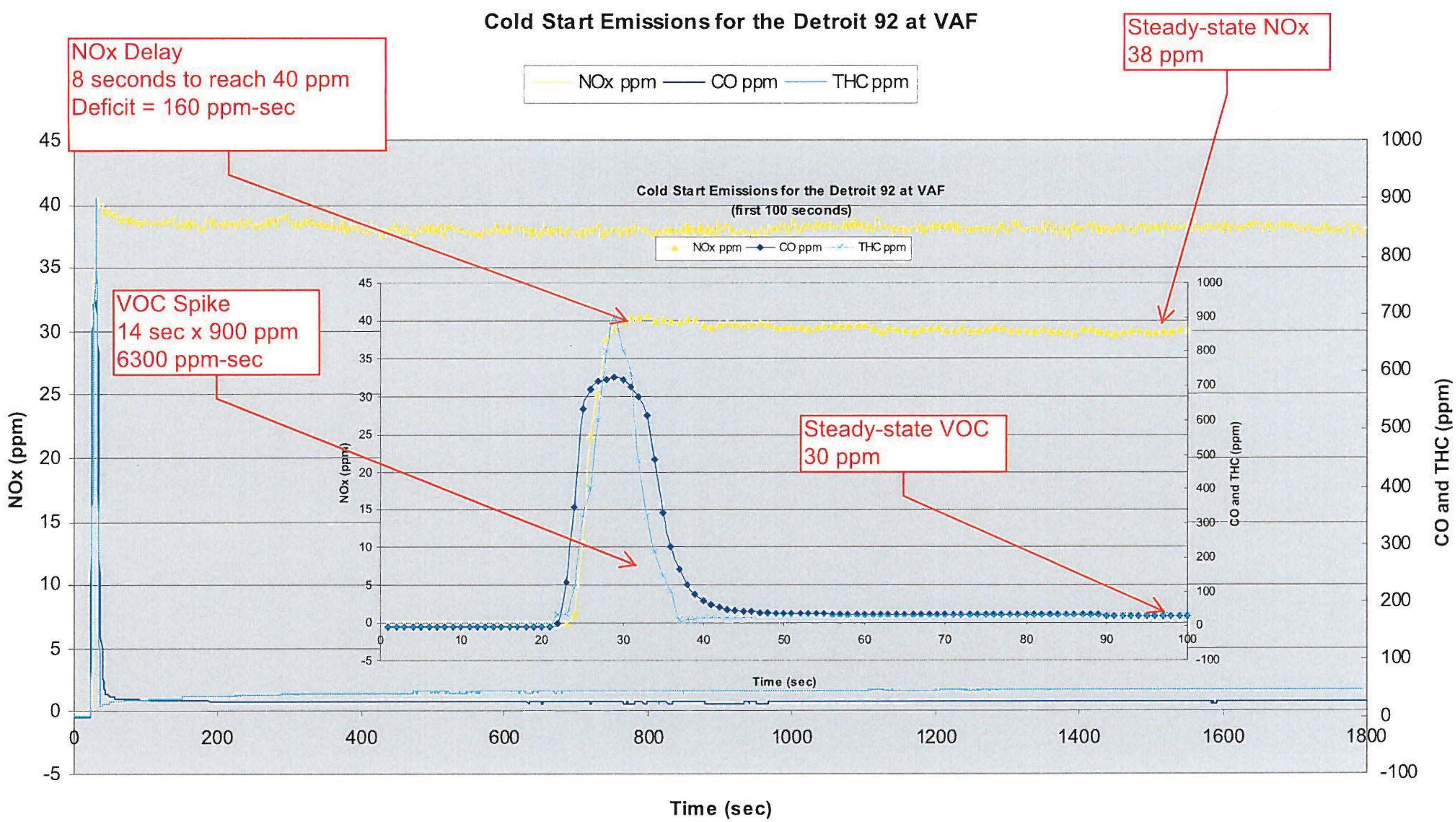
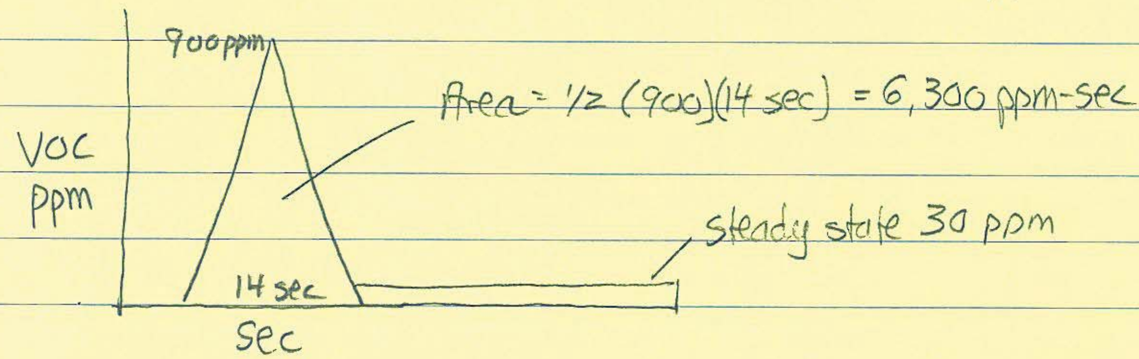


Figure 19. Cold-start emissions for CO and NO_X as a function of time

VOC Spike

VOC Spike Area = ½(900 ppm)(14 sec) = 6,300 ppm-sec



Steady State VOC Areas @ 30 ppm

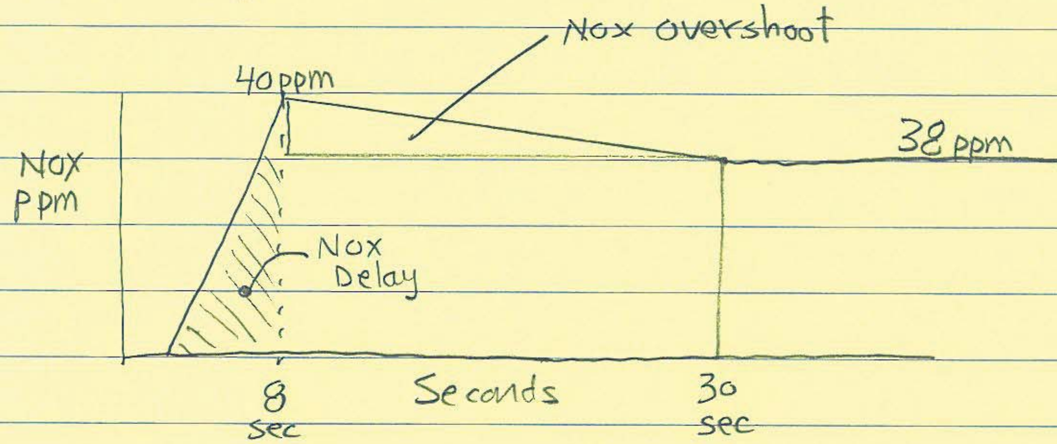
10-minutes Area = 30 ppm x 600 sec = 18,000 ppm-sec
Cold-Start Factor = 6,300/18,000 = 0.35
So DPM in 1st 10 minutes = 1.35 * Steady state

30-min Area = 30 ppm x 30 min x 60 = 54,000 ppm-sec
Cold Start factor = 6300/54,000 = 0.12
So DPM in 1st 30 min = 1.12 * Steady state

60-minutes = 30 ppm x 60 min x 60 sec/min = 108,000 ppm-sec
Cold start factor = 6300/108,000 = 0.058
So DPM in 1st 60 min = 1.058 * Steady state

8-hours: 30 ppm x 8 hrs x 3600 sec/hr = 864,000 ppm-sec
Cold Start factor = 6300/864,000 = 0.0073
So DPM in 8-hrs = 1.0073 * Steady state

NOx Delay



Nox Delay: 8 secs to reach 40 ppm

Area = 1/2 (8 sec)(40) = 160 ppm-sec

Nox Overshoot: 22 secs to drop to 38 ppm

Area = 1/2 (22 sec)(2 ppm) = 22 ppm-sec

Net Deficit = 22 ppm-sec − 160 ppm-sec = −138 ppm-sec

1-hour Nox Cold-Start Factor @ 38 ppm steady state

Steady state 1-hr = 3600 sec x 38 ppm = 137,000 ppm-sec

Cold start factor = −138 ppm-sec / 137,000 ppm-sec

So Cold start adjustment = 0.999 * Steady state

APPENDIX B
EMISSION CALCULATIONS AND AERMOD DISPERSION FACTORS

Table B-1. Per-Generator Emission Rates in lbs/hour

MTU's Stable Condition Not-to-Exceed (Stack Test Limits), lbs/hour					
Electrical Load	**PM**	**Nox**	**Primary NO2**	**CO**	**VOC**
100% (3,000 kWe)	0.484	10.3	0.4	1.35	0.22
93%	0.444	9.3	0.4	1.24	0.22
90%	0.425	8.83	0.4	1.19	0.22
81%	0.374	7.58	0.4	1.05	0.22
10%	0.4	2.6	1.5	0.6	0.25
Controlled, Cold-Start, Catalyst-Delayed Emissions Used for AERMOD, lbs/hour					
Electrical Load	**PM**	**Nox**	**Primary NO2**	**CO**	**VOC**
100%	0.512	17.2	1.22	2.39	0.39
93%	0.47	15.4	1.1	2.17	0.39
90%	0.45	14.6	1.06	2.11	0.39
81%	0.396	12.5	0.95	1.93	0.39
10%	0.422	3.12	0.88	1.41	0.61
Nominal Uncontrolled Emissions, lbs/hour					
Electrical Load	**PM**	**Nox**	**Primary NO2**	**CO**	**VOC**
100%	3.23	51.7	5.17	6.8	1.1
93%	2.96	46.1	4.61	6.3	1.1
90%	2.83	43.6	4.36	6	1.1
81%	2.49	37.2	3.72	5.3	1.1
10%	2.67	5.7	0.57	2.8	1.2

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Table B-2a. Fuel Usage and Emissions During Startup/Commissioning Testing

Activity	Hours	Load	Per-Gen Fuel, gal/hr	Per-Generator lbs/hr				Per-Generator Startup Emissions, lbs				Per-Gen Fuel, gal
				PM	NOX	VOC	CO	PM	NOX	VOC	CO	
Level 3 Testing	8	100%	232	0.512	17.2	0.39	2.39	4.10	138	3.1	19.1	1,856
Level 4 Testing	12	75%	183	0.357	11.02	0.39	1.69	4.28	132	4.7	20.3	2,196
Level 5 Testing	20	100%	232	0.512	17.2	0.39	2.39	10.2	344	7.8	47.8	4,640
Combined Startup/Commissioning Each Generator								18.6	614	16	87.2	8,692
Number of Generators Tested 70-year period								17	17	17	17	17
Facility-Wide Startup/Commissioning, Combined 17 Generators (lbs)								317	10,435	265	1,482	147,764
Annualized 70-yr Average Startup emissions (tons/yr)								0.0023	0.0745	0.0019	0.0106	
Number of Generators Commissioned Mx Year of Full buildout								5	5	5	5	5
5-Genset Max Buildout Peak Year (lbs)								93	3,069	78	436	43,460
Facility-Wide DEEP Emissions from Startup Testing (tons)								0.158	5.218	0.133	0.741	
Facility-Wide DEEP Emissions from Routine Operations (tons)								0.221	5.83	0.36	1.22	
70-Year DEEP Emissions from Routine Operations (tons)								15.47	408.1	25.2	85.4	
Fraction of 70-Year Emissions Contributed by Initial Startup Testing and Commissioning								1.0%	1.3%	0.5%	0.9%	

Table B-2B. Fuel Usage and Emissions During Triennial Stack Testing

Activity	Hours	Load	Per-Gen Fuel, gal/hr	Warmed Up Per-Generator lbs/hr				Per-Generator Startup Emissions, lbs				Per-Gen Fuel, gal
				PM	NOX	VOC	CO	PM	NOX	VOC	CO	
Stack Testing	10	100%	232	0.484	10.3	0.22	1.35	4.84	103	2.2	13.5	2,320
Combined Stack Testing Each Generator								4.8	103	2	13.5	2,320
Number of Generators Tested any one year								7	7	7	7	7
Max-year stack testing of Generators (lbs)								34	721	15	95	16,240
3-yr Annualized Stack Testing, tons/yr (5.7 gens each year)								0.01379	0.29355	0.00627	0.03848	
Facility-Wide DEEP Emissions from Routine Operations (tons)								0.221	5.83	0.36	1.22	
Fraction of Routine Operational Emissions Contributed by Triennial Stack Testing								6.2%	5.0%	1.7%	3.2%	
								PM	NOX	VOC	CO	
Fraction of Routine Operational Emissions Contributed by Triennial Stack Testing and Initial Startup/Commissioning								7.3%	6.3%	2.3%	4.0%	

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Table B-3

CATALYST-DELAY EMISSION FACTORS

NOX-NO2 AFTER DISCUSSIONS WITH JAMES RICHMOND AND TODD SNARR, 9-13-2012

Elm-Approved Increases-Decreases
NO2 Emissions (lbs/hr) Accounting For Catalyst Delay Time

Load	Tot Run Time Min	Warm Up time	Untreated NO2 lbs/hr	Subtotal Time x NO2	Treated Time Min	Treated NO2 lbs/hr	Subtotal Time x NO2	Wt. Average NO2 lbs/hr
81	60	10	3.72	0.62	50	0.4	0.333333	0.95
90	60	10	4.36	0.727	50	0.4	0.333333	1.06
93	60	10	4.61	0.768	50	0.4	0.333333	1.10
Idle	60	20	0.57	0.19	40	1.5	1	1.190
Idle	30	20	0.57	0.38	10	1.5	0.5	0.880

Elm-Approved Increases-Decreases
NOX Emissions (lbs/hr) Accounting For Catalyst Delay Time

Load	Tot Run Time Min	Warm Up time	Untreated NOX lbs/hr	Subtotal Time x NOX	Treated Time Min	Treated NOX lbs/hr	Subtotal Time x NOX	Wt. Average NOX lbs/hr
81	60	10	37.2	6.2	50	7.58	6.316667	12.52
90	60	10	43.6	7.267	50	8.83	7.358333	14.63
93	60	10	46.1	7.683	50	9.3	7.75	15.43
Idle	60	20	6	2	40	2.6	1.733333	3.733
Idle	30	20	6	4	10	2.6	0.866667	4.867

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Controlled PM Emission Rates

Load	PM lbs/hr
100	0.484
81	0.374
90	0.425
93	0.444
Idle	0.40

Elm-Approved Increases-Decreases
CO Emissions (lbs/hr) Accounting For Catalyst Delay Time

Load	Tot Run Time Min	Warm Up time	Untreated CO lbs/hr	Subtotal Time x CO	Treated Time Min	Treated CO lbs/hr	Subtotal Time x CO	Wt. Average CO lbs/hr
81	60	10	5.3	0.883333	50	1.05	0.875	1.76
90	60	10	6	1.000	50	1.19	0.991667	1.99
93	60	10	6.3	1.050	50	1.24	1.033333	2.08
Idle	60	20	2.8	0.933333	40	0.6	0.4	1.333
50	60	10	4.2	0.7	50	0.84	0.7	1.40
60	60	10	4.4	0.733333	50	0.87	0.725	1.46
70	60	10	4.6	0.766667	50	0.91	0.758333	1.53
Idle	30	20	2.8	1.866667	10	0.6	0.2	2.067

Elm-Approved Increases-Decreases
VOC Emissions (lbs/hr) Accounting For Catalyst Delay Time

Load	Tot Run Time Min	Warm Up time	Untreated lbs/hr	Subtotal Time x conc	Treated Time Min	Treated lbs/hr	Subtotal Time x conc	Wt. Average VOC lbs/hr
81	60	10	1.1	0.183333	50	0.22	0.183333	0.37
90	60	10	1.1	0.183	50	0.22	0.183333	0.37
93	60	10	1.1	0.183	50	0.22	0.183333	0.37
Idle	60	20	1.23	0.41	40	0.25	0.166667	0.577
50	60	10	1.1	0.183333	50	0.22	0.183333	0.37
60	60	10	1.1	0.183333	50	0.22	0.183333	0.37
70	60	10	1.1	0.183333	50	0.22	0.183333	0.37
Idle	30	20	1.23	0.82	10	0.25	0.083333	0.903

Table B-4

ANNUAL EMISSIONS_ Oct-2012-INCREASED IDLE RATE_ Riker Data Center (10-11-2012)

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DAYIME-MASKED TABLE AA. Annual DPM - Scheduled Diagnostic Testing, Power Outage + Storm Avoidance, Corrective Maintenance, and De-energized Building Maintenance,

				Hours at Each Runtime Mode																							
Gen #	Gen Area	Engine Load	No. Gens	W	M	Q	A-F	A-Step	Corr	De-En	Outage	Cool	Total hrs/yr	AERMOD Hrs/day	Each Genset DPM lbs/hr	Each Genset Fuel Gal/Hr	Each Genset NOX lbs/hr	Each Genset DPM lbs/yr	Facility Wide DPM Tons/yr	Facility-Wide Fuel Gal/Year	Facility Wide NOX Tons/yr	Each Genset CO lbs/hr	Facility-Wide CO Tons/Yr	Each Genset HC lbs/hr	Facility-Wide HC Tons/Yr	Each Genset NO2 lbs/hr	Facility-Wide NO2 Tons/Yr
A - Unplanned Outage + Storm Avoidance (24 hrs/d				Unplanned Outage + Storm Avoidance																							
1-1 to 1-5	Bldg 1	81%	5								24		24	24	0.396	195	12.5	9.5	0.02376	23,400	0.75	1.76	0.1056	0.37	0.0222	0.95	0.057
2-1 to 2-3	Bldg 2	90%	3								24		24	24	0.45	213	14.6	10.8	0.0162	15,336	0.5256	1.99	0.07164	0.37	0.01332	1.06	0.038
3-1 to 3-3	Bldg 3	90%	3								24		24	24	0.45	213	14.6	10.8	0.0162	15,336	0.5256	1.99	0.07164	0.37	0.01332	1.06	0.038
ETC-1	ETC	93%	1								24		24	24	0.47	220	15.4	11.3	0.00564	5,280	0.1848	2.08	0.02496	0.37	0.00444	1.1	0.013
Group B - Testing at Full Outage Loads				Testing at Full Outage Loads																							
1-1 to 1-5	Bldg 1	81%	5			3	6			8			17	12	0.396	195	12.5	6.7	0.01683	16,575	0.53125	1.76	0.0748	0.37	0.015725	0.95	0.040
2-1 to 2-3	Bldg 2	90%	3			3	6			8			17	12	0.45	213	14.6	7.7	0.011475	10,863	0.3723	1.99	0.050745	0.37	0.009435	1.06	0.027
3-1 to 3-3	Bldg 3	90%	3			3	6			8			17	12	0.45	213	14.6	7.7	0.011475	10,863	0.3723	1.99	0.050745	0.37	0.009435	1.06	0.027
ETC-1	ETC	93%	1			3	6			8			17	12	0.47	220	15.4	8.0	0.003995	3,740	0.1309	2.08	0.01768	0.37	0.003145	1.1	0.009
Group C - 100% Load During Testing (Daytime				Testing at 100% Load																							
1-1 to 1-5	Bldg 1	100%	5					0.5	8				8.5	12	0.512	232	17.2	4.4	0.01088	9,860	0.3655	2.39	0.050788	0.37	0.007863	1.22	0.026
2-1 to 2-3	Bldg 2	100%	3					0.5	8				8.5	12	0.512	232	17.2	4.4	0.006528	5,916	0.2193	2.39	0.030473	0.37	0.004718	1.22	0.016
3-1 to 3-3	Bldg 3	100%	3					0.5	8				8.5	12	0.512	232	17.2	4.4	0.006528	5,916	0.2193	2.39	0.030473	0.37	0.004718	1.22	0.016
ETC-1	ETC	100%	1					0.5	8				8.5	12	0.512	232	17.2	4.4	0.002176	1,972	0.0731	2.39	0.010158	0.37	0.001573	1.22	0.005
1-6 and 1-7 Reserve	Bldg 1	100%	2					0.5	8				8.5	12	0.512	232	17.2	4.4	0.004352	3,944	0.1462	2.39	0.020315	0.37	0.003145	1.22	0.010
2-4 Reserve	Bldg 2	100%	1					0.5	8				8.5	12	0.512	232	17.2	4.4	0.002176	1,972	0.0731	2.39	0.010158	0.37	0.001573	1.22	0.005
3-4 Reserve	Bldg 3	100%	1					0.5	8				8.5	12	0.512	232	17.2	4.4	0.002176	1,972	0.0731	2.39	0.010158	0.37	0.001573	1.22	0.005
ETC-2 Reserve	ETC	100%	1					0.5	8				8.5	12	0.512	232	17.2	4.4	0.002176	1,972	0.0731	2.39	0.010158	0.37	0.001573	1.22	0.005
D1 _ Idle During Emergency Outages (24				Idle During Outages (24 hrs/day)																							
1-1 to 1-5	Bldg 1	10%	5	0	0	0	0	0	0	0	0	4	4	24	0.4224	45	3.73	1.7	0.004224	900	0.0373	1.333	0.01333	0.577	0.00577	1.19	0.012
2-1 to 2-3	Bldg 2	10%	3	0	0	0	0	0	0	0	0	4	4	24	0.4224	45	3.73	1.7	0.002534	540	0.02238	1.333	0.007998	0.577	0.003462	1.19	0.007
3-1 to 3-3	Bldg 3	10%	3	0	0	0	0	0	0	0	0	4	4	24	0.4224	45	3.73	1.7	0.002534	540	0.02238	1.333	0.007998	0.577	0.003462	1.19	0.007
ETC-1	ETC	10%	1	0	0	0	0	0	0	0	0	4	4	24	0.4224	45	3.73	1.7	0.000845	180	0.00746	1.333	0.002666	0.577	0.001154	1.19	0.002
1-6 and 1-7 Reserve	Bldg 1	10%	2	0	0	0	0	0	0	0	12	1	13	24	0.4224	45	3.73	5.5	0.005491	1,170	0.04849	1.333	0.017329	0.577	0.007501	1.19	0.015
2-4 Reserve	Bldg 2	10%	1	0	0	0	0	0	0	0	24	1	25	24	0.4224	45	3.73	10.6	0.00528	1,125	0.046625	1.333	0.016663	0.577	0.007213	1.19	0.015
3-4 Reserve	Bldg 3	10%	1	0	0	0	0	0	0	0	24	1	25	24	0.4224	45	3.73	10.6	0.00528	1,125	0.046625	1.333	0.016663	0.577	0.007213	1.19	0.015
ETC-2 Reserve	ETC	10%	1	0	0	0	0	0	0	0	24	1	25	24	0.4224	45	3.73	10.6	0.00528	1,125	0.046625	1.333	0.016663	0.577	0.007213	1.19	0.015
D2 _ Idle During Testing (Daytime Only)				Idle During Testing (Daytime Only)																							
1-1 to 1-5	Bldg 1	10%	5	20	3	0	0	0	0	0	0	5.5	28.5	12	0.4224	45	3.73	12.0	0.030096	6,413	0.265763	2.07	0.147488	0.903	0.064339	0.88	0.063
2-1 to 2-3	Bldg 2	10%	3	20	3	0	0	0	0	0	0	5.5	28.5	12	0.4224	45	3.73	12.0	0.018058	3,848	0.159458	2.07	0.088493	0.903	0.038603	0.88	0.038
3-1 to 3-3	Bldg 3	10%	3	20	3	0	0	0	0	0	0	5.5	28.5	12	0.4224	45	3.73	12.0	0.018058	3,848	0.159458	2.07	0.088493	0.903	0.038603	0.88	0.038
ETC-1	ETC	10%	1	20	3	0	0	0	0	0	0	5.5	28.5	12	0.4224	45	3.73	12.0	0.006019	1,283	0.053153	2.07	0.029498	0.903	0.012868	0.88	0.013
1-6 and 1-7 Reserve	Bldg 1	10%	2	20	3	3	6			8	0	0.5	40.5	12	0.4224	45	3.73	17.1	0.017107	3,645	0.151065	2.07	0.083835	0.903	0.036572	0.88	0.036
2-4 Reserve	Bldg 2	10%	1	20	3	3	6			8	0	0.5	40.5	12	0.4224	45	3.73	17.1	0.008554	1,823	0.075533	2.07	0.041918	0.903	0.018286	0.88	0.018
3-4 Reserve	Bldg 3	10%	1	20	3	3	6			8	0	0.5	40.5	12	0.4224	45	3.73	17.1	0.008554	1,823	0.075533	2.07	0.041918	0.903	0.018286	0.88	0.018
ETC-2 Reserve	ETC	10%	1	20	3	3	6			8	0	0.5	40.5	12	0.4224	45	3.73	17.1	0.008554	1,823	0.075533	2.07	0.041918	0.903	0.018286	0.88	0.018
New Group E - 100% Load During Stack Testing + Commissioning (Daytime Only)				100% Load During Stack Testing + Commissioning (Daytime Only)																							
Gen #	Gen Area	Engine Load	No. Gens	1/70 Comm	1/3 Stack Testing	Q	A-F	A-Step	Corr	De-En	Outage	Cool	Total hrs/yr	AERMOD Hrs/day	Each Genset DPM lbs/hr	Each Genset Fuel Gal/Hr	Each Genset NOX lbs/hr	Each Genset DPM lbs/yr	Facility Wide DPM Tons/yr	Facility-Wide Fuel Gal/Year	Facility Wide NOX Tons/yr	Each Genset CO lbs/hr	Facility-Wide CO Tons/Yr	Each Genset HC lbs/hr	Facility-Wide HC Tons/Yr		Facility Wide NO2 Tons/yr
1-1 to 1-5	Bldg 1	100%	5	0.519	3.33								3.849	12	0.512	232	17.2	1.97	0.004927	4,465	0.165507	2.39	0.022998	0.37	0.00356	1.22	0.012
2-1 to 2-3	Bldg 2	100%	3	0.519	3.33								3.849	12	0.512	232	17.2	1.97	0.002956	2,679	0.099304	2.39	0.013799	0.37	0.002136	1.22	0.007
3-1 to 3-3	Bldg 3	100%	3	0.519	3.33								3.849	12	0.512	232	17.2	1.97	0.002956	2,679	0.099304	2.39	0.013799	0.37	0.002136	1.22	0.007
ETC-1	ETC	100%	1	0.519	3.33								3.849	12	0.512	232	17.2	1.97	0.000985	893	0.033101	2.39	0.0046	0.37	0.000712	1.22	0.002
1-6 and 1-7 Reserve	Bldg 1	100%	2	0.519	3.33								3.849	12	0.512	232	17.2	1.97	0.001971	1,786	0.066203	2.39	0.009199	0.37	0.001424	1.22	0.005
2-4 Reserve	Bldg 2	100%	1	0.519	3.33								3.849	12	0.512	232	17.2	1.97	0.000985	893	0.033101	2.39	0.0046	0.37	0.000712	1.22	0.002
3-4 Reserve	Bldg 3	100%	1	0.519	3.33								3.849	12	0.512	232	17.2	1.97	0.000985	893	0.033101	2.39	0.0046	0.37	0.000712	1.22	0.002
ETC-2 Reserve	ETC	100%	1	0.519	3.33								3.849	12	0.512	232	17.2	1.97	0.000985	893	0.033101	2.39	0.0046	0.37	0.000712	1.22	0.002
														70-yr Facility-Wide Incl. Startup and Stack Testing					0.306	181,305	6.49		1.38		0.419		0.707
														70-yr Facility-Wide Routine Annual					0.289	166,125	5.93		1.30		0.407		0.667

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APPENDIX C
AERMOD STACK PARAMETERS

TABLE AA2 - Oct-2012-INCREASED IDLE RATE_ AERMOD Generator Parameters for Riker Data Center (10-11-2012)

G:\Seattle\PNWProjects\PACLAND__-11_Riker Data Center\03_Reports-Analyses\NO2 Requested Revised Emission Limits\[AERMOD-Input_-Revised DEEP-NOX-NO2_jmw_10-11-2012.xls]AA2-Sep-2012 DEEP AERM

DAYIME-MASKED TABLE AA. Annual DPM - Scheduled Diagnostic Testing, Power Outage + Storm Avoidance, Corrective Maintenance, and De-energized Building Maintenance,

													Hours at Each Runtime Mode														
Gen #	Gen Area	Engine Load	Exit Temp (K)	Exit Velocity (m/sec)	Stack Dia (m)	Annual-Avg DPM Rate per Engine (g/sec)	No. Gens	Temp F	ACFM	Dia Inches	Area ft2	Velocity fps	W	M	Q	A-F	A-Step	Corr	De-En	Outage	Cool	Total hrs/yr	AERMOD Hrs/day	Each Genset DPM lbs/hr	Each Genset DPM lbs/yr	Facility Wide DPM Tons/yr	Facility-Wide Fuel Gal/Year
A - Unplanned Outage + Storm Avoidance (24 hrs/day)													Unplanned Outage + Storm Avoidance														
1-1 to 1-5	Bldg 1	81%	720	29.2	0.661	1.37E-04	5	836	21208	26	3.69	95.92								24		24	24	0.396	9.5	0.02376	23,400
2-1 to 2-3	Bldg 2	90%	742	30.3	0.661	1.55E-04	3	877	22000	26	3.69	99.50								24		24	24	0.45	10.8	0.0162	15,336
3-1 to 3-3	Bldg 3	90%	742	30.3	0.661	1.55E-04	3	877	22000	26	3.69	99.50								24		24	24	0.45	10.8	0.0162	15,336
ETC-1	ETC	93%	750	30.7	0.661	1.62E-04	1	891	22273	26	3.69	100.73								24		24	24	0.47	11.3	0.00564	5,280
Group B - Testing at Full Outage Loads (Daytime Only)													Testing at Full Outage Loads														
1-1 to 1-5	Bldg 1	81%	720	29.2	0.661	1.94E-04	5	836	21208	26	3.69	95.92			3	6			8			17	12	0.396	6.7	0.01683	16,575
2-1 to 2-3	Bldg 2	90%	742	30.3	0.661	2.20E-04	3	877	22000	26	3.69	99.50			3	6			8			17	12	0.45	7.7	0.011475	10,863
3-1 to 3-3	Bldg 3	90%	742	30.3	0.661	2.20E-04	3	877	22000	26	3.69	99.50			3	6			8			17	12	0.45	7.7	0.011475	10,863
ETC-1	ETC	93%	750	30.7	0.661	2.30E-04	1	891	22273	26	3.69	100.73			3	6			8			17	12	0.47	8.0	0.003995	3,740
Group C - 100% Load During Testing (Daytime Only)													Testing at 100% Load														
1-1 to 1-5	Bldg 1	100%	768	31.6	0.661	1.25E-04	5	923	22895	26	3.69	103.55					0.5	8				8.5	12	0.512	4.4	0.01088	9,860
2-1 to 2-3	Bldg 2	100%	768	31.6	0.661	1.25E-04	3	923	22895	26	3.69	103.55					0.5	8				8.5	12	0.512	4.4	0.006528	5,916
3-1 to 3-3	Bldg 3	100%	768	31.6	0.661	1.25E-04	3	923	22895	26	3.69	103.55					0.5	8				8.5	12	0.512	4.4	0.006528	5,916
ETC-1	ETC	100%	768	31.6	0.661	1.25E-04	1	923	22895	26	3.69	103.55					0.5	8				8.5	12	0.512	4.4	0.002176	1,972
1-6 and 1-7 Reserve	Bldg 1	100%	768	31.6	0.661	1.25E-04	2	923	22895	26	3.69	103.55					0.5	8				8.5	12	0.512	4.4	0.004352	3,944
2-4 Reserve	Bldg 2	100%	768	31.6	0.661	1.25E-04	1	923	22895	26	3.69	103.55					0.5	8				8.5	12	0.512	4.4	0.002176	1,972
3-4 Reserve	Bldg 3	100%	768	31.6	0.661	1.25E-04	1	923	22895	26	3.69	103.55					0.5	8				8.5	12	0.512	4.4	0.002176	1,972
ETC-2 Reserve	ETC	100%	768	31.6	0.661	1.25E-04	1	923	22895	26	3.69	103.55					0.5	8				8.5	12	0.512	4.4	0.002176	1,972
D1 _ Idle During Emergency Outages (24 hrs/day)													Idle During Outages (24 hrs/day)														
1-1 to 1-5	Bldg 1	10%	584	7.9	0.661	2.43E-05	5	592	5741	26	3.69	25.96	0	0	0	0	0	0	0	0	4	4	24	0.4224	1.7	0.004224	900
2-1 to 2-3	Bldg 2	10%	584	7.9	0.661	2.43E-05	3	592	5741	26	3.69	25.96	0	0	0	0	0	0	0	0	4	4	24	0.4224	1.7	0.002534	540
3-1 to 3-3	Bldg 3	10%	584	7.9	0.661	2.43E-05	3	592	5741	26	3.69	25.96	0	0	0	0	0	0	0	0	4	4	24	0.4224	1.7	0.002534	540
ETC-1	ETC	10%	584	7.9	0.661	2.43E-05	1	592	5741	26	3.69	25.96	0	0	0	0	0	0	0	0	4	4	24	0.4224	1.7	0.000845	180
1-6 and 1-7 Reserve	Bldg 1	10%	584	7.9	0.661	7.91E-05	2	592	5741	26	3.69	25.96	0	0	0	0	0	0	0	12	1	13	24	0.4224	5.5	0.005491	1,170
2-4 Reserve	Bldg 2	10%	584	7.9	0.661	1.52E-04	1	592	5741	26	3.69	25.96	0	0	0	0	0	0	0	24	1	25	24	0.4224	10.6	0.00528	1,125
3-4 Reserve	Bldg 3	10%	584	7.9	0.661	1.52E-04	1	592	5741	26	3.69	25.96	0	0	0	0	0	0	0	24	1	25	24	0.4224	10.6	0.00528	1,125
ETC-2 Reserve	ETC	10%	584	7.9	0.661	1.52E-04	1	592	5741	26	3.69	25.96	0	0	0	0	0	0	0	24	1	25	24	0.4224	10.6	0.00528	1,125
D2 _ Idle During Testing (Daytime Only)													Idle During Testing (Daytime Only)														
1-1 to 1-5	Bldg 1	10%	584	7.9	0.661	3.47E-04	5	592	5741	26	3.69	25.96	20	3	0	0	0	0	0	0	5.5	28.5	12	0.4224	12.0	0.030096	6,413
2-1 to 2-3	Bldg 2	10%	584	7.9	0.661	3.47E-04	3	592	5741	26	3.69	25.96	20	3	0	0	0	0	0	0	5.5	28.5	12	0.4224	12.0	0.018058	3,848
3-1 to 3-3	Bldg 3	10%	584	7.9	0.661	3.47E-04	3	592	5741	26	3.69	25.96	20	3	0	0	0	0	0	0	5.5	28.5	12	0.4224	12.0	0.018058	3,848
ETC-1	ETC	10%	584	7.9	0.661	3.47E-04	1	592	5741	26	3.69	25.96	20	3	0	0	0	0	0	0	5.5	28.5	12	0.4224	12.0	0.006019	1,283
1-6 and 1-7 Reserve	Bldg 1	10%	584	7.9	0.661	4.93E-04	2	592	5741	26	3.69	25.96	20	3	3	6			8	0	0.5	40.5	12	0.4224	17.1	0.017107	3,645
2-4 Reserve	Bldg 2	10%	584	7.9	0.661	4.93E-04	1	592	5741	26	3.69	25.96	20	3	3	6			8	0	0.5	40.5	12	0.4224	17.1	0.008554	1,823
3-4 Reserve	Bldg 3	10%	584	7.9	0.661	4.93E-04	1	592	5741	26	3.69	25.96	20	3	3	6			8	0	0.5	40.5	12	0.4224	17.1	0.008554	1,823
ETC-2 Reserve	ETC	10%	584	7.9	0.661	4.93E-04	1	592	5741	26	3.69	25.96	20	3	3	6			8	0	0.5	40.5	12	0.4224	17.1	0.008554	1,823

New Group E - 100% Load During Stack Testing + Commissioning (Daytime Only)													100% Load During Stack Testing + Commissioning (Daytime Only)														
Gen #	Gen Area	Engine Load	Exit Temp (K)	Exit Velocity (m/sec)	Stack Dia (m)	Annual-Avg DPM Rate per Engine (g/sec)	No. Gens	Temp F	ACFM	Dia Inches	Area ft2	Velocity fps	1/70 Comm	1/3 Stack Testing	Q	A-F	A-Step	Corr	De-En	Outage	Cool	Total hrs/yr	AERMOD Hrs/day	Each Genset DPM lbs/hr	Each Genset DPM lbs/yr	Facility Wide DPM Tons/yr	Facility-Wide Fuel Gal/Year
1-1 to 1-5	Bldg 1	100%	768	31.6	0.661	5.67E-05	5	923	22895	26	3.69	103.55	0.519	3.33								3.849	12	0.512	1.97	0.004927	4,465
2-1 to 2-3	Bldg 2	100%	768	31.6	0.661	5.67E-05	3	923	22895	26	3.69	103.55	0.519	3.33								3.849	12	0.512	1.97	0.002956	2,679
3-1 to 3-3	Bldg 3	100%	768	31.6	0.661	5.67E-05	3	923	22895	26	3.69	103.55	0.519	3.33								3.849	12	0.512	1.97	0.002956	2,679
ETC-1	ETC	100%	768	31.6	0.661	5.67E-05	1	923	22895	26	3.69	103.55	0.519	3.33								3.849	12	0.512	1.97	0.000985	893
1-6 and 1-7 Reserve	Bldg 1	100%	768	31.6	0.661	5.67E-05	2	923	22895	26	3.69	103.55	0.519	3.33								3.849	12	0.512	1.97	0.001971	1,786
2-4 Reserve	Bldg 2	100%	768	31.6	0.661	5.67E-05	1	923	22895	26	3.69	103.55	0.519	3.33								3.849	12	0.512	1.97	0.000985	893
3-4 Reserve	Bldg 3	100%	768	31.6	0.661	5.67E-05	1	923	22895	26	3.69	103.55	0.519	3.33								3.849	12	0.512	1.97	0.000985	893
ETC-2 Reserve	ETC	100%	768	31.6	0.661	5.67E-05	1	923	22895	26	3.69	103.55	0.519	3.33								3.849	12	0.512	1.97	0.000985	893

acility-Wide Incl. Startup and Stack T	0.306	181,305
70-yr Facility-Wide Routine Annual	0.289	166,125

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Vantage Data Center - Annual DEEP KLK 09-20-2012

Revised NO2 Limit (Higher idle emissions during 30 min weekly testing)

AERMOD File: Vantage Annual DPM_S_Sep Rev

AERMOD File (full grid for 20080: Vantage Annual DPM_AA2_Oct2012

AERMOD Output:

Year	Maximum Conc.	Location	Max along property Conc.	Location	Max near SW home Conc.
2004	0.0417	Building 1	0.028	South Boundary	0.020
2005	0.0438	Building 1	0.030	South Boundary	0.020
2006	0.0381	Office B	0.027	East Boundary next to Bldg 3	0.019
2007	0.0386	Office B	0.032	East Boundary next to Bldg 3	0.022
2008	0.0475	Building 1	0.042	East Boundary next to Bldg 3	0.031

2008 AERMOD Output:

Maximum Conc.	Location
0.047	Point of max impact - rooftop of Building 1
0.047	MICR - Building 1
0.042	MIBR - along east property, approximately 360 meters from north fenceline
0.031	MIRR - at closest property line (SW home)
0.018	MIRR - at house structure (SW home)
0.026	Maximum off-site impacted bussiness/office (Sabey)
0.009	SE home

TABLE BB2. Sep-2012; Increased Idle Emissions; 24-hr PM10 AERMOD Input for Full Power Outage

G:\Seattle\PNWProjects\PACLAND__-11_Riker Data Center\03_Reports-Analyses\NO2 Requested Revised Emission Limits\[AERMOD-Input_-Revised DEEP-NOX-NO2_jmw_10-11-2012.xls]BB2-Sep2012_24hr PM10 AERM

													Hours/Day at Each Runtime Mode																
Gen #	Gen Area	Engine Load	Exit Temp (K)	Exit Velocity (m/sec)	Stack Dia (m)	24-Hr PM10 Rate per Engine (g/sec)	No. Gens	Temp F	ACFM	Dia Inches	Area ft2	Velocity fps	W	M	Q	A-F	A-Step	Corr	De-En	Outage	Cool	Total hrs in Max Day	AERMOD Hrs/day	Each Genset PM10 lbs/hr	Each Genset Fuel Gal/Hr	Each Genset NOX lbs/hr	Each Genset PM10 lbs/DAY	Facility Wide PM10 lbs/DAY	Facility-Wide Fuel Gal/DAY
Unplanned Outage + Storm Avoidance																Unplanned Outage + Storm Avoidance													
1-1 to 1-5	Bldg 1	81%	720	29.2	0.661	4.99E-02	5	836	21208	26	3.69	95.92								24		24	**24**	0.396	195	12.5	9.5	47.5	23,400
2-1 to 2-3	Bldg 2	90%	742	30.3	0.661	5.68E-02	3	877	22000	26	3.69	99.50								24		24	**24**	0.45	213	14.6	10.8	32.4	15,336
3-1 to 3-3	Bldg 3	90%	742	30.3	0.661	5.68E-02	3	877	22000	26	3.69	99.50								24		24	**24**	0.45	213	14.6	10.8	32.4	15,336
ETC-1	ETC	93%	750	30.7	0.661	5.93E-02	1	891	22273	26	3.69	100.73								24		24	**24**	0.47	220	15.4	11.3	11.3	5,280
10% Idle																Zero Idle													
1-6 and 1-7 Reserve	Bldg 1	10%	584	7.9	0.661	5.08E-02	2	592	5741	26	3.69	25.96								24		24	**24**	0.4028	45	3.12	9.7	19.3	2,160
2-4 Reserve	Bldg 2	10%	584	7.9	0.661	5.08E-02	1	592	5741	26	3.69	25.96								24		24	**24**	0.4028	45	3.12	9.7	9.7	1,080
3-4 Reserve	Bldg 3	10%	584	7.9	0.661	5.08E-02	1	592	5741	26	3.69	25.96								24		24	**24**	0.4028	45	3.12	9.7	9.7	1,080
ETC-2 Reserve	ETC	10%	584	7.9	0.661	5.08E-02	1	592	5741	26	3.69	25.96								24		24	**24**	0.4028	45	3.12	9.7	9.7	1,080

Changed by Belle

Facility-Wide Emissions	172	64,752
	lbs/DAY	gal/DAY

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Vantage Data Center - 24hr PM10 NAAQS KLK 10-14-2012
24-hr PM10 during Full Power Outage (Increased Idle Emissions)

AERMOD File: Vantage 24hr PM10 Outage_BB2_Oct2012

AERMOD Output:

Average	Conc/Dep.	East(X)	North(Y)	Year	
1ST-HIGHEST 24-HR	20.78	287077	5236748	2005	
1ST-HIGHEST 24-HR	18.71	287068	5236742	2005	
1ST-HIGHEST 24-HR	17.90	287068	5236742	2006	
1ST-HIGHEST 24-HR	23.64	287068	5236742	2007	
1ST-HIGHEST 24-HR	28.38	287068	5236742	2008	Rooftop of Building 1

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PM2.5-NAAQS Modeling for Scheduled Maintenance: De-Energized Full-Building Maintenanc

Changed by Belle, 12/3

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TABLE CC2 - SEP 2012, INCRTERASED PER-GENSET IDLE LOAD EMISSIONS, BUT SHUTTING DOWN ONE RESERVE GENSET AFTER 15 MINUTES

Maximum 24-Hour PM2.5 Emission Rates and Stack Parameters for De-energized Full-Building Maintenance at Data Center 1 (Riker Data Center)

													Hours/Year at Each Runtime Mode														
Gen #	Gen Area	Engine Load	Exit Temp (K)	Exit Velocity (m/sec)	Stack Dia (m)	1st-Highest 24-hr PM2.5 Rate per Engine (g/sec)	No. Gens	Temp F	ACFM	Dia Inches	Area ft2	Velocity fps	W	M	Q	A-F	A-Step	Corr	De-En	Outage	Cool	Total hrs/day	Worst Case Emission Hours on One Day	AERMOD Hrs/day		Each Genset DPM lbs/hr	Facility Wide DPM lbs/day
De-energized Maintenance at Full Outage Loads							De-energized Maintenance at Full Outage Loads																				
1-1 to 1-5	Bldg 1	81%	720	29.2	0.661	0.0333	5	836	21208	26	3.69	95.92			0	0			8			8	8	**12**		0.396	3.168
Zero Idle							Zero Idle																				
1-1 to 1-5	Bldg 1	10%	584	7.9	0.661	0.0021	5	592	5741	26	3.69	25.96							0		0.5	0.5	0.5	**12**		0.4028	0.2014
1-6 and 1-7 Reserve	Bldg 1	10%	584	7.9	0.661	0.0339	2	592	5741	26	3.69	25.96							4		0	4	8	**12**		0.4028	3.2224
							Annual Days Per Year at Data Center 1								4	1			1								

ide Emissions	6.592	lbs/day PM2.5
	0.0346	g/sec

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Vantage Data Center - 24hr PM2.5 NAAQS KLK 10-14-2012
24-hr PM2.5 for Scheduled Maintenance: De-Energized Full-Building Maintenance

AERMOD File: Bldg1 24hr PM25 Maintain_CC2_Oct2012

AERMOD Output:

Average	Conc/Dep.	East(X)	North(Y)	Year	
1ST-HIGHEST 24-HR	6.65	287102	5236766	2005	Roof top of Building 1
1ST-HIGHEST 24-HR	5.02	287068	5236742	2005	
1ST-HIGHEST 24-HR	4.90	287068	5236742	2006	
1ST-HIGHEST 24-HR	5.15	287068	5236742	2007	
1ST-HIGHEST 24-HR	6.60	287068	5236742	2008	

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DD2 - SEP-2012_NO2-ASIL DURING POWER OUTAGE, RESERVE GENSETS AT IDLE WITH INCREASE NOX AND NO2
Revised NO2 Limit (Higher idle emissions - Lower emissions at high loads) - Aug 2012

AERMOD File: Vantage 1hr NO2 Outage_Rev Limit v2
PVMRM: NO2/NOx Ratio = see table below; Equilibrium Ratio = 0.9.
Stack Input:

										Jim's notes 9-18-2012		
	Source ID	Source Description	Easting (X) (m)	Northing (Y) (m)	Base Elevation (m)	Stack Height (m)	Temperature (K)	Exit Velocity (m/s)	Stack Diameter (m)	NOX (lb/hr)	Primary NO2 (lb/hr)	Stack NO2:NOx Mass Ratio
1	1_1	81% Load	287054.05	5236880.14	402.336	12.4968	720	29.2	0.6604	12.5	0.95	7.6%
2	1_2	81% Load	287057.12	5236875.48	402.336	12.4968	720	29.2	0.6604	12.5	0.95	7.6%
3	1_3	81% Load	287061.43	5236868.98	402.336	12.4968	720	29.2	0.6604	12.5	0.95	7.6%
4	1_4	81% Load	287065.53	5236862.87	402.336	12.4968	720	29.2	0.6604	12.5	0.95	7.6%
5	1_5	81% Load	287069.59	5236856.78	402.336	12.4968	720	29.2	0.6604	12.5	0.95	7.6%
6	1_6R	10% Load	287073.68	5236850.63	402.336	12.4968	584	7.9	0.6604	3.73	1.19	31.9%
7	1_7R	10% Load	287077.74	5236844.57	402.336	12.4968	584	7.9	0.6604	3.73	1.19	31.9%
8	2_1	90% Load	287173.92	5237286.15	406.2984	12.4968	742	30.3	0.6604	14.6	1.06	7.3%
9	2_2	90% Load	287165.37	5237280.84	406.2984	12.4968	742	30.3	0.6604	14.6	1.06	7.3%
10	2_3	90% Load	287156.44	5237275.28	406.2984	12.4968	742	30.3	0.6604	14.6	1.06	7.3%
11	2_4R	10% Load	287147.9	5237269.94	406.2984	12.4968	584	7.9	0.6604	3.73	1.19	31.9%
12	3_1	90% Load	287136.21	5237037.04	403.86	12.4968	742	30.3	0.6604	14.6	1.06	7.3%
13	3_2	90% Load	287144.21	5237030.91	403.86	12.4968	742	30.3	0.6604	14.6	1.06	7.3%
14	3_3	90% Load	287152.15	5237024.82	403.86	12.4968	742	30.3	0.6604	14.6	1.06	7.3%
15	3_4R	10% Load	287160.17	5237018.74	403.86	12.4968	584	7.9	0.6604	3.73	1.19	31.9%
16	ETC_1	93% Load	287063.11	5237220.51	406.6032	13.3502	750	30.7	0.6604	15.4	1.1	7.1%
17	ETC_2R	10% Load	287056.99	5237227.29	406.6032	13.3502	584	7.9	0.6604	3.73	1.19	31.9%
										184.15	18.16	

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Vantage Data Center - 1hr NO2 ASIL KLK 10-14-2012

Revised NO2 Limit (Higher idle emissions - Lower emissions at high loads)

AERMOD File: Vantage 1hr NO2 Outage_DD2_Oct2012

PVMRM: NO2/NOx Ratio = 0.1; Equilibrium Ratio = 0.9.

Stack Input:

Source ID	Source Description	Easting (X) (m)	Northing (Y) (m)	Base Elevation (m)	Stack Height (m)	Temperature (K)	Exit Velocity (m/s)	Stack Diameter (m)	Jim's notes 9-18-2012 NOX (lb/hr)	Primary NO2 (lb/hr)	NO2:NOx Ratio
1_1	81% Load	287054.05	5236880.14	402.34	12.4968	720	29.2	0.6604	12.5	0.95	7.6%
1_2	81% Load	287057.12	5236875.48	402.34	12.4968	720	29.2	0.6604	12.5	0.95	7.6%
1_3	81% Load	287061.43	5236868.98	402.34	12.4968	720	29.2	0.6604	12.5	0.95	7.6%
1_4	81% Load	287065.53	5236862.87	402.34	12.4968	720	29.2	0.6604	12.5	0.95	7.6%
1_5	81% Load	287069.59	5236856.78	402.34	12.4968	720	29.2	0.6604	12.5	0.95	7.6%
1_6R	10% Load	287073.68	5236850.63	402.34	12.4968	584	7.9	0.6604	3.73	1.19	31.9%
1_7R	10% Load	287077.74	5236844.57	402.34	12.4968	584	7.9	0.6604	3.73	1.19	31.9%
2_1	90% Load	287173.92	5237286.15	406.30	12.4968	742	30.3	0.6604	14.6	1.06	7.3%
2_2	90% Load	287165.37	5237280.84	406.30	12.4968	742	30.3	0.6604	14.6	1.06	7.3%
2_3	90% Load	287156.44	5237275.28	406.30	12.4968	742	30.3	0.6604	14.6	1.06	7.3%
2_4R	10% Load	287147.9	5237269.94	406.30	12.4968	584	7.9	0.6604	3.73	1.19	31.9%
3_1	90% Load	287136.21	5237037.04	403.86	12.4968	742	30.3	0.6604	14.6	1.06	7.3%
3_2	90% Load	287144.21	5237030.91	403.86	12.4968	742	30.3	0.6604	14.6	1.06	7.3%
3_3	90% Load	287152.15	5237024.82	403.86	12.4968	742	30.3	0.6604	14.6	1.06	7.3%
3_4R	10% Load	287160.17	5237018.74	403.86	12.4968	584	7.9	0.6604	3.73	1.19	31.9%
ETC_1	93% Load	287063.11	5237220.51	406.60	13.3502	750	30.7	0.6604	15.4	1.1	7.1%
ETC_2R	10% Load	287056.99	5237227.29	406.60	13.3502	584	7.9	0.6604	3.73	1.19	31.9%

AERMOD Output:

Average	Conc/Dep.	East(X)	North(Y)	Year	
1ST-HIGHEST MAX DAILY 1-HR	336	287096	5236775	2004	
1ST-HIGHEST MAX DAILY 1-HR	351	286999	5236686	2005	
1ST-HIGHEST MAX DAILY 1-HR	342	286994	5236693	2006	
1ST-HIGHEST MAX DAILY 1-HR	335	287090	5236784	2007	
1ST-HIGHEST MAX DAILY 1-HR	345	287004	5236678	2008	Along SW fenceline

FF2-Vantage Data Center - Sep-2012, NO2 NAAQS, Bldg 3 with 30-minute test and Elm's Nox/NO2 limits
Revised NO2 Limit (Higher idle emissions during 30 min weekly testing) - Sep 2012

Stack Run Time: 7 am to 6 pm
Stack Input:

Source ID	Source Description	Easting (X) (m)	Northing (\ (m)	Base Elevat (m)	Stack Heigl (m)	Temperatu (K)	Exit Velocit (m/s)	Stack Diam (m)	Jim's notes 9-18-12 (30 minute test) Prim NOX (lb/hr)	Prim NO2 (lb/hr)	NO2:NOX Ratio
3_1	weekly testing 10% load	287136.2	5237037	403.86	12.5	584	7.9	0.6604	4.87	0.88	18.1%
3_2	weekly testing 10% load	287144.2	5237031	403.86	12.5	584	7.9	0.6604	4.87	0.88	18.1%
3_3	weekly testing 10% load	287152.2	5237025	403.86	12.5	584	7.9	0.6604	4.87	0.88	18.1%
									14.61	2.64	

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Vantage Data Center - 1hr NO2 NAAQS KLK 10-14-2012
Revised NO2 Limit (Higher idle emissions during 30 min weekly testing)

AERMOD File: Bldg3 1hr NO2 30min Test_FF2_Oct2012
PVMRM: NO2/NOx Ratio = 0.181; Equilibrium Ratio = 0.9.
Stack Run Time: 7 am to 6 pm
Stack Input:

Source ID	Source Description	Easting (X) (m)	Northing (Y) (m)	Base Elevation (m)	Stack Height (m)	Temperature (K)	Exit Velocity (m/s)	Stack Diameter (m)	Jim's notes 9-18-12 (30 minute test) Prim NOX (lb/hr)	Prim NO2 (lb/hr)	NO2:NOX Ratio
3_1	weekly testing 10% load	287136.2	5237037.0	403.9	12.5	584	7.9	0.6604	4.87	0.88	18.1%
3_2	weekly testing 10% load	287144.2	5237030.9	403.9	12.5	584	7.9	0.6604	4.87	0.88	18.1%
3_3	weekly testing 10% load	287152.2	5237024.8	403.9	12.5	584	7.9	0.6604	4.87	0.88	18.1%

3-Year Average

Rank	Ave. Conc.	East(X)	North(Y)	Years	
1st	243	287303	5237047	2005-2007	Along east fenceline, next to building 3
2nd	229	287303	5237047	2005-2007	
3rd	222	287303	5237047	2005-2007	

1-hr NO2 impact for 30-minute test:
243 ug/m3 x (30 min / 60 min) = 122 ug/m3

AERMOD Output:

Average	Conc/Dep.	East(X)	North(Y)	Year
1ST-HIGHEST MAX DAILY 1-HR	263	287303	5237037	2004
2ND-HIGHEST MAX DAILY 1-HR	246	287303	5237037	2004
3RD-HIGHEST MAX DAILY 1-HR	220	287303	5237047	2004
4TH-HIGHEST MAX DAILY 1-HR	212	287303	5237047	2004
5TH-HIGHEST MAX DAILY 1-HR	209	287303	5237047	2004
6TH-HIGHEST MAX DAILY 1-HR	194	287303	5237057	2004
7TH-HIGHEST MAX DAILY 1-HR	192	287303	5237057	2004
8TH-HIGHEST MAX DAILY 1-HR	191	287303	5237057	2004
9TH-HIGHEST MAX DAILY 1-HR	180	287303	5237057	2004
10TH-HIGHEST MAX DAILY 1-HR	177	287303	5237057	2004
1ST-HIGHEST MAX DAILY 1-HR	257	287303	5237047	2005
2ND-HIGHEST MAX DAILY 1-HR	250	287303	5237037	2005
3RD-HIGHEST MAX DAILY 1-HR	231	287303	5237047	2005
4TH-HIGHEST MAX DAILY 1-HR	229	287303	5237037	2005
5TH-HIGHEST MAX DAILY 1-HR	223	287303	5237047	2005
6TH-HIGHEST MAX DAILY 1-HR	222	287303	5237047	2005
7TH-HIGHEST MAX DAILY 1-HR	197	287303	5237047	2005
8TH-HIGHEST MAX DAILY 1-HR	189	287303	5237047	2005
9TH-HIGHEST MAX DAILY 1-HR	188	287303	5237047	2005
10TH-HIGHEST MAX DAILY 1-HR	183	287303	5237047	2005
1ST-HIGHEST MAX DAILY 1-HR	232	287303	5237047	2006
2ND-HIGHEST MAX DAILY 1-HR	224	287303	5237047	2006
3RD-HIGHEST MAX DAILY 1-HR	217	287303	5237047	2006
4TH-HIGHEST MAX DAILY 1-HR	201	287303	5237047	2006
5TH-HIGHEST MAX DAILY 1-HR	196	287303	5237047	2006
6TH-HIGHEST MAX DAILY 1-HR	193	287303	5237047	2006
7TH-HIGHEST MAX DAILY 1-HR	187	287303	5237047	2006
8TH-HIGHEST MAX DAILY 1-HR	180	287303	5237047	2006
9TH-HIGHEST MAX DAILY 1-HR	179	287303	5237047	2006
10TH-HIGHEST MAX DAILY 1-HR	173	287303	5237047	2006
1ST-HIGHEST MAX DAILY 1-HR	241	287303	5237047	2007
2ND-HIGHEST MAX DAILY 1-HR	232	287303	5237047	2007
3RD-HIGHEST MAX DAILY 1-HR	227	287303	5237047	2007
4TH-HIGHEST MAX DAILY 1-HR	216	287303	5237047	2007
5TH-HIGHEST MAX DAILY 1-HR	207	287303	5237037	2007
6TH-HIGHEST MAX DAILY 1-HR	200	287303	5237047	2007
7TH-HIGHEST MAX DAILY 1-HR	191	287303	5237047	2007
8TH-HIGHEST MAX DAILY 1-HR	190	287303	5237047	2007
9TH-HIGHEST MAX DAILY 1-HR	189	287303	5237047	2007
10TH-HIGHEST MAX DAILY 1-HR	185	287303	5237047	2007
1ST-HIGHEST MAX DAILY 1-HR	233	287303	5237047	2008
2ND-HIGHEST MAX DAILY 1-HR	226	287303	5237047	2008
3RD-HIGHEST MAX DAILY 1-HR	221	287303	5237047	2008
4TH-HIGHEST MAX DAILY 1-HR	218	287303	5237047	2008
5TH-HIGHEST MAX DAILY 1-HR	206	287303	5237047	2008
6TH-HIGHEST MAX DAILY 1-HR	205	287303	5237047	2008
7TH-HIGHEST MAX DAILY 1-HR	203	287303	5237047	2008
8TH-HIGHEST MAX DAILY 1-HR	201	287303	5237047	2008
9TH-HIGHEST MAX DAILY 1-HR	200	287303	5237047	2008
10TH-HIGHEST MAX DAILY 1-HR	197	287303	5237047	2008

APPENDIX D
GENERATOR SPECIFICATIONS AND EMISSION CONTROLS

Table D-1. BACT Capital Cost for MTU AirClarity System (SCR and Catalyzed DPF) Vantage Data Center

Cost Category	Cost Factor	Source of Cost Factor	Quant.	Unit Cost	Subtotal Cost
Direct Costs					
Purchased Equipment Costs					
FOB Purchase Price	As quoted by MTU	MTU	17	$400,000	$6,800,000
Instrumentation	Assume no cost	Assume no cost	0	0	0
Sales Tax	WA state tax	WA state tax	6.5%	--	$442,000
Shipping	0.05A	EPA Cost Manual	5.0%	--	$340,000
Subtotal Purchased Equipment Cost, PEC					$7,582,000
Direct Installation Costs					
Enclosure structural supports	Assume no cost	Assume no cost	0	$0	$0
Installation	1/2 of EPA Cost Manual	1/2 of EPA Cost Manual	2.5%	--	$189,550
Electrical	Assume no cost	Assume no cost	0	0	0
Piping	Assume no cost	Assume no cost	0	0	0
Insulation	Assume no cost	Assume no cost	0	0	0
Painting	Assume no cost	Assume no cost	0	0	0
Subtotal Direct Installation Costs					$189,550
Site Preparation and Buildings (SP)	Assume no cost	Assume no cost	0	0	0
Total Direct Costs, DC (PEC + Direct Installation + Site Prep)					$7,771,550
Indirect Costs (Installation)					
Engineering	0.025*PEC	1/4 of EPA Cost Manual	2.5%	--	$189,550
Construction and field expenses	0.025*PEC	1/2 of EPA Cost Manual	2.5%	--	$189,550
Contractor Fees	From DIS data center	From DIS data center	6.8%	--	$532,645
Startup	0.02*PEC	EPA Cost Manual	2.0%	--	$151,640
Performance Test (Tech support)	0.01*PEC	EPA Cost Manual	1.0%	--	$75,820
Contingencies	0.03*PEC	EPA Cost Manual	3.0%	--	$227,460
Subtotal Indirect Costs, IC					$1,366,665
Total Capital Investmant (TCI = DC+IC)					$9,138,215

TCI/PEC
1.21

TCI per gen
$537,542

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Table D-2. Vantage Data Center Annualized BACT Cost-Effectiveness for MTU AirClarity System

Item	Quantity	Units	Unit cost	Subtotal
Annualized Capital Recovery				
Total Capital Cost				$9,138,215
Capital Recovery Factor, 25 yrs, 4% discount rate				0.06401
Subtotal Annualized 25-year Capital Recovery Cost				$584,937
Direct Annual Costs				
Annual Admin charges	2% of TCI (EPA Manual)		0.02	$182,764
Annual Property tax	1% of TCI (EPA Manual)		0.01	$91,382
Annual Insurance	1% of TCI (EPA Manual)		0.01	$91,382
Annual operation/labor/maintenance costs: Upperbound estimate would assume CARB's value of $3.00/hp/year and would result in $206,000/year. Lower bound estimate would assume zero annual O&M. Mid-range value would account for urea, fuel for pressure drop, increased inspections, periodic OEM visits, and the costs for Ecology's increased emission testing requirements. **For this screening-level analysis we assumed the lower-bound annual O&M cost of zero.**				$0
Subtotal Direct Annual Costs				$365,529
Total Annual Cost (Capital Recovery + Direct Annual Costs)				**$950,466**
Uncontrolled emissions				27.6
Assumed Control Efficiency				Varies
Annual Tons Removed				19.92
Cost Effectiveness ($ per tons combined pollutant destroyed)				**$47,714**

TCI/gen	$537,542

Combined Pollutants

Pollutant	DEEP	CO	VOC	NOX
Uncontrolled TPY	**1.48**	**5.67**	**1.14**	**19.3**
Controlled TPY	**0.22**	**1.22**	**0.36**	**5.83**
Tons Removed/Year	**1.26**	**4.45**	**0.78**	**13.43**
Overall Removal Effcy	85%	78%	68%	70%

"Reasonableness Cost-Effectiveness" of Acceptable Control Cost vs. Actual Control Cost

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (tons/yr)	Subtotal Acceptable Annual Cost ($/year)	
NOX	$9,473	13.43	$127,222	per year
CO	$5,000	4.45	$22,250	per year
VOC	$9,473	0.78	$7,389	per year
PM	$23,200	1.26	$29,232	per year
Total Accetable Annual Control Cost for Combined Pollutants			**$186,093**	**per year**
Actual Annual Control Cost			**$950,466**	**per year**
Is The Control Device Reasonable?			**NO (Actual >> Acceptable)**	

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3/7/2012, 1:55 PM

DIESEL ENGINE-GENERATOR SET
3000-XC6DT2

3000 kWe / 60 Hz / Standby
480 - 13.8kV

(Reference 2800-XC6DT2 for Prime Rating Technical Data)

SYSTEM RATINGS

Standby

Voltage (L-L)	480V	600V	4160V	12470V	13200V	13800V
Phase	3	3	3	3	3	3
PF	0.8	0.8	0.8	0.8	0.8	0.8
Hz	60	60	60	60	60	60
kW	3000	3000	3000	3000	3000	3000
kVA	3750	3750	3750	3750	3750	3750
AMPS	4511	3609	520	174	164	157
skVA@30% Voltage Dip	6400	6800	5250	C/F	C/F	C/F
Generator Model*	1030FDL1005	1030FDS1015	1020FDM1204	1030FDH1429	1030FDH1429	1030FDH1429
Temp Rise	130 °C/27 °C	125 °C/40 °C	130 °C/27 °C	130 °C/27 °C	130 °C/27 °C	130 °C/27 °C
Connection	6 LEAD WYE	6 LEAD WYE	6 LEAD WYE	6 LEAD WYE	6 LEAD WYE	6 LEAD WYE

CERTIFICATIONS AND STANDARDS

Emissions –

Engine-generator set is designed and manufactured

UL 2200 / CSA – Optional
– UL 2200 Listed
–

Performance Assurance Certification (PAC)
- Engine-Generat o ISO 8528-5 f
  Transient Response
- V rified product design, quality and per
-

Power Rating
- Accepts Rated Load in One Step Per NFPA 110
- v
  operation is approved up to 85%.

STANDARD FEATURES*

MTU Onsit
Global Product Support

20V 4000 Diesel Engine
- 95.4 Liter Displacement
- Common Rail Fuel Injection
- 4-Cy

Generator
- Br
- PMG (P
- 300% Shor
- 2/3 Pitch Windings
- S or 5
- Op

Digital Control Panel(s)
- UL Recognized, CS
- Comple
- L

- Integral Set-Mounted
- Engine Driven Fan

STANDARD EQUIPMENT*

Engine

Air Cleaners
Oil Pump
Oil Drain Extension & S/O Valve
Full Flow Oil Filter
Closed Crankcase Ventilation
Jacket Water Pump
Inter Cooler Water Pump
Thermostats
Blower Fan & Fan Drive
Radiator - Unit Mounted
Electric Starting Motor - 24V
Governor – Electronic Isochronous
Base - Structural Steel
AE Flywheel & Bell Housing
Charging Alternator - 24V
Batt y Bo
Flexible Fuel Connectors
Flexible Exhaust Connection

Generator

and motor starting
up to 10 seconds
Self-V ed and Drip-Proof
Superior V v
e, Volts-per-Hertz R

No Load to Full Load Regulation
Brushless Alternator with Brushless Pilot Exciter
2 Bearing, Sealed
Flexible Coupling
Full Amortisseur Windings
125% Rotor Balancing
3-Phase Voltage Sensing
±0.25% Voltage Regulation
ed Load - One S
3% Maximum Harmonic Content

Digital Control Panel(s)

Digital Metering
Engine Parameters
Generator Protection Functions
Engine Protection
CAN Bus ECU Communications
s-Based Sof
Remote Communications to RDP-110 Remote Annunciator
16 Programmable Contact Inputs
Up to 11 Contact Outputs
ecognized, CS v
Event Recording
IP 54 Front Panel Rating with Integrated Gasket
NFPA 110 Compatible

Consult Factory/MTU Onsite Energy Distributor for additional configurations.

APPLICATION DATA

Engine

Model	20V 4000 G83L 6 ECT
	4-Cy
Arrangement	20V
Displacement: L (in³	95.4 (5,822)
Bore: cm (in)	17 (6.69)
Stroke: cm (in)	21 (8.27)
Compression Ratio	16.5:1
Engine Governor	Electronic Isochronous (ADEC)
Speed Regulation	±0.25%

Liquid Capacity (Lubrication)

tal Oil Sy	
	205 (54.2)
	55 (14.5)
	5

Electrical

Electric Volts DC	24
Cold Cranking Amps Under -1	

Fuel System

uel Supply Connection Size	
n Connection Size	
Recommended Fuel	Diesel #2

Fuel Consumption

	STANDBY
5% of P	5 5
t 50% of P	

Cooling - Radiator System

	STANDBY
Maximum Allowable Static Pressure on Rad. Exhaust: kPa (in. H_20)	0.12 (0.5)
	,56
	5 50)
o Coolant: kW (BTUM)	
: kW (BTUM)	70 (55,
o Ambient: kW (BTUM)	

Air Requirements

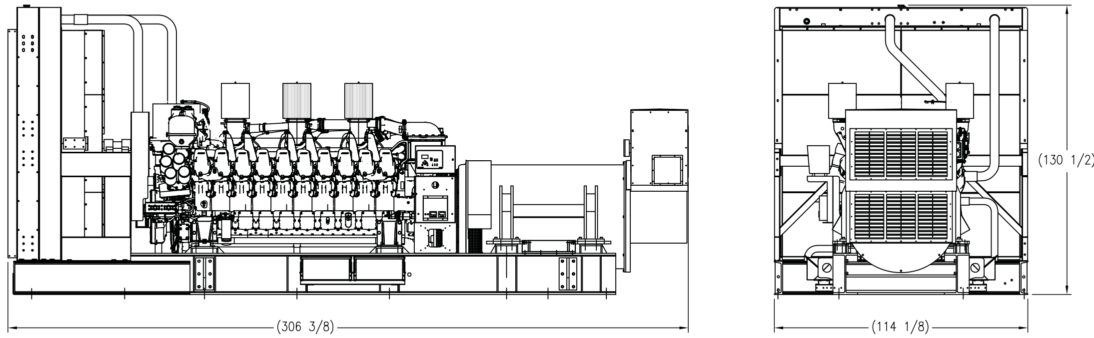
	STANDBY
Aspirating: *m³	
equired f Cooled Unit: *m³	35,36
Remote Cooled Applications; equired f ed Gen-se Max of 25 °F Rise: *m³	40 (29,500)

³)

Exhaust System

	STANDBY
Gas Temp. (Stack): °C (°F)	525 (977)
Gas Volume at Stack Temp: m³	
Maximum Allowable Back Pressure: kPa (in. H_20)	8.5 (34.1)

WEIGHTS AND DIMENSIONS



Drawing above for illustration purposes only, based on standard open power 480 volt engine-generator set. Lengths may vary with other voltages. Do not use for installation design. See website for unit specific template drawings.

System	Dimensions (L x W x H)	Weight (less tank)
OPU	7,780 x 2,900 x 3,310 mm (306.38 x 114.13 x 130.5 in)	27,466 kg (60,553 lb)

Weights and dimensions are based on open power units and are estimates only. Consult the factory for accurate weights and dimensions for your specific engine-generator set.

SOUND DATA

Unit Type	Standby Full Load
Level 0: Open Power Unit (dBA)	107

Sound data is provided at 7 m (23 ft). Engine-generator set tested in accordance with ISO 8528-10 and with infinite exhaust.

EMISSIONS DATA

NO_x + NMHC	CO	PM
4.21	0.52	0.06

All units are in g/hp-hr and are EPA D2 cycle values. Emission levels of the engine may vary as a function of ambient temperature, barometric pressure, humidity, fuel type and quality, installation parameters, measuring instrumentation, etc. The data provided are laboratory results from one engine representing this rating. The data was obtained under controlled environmental conditions with calibrated instrumentation traceable to the United States National Bureau of Standards and in compliance with US EPA regulations found within 40 CFR Part 89. The weighted cycle value from each engine is guaranteed to be below the US EPA Standards at the US EPA defined conditions.

RATING DEFINITIONS AND CONDITIONS

// Standby ratings apply to installations served by a reliable utility source. The standby rating is applicable to varying loads for the duration of a power outage. No overload capability for this rating. Ratings are in accordance with ISO 8528-1, ISO 3046-1, BS 5514, AS 2789, and DIN 6271.

// Deration Factor:
Altitude: Consult your local MTU Onsite Energy Power Generation Distributor for altitude derations.
Temperature: Consult your local MTU Onsite Energy Power Generation Distributor for temperature derations.

Materials and specifications subject to change without notice.
C/F = Consult Factory/MTU Onsite Energy Distributor

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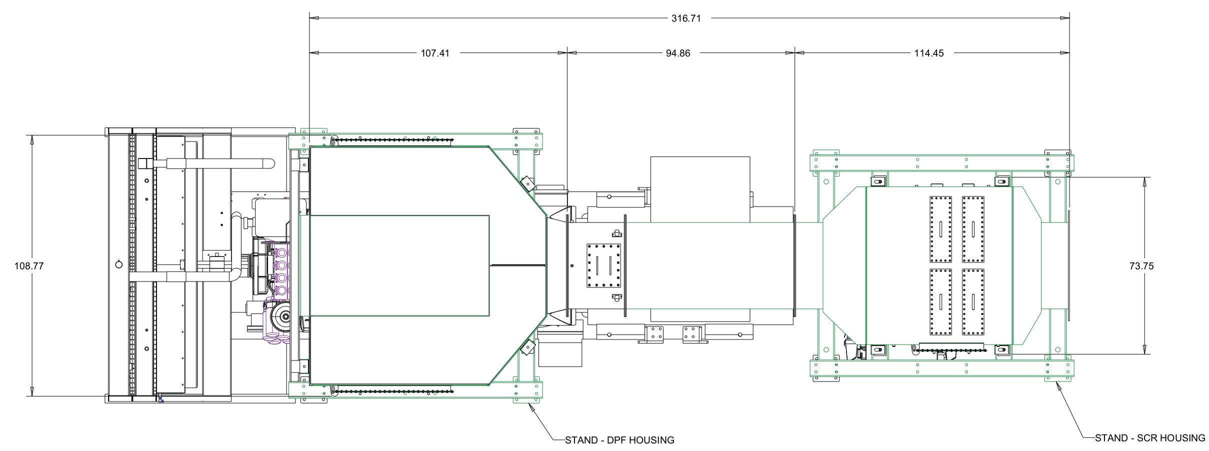
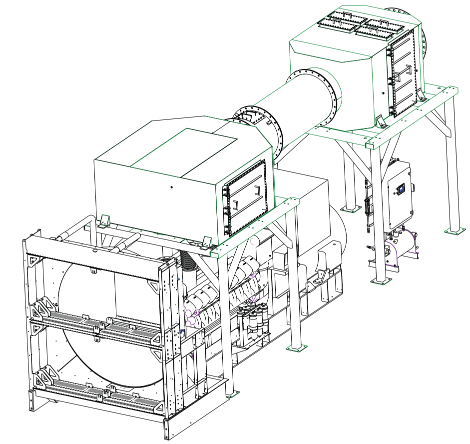
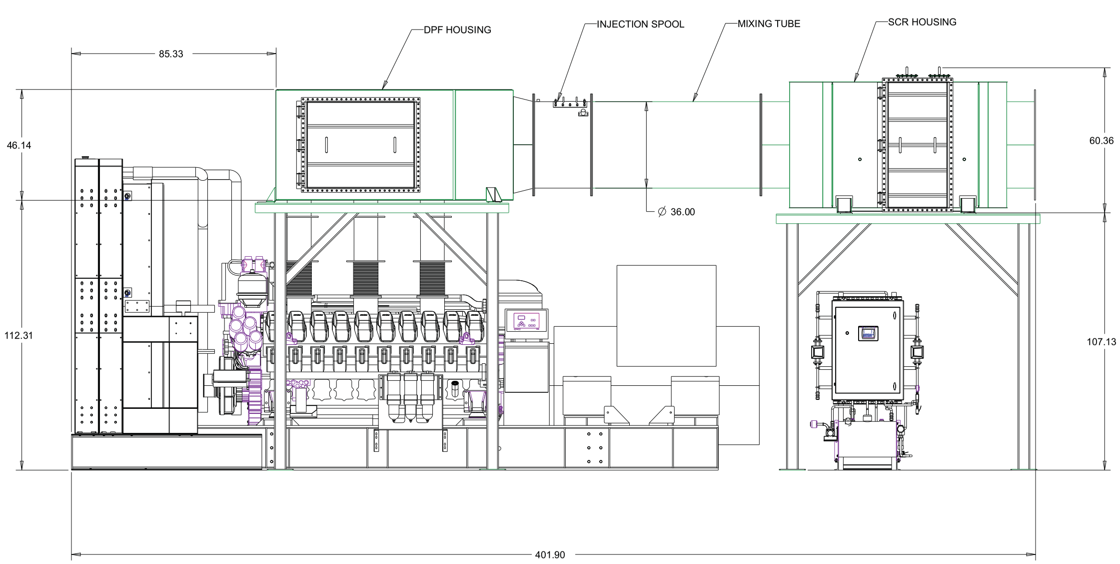
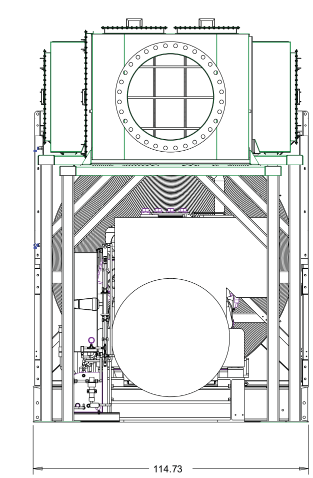




PRELIMINARY





COMPONENT WEIGHT CHART

COMPONENT	WEIGHT (LBS)
DPF HOUSING	3200
MIXING SPOOL	300
MIXING TUBE	400
SCR HOUSING	2700
STAND-DPF HSG	1300
STAND-SCR HSG	1400
DOSING CONTROLLER	450

GenAcc Products

MATERIAL:			
UNIT OF MEASURE:	INCH		
3250/3000/2800/2500 EKW MTU TIER IV SYSTEM			
	AirClarity 3250		
DATE: 8/23/2011	DRAWN BY: ESD	CHANGE LEVEL: 01	
SCALE: 1/20	DWG SIZE: E	SHEET: 1 OF 1	

ELM Permitting Information

9. Narrative of Tier-4 emission control equipment, including vendor-guaranteed removal efficiencies.

The diesel emission control strategy the AirClarity utilizes highly oxidizing precious metal particulate matter filters to control PM, HC, and CO reductions, as well as a Selective Catalytic Reducer coupled with an airless DEF injection system.

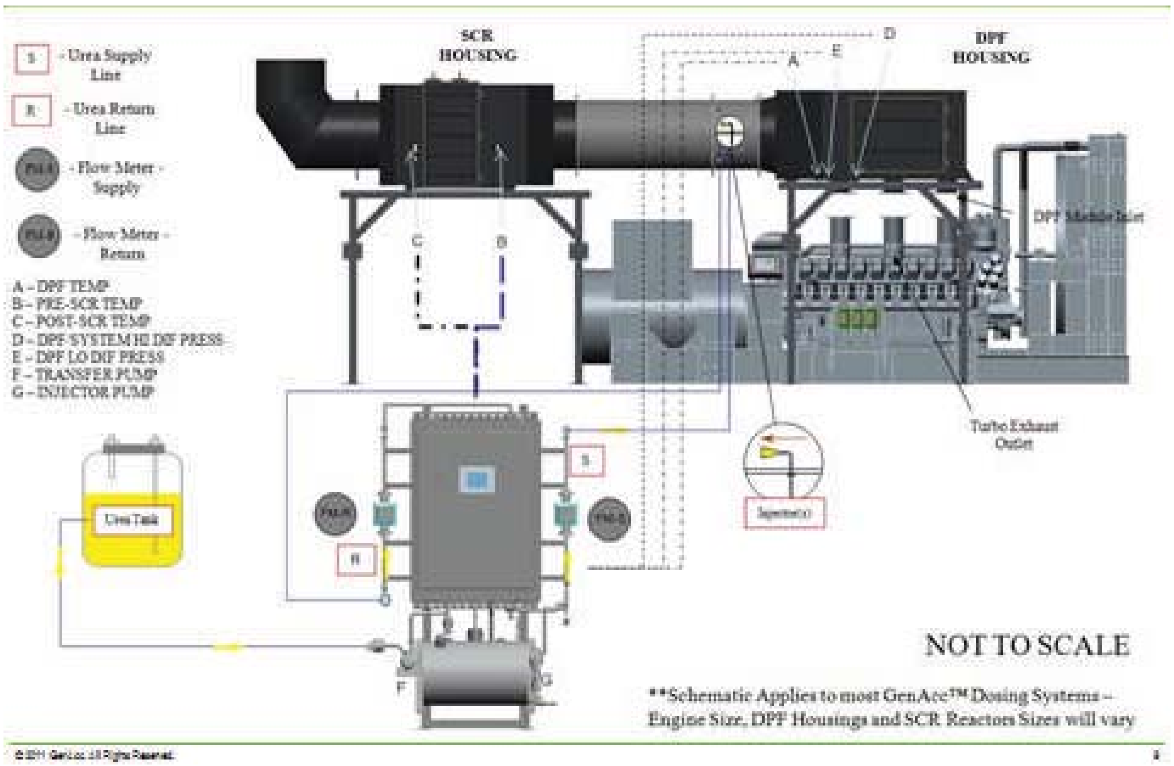
The injection system includes reductant tank level monitoring, return and supply flow metering, DPF temperature, SCR temperature (pre and post), DPF backpressure, system backpressure, and SCR outlet NOx sensor; all parameters are logged and will produce alarms should the system operate out of spec. A relative humidity sensor will also be utilized in the system, as humidity has been known to affect engine-out NOx by as much as 15% depending on ambient conditions.

The EnviCat® 2055 DPF is a wall flow ceramic Diesel Particulate Filter coated with a Süd-Chemie proprietary precious metal based coating on a cordierite ceramic substrate. The device is designed to filter and passively reduce >95% diesel particulate matter mass found in diesel engine exhaust. Furthermore, carbon monoxide and hydrocarbon emissions in the exhaust are reduced by means of catalytic oxidation. This device does not employ zone coating. The catalyzed DPF is also responsible for reducing hydrocarbons by almost 96%, as well as carbon monoxide reductions of greater than 99% (reductions based on engine baseline and emissions testing at 5-mode average).

The EnviCat® 20019 SCR is a flow through ceramic substrate coated with a Süd-Chemie proprietary SCR coating. The SCR is designed to reduce engine out NO_x emissions across a broad range of engine operating conditions.

Vendor-guaranteed removal efficiencies are as follows:

NOx >90%
CO >90%
HC >90%
PM >87%



10. Has the Tier-4 generator achieved CARB certification? If so, provide the certification data.

No. In process.

11. Vendor-estimated purchase price of emission control equipment compared to Tier-2 generators

Estimated $400,000 increase per Tier-2 generator.

12. Vendor's "Not-to-Exceed" and "Nominal" emission data.

See attached spreadsheets for both "Not-to-Exceed" (NTE) and nominal controlled emissions information.

13. Narrative of cold-start delay time before catalysts reach activation temperature and perform at vendor-guaranteed removal efficiency

The SCR is designed to operate nominally at 900 degrees Fahrenheit, however NOx conversion can be achieved from 300 to 1000 degrees Fahrenheit. Due to the possibility of forming ammonia salts at lower temperatures, DEF will only be injected at 425 degrees Fahrenheit or higher. Should the temperatures exceed 1000 degrees, the system will alarm as temperatures higher than this can result in catalyst degradation and possible destruction of the honeycomb material. Testing on the 20v4000 indicates we can run at 10% load and dose Urea to reduce NOx. We believe this would happen in under 20 minutes with most conditions having dosing start in less than 15 minutes.

The DPF will reduce PM at all times but should be regenerated when one of the following conditions is met:

- After back pressure readings have reached the maximum allowable backpressure per manufacturers specifications (27" W.C.)
- After 24 idle cold starts of 30-minutes or less and no regeneration has been performed between the cold starts.
- After operation below the recommended regeneration temperature of 300°C for a consecutive period of 720-minutes

Regeneration is accomplished by bringing the engine load level required to achieve a minimum 300°C exhaust gas temperature at the filter inlet and holding for a minimum period of 30-minutes. In testing with the 20v4000 the filters should regen at 10% load unless ambient temperatures are extremely low.

Should the soot loading reach a high level before cold start maximum is reached, the DPF differential pressure sensor will read a high backpressure and the system will alarm. Should the system reach 24 cold starts without reaching the maximum backpressure, the system will alarm and alert the user for the need to regenerate the DPF elements.

14. Can the vendor provide a document of stack test data?

Stack test data (except for particulate and ammonia) are attached for NOx, CO, & HC at 100%, 75%, 50%, 25%, and 10% loads. Final stack test results for ammonia and particulate are expected to be available next week and completed results will be forwarded as soon as they are received.

Memorandum

Date: July 11, 2012

To: Greg Flibbert and Robert Koster, Dept. of Ecology Eastern Regional Office

cc: Mike Duffy, Vantage Data Centers

From: Jim Wilder, P.E.

Subject: **Top-Down BACT Assessment**
Vantage-Quincy Data Center, Quincy, WA

Introduction

This top-down Best Available Control Technology (BACT) assessment for the Vantage-Quincy Data Center was conducted at the request of Department of Ecology, to supplement the BACT calculations that were submitted with the May 29, 2012 Notice of Construction permit application package. The BACT calculations in the permit application package were limited to evaluating only Vantage's proposed AirClarity emission control system that includes a catalyzed diesel particulate filter (DPF) and a urea-based selective catalytic reduction system (SCR). Ecology requested the supplemental top-down BACT assessment to evaluate the full range of commercially available control technologies. Note, Vantage's proposed AirClarity emission control system is more efficient than any other emission control technology that has been considered for use on data centers in Washington state.

Summary and Conclusion

The proposed diesel engines will emit the following regulated pollutants which are subject to BACT review: nitrogen oxides (NOx), carbon monoxide (CO), volatile organic compounds (VOCs), particulate matter (PM, PM_{10} and $PM_{2.5}$) and sulfur dioxide.

Generators equipped with EPA Tier-2 certified engines were considered the base case for the BACT assessment. The following add-on technologies were considered for the top-down BACT assessment:

- AirClarity System (Catalyzed DPF and SCR) proposed by Vantage
- Catalyzed Diesel Particulate Filter
- Urea-Selective Catalytic Reduction
- Three-Way Catalyst

- Diesel Oxidation Catalyst

All of the add-on technologies are technically feasible. They are commercially available, and offer substantial pollutant removal efficiencies. None of them would pose unreasonable operational difficulties.

However, all of the add-on technologies failed the cost-effectiveness criteria, for the individual pollutants and for the multi-pollutant reasonableness test. The cost-effectiveness values for each technology are listed in Table 1.

Table 1. Comparison of Cost-Effectiveness Evaluations

	Cost-Effectiveness ($/ton)				
Control Device	**NOX**	**Total PM**	**CO**	**VOC**	**Combined Pollutants**
MTU AirClarity System (Catalyzed DPF + SCR) proposed by Vantage	$81,000	$700,000	$434,000	$1,645,000	$60,000
Catalyzed DPF Alone	Ineffective	$252,000	$152,000	$578,000	$81,000
SCR Alone	$40,300	$1,519,000	$216,000	$820,000	$32,000
3-Way Catalyst	$37,500	$125,000	$71,000	$296,000	$19,200
Diesel Oxidation Catalyst	Ineffective	$310,000	$55,000	$314,000	$41,000
Ecology Cost-Effectiveness Criterion	$10,000	$23,200	$5,000	$10,000	N/A

Because all of the add-on technologies failed the cost-effectiveness criterion, ICF recommends that none of them should be defined as BACT. Instead, ICF recommends that BACT for each pollutant should be defined as use of EPA Tier-2 certified engines, with diligent annual operation and maintenance requirements required under New Source Performance Standards Subpart IIII.

Methodology

Emission Estimation Methods (Nominal-Controlled Emission Rates)

The AERMOD modeling used for NAAQS compliance and risk assessments for Vantage's permit application used the vendor-guaranteed, "not-to-exceed" (NTE) load-specific controlled emission rates as the starting point for the emission calculations. Vantage's equipment contractor is ELM Energy, LLC. ELM's vendor guaranteed NTE controlled emission rates apply to each individual engine at each load.

However, for this BACT assessment Ecology directed ICF to use emission rates that are fundamentally different from ELM's vendor-guaranteed controlled rates used for Vantage's AERMOD modeling. For this BACT assessment Ecology directed ICF to forecast the uncontrolled emissions by using ELM's "nominal uncontrolled" rates. These estimated uncontrolled rates, which were provided by ELM, represent ELM's judgment of the likely overall average emission rates for the overall population of generators manufactured by MTU. They do not apply to any individual generator, and they are called "nominal" because they are not guaranteed by ELM or MTU. ELM's "nominal-uncontrolled" emission rates are listed in Table 1. Note, the listed values for particulate matter include ICF's adjustment factors to account for the total particulate including both the "front half" and the "back half" (FH+BH).

Table 1. ELM Energy Nominal Uncontrolled Emission Rates (lbs/hr)

Load	NOX	Total PM (FH+BH)	CO	VOC
10%	6.0	1.45	2.8	1.2
81.3%	37.2	2.55	5.3	1.1
90%	43.6	2.92	6.0	1.1
93.3%	46.1	3.04	6.3	1.1
100%	51.5	3.24	6.8	1.1

The load-specific "nominal-uncontrolled" rates were adjusted upward by applying the cold-start factors that were also used for Vantage's permit application package. The overall cold-start adjusted uncontrolled emission rates, expressed as pounds per hour at each generator load, are presented in Attachment A.

To forecast the hourly controlled emission rates at each generator load, Ecology directed ICF to calculate the "nominal-controlled" rates by multiplying the "nominal uncontrolled" rate times the removal efficiency provided by the control device being considered. The vendor-supplied removal efficiencies for each of the control devices considered are listed in Table 2.

Table 2. Vendor-Provided Steady-State Pollutant Removal Efficiencies for Commercially Available Control Devices

Pollutant	MTU AirClarity System Proposed by Vantage (Catalyzed DPF + Urea SCR)	Clean Air Systems Catalyzed DPF	Clean Air Systems Urea SCR NOX System Incl. DOC	Clean Emission Products 3-Way Catalyst	MiraTech Diesel Oxidation Catalyst
NOx	90%	0%	90%	35%	0%
PM (FH+BH)	87%	85%	20%	88%	25%
CO	90%	90%	90%	99%	90%
VOC	90%	90%	90%	90%	60%

Most of the control devices considered for this BACT assessment use a metal catalyst to destroy the pollutants. After a cold start, these catalysts temporarily remain inactive until the hot flue gas heats the catalyst up to its minimum operating temperature. To account for this temporary cold-start delay, an additional cold-start catalyst delay factor was applied to each control device. The cold-start catalyst delay factors for each control device are calculated in Attachments B-F.

After the load-specific, cold-start "nominal-controlled" emission rates were calculated for each control device, the facility-wide "nominal-uncontrolled" and "nominal-controlled" emission rates were calculated by applying the hourly emission rates to the runtime hours presented in Vantage's permit application. The runtime hours considered for the BACT assessment included scheduled testing, corrective maintenance, storm avoidance, and unplanned power outages. The annual-average runtime hours for initial commissioning tests and for periodic stack emission testing were not included in the BACT assessment. The facility-wide "nominal-uncontrolled" emission rates are calculated in Attachment A. The facility-wide "nominal-controlled" emission rates for each control device are calculated in Attachments B-F.

Cost Estimating Methods

Cost spreadsheets for each category of control device considered for this BACT assessment are provided in Attachments B-F. The methods used to calculate the total capital investment (TCI) for each type of control device were as follows:

- For each control device other than DOCs, the purchase price listed as "Freight on Board (FOB" at the manufacturer's facility was provided. For DOCs, the Department of Information Services (DIS) provided a tally of the total installed cost at their Olympia data center.

- In some cases ICF used FOB purchase price information for control devices designed for either 2,000 kWe or 2,500 kWe generators at other data centers, rather than the 3,000 kWe generators at the Vantage Data Center. In those cases, ICF adjusted the FOB purchase price upward using the "0.6 rule".

- Cost factors for indirect installation costs (shipping, installation, design fees, etc.) were derived from EPA's guidance manual EPA Pollution Control Cost Manual, January 2002. The cost factors from Section 4.2 Chapter 1, Selective Catalytic Reduction, were used.

- Annual capital recovery cost was based on an assumed 25-year equipment life, with a conservatively low discount rate of 4%.

- Indirect annual costs (overhead, insurance, and taxes) were calculated by cost factors from EPA's control cost guidance manual listed above.

- For this screening-level analysis it was assumed that none of the control devices would incur annual costs for operation and maintenance. This results in a conservatively low estimate of the control device capital cost, annual cost, and cost-effectiveness.

- The Total Annual Cost for each control device was calculated by summing the estimate annual costs for capital recovery, direct operation and maintenance, and indirect annual costs.

Cost-Effectiveness Criteria for Individual Pollutants

For the individual pollutants, the individual pollutant cost-effectiveness was calculated by dividing the total annual cost ($/year) by the tons of facility-wide pollutant removed by the control device. The derived cost-effectiveness was then compared to the following cost-effectiveness criteria values, which were developed by Ecology for the Sabey-Intergate-Quincy data center's air quality permit:

NOX: $10,000/ton
Total PM (FH+BH): $23,200/ton
CO: $5,000/ton
VOC: no value listed. Assumed to be $10,000/ton (same as NOx)

Reasonableness Cost Effectiveness for Multi-Pollutant Analyses

All of the control devices considered for this BACT assessment are at least marginally effective at controlling the entire range of pollutants. The manufacturer-provided removal efficiencies range from a low of 25% for PM removed by DOCs, to as high as 99.9% for CO removed by 3-Way Catalysts.

To account for the variable reduction efficiencies for the various pollutants, for each control device the multi-pollutant cost effectiveness was evaluated by comparing two facility-wide cost parameters: the actual total annual cost to own and operate the control device being considered; and the "reasonable annual control cost for combined pollutants". The evaluation is done using a three-step process:

- The "reasonable annual cost" for each individual pollutant is calculated by multiplying the annual tons/year of that pollutant removed by the control device times the Ecology cost-effectiveness criterion for that pollutant.

- The facility-wide "total reasonable annual cost" is calculated by summing the calculated values for each individual pollutant.

- The "total reasonable annual cost" is then compared to the actual total annual cost. If the actual annual cost is less than the "total reasonable annual cost" then the cost for multi-pollutant treatment is considered "reasonable" and the control device satisfies the BACT cost-effectiveness criterion. However, if the actual annual cost exceeds the "total reasonable annual cost" then the cost for multi-pollutant treatment is considered "non-reasonable" and the control device fails the BACT cost-effectiveness criterion.

Identification of Technically Feasible Control Technologies

Since 2007 Ecology and other Washington state agencies have issued air quality permits for the following data centers that use large diesel emergency generators: Sabey-Intergate-Quincy; Dell-Quincy; Yahoo-Quincy; Microsoft-Quincy; Intuit-Quincy; Titan-Moses Lake; Dept. of Information Services (DIS) Data Center –Olympia; Sabey-Intergate-Wenatchee; and T-Mobile-Wenatchee. ICF reviewed Ecology's BACT determinations for these existing data centers, and developed the following list of technically feasible emission controls applicable for diesel generators:

- EPA Tier-2 certified engines with combustion controls including timing retard, exhaust gas cooling, exhaust gas recirculation, and turbocharging. This technology is considered the base case for the BACT assessment.

- Vantage's proposed AirClarity system (catalyzed Diesel Particulate Filter plus Urea-based Selective Catalytic Reduction). Technical information, emission estimates, cost data, and cost-effectiveness calculations are provided in Attachment B.

- Catalyzed Diesel Particulate Filter by itself (technical information in Attachment C).

- Urea-Selective Catalytic Reduction by itself (technical information in Attachment D).

- Three-Way Catalyst (also known as Two-Stage Catalyst). Technical information is provided in Attachment E.

- Diesel Oxidation Catalyst (see Attachment F).

BACT Analysis for NOx

Vantage's Proposed AirClarity System (Urea-Based SCR Plus Catalyzed DPF)

ELM energy has contracted with Vantage to install MTU's AirClarity emission control system on each generator. Technical information is provided in Attachment B. The AirClarity system consists of a modular system including a catalyzed DPF and a urea-based SCR.

The SCR system evaluated for this analysis is the Clean Air Systems package. Technical information is provided in Attachment C. The SCR system functions by injecting a liquid reducing agent, such as urea, through a catalyst into the exhaust stream of the diesel engine. The urea reacts with the exhaust stream converting nitrogen oxides into nitrogen and water. The use of a lean ultralow sulfur fuel is required to achieve good NOx destruction efficiencies. SCR can reduce NOx emissions by up to 90-95 percent while simultaneously reducing hydrocarbon (VOC), CO and PM emissions.

For SCR systems to function effectively, exhaust temperatures must be high enough (about 200 to 500 degrees C) to enable catalyst activation. For this reason, SCR control efficiencies are expected to be relatively low during the first 10 to 20 minutes after engine start up, especially during maintenance, and testing loads. There are also complications of managing and controlling the excess ammonia (ammonia slip) from SCR use. However, Vantage accounted for ammonia slip in its permit application and demonstrated the small amount of ammonia emissions would not cause ambient concentrations beyond the facility boundary to exceed the ASIL for ammonia. Because backup engines typically experience long inactive periods between operations, the facility must conduct diligent inspection and maintenance of the urea storage and injection system to ensure that urea crystallization inside reagent distribution lines does not interfere with the SCR system.

ELM has provided vendor-guaranteed removal efficiencies for the AirClarity system as follows: NOx = 90%; CO and VOC = 90%; and total PM (front-half plus back-half) = 87%. The AirClarity system provides substantial removal efficiencies for all key pollutants. The system is reliable, and would pose not substantial operating constraints. Therefore, the AirClarity system is considered a technically feasible add-on technology.

However, Vantage's proposed AirClarity system failed the cost-effectiveness evaluation. ICF evaluated the cost effectiveness of installing and operating AirClarity systems on the proposed Vantage diesel engines. Emission calculations and cost-effectiveness calculations for an AirClarity system installed on the Vantage generators are provided in Attachment B. The individual-pollutant cost-effectiveness for NOx, PM, CO and VOC is presented in Table AC-1 below. The analysis indicates that the use of the AirClarity systems would cost approximately $700,000 per ton of PM removed from the exhaust stream based on Vantage's permitted annual runtime scenario including power outage of eight (8) hours per year. A previous survey by Ecology found that the permitting agencies surveyed have required installation of NOx controls as BACT with expected operational costs ranging from $143 to $9,473 per ton of NOx removed, and Ecology has set the NOx cost-effectiveness criterion at $10,000 per ton. Therefore, the AirClarity system fails the cost-effectiveness test on an individual pollutant basis.

Table AC-1. AirClarity System, Individual Pollutants Removal Tonnages (Nominal-Controlled)

Pollutant	PM (FH+BH)	CO	VOC	NOX
Nominal Cold-Start Uncontrolled TPY	1.56	3.15	0.870	16.1
Nominal Cold-Start Controlled TPY	0.203	0.958	0.293	4.38
Tons Removed/Year	1.36	2.19	0.578	11.8
Overall Cold-Start Removal Effcy	87%	70%	66%	73%
Annualized Cost ($/yr)	$950,466	$950,466	$950,466	$950,466
Individual Pollutant $/Ton Removed	$700,039	$433,611	$1,644,950	$80,819
Ecology Cost-Effectiveness Threshold	$23,200	$5,000	$10,000	$10,000
Pass or Fail?	Fail	Fail	Fail	Fail

The AirClarity system would also provide substantial removal efficiencies for PM, CO and VOC, as well as for NOx. However, the AirClarity system failed the multi-pollutant cost effectiveness evaluation. Table AC-2 below shows the multi-pollutant evaluation. The actual annual cost to own and operate the AirClarity system would be $950,000 per year, which far exceeds the "Total

Reasonable Annual Cost" of $166,000 per year based on Ecology's cost criteria for the individual pollutants.

Table AC-2. AirClarity System: Multi-Pollutant Cost-Effectiveness for Reasonable Control Cost vs. Actual Control Cost

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (tons/yr)	Subtotal Reasonable Annual Cost ($/year)	
NOX	$10,000	11.76	$117,604	per year
CO	$5,000	2.19	$10,960	per year
VOC	$9,999	0.58	$5,778	per year
PM (FH+BH)	$23,200	1.36	$31,499	per year
Total Reasonable Annual Control Cost for Combined Pollutants			**$165,841**	**per year**
Actual Annual Control Cost			**$950,466**	**per year**
Is The Control Device Reasonable?			**NO (Actual >> Reasonable)**	

ICF concludes that while Vantage's proposed AirClarity system is a potentially-feasible emission control technology for diesel engines, it is not economically feasible under BACT. Therefore, ICF recommends that Ecology should reject this control option as BACT.

Selective Catalytic Reduction (SCR) By Itself (See Attachment D for details)

The SCR system evaluated for this analysis is the Clean Air Systems package that was originally evaluated by Sabey for the BACT analysis for their Intergate-Quincy data center. Technical information is provided in Attachment D. The Clean Air Systems package includes a urea-based SCR and a diesel oxidation catalyst, to provide substantial removal efficiencies for NOx, CO and VOC. The Clean Air Systems package does not include a DPF, so it provides only marginal removal efficiency for PM (20% estimated efficiency).

The SCR system functions by injecting a liquid reducing agent, such as urea, through a catalyst into the exhaust stream of the diesel engine. The urea reacts with the exhaust stream converting nitrogen oxides into nitrogen and water. The use of a lean ultralow sulfur fuel is required to achieve good NOx destruction efficiencies. SCR can reduce NOx emissions by up to 90-95 percent while simultaneously reducing hydrocarbon (VOC), CO and PM emissions.

For SCR systems to function effectively, exhaust temperatures must be high enough (about 200 to 500 degrees C) to enable catalyst activation. For this reason, SCR control efficiencies are expected to be relatively low during the first 10 to 20 minutes after engine start up, especially during maintenance, and testing loads. There are also complications of managing and controlling the excess ammonia (ammonia slip) from SCR use. However, Vantage accounted for ammonia slip in its permit application and demonstrated the small amount of ammonia emissions would not cause ambient concentrations beyond the facility boundary to exceed the ASIL for ammonia. Because backup engines typically experience long inactive periods between operations, the facility must conduct diligent inspection and maintenance of the urea storage and injection system to ensure that urea crystallization inside reagent distribution lines does not interfere with the SCR system.

Based on these considerations, ICF concludes SCR is a technically feasible add-on technology for NOx, PM, VOC and CO control.

However, SCR failed the cost-effectiveness evaluation. ICF evaluated the cost effectiveness of installing and operating SCR systems on the proposed diesel engines. Emission calculations and cost-effectiveness calculations for an SCR system installed on the Vantage generators are provided in Attachment D. The individual-pollutant cost-effectiveness for NOx, PM, CO and VOC is presented in Table SCR-1 below. The analysis indicates that the use of SCR systems would cost approximately $40,300 per ton of NOx removed from the exhaust stream based on Vantage's worst-case annual runtime scenario including power outage of eight (8) hours per year. A previous survey by Ecology found that the permitting agencies surveyed have required installation of NOx controls as BACT with expected operational costs ranging from $143 to $9,473 per ton of NOx removed, and Ecology has set the NOx cost-effectiveness criterion at $10,000 per ton.

Table SCR-1. Urea-SCR, Individual Pollutant Removal Tonnages (Nominal-Controlled)

Pollutant	PM (FH+BH)	CO	VOC	NOX
Nominal Cold-Start Uncontrolled TPY	1.56	3.15	0.870	16.1
Nominal Cold-Start Controlled TPY	1.248	0.958	0.293	4.38
Tons Removed/Year	0.31	2.19	0.578	11.8
Overall Cold-Start Removal Effcy	20%	70%	66%	73%
Annual Cost ($/yr)	$473,994	$473,994	$473,994	$473,994
Individual Pollutant $/Ton Removed	$1,518,616	$216,240	$820,331	$40,304
Ecology Cost-Effectiveness Threshold	$23,200	$5,000	$10,000	$10,000
Pass or Fail?	Fail	Fail	Fail	Fail

A typical SCR system would also provide substantial removal efficiencies for PM, CO and VOC, as well as for NOx. However, the SCR failed the multi-pollutant cost effectiveness evaluation. Table SCR-2 below shows the multi-pollutant evaluation. The actual annual cost to own and operate the SCR would be $473,000 per year, which far exceeds the "Total Reasonable Annual Cost" of $142,000 per year based on Ecology's cost criteria for the individual pollutants.

Table SCR-2. Urea-SCR Multi-Pollutant Cost-Effectiveness for "Reasonable Control Cost" vs. Actual Control Cost

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (tons/yr)	Subtotal Reasonable Annual Cost ($/year)	
NOX	$10,000	11.76	$117,604	per year
CO	$5,000	2.19	$10,960	per year
VOC	$9,999	0.58	$5,778	per year
PM (FH+BH)	$23,200	0.31	$7,241	per year
Total Reasonable Annual Control Cost for Combined Pollutants			**$141,583**	**per year**
Actual Annual Control Cost			**$473,994**	**per year**
Is The Control Device Reasonable?			**NO (Actual >> Reasonable)**	

ICF concludes that while SCR is a demonstrated emission control technology for emergency diesel generators, it is not economically feasible for this project. Therefore, ICF recommends that Ecology should reject this NOx control option as BACT.

3-Way Catalyst (Two-Stage Catalyst)

For this BACT assessment, ICF considered the Clean Emission Products 3-Way Catalyst system that was permitted for the Titan Data Center in Moses Lake, WA. Technical specifications, removal efficiency data, emission calculations, and cost-effectiveness calculations are provided in Attachment E.

Based on the experience at the Titan Data Center, ICF concludes it is possible that 2-stage oxidation catalysts ("3-way" catalysts) might be able to be designed to provide some marginal NOx emission reductions from modern emergency generators. The Clean Emission Products system proposed by R S Titan Lotus, LLC and approved by Ecology is specially designed to remove up to 35% of NOx emissions, as well as considerable quantities of diesel particulate, CO and VOC emissions. The system reviewed by Ecology is a single-pass system that can be installed without retrofitting closed-loop systems such as Exhaust Gas Recirculation. Each catalyst system uses a stainless steel honeycomb mesh catalyst element coated with three catalysts: cerium washcoat; platinum (Pt) and rhodium (Rh) catalyst coatings.

The 2-stage oxidation catalysts first oxidize CO and VOC while removing oxygen from the gas stream, then the remaining rich-burn environment reacts with the Rh catalyst to chemically convert the NO and NO2 in the exhaust stream to nitrogen. The system achieves the required low-oxygen environment by using a specialized catalyst coating and cell structure to remove oxygen molecules from the diesel exhaust stream. Exhaust temperature must be at least 250^{o}C and not exceed 750^{o}C for the system to be effective.

Although 2-stage oxidation catalyst systems appear to have been commercially deployed for standby diesel engine applications in Europe, Australia and Canada, Ecology is unaware of specific applications within the United Sates. The Titan Data Center (Moses Lake, Washington) has proposed to use two 35" diameter x 3.5" thick 3-way catalysts within one stainless steel housing for their planned expansion. The manufacturer of that catalyst system (Clean Emissions Products, Inc.) guaranteed a NOx reduction of not less than 35% although their website and a company salesman both claim that their 2-stage catalysts are capable of reducing up to 99% of CO, 70% of NOx and 90% of diesel particulate. The catalysts proposed by the Titan Data Center are also expected to reduce at least 90% of VOC. Clean Emission Products' limited test data have reported about 43% NOx reduction and about 88% diesel particulate reduction. However, Clean Emission Products have been unable to provide any test data for a lean-burn Tier-2 diesel engine such as those proposed at Vantage. As of this writing, the diesel generators at the Titan Data Center have not been installed, so no compliance test data are available for that facility.

Regardless, based on Clean Emission Products' vendor-guaranteed contract with Titan Data Center, ICF concludes 3-Way Catalysts appear to be a technically-feasible add-on technology to provide marginal NOx reduction on diesel generators.

However, 3-Way Catalysts failed the cost-effectiveness evaluation. ICF evaluated the cost effectiveness of installing and operating 3-Way Catalyst systems on the proposed Vantage diesel engines. Emission calculations and cost-effectiveness calculations for an SCR system installed on the Vantage generators are provided in Attachment E. The individual-pollutant cost-effectiveness for NOx, PM, CO and VOC is presented in Table 3WC-1 below. The analysis indicates that the use of 3-Way Catalyst systems would cost approximately $37,457 per ton of NOx removed from the exhaust stream based on Vantage's worst-case annual runtime scenario including power outage of eight (8) hours per year. A previous survey by Ecology found that the permitting agencies surveyed have required installation of NOx controls as BACT with expected operational costs ranging from $143 to $9,473 per ton of NOx removed, and Ecology has set the NOx cost-effectiveness criterion at $10,000 per ton. Therefore, the 3-Way Catalyst fails the cost-effectiveness test on an individual pollutant basis.

Table 3WC-1. Three-Way Catalyst Individual Pollutant Removal Tonnages (Nominal-Controlled)

Pollutant	PM (FH+BH)	CO	VOC	NOX
Nominal Cold-Start Uncontrolled TPY	1.56	3.15	0.870	16.1
Nominal Cold-Start Controlled TPY	0.187	0.739	0.293	11.57
Tons Removed/Year	1.37	2.41	0.578	4.6
Overall Cold-Start Removal Effcy	88%	77%	66%	28%
Annual Cost ($/year)	$171,311	$171,311	$171,311	$171,311
Individual Pollutant $/Ton Removed	$124,740	$71,049	$296,484	$37,457
Ecology Cost-Effectiveness Threshold	$23,200	$5,000	$10,000	$10,000
Pass or Fail?	Fail	Fail	Fail	Fail

A typical 3-Way Catalyst system would also provide substantial removal efficiencies for PM, CO and VOC, as well as for NOx. However, the 3-Way Catalyst failed the multi-pollutant cost effectiveness evaluation. Table 3WC-2 below shows the multi-pollutant evaluation. The actual annual cost to own and operate the 3-Way Catalyst would be $171,000 per year, which exceeds the "Total Reasonable Annual Cost" of $95,000 per year based on Ecology's cost criteria for the individual pollutants.

Table 3WC-2. Three-Way Catalyst, Multi-Pollutant Cost-Effectiveness for "Reasonable Control Cost" vs. Actual Control Cost

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (tons/yr)	Subtotal Reasonable Annual Cost ($/year)	
NOX	$10,000	4.57	$45,735	per year
CO	$5,000	2.41	$12,056	per year
VOC	$9,999	0.58	$5,778	per year
PM (FH+BH)	$23,200	1.37	$31,861	per year
Total Reasonable Annual Control Cost for Combined Pollutants			**$95,430**	**per year**
Actual Annual Control Cost			**$171,311**	**per year**
Is The Control Device Reasonable?			**NO (Actual >> Reasonable)**	

ICF concludes that while 3-Way Catalysts are a potentially-feasible emission control technology for diesel engines, it is not economically feasible for this project. Therefore, ICF recommends that Ecology should reject this NOx control option as BACT.

NOx Adsorbers (Experimental Technology)

The use of NOx adsorbers (sometimes called lean NOx traps) is a catalytic method being developed and tested by diesel engine manufacturers to reduce NOx emissions, primarily from mobile sources. The NOx adsorber contains a catalyst (e.g., zeolite or platinum) that is used to "trap" NOx (NO and NO2) molecules found in the exhaust. NOx adsorbers can achieve NOx reductions greater than 90% at typical steady-state exhaust gas temperatures.

However, as of this writing, NOx adsorbers are experimental technology and are, therefore, very expensive. Additionally, a literature search did not reveal any indication that this technology is commercially available for stationary backup generators. Thus, ICF recommends that Ecology should reject NOx adsorbers as BACT for the proposed diesel engines.

Combustion Controls and Tier-2 Compliance

Diesel engine manufacturers typically use proprietary combustion control methods to achieve the emission reductions needed to meet applicable EPA Tier-2 standards. Common controls include fuel injection timing retard and exhaust gas recirculation. Injection timing retard reduces the peak flame temperature and NOx emissions, but may lead to higher fuel consumption.

Vantage will install generators equipped with MTU engines that will use a combination of combustion control methods, including fuel injection timing retard, to comply with EPA Tier-2 emission limits.

This is the only technology that provides substantial emission reductions while also satisfying cost-effectiveness criteria. ICF recommends that Ecology should require this technology as BACT for NOx.

BACT Analysis for Combined Particulate Matter, Carbon Monoxide, and Volatile Organic Compounds

Vantage's Proposed AirClarity System (Catalyzed DPF Plus SCR)

The MTU AirClarity emission control system proposed by Vantage consists of a modular sytem including a catalyzed DPF and a urea-based SCR. ELM energy has provided vendor guaranteed removal efficiencies of 87% for total PM (front-half plus back-half), and 90% for NOx, CO and VOC. Technical specifications, emission estimates, and cost-effectiveness calculations are provided in Attachment B. The AirClarity system provides substantial removal efficiencies for all key pollutants. The system is reliable, and would pose not substantial operating constraints. Therefore, the AirClarity system is considered a technically feasible add-on technology.

However, Vantage's proposed AirClarity system failed the cost-effectiveness evaluation. ICF evaluated the cost effectiveness of installing and operating AirClarity systems on the proposed Vantage diesel engines. Emission calculations and cost-effectiveness calculations for an AirClarity system installed on the Vantage generators are provided in Attachment B. The individual-pollutant cost-effectiveness for NOx, PM, CO and VOC is presented in Table AC-1 below. The analysis indicates that the use of the AirClarity systems would cost approximately $700,000 per ton of PM removed from the exhaust stream based on Vantage's worst-case annual runtime scenario including power outage of eight (8) hours per year.

For PM, a previous survey by Ecology found that none of the permitting agencies surveyed had required installation of a particulate matter control device (as BACT) that was expected to cost more than $23,200 per ton of particulate removed. Therefore, Ecology has specified the PM cost-effectiveness criterion of $23,200 per ton.

For CO, a previous survey by Ecology found that the permitting agencies surveyed have required installation of carbon monoxide controls as BACT on other types of emission units, with expected operational costs ranging from $300 to $9,795 per ton of carbon monoxide removed. The upper level of that range is suspect and it is possible that that number actually reflects California BACT which is typically equivalent to a Lowest Achievable Emissions Rate (LAER) limit. In Washington, costs for controlling CO from combined cycle natural gas electric generating facilities are usually in the $3,500 to $5,000 range. Therefore, Ecology has specified a BACT cost-effectiveness criterion of $5,00 per ton removed for CO.

A previous survey by Ecology found that the permitting agencies surveyed have required installation of NOx controls as BACT with expected operational costs ranging from $143 to $9,473 per ton of NOx removed, and Ecology has set the NOx cost-effectiveness criterion at $10,000 per ton.

Ecology has not set a BACT cost-effectiveness criterion for VOC. For this BACT assessment, ICF assumed the VOC cost-effectiveness threshold is the same as for NOx, because both pollutants are ozone precursors. Therefore, the VOC criterion was assumed to be $10,000 per ton.

As listed in Table AC-1 below, the calculated cost-effectiveness values for each individual pollutant controlled by the AirClarity system far exceed their respective Ecology criteria. Therefore, the AirClarity system fails the cost-effectiveness test on an individual pollutant basis.

Table AC-1. AirClarity System, Individual Pollutants Removal Tonnages (Nominal-Controlled)

Pollutant	PM (FH+BH)	CO	VOC	NOX
Nominal Cold-Start Uncontrolled TPY	1.56	3.15	0.870	16.1
Nominal Cold-Start Controlled TPY	0.203	0.958	0.293	4.38
Tons Removed/Year	1.36	2.19	0.578	11.8
Overall Cold-Start Removal Effcy	87%	70%	66%	73%
Annualized Cost ($/yr)	$950,466	$950,466	$950,466	$950,466
Individual Pollutant $/Ton Removed	$700,039	$433,611	$1,644,950	$80,819
Ecology Cost-Effectiveness Threshold	$23,200	$5,000	$10,000	$10,000
Pass or Fail?	Fail	Fail	Fail	Fail

The AirClarity system would also provide substantial removal efficiencies for PM, CO and VOC, as well as for NOx. However, the AirClarity system failed the multi-pollutant cost effectiveness evaluation. Table AC-2 below shows the multi-pollutant evaluation. The actual annual cost to own and operate the AirClarity system would be $950,000 per year, which far exceeds the "Total Reasonable Annual Cost" of $166,000 per year based on Ecology's cost criteria for the individual pollutants.

Table AC-2. AirClarity System: Multi-Pollutant Cost-Effectiveness for Reasonable Control Cost vs. Actual Control Cost

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (tons/yr)	Subtotal Reasonable Annual Cost ($/year)	
NOX	$10,000	11.76	$117,604	per year
CO	$5,000	2.19	$10,960	per year
VOC	$9,999	0.58	$5,778	per year
PM (FH+BH)	$23,200	1.36	$31,499	per year
Total Reasonable Annual Control Cost for Combined Pollutants			**$165,841**	**per year**
Actual Annual Control Cost			**$950,466**	**per year**
Is The Control Device Reasonable?			**NO (Actual >> Reasonable)**	

ICF concludes that while Vantage's proposed AirClarity system is a potentially-feasible emission control technology for diesel engines, it is not economically feasible under BACT. Therefore, ICF recommends that Ecology should reject this control option as BACT.

Catalyzed Diesel Particulate Filters (DPFs)

For this BACT assessment, ICF evaluated the Clean Air Systems catalyzed DPFs that were originally considered for the Sabey-Intergate-Quincy data center. Technical specifications, emission estimates, and cost-effectiveness calculations are provided in Attachment C.

The Clean Air Systems catalyzed DPF package includes their PERMIT DPF plus their ASSURE diesel oxidation catalyst. Clean Air Systems estimated 85% removal efficiency for PM, and 90% removal efficiency for CO and VOC. The DPF-DOC system would not remove any NOx.

The catalyzed DPF system would be reliable, and would pose no substantial operating constraints for the generators. There is one identified problem with the catalyzed DPF system. Field tests on a DOC conducted by Microsoft on one of their diesel generators showed that DOCs can convert some of the non-toxic nitric oxide (NO) in the exhaust stream to highly-toxic nitrogen dioxide (NO2). At this time it is uncertain whether the increased emissions of toxic NO2 might pose human health concerns at receptors beyond the facility.

Regardless of that potential issue, ICF concludes that catalyzed DPFs would be a reliable and efficient system to reduce the emissions of PM, CO and VOC. Therefore, ICF concludes that catalyzed DPFs, by themselves, would be a technically feasible add-on control technology.

However, catalyzed DPFs failed the cost-effectiveness evaluation. ICF evaluated the cost effectiveness of installing and operating 3-Way Catalyst systems on the proposed Vantage diesel engines. Emission calculations and cost-effectiveness calculations for a catalyzed DPF system installed on the Vantage generators are provided in Attachment C. The individual-pollutant cost-effectiveness for NOx, PM, CO and VOC is presented in Table DPF-1 below. The analysis indicates that the use of a catalyzed DPF systems would cost approximately $252,000 per ton of PM removed from the exhaust stream based on Vantage’s worst-case annual runtime scenario including power outage of eight (8) hours per year.

As described previously, Ecology has set BACT cost-effectiveness thresholds for the individual pollutants at the values listed below in Table DPF-1. For each individual pollutant the forecast actual cost far exceeds Ecology’s BACT cost-effectiveness criterion. Therefore, the catalyzed DPFs fails the cost-effectiveness test on an individual pollutant basis.

Table DPF-1. Catalyzed DPF, Individual Pollutant Removal Tonnages (Nominal-Controlled)

Pollutant	PM (FH+BH)	CO	VOC	NOX
Nominal Cold-Start Uncontrolled TPY	1.56	3.15	0.870	16.1
Nominal Cold-Start Controlled TPY	0.234	0.958	0.293	16.14
Tons Removed/Year	1.33	2.19	0.578	0.0
Overall Cold-Start Removal Effcy	85%	70%	66%	0%
Annual Cost ($/year)	$333,734	$333,734	$333,734	$333,734
Individual Pollutant $/Ton Removed	$251,586	$152,252	$577,585	N/A
Ecology Cost-Effectiveness Threshold	$23,200	$5,000	$10,000	$10,000
Pass or Fail?	Fail	Fail	Fail	Fail

A typical catalyzed DPF system would also provide substantial removal efficiencies for CO and VOC, as well as for PM. However, the DPF failed the multi-pollutant cost effectiveness evaluation. Table DPF-2 below shows the multi-pollutant evaluation. The actual annual cost to own and operate the DPF would be $333,000 per year, which far exceeds the "Total Reasonable Annual Cost" of $47,000 per year based on Ecology's cost criteria for the individual pollutants.

Table DPF-2. Catalyzed DPF, Multi-Pollutant Cost-Effectiveness for "Reasonable Control Cost" vs. Actual Control Cost

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (tons/yr)	Subtotal Reasonable Annual Cost ($/year)	
NOX	$10,000	0.00	$0	per year
CO	$5,000	2.19	$10,960	per year
VOC	$9,999	0.58	$5,778	per year
PM (FH+BH)	$23,200	1.33	$30,775	per year
Total Reasonable Annual Control Cost for Combined Pollutants			**$47,513**	**per year**
Actual Annual Control Cost			**$333,734**	**per year**
Is The Control Device Reasonable?			**NO (Actual >> Reasonable)**	

ICF concludes that while DPFs are a potentially-feasible emission control technology for diesel engines, it is not economically feasible under BACT. Therefore, ICF recommends that Ecology should reject this control option as BACT.

Diesel Oxidation Catalysts (see Attachment F)

For this BACT assessment ICF considered installing DOCs by themselves. That control strategy was required for the Department of Information Services (DIS) Data Center in Olympia, WA. For this assessment ICF considered the MiraTech DOC system that was installed at the DIS Data Center. Technical specifications, emission estimates, installation cost information, and cost-effectiveness calculations are provided in Attachment F.

This method utilizes metal catalysts to oxidize carbon monoxide, particulate matter, and hydrocarbons in the diesel exhaust. Diesel oxidation catalysts (DOCs) are commercially available and reliable for controlling particulate matter, carbon monoxide and hydrocarbon emissions from diesel engines. While the primary pollutant controlled by DOCs is carbon monoxide (approximately 90% reduction), DOCs have also been demonstrated to reduce up to 25% of diesel engine exhaust particulate emissions, and up to 60% of hydrocarbon emissions.

The DOC system would be reliable. It would provide high removal efficiencies for CO and VOC, while also providing a small amount of PM removal. In general it would pose no substantial operating constraints for the generators. There is one identified problem with the catalyzed DPF system. Field tests on a DOC conducted by Microsoft on one of their diesel generators showed that DOCs can convert some of the non-toxic nitric oxide (NO) in the exhaust stream to highly-toxic nitrogen dioxide (NO2). At this time it is uncertain whether the increased emissions of toxic NO2 might pose human health concerns at receptors beyond the facility.

Regardless of that potential issue, ICF concludes that DOCs would be a reliable and efficient system to reduce the emissions of PM, CO and VOC. Therefore, ICF concludes that catalyzed DPFs, by themselves, would be a technically feasible add-on control technology.

However, DOCs failed the cost-effectiveness evaluation on an individual-pollutant basis and on a multi-pollutant basis. ICF evaluated the cost effectiveness of installing and operating DOC systems on the proposed Vantage diesel engines. Emission calculations and cost-effectiveness calculations for the DOC system installed on the Vantage generators are provided in Attachment F. The individual-pollutant cost-effectiveness for NOx, PM, CO and VOC is presented in Table DOC-1 below. For each pollutant the forecast actual control cost far exceeds Ecology's cost-effectiveness criterion. Therefore, the DOC fails the cost-effectiveness test on an individual pollutant basis.

Table DOC-1. DOC Individual Pollutant Removal Tonnages (Nominal-Controlled)

Pollutant	PM (FH+BH)	CO	VOC	NOX
Nominal Cold-Start Uncontrolled TPY	1.56	3.15	0.870	16.1
Nominal Cold-Start Controlled TPY	1.170	0.958	0.485	16.14
Tons Removed/Year	0.39	2.19	0.385	0.0
Overall Cold-Start Removal Effcy	25%	70%	44%	0%
Total Annual Cost ($/year)	$120,766	$120,766	$120,766	$120,766
Individual Pollutant $/Ton Removed	$309,535	$55,094	$313,511	N/A
Ecology Cost-Effectiveness Threshold	$23,200	$5,000	$10,000	$10,000
Pass or Fail?	Fail	Fail	Fail	Fail

A typical DOC system would also provide some marginal efficiencies for PM, as wells as substantial removal for CO and VOC. However, the DOC failed the multi-pollutant cost effectiveness evaluation. Table DOC-2 below shows the multi-pollutant evaluation. The actual annual cost to own and operate the DOC would be $121,000 per year, which far exceeds the "Total Reasonable Annual Cost" of $24,000 per year based on Ecology's cost criteria for the individual pollutants.

Table DOC-2. DOC, Multi-Pollutant Cost-Effectiveness for "Reasonable Control Cost" vs. Actual Control Cost

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (tons/yr)	Subtotal Acceptable Annual Cost ($/year)	
NOX	$10,000	0.00	$0	per year
CO	$5,000	2.19	$10,960	per year
VOC	$9,999	0.39	$3,852	per year
PM (FH+BH)	$23,200	0.39	$9,052	per year
Total Reasonable Annual Control Cost for Combined Pollutants			**$23,863**	**per year**
Actual Annual Control Cost			**$120,766**	**per year**
Is The Control Device Reasonable?			**NO (Actual >> Reasonable)**	

ICF concludes that while DOCs are a potentially-feasible emission control technology for diesel engines, it is not economically feasible for this project. Therefore, ICF recommends that Ecology should reject this control option as BACT.

3-Way Catalysts (2-Stage Catalysts)

The theory and design of 2-stage diesel oxidation catalysts (i.e., diesel oxidation catalysts operating in a 3-way catalyst mode) was described previously under NOx controls. As stated above, one manufacturer of one such commercially-available system (Clean Emission Products) claims their systems are capable of reducing up to 99% of CO, 70% of NOx, 90% of VOC, and 90% of diesel particulate. For the Titan Data Center, Clean Emission Products issued a vendor guarantee for up to 35% NOx removal, and also provided non-guaranteed estimates of 88% for PM, 99% for CO, and 90% for VOC.

ICF is concerned that Clean Emission Products has been unable to provide stack test performance data for use of their 3-Way Catalyst on a lean-burn, Tier-2 certified modern generator. Regardless, based on Clean Emission Products' vendor guarantee for the Titan Data Center, ICF concludes this technology should be considered technically feasible for the Vantage Data Center.

However, ICF concludes 3-Way Catalysts are economically infeasible for the Vantage Data Center. As listed in Table 3WC-1 earlier in this memo, ICF estimates that the use of these catalysts would cost Vantage more than the following:

- $125,000 for each ton of PM removed from the exhaust stream;
- $71,000 for each ton of CO removed from the exhaust stream; and
- $296,000 for each ton of VOC removed from the exhaust stream.

Ecology considers the above annual control cost estimates to be prohibitive under BACT guidelines. Ecology concludes that while specially designed 2-stage oxidation catalysts are promising and potentially effective for CO, PM and VOC control, they are not cost effective under general BACT guidelines. Therefore, ICF recommends Ecology should reject this technology as BACT for the Vantage Data Center.

Combustion Controls and Tier-2 Compliance

Diesel engine manufacturers typically use proprietary combustion control methods to achieve the emission reductions needed to meet applicable EPA Tier-2 standards. Common controls include fuel injection timing retard and exhaust gas recirculation. Injection timing retard reduces the peak flame temperature and NOx emissions, but may lead to higher fuel consumption.

Vantage will install generators equipped with MTU engines that will use a combination of combustion control methods, including fuel injection timing retard, to comply with EPA Tier-2 emission limits. As described in Vantage's air quality permit application, Vantage will also install add-on controls consisting of the AirClarity system.

This is the only technology that provides substantial emission reductions while also satisfying cost-effectiveness criteria. ICF recommends that Ecology should require this technology as BACT for NOx, PM, CO and VOCs.

BACT ANALYSIS FOR SULFUR DIOXIDE

ICF did not find any add-on control options commercially available and feasible for controlling sulfur dioxide emissions from diesel engines. Vantage's proposed BACT for sulfur dioxide is the use of ultra-low sulfur diesel fuel (15 ppm by weight of sulfur).

BACT Recommendation for Sulfur Dioxide. ICF recommends that BACT for sulfur dioxide is the use of ultra-low sulfur diesel fuel containing no more than 15 parts per million by weight of sulfur.

BEST AVAILABLE CONTROL TECHNOLOGY FOR AIR TOXICS

Best Available Control Technology for Toxics (tBACT) means BACT, as applied to toxic air pollutants. The procedure for determining tBACT follows the same procedure used above for determining BACT. Under state rules, tBACT is required for all toxic air pollutants for which the increase in emissions will exceed de minimis emission values as found in WAC 173-460-150.

For the proposed project, tBACT must be determined for each of the toxic air pollutants listed in Table TBACT-1 below. As illustrated by Table TBACT-1, ICF recommends that compliance with BACT, as determined above, satisfies the tBACT requirement.

Table TBACT-1. tBACT Determination

Toxic Air Pollutant	tBACT
Acetaldehyde	Compliance with the VOC BACT requirement
Acrolein	Compliance with the VOC BACT requirement
Benzene	Compliance with the VOC BACT requirement
Benzo(a)pyrene	Compliance with the VOC BACT requirement
1,3-Butadiene	Compliance with the VOC BACT requirement
Carbon monoxide	Compliance with the CO BACT requirement
Diesel engine exhaust particulate	Compliance with the PM BACT requirement
Formaldehyde	Compliance with the VOC BACT requirement
Nitrogen dioxide	Compliance with the NOx BACT requirement
Sulfur dioxide	Compliance with the SO_2 BACT requirement
Toluene	Compliance with the VOC BACT requirement
Total PAHs	Compliance with the VOC BACT requirement
Xylenes	Compliance with the VOC BACT requirement

ATTACHMENT A
NOMINAL-UNCONTROLLED EMISSION ESTIMATES

TABLE UNC-1. NOMINAL UNCONTROLLED (COLD-START ADJUSTED) EMISSION RATES FOR BACT ANALYSIS

Table X. Nominal-Controlled Cold-Start NOX Emissions Accounting for SCR Delay Time

Load	Nominal Uncon.trolled NOX, lbs/hr	Minutes SCR Delay	Guaranteed Effcy (%)	Nominal Controlled CO, lbs/hr	Minutes Full SCR Control	Nominal Controlled NOX Emission, lbs/hr	Overall Cold Start % NOX Removal
10%	6.0	20	0%	6.00	40	6.00	0%
81.3%	37.2	10	0%	37.17	50	37.2	0%
90%	43.6	10	0%	43.57	50	43.6	0%
93.3%	46.1	10	0%	46.14	50	46.1	0%
100%	51.5	10	0%	51.50	50	51.5	0%

STEADY-STATE REMOVAL EFFICIENCIES

Pollutant	Removal Effct (%)
Nox	0%
PM (FH+BH)	0%
CO	0%
VOC	0%

Table X. Nominal-Controlled (Cold-Start Adjusted) PM Emission Rates (Includes FH+BH Factor)

Elec Load	Nominal Uncontrolled Front-Half Only Emiss Rate (lbs/hr)	Total PM to Front Half PM Ratio	Nominal Uncontrolled Total PM Emiss Rate (lbs/hr)	Guaranteed Effcy (%)	Nominal Contr Total PM (lbs/hr)	Dell 1-Hour Cold Start Factor	Nominal Controlled Total PM, lbs/hr
10%	0.43	3.38	1.45	0%	1.451	1.058	1.54
81.3%	0.83	3.08	2.55	0%	2.552	1.058	2.70
90%	0.95	3.08	2.92	0%	2.921	1.058	3.09
93.3%	0.99	3.08	3.04	0%	3.044	1.058	3.22
100%	1.08	3.00	3.24	0%	3.240	1.058	3.43

Total:FH Adjustment Factors

Load	Stacktest Tot PM	Stacktest FH Only PM	Total PM to Front Half PM Ratio
80%-90%			3.08
100%	0.36	0.12	3.00
50%	0.27	0.08	3.38

Table Y. Nominal-Controlled Cold-Start CO Emissions Accounting for DOC Delay Time

Load	Nominal Uncontrolled Rate, lbs/hr	Minutes DOC Delay	Guaranteed Effcy (%)	Nominal Controlled CO, lbs/hr	Minutes Full DOC Control	Wt. Average 1-Hour CO Emission, lbs/hr	Cold Start Factor	Nominal Controlled CO, lbs/hr	Overall Cold Start % CO Removal
10%	2.8	20	0%	2.80	40	2.80	1.058	2.96	0%
81.3%	5.3	10	0%	5.30	50	5.30	1.058	5.61	0%
90%	6.0	10	0%	6.00	50	6.00	1.058	6.35	0%
93.3%	6.3	10	0%	6.30	50	6.30	1.058	6.67	0%
100%	6.8	10	0%	6.80	50	6.80	1.058	7.19	0%

Table Y. Nominal-Controlled Cold-Start VOC Emissions Accounting for DOC Delay Time

Load	Nominal Uncontrolled Rate, lbs/hr	Minutes DOC Delay	Guaranteed Effcy (%)	Nominal Controlled VOC, lbs/hr	Minutes Full DOC Control	Wtd Average 1-Hour Emission, lbs/hr	Cold Start Factor	Nominal Controlled VOC, lbs/hr	Overall Cold Start % Removal
10%	1.2	20	0%	1.23	40	1.23	1.058	1.30	0%
81.3%	1.1	10	0%	1.10	50	1.10	1.058	1.16	0%
90%	1.1	10	0%	1.10	50	1.10	1.058	1.16	0%
93.3%	1.1	10	0%	1.10	50	1.10	1.058	1.16	0%
100%	1.1	10	0%	1.10	50	1.10	1.058	1.16	0%

G:\Seattle\PNWProjects\PACLAND__-11_Riker Data Center\03_Reports-Analyses\BACT-July-2012\[3-way-CEP_Vantage-BACT_July-2012.xls]NOM-Uncontrolled

Table UNC-2. Uncontrolled Facility-Wide Emissions (Basis = ELM's Nominal-Uncontrolled, Plus Cold-Start Factors)

				Hours at Each Runtime Mode																				
Gen #	Gen Area	Elec Load	No. Gens	W	M	Q	A-F	A-Step	Correct Tests	De-En Bldg Maint	Outage or Storm Avoid	Cool	Total hrs/yr	AERMOD Hrs/day	Each Genset DPM lbs/hr	Each Genset Fuel Gal/Hr	Each Genset NOX lbs/hr	Facility Wide Total PM Tons/yr	Facility-Wide Fuel Gal/Year	Facility Wide NOX Tons/yr	Each Genset CO lbs/hr	Facility-Wide CO Tons/Yr	Each Genset HC lbs/hr	Facility-Wide VOC Tons/Yr
Unplanned Outage + Storm Avoidance									Unplanned Outage + Storm Avoidance															
1-1 to 1-5	Bldg 1	81%	5								24		24	24	2.70	195	37.2	0.162	23,400	2.23	5.61	0.34	1.16	0.070
2-1 to 2-3	Bldg 2	90%	3								24		24	24	3.09	213	43.57	0.111	15,336	1.57	6.35	0.23	1.16	0.042
3-1 to 3-3	Bldg 3	90%	3								24		24	24	3.09	213	43.57	0.111	15,336	1.57	6.35	0.23	1.16	0.042
ETC-1	ETC	93%	1								24		24	24	3.22	220	46.14	0.039	5,280	0.55	6.67	0.08	1.16	0.014
Testing at Full Outage Loads									Testing at Full Outage Loads															
1-1 to 1-5	Bldg 1	81%	5			3	6			8			17	24	2.70	195	37.2	0.115	16,575	1.58	5.61	0.24	1.16	0.049
2-1 to 2-3	Bldg 2	90%	3			3	6			8			17	24	3.09	213	43.57	0.079	10,863	1.11	6.35	0.16	1.16	0.030
3-1 to 3-3	Bldg 3	90%	3			3	6			8			17	24	3.09	213	43.57	0.079	10,863	1.11	6.35	0.16	1.16	0.030
ETC-1	ETC	93%	1			3	6			8			17	24	3.22	220	46.14	0.027	3,740	0.39	6.67	0.06	1.16	0.010
100% Load									Testing at 100% Load															
1-1 to 1-5	Bldg 1	100%	5					0.5	8				8.5	24	3.43	232	51.50	0.073	9,860	1.09	7.19	0.15	1.16	0.025
2-1 to 2-3	Bldg 2	100%	3					0.5	8				8.5	24	3.43	232	51.50	0.044	5,916	0.66	7.19	0.09	1.16	0.015
3-1 to 3-3	Bldg 3	100%	3					0.5	8				8.5	24	3.43	232	51.50	0.044	5,916	0.66	7.19	0.09	1.16	0.015
ETC-1	ETC	100%	1					0.5	8				8.5	24	3.43	232	51.50	0.015	1,972	0.22	7.19	0.03	1.16	0.005
1-6 and 1-7 Reserve	Bldg 1	100%	2					0.5	8				8.5	24	3.43	232	51.50	0.029	3,944	0.44	7.19	0.06	1.16	0.010
2-4 Reserve	Bldg 2	100%	1					0.5	8				8.5	24	3.43	232	51.50	0.015	1,972	0.22	7.19	0.03	1.16	0.005
3-4 Reserve	Bldg 3	100%	1					0.5	8				8.5	24	3.43	232	51.50	0.015	1,972	0.22	7.19	0.03	1.16	0.005
ETC-2 Reserve	ETC	100%	1					0.5	8				8.5	24	3.43	232	51.50	0.015	1,972	0.22	7.19	0.03	1.16	0.005
Idle (set to 10% for emission calculations)									Idle															
1-1 to 1-5	Bldg 1	10%	5	20	6	0	0	0	0	0	0	9.5	35.5	24	1.54	45	6.00	0.136	7,988	0.53	2.96	0.26	1.30	0.115
2-1 to 2-3	Bldg 2	10%	3	20	6	0	0	0	0	0	0	9.5	35.5	24	1.54	45	6.00	0.082	4,793	0.32	2.96	0.16	1.30	0.069
3-1 to 3-3	Bldg 3	10%	3	20	6	0	0	0	0	0	0	9.5	35.5	24	1.54	45	6.00	0.082	4,793	0.32	2.96	0.16	1.30	0.069
ETC-1	ETC	10%	1	20	6	0	0	0	0	0	0	9.5	35.5	24	1.54	45	6.00	0.027	1,598	0.11	2.96	0.05	1.30	0.023
1-6 and 1-7 Reserve	Bldg 1	10%	2	20	6	3	6			8	24	1.5	68.5	24	1.54	45	6.00	0.105	6,165	0.41	2.96	0.20	1.30	0.089
2-4 Reserve	Bldg 2	10%	1	20	6	3	6			8	24	1.5	68.5	24	1.54	45	6.00	0.053	3,083	0.21	2.96	0.10	1.30	0.045
3-4 Reserve	Bldg 3	10%	1	20	6	3	6			8	24	1.5	68.5	24	1.54	45	6.00	0.053	3,083	0.21	2.96	0.10	1.30	0.045
ETC-2 Reserve	ETC	10%	1	20	6	3	6			8	24	1.5	68.5	24	1.54	45	6.00	0.053	3,083	0.21	2.96	0.10	1.30	0.045
																		PM (tpy)		NOX (tpy)		CO (tpy)		VOC (tpy)
															Uncontrolled Facility-Wide Emissions			1.56	169,500	16.14		3.15		0.87

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ATTACHMENT B
AIRCLARITY EMISSION CONTROL SYSTEM (CATALYZED DPF + SCR)
BACT ASSESSMENT

MTU AIRCLARITY CONTROL SYSTEM
CATALYZED DPF + UREA SCR

ELM Permitting Information

9. Narrative of Tier-4 emission control equipment, including vendor-guaranteed removal efficiencies.

The diesel emission control strategy the AirClarity utilizes highly oxidizing precious metal particulate matter filters to control PM, HC, and CO reductions, as well as a Selective Catalytic Reducer coupled with an airless DEF injection system.

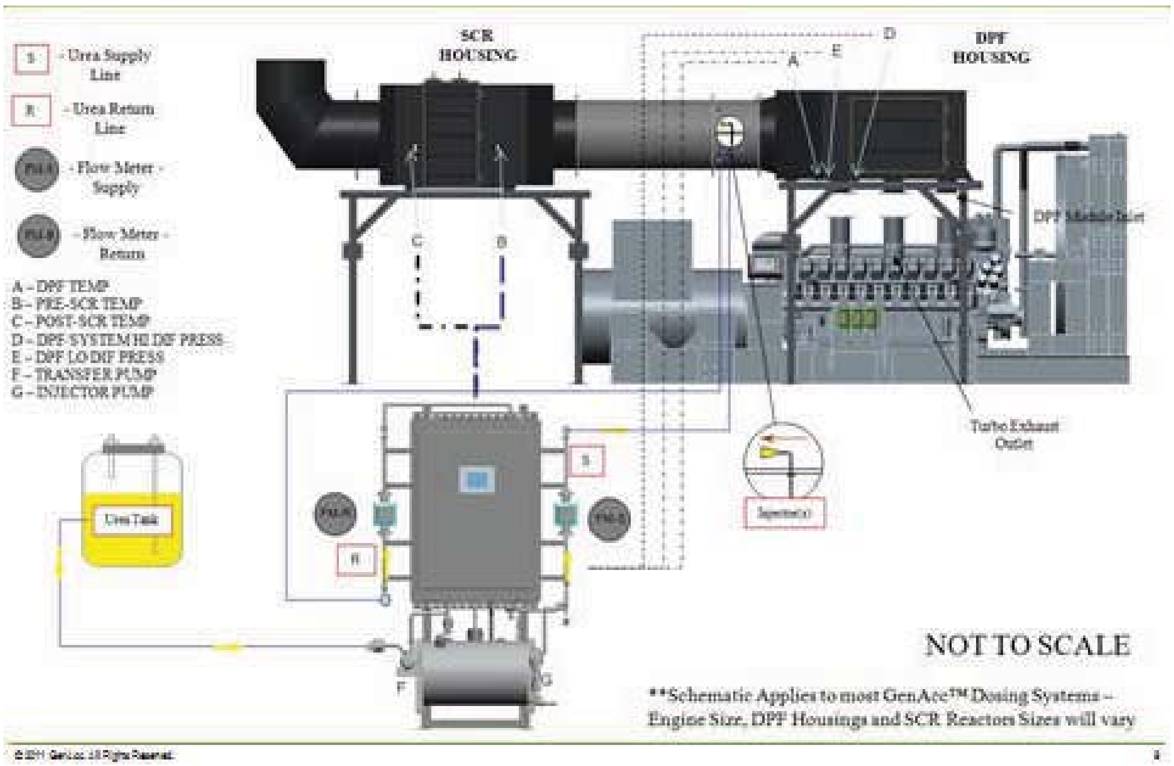
The injection system includes reductant tank level monitoring, return and supply flow metering, DPF temperature, SCR temperature (pre and post), DPF backpressure, system backpressure, and SCR outlet NOx sensor; all parameters are logged and will produce alarms should the system operate out of spec. A relative humidity sensor will also be utilized in the system, as humidity has been known to affect engine-out NOx by as much as 15% depending on ambient conditions.

The EnviCat® 2055 DPF is a wall flow ceramic Diesel Particulate Filter coated with a Süd-Chemie proprietary precious metal based coating on a cordierite ceramic substrate. The device is designed to filter and passively reduce >95% diesel particulate matter mass found in diesel engine exhaust. Furthermore, carbon monoxide and hydrocarbon emissions in the exhaust are reduced by means of catalytic oxidation. This device does not employ zone coating. The catalyzed DPF is also responsible for reducing hydrocarbons by almost 96%, as well as carbon monoxide reductions of greater than 99% (reductions based on engine baseline and emissions testing at 5-mode average).

The EnviCat® 20019 SCR is a flow through ceramic substrate coated with a Süd-Chemie proprietary SCR coating. The SCR is designed to reduce engine out NO_x emissions across a broad range of engine operating conditions.

Vendor-guaranteed removal efficiencies are as follows:

NOx >90%
CO >90%
HC >90%
PM >87%



10. Has the Tier-4 generator achieved CARB certification? If so, provide the certification data.

No. In process.

11. Vendor-estimated purchase price of emission control equipment compared to Tier-2 generators

Estimated $400,000 increase per Tier-2 generator.

12. Vendor's "Not-to-Exceed" and "Nominal" emission data.

See attached spreadsheets for both "Not-to-Exceed" (NTE) and nominal controlled emissions information.

13. Narrative of cold-start delay time before catalysts reach activation temperature and perform at vendor-guaranteed removal efficiency

The SCR is designed to operate nominally at 900 degrees Fahrenheit, however NOx conversion can be achieved from 300 to 1000 degrees Fahrenheit. Due to the possibility of forming ammonia salts at lower temperatures, DEF will only be injected at 425 degrees Fahrenheit or higher. Should the temperatures exceed 1000 degrees, the system will alarm as temperatures higher than this can result in catalyst degradation and possible destruction of the honeycomb material. Testing on the 20v4000 indicates we can run at 10% load and dose Urea to reduce NOx. We believe this would happen in under 20 minutes with most conditions having dosing start in less than 15 minutes.

The DPF will reduce PM at all times but should be regenerated when one of the following conditions is met:

- After back pressure readings have reached the maximum allowable backpressure per manufacturers specifications (27" W.C.)
- After 24 idle cold starts of 30-minutes or less and no regeneration has been performed between the cold starts.
- After operation below the recommended regeneration temperature of 300°C for a consecutive period of 720-minutes

Regeneration is accomplished by bringing the engine load level required to achieve a minimum 300°C exhaust gas temperature at the filter inlet and holding for a minimum period of 30-minutes. In testing with the 20v4000 the filters should regen at 10% load unless ambient temperatures are extremely low.

Should the soot loading reach a high level before cold start maximum is reached, the DPF differential pressure sensor will read a high backpressure and the system will alarm. Should the system reach 24 cold starts without reaching the maximum backpressure, the system will alarm and alert the user for the need to regenerate the DPF elements.

14. Can the vendor provide a document of stack test data?

Stack test data (except for particulate and ammonia) are attached for NOx, CO, & HC at 100%, 75%, 50%, 25%, and 10% loads. Final stack test results for ammonia and particulate are expected to be available next week and completed results will be forwarded as soon as they are received.

TABLE AIRCLARITY-1. AIRCLARITY NOMINAL CONTROLLED (COLD-START ADJUSTED) EMISSION RATES FOR BACT ANALYSIS

Table X. Nominal-Controlled Cold-Start NOX Emissions Accounting for SCR Delay Time

Load	Nominal Uncon.trolled NOX, lbs/hr	Minutes SCR Delay	Guaranteed Effcy (%)	Nominal Controlled CO, lbs/hr	Minutes Full SCR Control	Nominal Controlled NOX Emission, lbs/hr	Overall Cold Start % NOX Removal
10%	6.0	20	90%	0.60	40	2.40	60%
81.3%	37.2	10	90%	3.72	50	9.29	75%
90%	43.6	10	90%	4.36	50	10.89	75%
93.3%	46.1	10	90%	4.61	50	11.53	75%
100%	51.5	10	90%	5.15	50	12.88	75%

AIRCLARITY STEADY-STATE REMOVAL EFFICIENCIES

Pollutant	Removal Effct (%)
Nox	90%
PM (FH+BH)	87%
CO	90%
VOC	90%

Table X. Nominal-Controlled (Cold-Start Adjusted) PM Emission Rates (Includes FH+BH Factor)

Elec Load	Nominal Uncontrolled Front-Half Only Emiss Rate (lbs/hr)	Total PM to Front Half PM Ratio	Nominal Uncontrolled Total PM Emiss Rate (lbs/hr)	Guaranteed Effcy (%)	Nominal Contr Total PM (lbs/hr)	Dell 1-Hour Cold Start Factor	Nominal Controlled Total PM, lbs/hr
10%	0.43	3.38	1.45	87%	0.189	1.058	0.200
81.3%	0.83	3.08	2.55	87%	0.332	1.058	0.351
90%	0.95	3.08	2.92	87%	0.380	1.058	0.402
93.3%	0.99	3.08	3.04	87%	0.396	1.058	0.419
100%	1.08	3.00	3.24	87%	0.421	1.058	0.446

Total:FH Adjustment Factors

Load	Stacktest Tot PM	Stacktest FH Only PM	Total PM to Front Half PM Ratio
80%-90%			3.08
100%	0.36	0.12	3.00
50%	0.27	0.08	3.38

Table Y. Nominal-Controlled Cold-Start CO Emissions Accounting for DOC Delay Time

Load	Nominal Uncontrolled Rate, lbs/hr	Minutes DOC Delay	Guaranteed Effcy (%)	Nominal Controlled CO, lbs/hr	Minutes Full DOC Control	Wt. Average 1-Hour CO Emission, lbs/hr	Cold Start Factor	Nominal Controlled CO, lbs/hr	Overall Cold Start % CO Removal
10%	2.8	20	90%	0.28	40	1.12	1.058	1.18	60%
81.3%	5.3	10	90%	0.53	50	1.33	1.058	1.40	75%
90%	6.0	10	90%	0.60	50	1.50	1.058	1.59	75%
93.3%	6.3	10	90%	0.63	50	1.58	1.058	1.67	75%
100%	6.8	10	90%	0.68	50	1.70	1.058	1.80	75%

Table Y. Nominal-Controlled Cold-Start VOC Emissions Accounting for DOC Delay Time

Load	Nominal Uncontrolled Rate, lbs/hr	Minutes DOC Delay	Guaranteed Effcy (%)	Nominal Controlled VOC, lbs/hr	Minutes Full DOC Control	Wtd Average 1-Hour Emission, lbs/hr	Cold Start Factor	Nominal Controlled VOC, lbs/hr	Overall Cold Start % Removal
10%	1.2	20	90%	0.12	40	0.49	1.058	0.52	60%
81.3%	1.1	10	90%	0.11	50	0.28	1.058	0.29	75%
90%	1.1	10	90%	0.11	50	0.28	1.058	0.29	75%
93.3%	1.1	10	90%	0.11	50	0.28	1.058	0.29	75%
100%	1.1	10	90%	0.11	50	0.28	1.058	0.29	75%

Table AIRCLARITY-2. AirClarity Nominal-Controlled Facility-Wide Emissions (Basis = ELM's Nominal-Uncontrolled + Cold-Start Factors)

Gen #	Gen Area	Elec Load	No. Gens	Hours at Each Runtime Mode: W	M	Q	A-F	A-Step	Correct Tests	De-En Bldg Maint	Outage or Storm Avoid	Cool	Total hrs/yr	Each Genset DPM lbs/hr	Each Genset Fuel Gal/Hr	Each Genset NOX lbs/hr	Facility Wide Total PM Tons/yr	Facility-Wide Fuel Gal/Year	Facility Wide NOX Tons/yr	Each Genset CO lbs/hr	Facility-Wide CO Tons/Yr	Each Genset HC lbs/hr	Facility-Wide VOC Tons/Yr
Unplanned Outage + Storm Avoidance				Unplanned Outage + Storm Avoidance																			
1-1 to 1-5	Bldg 1	81%	5								24		24	0.35	195	9.3	0.021	23,400	0.56	1.40	0.08	0.29	0.017
2-1 to 2-3	Bldg 2	90%	3								24		24	0.40	213	10.89	0.014	15,336	0.39	1.59	0.06	0.29	0.010
3-1 to 3-3	Bldg 3	90%	3								24		24	0.40	213	10.89	0.014	15,336	0.39	1.59	0.06	0.29	0.010
ETC-1	ETC	93%	1								24		24	0.42	220	11.53	0.005	5,280	0.14	1.67	0.02	0.29	0.003
Testing at Full Outage Loads				Testing at Full Outage Loads																			
1-1 to 1-5	Bldg 1	81%	5			3	6			8			17	0.35	195	9.3	0.015	16,575	0.39	1.40	0.06	0.29	0.012
2-1 to 2-3	Bldg 2	90%	3			3	6			8			17	0.40	213	10.89	0.010	10,863	0.28	1.59	0.04	0.29	0.007
3-1 to 3-3	Bldg 3	90%	3			3	6			8			17	0.40	213	10.89	0.010	10,863	0.28	1.59	0.04	0.29	0.007
ETC-1	ETC	93%	1			3	6			8			17	0.42	220	11.53	0.004	3,740	0.10	1.67	0.01	0.29	0.002
100% Load				Testing at 100% Load																			
1-1 to 1-5	Bldg 1	100%	5					0.5	8				8.5	0.45	232	12.88	0.009	9,860	0.27	1.80	0.04	0.29	0.006
2-1 to 2-3	Bldg 2	100%	3					0.5	8				8.5	0.45	232	12.88	0.006	5,916	0.16	1.80	0.02	0.29	0.004
3-1 to 3-3	Bldg 3	100%	3					0.5	8				8.5	0.45	232	12.88	0.006	5,916	0.16	1.80	0.02	0.29	0.004
ETC-1	ETC	100%	1					0.5	8				8.5	0.45	232	12.88	0.002	1,972	0.05	1.80	0.01	0.29	0.001
1-6 and 1-7 Reserve	Bldg 1	100%	2					0.5	8				8.5	0.45	232	12.88	0.004	3,944	0.11	1.80	0.02	0.29	0.002
2-4 Reserve	Bldg 2	100%	1					0.5	8				8.5	0.45	232	12.88	0.002	1,972	0.05	1.80	0.01	0.29	0.001
3-4 Reserve	Bldg 3	100%	1					0.5	8				8.5	0.45	232	12.88	0.002	1,972	0.05	1.80	0.01	0.29	0.001
ETC-2 Reserve	ETC	100%	1					0.5	8				8.5	0.45	232	12.88	0.002	1,972	0.05	1.80	0.01	0.29	0.001
Idle (set to 10% for emission calculations)				Idle																			
1-1 to 1-5	Bldg 1	10%	5	20	6	0	0	0	0	0	0	9.5	35.5	0.20	45	2.40	0.018	7,988	0.21	1.18	0.11	0.52	0.046
2-1 to 2-3	Bldg 2	10%	3	20	6	0	0	0	0	0	0	9.5	35.5	0.20	45	2.40	0.011	4,793	0.13	1.18	0.06	0.52	0.028
3-1 to 3-3	Bldg 3	10%	3	20	6	0	0	0	0	0	0	9.5	35.5	0.20	45	2.40	0.011	4,793	0.13	1.18	0.06	0.52	0.028
ETC-1	ETC	10%	1	20	6	0	0	0	0	0	0	9.5	35.5	0.20	45	2.40	0.004	1,598	0.04	1.18	0.02	0.52	0.009
1-6 and 1-7 Reserve	Bldg 1	10%	2	20	6	3	6			8	24	1.5	68.5	0.20	45	2.40	0.014	6,165	0.16	1.18	0.08	0.52	0.036
2-4 Reserve	Bldg 2	10%	1	20	6	3	6			8	24	1.5	68.5	0.20	45	2.40	0.007	3,083	0.08	1.18	0.04	0.52	0.018
3-4 Reserve	Bldg 3	10%	1	20	6	3	6			8	24	1.5	68.5	0.20	45	2.40	0.007	3,083	0.08	1.18	0.04	0.52	0.018
ETC-2 Reserve	ETC	10%	1	20	6	3	6			8	24	1.5	68.5	0.20	45	2.40	0.007	3,083	0.08	1.18	0.04	0.52	0.018

	Total PM	Fuel	NOX		CO		VOC
CONTROLLED Facility-Wide Emissions	0.203	169,500	4.38		0.958		0.293
UNCONTROLLED Facility-Wide Emissions	1.56		16.14		3.15		0.870
Tons/Yr Removed	1.36		11.76		2.19		0.58
Overall Removal Effcy, %	87%		73%		70%		66%

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Table AIRCLARITY-3. BACT Capital Cost for MTU AirClarity System (SCR and Catalyzed DPF)

Vantage Data Center

Cost Category	Cost Factor	Source of Cost Factor	Quant.	Unit Cost	Subtotal Cost
Direct Costs					
Purchased Equipment Costs					
FOB Purchase Price	As quoted by MTU	MTU	17	$400,000	$6,800,000
Instrumentation	Assume no cost	Assume no cost	0	0	0
Sales Tax	WA state tax	WA state tax	6.5%	--	$442,000
Shipping	0.05A	EPA Cost Manual	5.0%	--	$340,000
Subtotal Purchased Equipment Cost, PEC					$7,582,000
Direct Installation Costs					
Enclosure structural supports	Assume no cost	Assume no cost	0	$0	$0
Installation	1/2 of EPA Cost Manual	1/2 of EPA Cost Manual	2.5%	--	$189,550
Electrical	Assume no cost	Assume no cost	0	0	0
Piping	Assume no cost	Assume no cost	0	0	0
Insulation	Assume no cost	Assume no cost	0	0	0
Painting	Assume no cost	Assume no cost	0	0	0
Subtotal Direct Installation Costs					$189,550
Site Preparation and Buildings (SP)	Assume no cost	Assume no cost	0	0	0
Total Direct Costs, DC (PEC + Direct Installation + Site Prep)					$7,771,550
Indirect Costs (Installation)					
Engineering	0.025*PEC	1/4 of EPA Cost Manual	2.5%	--	$189,550
Construction and field expenses	0.025*PEC	1/2 of EPA Cost Manual	2.5%	--	$189,550
Contractor Fees	From DIS data center	From DIS data center	6.8%	--	$532,645
Startup	0.02*PEC	EPA Cost Manual	2.0%	--	$151,640
Performance Test (Tech support)	0.01*PEC	EPA Cost Manual	1.0%	--	$75,820
Contingencies	0.03*PEC	EPA Cost Manual	3.0%	--	$227,460
Subtotal Indirect Costs, IC					$1,366,665
Total Capital Investment (TCI = DC+IC)					$9,138,215
					TCI per gen
					$537,542

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Table AIRCLARITY-4. Nominal-Controlled BACT Cost-Effectiveness for MTU AirClarity System

Item	Quantity	Units	Unit cost	Subtotal
Annualized Capital Recovery				
Total Capital Cost				$9,138,215
Capital Recovery Factor, 25 yrs, 4% discount rate				0.06401
Subtotal Annualized 25-year Capital Recovery Cost				$584,937
Direct Annual Costs				
Annual Admin charges	2% of TCI (EPA Manual)		0.02	$182,764
Annual Property tax	1% of TCI (EPA Manual)		0.01	$91,382
Annual Insurance	1% of TCI (EPA Manual)		0.01	$91,382
Annual operation/labor/maintenance costs: Upperbound estimate would assume CARB's value of $3.00/hp/year and would result in $206,000/year. Lower bound estimate would assume zero annual O&M. Mid-range value would account for urea, fuel for pressure drop, increased inspections, periodic OEM visits, and the costs for Ecology's increased emission testing requirements. **For this screening-level analysis we assumed the lower-bound annual O&M cost of zero.**				$0
Subtotal Direct Annual Costs				$365,529
Total Annual Cost (Capital Recovery + Direct Annual Costs)				**$950,466**
Uncontrolled emissions (Combined Pollutants)				21.7
Assumed Control Efficiency				Varies
Annual Tons Removed (Combined Pollutants)				15.89
Cost Effectiveness ($ per tons combined pollutant destroyed)				**$59,823**

TCI/gen	$537,542

Combined Pollutants Removal Tonnages (Nominal-Controlled)

Pollutant	PM (FH+BH)	CO	VOC	NOX
Nominal Cold-Start Uncontrolled TPY	**1.56**	**3.15**	**0.870**	**16.1**
Nominal Cold-Start Controlled TPY	**0.203**	**0.958**	**0.293**	**4.38**
Tons Removed/Year	**1.36**	**2.19**	**0.578**	**11.8**
Overall Cold-Start Removal Effcy	87%	70%	66%	73%
Indiv Poll $/Ton Removed	$700,039	$433,611	$1,644,950	$80,819

Multi-PollutantCost-Effectiveness for Acceptable Control Cost vs. Actual Control Cost

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (tons/yr)	Subtotal Acceptable Annual Cost ($/year)	
NOX	$10,000	11.76	$117,604	per year
CO	$5,000	2.19	$10,960	per year
VOC	$9,999	0.58	$5,778	per year
PM (FH+BH)	$23,200	1.36	$31,499	per year
Total Accetable Annual Control Cost for Combined Pollutants			**$165,841**	**per year**
Actual Annual Control Cost			**$950,466**	**per year**
Is The Control Device Reasonable?			**NO (Actual >> Acceptable)**	

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ATTACHMENT C
CATALYZED DPF BACT ASSESSMENT

CleanAIR SYSTEMS
A Caterpillar Company

CATALYZED DPF TECHNICAL DATA AND COST QUOTE
SABEY-INTERGATE-QUINCY DATA CENTER

PROPOSAL

Proposal Date: Wednesday, December 08, 2010
Quotation Number: 10120806RW-F **Rev:**

Customer Contact:	John Ford	**Project Description**
Title:	Director of Technology Real Extate	Sabey Construction - CAT 3516C 2000 ekW Generator
Email:	johnf@sabey.com	**Address:**
Phone:	206-277-5209	,
Cell:		
Company Name:	Sabey Corporation	
Address :	12201 Tukwila International Blvd. Seattle, WA 98168	
Product Quoted:	PERMIT Filter System in a 304L Stainless Steel Double Wall Insulated Critical Grade Silencer	
Purchase Order Date:		**Requested Installation Date:**

Engine Specifications: *CAT*

Engine Model:	**3516C**		Engine S/N:				
EPA Tier Level:	Tier 2		EPA Family #:				
Engine Displacement:	69	liters	Engine Specification #:	DM8263			
Fuel Type:	ULSD (<50 PPM)		Engine Model Year:	2010			
Required Fuel Content:	<50	ppm	Sulfur				
Generator Power Rating:	**2,000**	**ekW**	**Standby**	Model #:			
Average Running Load:		Runtime:		hours/year			
Engine Power Output:	2,937	bhp or	2188	kW	@	1,800	RPM
Exhaust Flow Rate:	15,136	ACFM					
Exhaust Stack Temp:	762	deg F					
Maximum Exhaust Pressure:	27	inches H_2O					

Emissions Specifications:

Engine Emissions:	***Certified***	
NOx:	3.93 g/bhp-hr	
CO:	0.49 g/bhp-hr	
HC:	0.25 g/bhp-hr	
PM:	0.08 g/bhp-hr	
Emissions Reduction Required:		**% Reduction**
CO:	g/bhp-hr	
HC:	g/bhp-hr	
PM:	g/bhp-hr	
Emissions Post After Treatment:	***Estimated***	**% Reduction**
CO:	**0.049 g/bhp-hr**	**90%**
HC:	**0.025 g/bhp-hr**	**90%**
PM:	**0.012** g/bhp-hr	**85%**

CleanAIR SYSTEMS
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PERMIT Filter Specifications:

Material:	Catalyzed Cordierite Ceramic wall-flow filter substrates	
PM Reduction:	85%	*CARB Level 3+ verified for greater than 85%*
CO Reduction:	90%	
HC(VOC) Reduction:	90%	
PERMIT Filter Part Number:	FDA221	
Number of Filters:	**9**	
Filter Pressure Drop:	**10.2**	inches H_2O as configured at rated load
Regeneration using ULSD:	Above 350 deg C (662 deg F) for 30% of the engine operating time and greater than 40% engine load	
Stationary Cold Starts:	12	consecutive 10 minute idle sessions followed by 2 hrs regeneration
Cleaning:	2,500	hour intervals
Catalyst Life Expectancy:	10,000	hours

Critical Grade Silencer Housing Specifications: *10081103AF*

Material:	**304L Stainless Steel**					
Construction:	**Double Wall, Rigid, & Light Weight**					
Insulation:	**2"**	**Between two 304L Stainless Steel Walls**				
Approximate Dimensions (inches):	**96**	**" Length**	**90**	**" Width**	**52**	**" Height**
Estimated Weight:	**3,750**	**pounds**	**1,705**	**kilograms**		
Sound Reduction:	**27-35**	**dBa, Critical Grade Silencing**				
Total System Pressure Drop Silencer+DPF:	**13.2**	inches H_2O as configured at rated load				
Inlet Size:	**22**	inches	**Flange**			
Outlet Size:	**22**	inches	**Flange**			

HiBACK USB Controller: *07010204AG*

Data Logger:	Monitors and Records the Exhaust Temperature, Pressure, Date, and Time every 15 sec. for 26,000 readings
Alarm System:	Red warning light for maximum pressure exceeded Yellow warning light for pending high pressure levels
Self Diagnostics:	Flashing lights indicate if the pressure or temperature not recording
Rugged Construction:	Cast Aluminum weathertight housing
Easy data downloads:	With software the logged data can be downloaded to an excel spreadsheet for analysis

CleanAIR SYSTEMS
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This System Includes:

PERMIT DPF	Yes	*>85% PM, >90% CO, >90% HC Reductions*
CRITICAL GRADE SILENCER - Stainless Steel	Yes	*Double wall Insulated Critical Grade Silencer*
HiBACK USB Controller	Yes	*Required by CARB and to validate warranty*
HiBACK USB Level 2 Software	Yes	*Required to download HiBACK USB data information*
Operation & Maintenance Manual	Yes	

This System Excludes:

Delivery/Freight Expenses

Installation of the PERMIT Filter System

Exhaust piping insulation *(CleanAIR Systems recommends insulating the exhaust from the engine to the inlet of the filter)*

All necessary permitting

Terms & Conditions: *FOB Santa Fe*

Shipping Date:	12	weeks from date of purchase order and approved design
Terms:	Net 30 Days	
Proposal Valid :	30	days from proposal date
Warranty:	1	year(s) or 1,000 hours of Operation from Commissioning

Notes:

CleanAIR SYSTEMS
A Caterpillar Company

Pricing:

	Part Number	Description	Quantity	Unit Price	Total (USD)
1	10081103AF	PERMIT Filter In an Insulated Double Wall 304L Stainless Steel Critical Grade Silencer System	3	$106,586	$319,758.00
2	07010204AG	HiBACK USB Pressure Alarm/ Data Logger	3	$1,023	$3,069.00
3	07010202AG	HiBACK USB Level 2 Software	1	$165	$165.00
4					$ -
5				Handling/Skidding:	$3,229,91
6				Estimated Freight:	
				Total:	$329,221.91

	Part Number	Description	Quantity	Unit Price	Total (USD)
	Recommended Optional Equipment:				
1		Custom Insulating Blanket for exhaust piping, etc.	Size TBD		TBD
2		Load Bank	Size TBD		TBD
3					$ -
4		Spare Set of Filter Elements for one system	9	$8,992.50	$80,932.50

Handling/Skidding : 1% of the total order will be charged to prepare the unit for shipping with a $10 minimum for orders under $100, $20 minimum for orders $101 to $1000, and a $30 minimum for orders $1,001 to $3,000.

Order Cancellations: **Standard Parts** – A flat 20% fee will be charged on canceled orders for standard parts.
Custom Parts – Customer will incur all expenses at the time of order cancellation including; materials, engineering & labor plus 20

Contact Information:

N C Power Systems
Don Lee King
Power Generation Sales
425-656-4586
DLKing@ncpowersystems.com

For additional information, visit:

TABLE DPF-1. CATALYZED DPF NOMINAL CONTROLLED (COLD-START ADJUSTED) EMISSION RATES FOR BACT ANALYSIS

Table X. Nominal-Controlled Cold-Start NOX Emissions Accounting for 3WC Delay Time

Load	Nominal Uncon.trolled NOX, lbs/hr	Minutes SCR Delay	Guaranteed Effcy (%)	Nominal Controlled CO, lbs/hr	Minutes Full SCR Control	Nominal Controlled NOX Emission, lbs/hr	Overall Cold Start % NOX Removal
10%	6.0	20	0%	6.00	40	6.00	0%
81.3%	37.2	10	0%	37.17	50	37.17	0%
90%	43.6	10	0%	43.57	50	43.57	0%
93.3%	46.1	10	0%	46.14	50	46.14	0%
100%	51.5	10	0%	51.50	50	51.50	0%

CATALYZED DPF STEADY-STATE REMOVAL EFFICIENCIES

Pollutant	Removal Effct (%)
Nox	0%
PM (FH+BH)	85%
CO	90%
VOC	90%

Table X. Nominal-Controlled (Cold-Start Adjusted) PM Emission Rates (Includes FH+BH Factor)

Elec Load	Nominal Uncontrolled Front-Half Only Emiss Rate (lbs/hr)	Total PM to Front Half PM Ratio	Nominal Uncontrolled Total PM Emiss Rate (lbs/hr)	Guaranteed Effcy (%)	Nominal Contr Total PM (lbs/hr)	Dell 1-Hour Cold Start Factor	Nominal Controlled Total PM, lbs/hr
10%	0.43	3.38	1.45	85%	0.218	1.058	0.230
81.3%	0.83	3.08	2.55	85%	0.383	1.058	0.405
90%	0.95	3.08	2.92	85%	0.438	1.058	0.464
93.3%	0.99	3.08	3.04	85%	0.457	1.058	0.483
100%	1.08	3.00	3.24	85%	0.486	1.058	0.514

Total:FH Adjustment Factors

Load	StacktestTot PM	Stacktest FH Only PM	Total PM to Front Half PM Ratio
80%-90%			3.08
100%	0.36	0.12	3.00
50%	0.27	0.08	3.38

Table Y. Nominal-Controlled Cold-Start CO Emissions Accounting for DOC Delay Time

Load	Nominal Uncontrolled Rate, lbs/hr	Minutes DOC Delay	Guaranteed Effcy (%)	Nominal Controlled CO, lbs/hr	Minutes Full DOC Control	Wt. Average 1-Hour CO Emission, lbs/hr	Cold Start Factor	Nominal Controlled CO, lbs/hr	Overall Cold Start % CO Removal
10%	2.8	20	90%	0.28	40	1.12	1.058	1.18	60%
81.3%	5.3	10	90%	0.53	50	1.33	1.058	1.40	75%
90%	6.0	10	90%	0.60	50	1.50	1.058	1.59	75%
93.3%	6.3	10	90%	0.63	50	1.58	1.058	1.67	75%
100%	6.8	10	90%	0.68	50	1.70	1.058	1.80	75%

Table Y. Nominal-Controlled Cold-Start VOC Emissions Accounting for DOC Delay Time

Load	Nominal Uncontrolled Rate, lbs/hr	Minutes DOC Delay	Guaranteed Effcy (%)	Nominal Controlled VOC, lbs/hr	Minutes Full DOC Control	Wtd Average 1-Hour Emission, lbs/hr	Cold Start Factor	Nominal Controlled VOC, lbs/hr	Overall Cold Start % Removal
10%	1.2	20	90%	0.12	40	0.49	1.058	0.52	60%
81.3%	1.1	10	90%	0.11	50	0.28	1.058	0.29	75%
90%	1.1	10	90%	0.11	50	0.28	1.058	0.29	75%
93.3%	1.1	10	90%	0.11	50	0.28	1.058	0.29	75%
100%	1.1	10	90%	0.11	50	0.28	1.058	0.29	75%

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Table DPF-2. DPF Nominal-Controlled Facility-Wide Emissions (Basis = ELM's Nominal-Uncontrolled + Cold-Start Factors)

				Hours at Each Runtime Mode																			
Gen #	Gen Area	Elec Load	No. Gens	W	M	Q	A-F	A-Step	Correct Tests	De-En Bldg Maint	Outage or Storm Avoid	Cool	Total hrs/yr	Each Genset DPM lbs/hr	Each Genset Fuel Gal/Hr	Each Genset NOX lbs/hr	Facility Wide Total PM Tons/yr	Facility-Wide Fuel Gal/Year	Facility Wide NOX Tons/yr	Each Genset CO lbs/hr	Facility-Wide CO Tons/Yr	Each Genset HC lbs/hr	Facility-Wide VOC Tons/Yr
Unplanned Outage + Storm Avoidance				Unplanned Outage + Storm Avoidance																			
1-1 to 1-5	Bldg 1	81%	5								24		24	0.41	195	37.2	0.024	23,400	2.23	1.40	0.08	0.29	0.017
2-1 to 2-3	Bldg 2	90%	3								24		24	0.46	213	43.57	0.017	15,336	1.57	1.59	0.06	0.29	0.010
3-1 to 3-3	Bldg 3	90%	3								24		24	0.46	213	43.57	0.017	15,336	1.57	1.59	0.06	0.29	0.010
ETC-1	ETC	93%	1								24		24	0.48	220	46.14	0.006	5,280	0.55	1.67	0.02	0.29	0.003
Testing at Full Outage Loads				Testing at Full Outage Loads																			
1-1 to 1-5	Bldg 1	81%	5			3	6			8			17	0.41	195	37.2	0.017	16,575	1.58	1.40	0.06	0.29	0.012
2-1 to 2-3	Bldg 2	90%	3			3	6			8			17	0.46	213	43.57	0.012	10,863	1.11	1.59	0.04	0.29	0.007
3-1 to 3-3	Bldg 3	90%	3			3	6			8			17	0.46	213	43.57	0.012	10,863	1.11	1.59	0.04	0.29	0.007
ETC-1	ETC	93%	1			3	6			8			17	0.48	220	46.14	0.004	3,740	0.39	1.67	0.01	0.29	0.002
100% Load				Testing at 100% Load																			
1-1 to 1-5	Bldg 1	100%	5					0.5	8				8.5	0.51	232	51.50	0.011	9,860	1.09	1.80	0.04	0.29	0.006
2-1 to 2-3	Bldg 2	100%	3					0.5	8				8.5	0.51	232	51.50	0.007	5,916	0.66	1.80	0.02	0.29	0.004
3-1 to 3-3	Bldg 3	100%	3					0.5	8				8.5	0.51	232	51.50	0.007	5,916	0.66	1.80	0.02	0.29	0.004
ETC-1	ETC	100%	1					0.5	8				8.5	0.51	232	51.50	0.002	1,972	0.22	1.80	0.01	0.29	0.001
1-6 and 1-7 Reserve	Bldg 1	100%	2					0.5	8				8.5	0.51	232	51.50	0.004	3,944	0.44	1.80	0.02	0.29	0.002
2-4 Reserve	Bldg 2	100%	1					0.5	8				8.5	0.51	232	51.50	0.002	1,972	0.22	1.80	0.01	0.29	0.001
3-4 Reserve	Bldg 3	100%	1					0.5	8				8.5	0.51	232	51.50	0.002	1,972	0.22	1.80	0.01	0.29	0.001
ETC-2 Reserve	ETC	100%	1					0.5	8				8.5	0.51	232	51.50	0.002	1,972	0.22	1.80	0.01	0.29	0.001
Idle (set to 10% for emission calculations)				Idle																			
1-1 to 1-5	Bldg 1	10%	5	20	6	0	0	0	0	0	0	9.5	35.5	0.23	45	6.00	0.020	7,988	0.53	1.18	0.11	0.52	0.046
2-1 to 2-3	Bldg 2	10%	3	20	6	0	0	0	0	0	0	9.5	35.5	0.23	45	6.00	0.012	4,793	0.32	1.18	0.06	0.52	0.028
3-1 to 3-3	Bldg 3	10%	3	20	6	0	0	0	0	0	0	9.5	35.5	0.23	45	6.00	0.012	4,793	0.32	1.18	0.06	0.52	0.028
ETC-1	ETC	10%	1	20	6	0	0	0	0	0	0	9.5	35.5	0.23	45	6.00	0.004	1,598	0.11	1.18	0.02	0.52	0.009
1-6 and 1-7 Reserve	Bldg 1	10%	2	20	6	3	6			8	24	1.5	68.5	0.23	45	6.00	0.016	6,165	0.41	1.18	0.08	0.52	0.036
2-4 Reserve	Bldg 2	10%	1	20	6	3	6			8	24	1.5	68.5	0.23	45	6.00	0.008	3,083	0.21	1.18	0.04	0.52	0.018
3-4 Reserve	Bldg 3	10%	1	20	6	3	6			8	24	1.5	68.5	0.23	45	6.00	0.008	3,083	0.21	1.18	0.04	0.52	0.018
ETC-2 Reserve	ETC	10%	1	20	6	3	6			8	24	1.5	68.5	0.23	45	6.00	0.008	3,083	0.21	1.18	0.04	0.52	0.018

	Total PM		NOX		CO		VOC
CONTROLLED Facility-Wide Emissions	0.234	169,500	16.14		0.958		0.293
UNCONTROLLED Facility-Wide Emissions	1.56		16.14		3.15		0.870
Tons/Yr Removed	1.33		0.00		2.19		0.58
Overall Removal Effcy, %	85%		0%		70%		66%

Table DPF-3. Catalyzed DPF BACT Capital Cost (Based on Sabey-Quincy)

Vantage Data Center

Cost Category	Cost Factor	Source of Cost Factor	Quant.	Unit Cost	Subtotal Cost
Direct Costs					
Purchased Equipment Costs					
FOB purchase price for Sabey Data Center's 2000 kWe generators was $107,700 each. The FOB price for Vantage's 3,000 kWe generators was scaled using the "0.6 rule": Cost for 3,000 kWe units = $109,700 *(3000/2000)^0.6 = $139,900 each					
Vantage 3000 kWe FOB Purchase Price	Clean Emission Products	CEP	17	$139,900	$2,378,300
Instrumentation	Assume no cost	Assume no cost	0	0	0
Sales Tax	WA state tax	WA state tax	6.5%	--	$154,590
Shipping	0.05A	EPA Cost Manual	5.0%	--	$118,915
Subtotal Purchased Equipment Cost, PEC					$2,651,805
Direct Installation Costs					
Enclosure structural supports	From MSFT CO-3	Robinson Enclosures	0	$9,812	$0
Installation	1/2 of EPA Cost Manual	1/2 of EPA Cost Manual	2.5%	--	$66,295
Electrical	Assume no cost	Assume no cost	0	0	0
Piping	Assume no cost	Assume no cost	0	0	0
Insulation	Assume no cost	Assume no cost	0	0	0
Painting	Assume no cost	Assume no cost	0	0	0
Subtotal Direct Installation Costs					$66,295
Site Preparation and Buildings (SP)	Assume no cost	Assume no cost	0	0	0
Total Direct Costs, DC (PEC + Direct Installation + Site Prep)					$2,718,100
Indirect Costs (Installation)					
Engineering	0.025*PEC	1/4 of EPA Cost Manual	2.5%	--	$66,295
Construction and field expenses	0.025*PEC	1/2 of EPA Cost Manual	2.5%	--	$66,295
Contractor Fees	From DIS data center	From DIS data center	6.8%	--	$198,871
Startup	0.02*PEC	EPA Cost Manual	2.0%	--	$53,036
Performance Test (Tech support)	0.01*PEC	EPA Cost Manual	1.0%	--	$26,518
Contingencies	0.03*PEC	EPA Cost Manual	3.0%	--	$79,554
Subtotal Indirect Costs, IC					$490,570
Total Capital Investment (TCI = DC+IC)					$3,208,669
					TCI per gen
					$188,745

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Table DPF-4. Catalyzed DPF Nominal-Controlled BACT Cost-Effectiveness

Item	Quantity	Units	Unit cost	Subtotal
Annualized Capital Recovery				
Total Capital Cost				$3,208,669
Capital Recovery Factor, 25 yrs, 4% discount rate				0.06401
Subtotal Annualized 25-year Capital Recovery Cost				$205,387
Direct Annual Costs				
Annual Admin charges	2% of TCI (EPA Manual)		0.02	$64,173
Annual Property tax	1% of TCI (EPA Manual)		0.01	$32,087
Annual Insurance	1% of TCI (EPA Manual)		0.01	$32,087
For this screening-level analysis we assumed the lower-bound annual O&M cost of zero.				$0
Subtotal Direct Annual Costs				$128,347
Total Annual Cost (Capital Recovery + Direct Annual Costs)				**$333,734**
Uncontrolled emissions (Combined Pollutants)				21.7
Assumed Control Efficiency				Varies
Annual Tons Removed (Combined Pollutants)				4.10
Cost Effectiveness ($ per tons combined pollutant destroyed)				**$81,472**

TCI/gen	$188,745

Combined Pollutants Removal Tonnages (Nominal-Controlled)

Pollutant	PM (FH+BH)	CO	VOC	NOX
Nominal Cold-Start Uncontrolled TPY	**1.56**	**3.15**	**0.870**	**16.1**
Nominal Cold-Start Controlled TPY	**0.234**	**0.958**	**0.293**	**16.14**
Tons Removed/Year	**1.33**	**2.19**	**0.578**	**0.0**
Overall Cold-Start Removal Effcy	85%	70%	66%	0%
Indiv Poll $/Ton Removed	$251,586	$152,252	$577,585	#DIV/0!

Multi-PollutantCost-Effectiveness for "Reasonable Control Cost" vs. Actual Control Cost

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (tons/yr)	Subtotal Acceptable Annual Cost ($/year)	
NOX	$10,000	0.00	$0	per year
CO	$5,000	2.19	$10,960	per year
VOC	$9,999	0.58	$5,778	per year
PM (FH+BH)	$23,200	1.33	$30,775	per year
Total Reasonable Annual Control Cost for Combined Pollutants			**$47,513**	**per year**
Actual Annual Control Cost			**$333,734**	**per year**
Is The Control Device Reasonable?			**NO (Actual >> Acceptable)**	

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ATTACHMENT D
UREA-SCR CONTROL SYSTEM
BACT ANALYSIS

CleanAIR SYSTEMS
A Caterpillar Company

UREA-SCR TECHNICAL DATA AND COST QUOTE
SABEY-INTERGATE-QUINCY DATA CENTER

PROPOSAL

Proposal Date: Wednesday, December 08, 2010
Quotation Number: 10120805RW-E **Revision:**

Customer Contact:	John Ford	Project Description	
Title:	Director of Technology Real Estate	Sabey Construction - CAT 3516C 2000 ekW Generator	
Email:	johnf@sabey.com	Address:	
Phone:	206-277-5209		,
Cell:			
Company Name:	Sabey Corporation		
Address :	12201 Tukwila International Blvd. Seattle, WA 98168		
Product Quoted:	E-POD with ENDURE SCR & ASSURE DOC or PERMIT Filter units in a 304L Stainless Steel Double Wall Insulated Critical Grade Silencer		
Purchase Order Date:		Requested Installation Date:	

Engine Specifications: CAT

Engine Model:	**3516C**			Engine S/N:			
EPA Tier Level:	Tier 2			EPA Family #:			
Engine Displacement:	69	liters		Engine Specification #:	DM8263		
Fuel Type:	ULSD (<50 PPM)			Engine Model Year:	2010		
Required Fuel Content:	<50	ppm	Sulfur				
Generator Power Rating:	**2,000**	**ekW**	**Standby**	**Model #:**			
Average Running Load:		Runtime:		hours/year			
Engine Power Output:	**2,937**	**bhp or**	**2188**	**bkW @**	**1,800**	**RPM**	
Exhaust Flow Rate:	15,136	ACFM					
Exhaust Stack Temp:	762	deg F					
Maximum Exhaust Pressure:	27	inches H_2O					

Emissions Specifications:

Engine Emissions:	***Certified***		
NOx:	3.93 g/bhp-hr		
CO:	0.49 g/bhp-hr		
HC:	0.25 g/bhp-hr		
PM:	0.08 g/bhp-hr		
Emissions Reduction Required:	*Tier 4 Final Levels*	**% Reduction**	
NOx:	0.50 g/bhp-hr	87.3%	
CO:	2.60 g/bhp-hr		
HC:	0.14 g/bhp-hr	44.0%	
PM:	0.02 g/bhp-hr	75.6%	*Tier 4 Interim PM Level is 0.075 g/bhp-hr*
Emissions Post After Treatment:	***Estimated***	**% Reduction**	
NOx:	**0.39 g/bhp-hr**	**90.0%**	
CO:	**0.05 g/bhp-hr**	**90.0%**	
HC:	**0.03 g/bhp-hr**	**90.0%**	
PM with ASSURE DOC Units:	**0.07 g/bhp-hr**	**20.0%**	*Meets Tier 4 Interim w/ASSURE DOCs*
PM with PERMIT Filter Units:	0.01 g/bhp-hr	85.0%	*Meets Tier 4 Final w/PERMIT Filters*

CleanAIR SYSTEMS
A Caterpillar Company

ENDURE SCR Specifications:					
NOx Reduction:	90%				
Material:	Zeolite based				
Temperature Range:	550 to 1,025 deg. F				
ENDURE SCR Catalyst Part Number:	EAA060612A				
Total Amount of Catalyst:	44	cubic feet			
Number of Catalyst Layers:	3	layers @	64	blocks/layer	
SCR Pressure Drop:	3.4	inches H_2O as configured at rated load			
Estimated Reductant Consumption:	**5.1**	**gal/hr of**	**32.5% Technical Urea**	**@ rated load**	
Estimated Reductant Consumption:	**19.1**	**liters/hr of**	**32.5% Technical Urea**	**@ rated load**	
Ammonia Slip:	<10	ppm			
Catalyst Life Expectancy:	20,000	hours			

E-POD Control System: ***Integrated within the Dosing Cabinet***

*Touch Screen Display & Dual NOx Sensors for a True Closed-Loop System
*Controller, Pressure Sensor, Temperature Sensor
*Power requirement: 240/120 volts AC, 10/20 amps, 50/60 Hertz
*Records NOx levels pre and post, Temperature and Pressure, Time and Date

Dosing Cabinet: ***Included***

*Housed in a NEMA 4 enclosure (30" tall by 24" wide by 12" deep)
*Auto Start, Stop and Purge Cycle
*Dosing Pump
*Pressure Regulator
*Secondary Urea / Aqua Ammonia Filter

Tube Bundle: ***Included***

*1/4" Heat Traced Stainless Steel tubing for Urea Flow
*1/2" Stainless Steel tubing for Compressed Air
*Signal Wires from Dosing Cabinet to E-POD

Injection and Mixing Section: ***Integrated within the E-POD housing***

Type of Injector: Air/Liquid Lance with Urea
Compressed Air Required: Yes, 10 SCFM @ 100 PSIG with refrigerated dryer / oil-free
Mixer: Static

Reductant Supply: *Not Included*

Reductant Supply Pump: *Not Provided & May not be necessary if gravity fed*
Urea Heat Tracing: *Not Provided before the Dosing Cabinet*
Storage Tanks: *Customer Supplied*
Reducing Agent: *Customer Supplied*

**The customer will supply the necessary tanks, plumbing safety equipment, monitoring devices, permitting and all parts and expenses to contain the selected reducing agent and supply the required amount to the Reducing Agent Injection System.*

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ASSURE DOC Specifications:	Option 1			
Material:	Catalyzed Cordierite Ceramic substrates			
PM Reduction:	~20%	@ steady state		
CO Reduction:	90%			
HC(VOC) Reduction:	90%			
ASSURE DOC Part Number:	CBH1250B			
Amount of Catalyst:	4.3	cubic ft.	10	DOC units
Catalyst Pressure Drop:	5.1	inches H_2O as configured at rated load		
Regeneration:	Not required			

PERMIT Filter Specifications:	Option 2	
Material:	Catalyzed Cordierite Ceramic wall-flow filter substrates	
PM Reduction:	85%	*CARB Level 3+ verified for greater than 85%*
CO Reduction:	90%	
HC(VOC) Reduction:	90%	
PERMIT Filter Part Number:	FDA221	
Number of Filters:	10	
Filter Pressure Drop:	9.2	inches H_2O as configured at rated load
Regeneration using ULSD:	Above 350 deg C (662 deg F) for 30% of the engine operating time and greater than 40% engine load	
Maximum Number of Stationary Cold Starts:	12	consecutive 10 minute idle sessions followed by 2 hrs regeneration
Typical Cleaning Interval:	2,500	hours
Catalyst Life Expectancy:	10,000	hours

Silencer Housing Specifications:	09093003AE					
Material:	**304L Stainless Steel**					
Construction:	**Double Wall, Rigid, & Light Weight**					
Insulation:	**2"**	**Between two Stainless Steel Walls**				
Approximate Dimensions (inches):	**172**	**" Length**	**94**	**" Width**	**58**	**" Height**
Estimated Weight:	**9,000**	**pounds**	**4,090**	**kilograms**		
Sound Reduction:	**27-35**	**dBa, Critical Grade Silencing**				
Total System Pressure Drop Silencer+SCR+DOC:	**13.5**	inches H_2O as configured at rated load				
Total System Pressure Drop Silencer+SCR+DPF:	**17.7**	inches H_2O as configured at rated load				
Inlet Size:	**20**	inches	Flange			
Outlet Size:	**20**	inches	Flange			

The E-POD Silencer Housing is designed to accommodate the ENDURE SCR and either the ASSURE DOC or the PERMIT Filter systems. If not initially purchased, any of these products can be installed at a future date.

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This System Includes:		
ENDURE SCR Catalyst	Yes	
ASSURE DOC	Option 1	*Meets Tier 4 Interim*
PERMIT DPF	Option 2	*Meets Tier 4 Final*
SILENCER - Stainless Steel	Yes	
INTERNAL Mixing and Reductant Injection	Yes	
E-POD Controller	Yes	**Closed-Loop System*
Operation & Maintenance Manual	Yes	
Start-up Commissioning	Yes	

This System Excludes:

Delivery/Freight Expenses
Consumables and Utilities (chemicals, water, electricity, etc.)
Reductant tanks, plumbing, supply pumps, etc.
Installation and supply of interconnecting power, control cables, and conduit
Installation of the E-POD System
Exhaust piping insulation *(CleanAIR Systems recommends insulating the exhaust from the engine to the inlet of the filter)*
All necessary permitting

Terms & Conditions:	*FOB Santa Fe*
Shipping Date:	20 weeks from date of purchase order and approved design
Terms:	Net 30 Days
Proposal Valid :	30 days from proposal date
Warranty:	2 year or 8,000 hours of operation from commissioning

Notes:

CleanAIR SYSTEMS
A Caterpillar Company

Pricing:

	Option 1 Part Number	*Closed-Loop System Description	Meets Tier 4 Interim & Upgradeable to Tier 4 Final Quantity	Unit Price	Total (USD)
1	09093003AE	E-POD w/ ENDURE SCR & ASSURE DOC in a 304L Stainless Steel Double Wall Insulated Critical Grade Silencer	3	$124,915.00	$374,745.00
2		Atlas Copco SF-4 Air Compressor (typically 460 Volt/ 3 phase, call for options)	3	$10,450.00	$31,350.00
3					$ -
4					$ -
5					$ -
6					$ -
7	SCEPD090121	Commissioning / technician / day (2 days on site)* *Please allow 6 weeks to schedule Commissioning*	3	$3,025.00	$ 49,075.00
8				Handling/Skidding:	$ 4,060.00
9				Estimated Freight:	
				Total:	$459,230.00

	Option 2 Part Number	*Closed-Loop System Description	Meets Tier 4 Final Quantity	Unit Price	Total (USD)
1	09093003AE	E-POD w/ ENDURE SCR & PERMIT Filter in a 304L Stainless Steel Double Wall Insulated Critical Grade Silencer	3	$197,658.00	$592,975.00
2		Atlas Copco SF-4 Air Compressor (typically 460 Volt/ 3 phase, call for options)	3	$10,450.00	$31,350.00
3					$ -
4					$ -
5					$ -
6					$ -
7	SCEPD090121	Commissioning / technician / day (2 days on site)* *Please allow 6 weeks to schedule Commissioning*	3	$3,025.00	$9,075.00
8				Handling/Skidding:	$6,245.00
9				Estimated Freight:	
				Total:	$639,645.00

	Recommended Optional Equipment: Part Number	Description	Quantity	Unit Price	Total (USD)
1	09022405AG	Replacement NOx Sensors (replace every 8,000 hours)	6	$2,420.00	$14,520.00
2		ModBus Controller Software upgrade	3	$1,265.00	$3,795.00
3		Injector Nozzle Kit	3	$396.00	$1,188.00
4		Replacement set of ENDURE SCR Catalyst (20,000 hrs)	3	$27,346.00	$82,038.00
5		Replacement set of PERMIT Filter Elements (10,000 hrs)	3	$89,595.00	$268,785.00
6		Replacement set of ASSURE DOC Elements (10,000 hrs)	3	$16,850	$50,552.00
7		Custom Insulating Blanket for Exhaust Piping	3	TBD	#VALUE!

*Commissioning exceeding 2 days will be charged a flat rate of $1,150 per day per technician.

Handling/Skidding : 1% of the total order will be charged to prepare the unit for shipping with a $10 minimum for orders under $100, $20 minimum for orders $101 to $1000, and a $30 minimum for orders $1,001 to $3,000.

Order Cancellations: **Standard Parts** – A flat 20% fee will be charged on canceled orders for standard parts.
Custom Parts – Customer will incur all expenses at the time of order cancellation including; materials, engineering & labor plus 20%.

Contact Information: N C Power Systems
Don Lee King
Power Generation Sales
425-656-4586
DLKing@ncpowersystems.com

For additional information, visit:

TABLE SCR-1. UREA-SCR NOMINAL CONTROLLED (COLD-START ADJUSTED) EMISSION RATES FOR BACT ANALYSIS

Table X. Nominal-Controlled Cold-Start NOX Emissions Accounting for 3WC Delay Time

Load	Nominal Uncon.trolled NOX, lbs/hr	Minutes SCR Delay	Guaranteed Effcy (%)	Nominal Controlled CO, lbs/hr	Minutes Full SCR Control	Nominal Controlled NOX Emission, lbs/hr	Overall Cold Start % NOX Removal
10%	6.0	20	90%	0.60	40	2.40	60%
81.3%	37.2	10	90%	3.72	50	9.29	75%
90%	43.6	10	90%	4.36	50	10.89	75%
93.3%	46.1	10	90%	4.61	50	11.53	75%
100%	51.5	10	90%	5.15	50	12.88	75%

SCR STEADY-STATE REMOVAL EFFICIENCIES

Pollutant	Removal Effct (%)
Nox	90%
PM (FH+BH)	20%
CO	90%
VOC	90%

Table X. Nominal-Controlled (Cold-Start Adjusted) PM Emission Rates (Includes FH+BH Factor)

Elec Load	Nominal Uncontrolled Front-Half Only Emiss Rate (lbs/hr)	Total PM to Front Half PM Ratio	Nominal Uncontrolled Total PM Emiss Rate (lbs/hr)	Guaranteed Effcy (%)	Nominal Contr Total PM (lbs/hr)	Dell 1-Hour Cold Start Factor	Nominal Controlled Total PM, lbs/hr
10%	0.43	3.38	1.45	20%	1.161	1.058	1.228
81.3%	0.83	3.08	2.55	20%	2.042	1.058	2.160
90%	0.95	3.08	2.92	20%	2.337	1.058	2.473
93.3%	0.99	3.08	3.04	20%	2.435	1.058	2.577
100%	1.08	3.00	3.24	20%	2.592	1.058	2.742

Total:FH Adjustment Factors

Load	StacktestTot PM	Stacktest FH Only PM	Total PM to Front Half PM Ratio
80%-90%			3.08
100%	0.36	0.12	3.00
50%	0.27	0.08	3.38

Table Y. Nominal-Controlled Cold-Start CO Emissions Accounting for DOC Delay Time

Load	Nominal Uncontrolled Rate, lbs/hr	Minutes DOC Delay	Guaranteed Effcy (%)	Nominal Controlled CO, lbs/hr	Minutes Full DOC Control	Wt. Average 1-Hour CO Emission, lbs/hr	Cold Start Factor	Nominal Controlled CO, lbs/hr	Overall Cold Start % CO Removal
10%	2.8	20	90%	0.28	40	1.12	1.058	1.18	60%
81.3%	5.3	10	90%	0.53	50	1.33	1.058	1.40	75%
90%	6.0	10	90%	0.60	50	1.50	1.058	1.59	75%
93.3%	6.3	10	90%	0.63	50	1.58	1.058	1.67	75%
100%	6.8	10	90%	0.68	50	1.70	1.058	1.80	75%

Table Y. Nominal-Controlled Cold-Start VOC Emissions Accounting for DOC Delay Time

Load	Nominal Uncontrolled Rate, lbs/hr	Minutes DOC Delay	Guaranteed Effcy (%)	Nominal Controlled VOC, lbs/hr	Minutes Full DOC Control	Wtd Average 1-Hour Emission, lbs/hr	Cold Start Factor	Nominal Controlled VOC, lbs/hr	Overall Cold Start % Removal
10%	1.2	20	90%	0.12	40	0.49	1.058	0.52	60%
81.3%	1.1	10	90%	0.11	50	0.28	1.058	0.29	75%
90%	1.1	10	90%	0.11	50	0.28	1.058	0.29	75%
93.3%	1.1	10	90%	0.11	50	0.28	1.058	0.29	75%
100%	1.1	10	90%	0.11	50	0.28	1.058	0.29	75%

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Table SCR-2. Urea-SCR Nominal-Controlled Facility-Wide Emissions (Basis = ELM's Nominal-Uncontrolled + Cold-Start Factors)

				Hours at Each Runtime Mode																			
Gen #	Gen Area	Elec Load	No. Gens	W	M	Q	A-F	A-Step	Correct Tests	De-En Bldg Maint	Outage or Storm Avoid	Cool	Total hrs/yr	Each Genset DPM lbs/hr	Each Genset Fuel Gal/Hr	Each Genset NOX lbs/hr	Facility Wide Total PM Tons/yr	Facility-Wide Fuel Gal/Year	Facility Wide NOX Tons/yr	Each Genset CO lbs/hr	Facility-Wide CO Tons/Yr	Each Genset HC lbs/hr	Facility-Wide VOC Tons/Yr
Unplanned Outage + Storm Avoidance				Unplanned Outage + Storm Avoidance																			
1-1 to 1-5	Bldg 1	81%	5								24		24	2.16	195	9.3	0.130	23,400	0.56	1.40	0.08	0.29	0.017
2-1 to 2-3	Bldg 2	90%	3								24		24	2.47	213	10.89	0.089	15,336	0.39	1.59	0.06	0.29	0.010
3-1 to 3-3	Bldg 3	90%	3								24		24	2.47	213	10.89	0.089	15,336	0.39	1.59	0.06	0.29	0.010
ETC-1	ETC	93%	1								24		24	2.58	220	11.53	0.031	5,280	0.14	1.67	0.02	0.29	0.003
Testing at Full Outage Loads				Testing at Full Outage Loads																			
1-1 to 1-5	Bldg 1	81%	5			3	6			8			17	2.16	195	9.3	0.092	16,575	0.39	1.40	0.06	0.29	0.012
2-1 to 2-3	Bldg 2	90%	3			3	6			8			17	2.47	213	10.89	0.063	10,863	0.28	1.59	0.04	0.29	0.007
3-1 to 3-3	Bldg 3	90%	3			3	6			8			17	2.47	213	10.89	0.063	10,863	0.28	1.59	0.04	0.29	0.007
ETC-1	ETC	93%	1			3	6			8			17	2.58	220	11.53	0.022	3,740	0.10	1.67	0.01	0.29	0.002
100% Load				Testing at 100% Load																			
1-1 to 1-5	Bldg 1	100%	5					0.5	8				8.5	2.74	232	12.88	0.058	9,860	0.27	1.80	0.04	0.29	0.006
2-1 to 2-3	Bldg 2	100%	3					0.5	8				8.5	2.74	232	12.88	0.035	5,916	0.16	1.80	0.02	0.29	0.004
3-1 to 3-3	Bldg 3	100%	3					0.5	8				8.5	2.74	232	12.88	0.035	5,916	0.16	1.80	0.02	0.29	0.004
ETC-1	ETC	100%	1					0.5	8				8.5	2.74	232	12.88	0.012	1,972	0.05	1.80	0.01	0.29	0.001
1-6 and 1-7 Reserve	Bldg 1	100%	2					0.5	8				8.5	2.74	232	12.88	0.023	3,944	0.11	1.80	0.02	0.29	0.002
2-4 Reserve	Bldg 2	100%	1					0.5	8				8.5	2.74	232	12.88	0.012	1,972	0.05	1.80	0.01	0.29	0.001
3-4 Reserve	Bldg 3	100%	1					0.5	8				8.5	2.74	232	12.88	0.012	1,972	0.05	1.80	0.01	0.29	0.001
ETC-2 Reserve	ETC	100%	1					0.5	8				8.5	2.74	232	12.88	0.012	1,972	0.05	1.80	0.01	0.29	0.001
Idle (set to 10% for emission calculations)				Idle																			
1-1 to 1-5	Bldg 1	10%	5	20	6	0	0	0	0	0	0	9.5	35.5	1.23	45	2.40	0.109	7,988	0.21	1.18	0.11	0.52	0.046
2-1 to 2-3	Bldg 2	10%	3	20	6	0	0	0	0	0	0	9.5	35.5	1.23	45	2.40	0.065	4,793	0.13	1.18	0.06	0.52	0.028
3-1 to 3-3	Bldg 3	10%	3	20	6	0	0	0	0	0	0	9.5	35.5	1.23	45	2.40	0.065	4,793	0.13	1.18	0.06	0.52	0.028
ETC-1	ETC	10%	1	20	6	0	0	0	0	0	0	9.5	35.5	1.23	45	2.40	0.022	1,598	0.04	1.18	0.02	0.52	0.009
1-6 and 1-7 Reserve	Bldg 1	10%	2	20	6	3	6			8	24	1.5	68.5	1.23	45	2.40	0.084	6,165	0.16	1.18	0.08	0.52	0.036
2-4 Reserve	Bldg 2	10%	1	20	6	3	6			8	24	1.5	68.5	1.23	45	2.40	0.042	3,083	0.08	1.18	0.04	0.52	0.018
3-4 Reserve	Bldg 3	10%	1	20	6	3	6			8	24	1.5	68.5	1.23	45	2.40	0.042	3,083	0.08	1.18	0.04	0.52	0.018
ETC-2 Reserve	ETC	10%	1	20	6	3	6			8	24	1.5	68.5	1.23	45	2.40	0.042	3,083	0.08	1.18	0.04	0.52	0.018
																	Total PM		NOX		CO		VOC
																CONTROLLED Facility-Wide Emissions	1.248	169,500	4.38		0.958		0.293
																UNCONTROLLED Facility-Wide Emissions	1.56		16.14		3.15		0.870
																Tons/Yr Removed	0.31		11.76		2.19		0.58
																Overall Removal Effcy, %	20%		73%		70%		66%

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Table SCR-3. Urea-SCR BACT Capital Cost (Based on Sabey-Quincy)

Vantage Data Center

Cost Category	Cost Factor	Source of Cost Factor	Quant.	Unit Cost	Subtotal Cost
Direct Costs					
Purchased Equipment Costs					
FOB purchase price for Sabey Data Center's 2000 kWe generators was $153,000 each. The FOB price for Vantage's 3,000 kWe generators was scaled using the "0.6 rule: Cost for 3,000 kWe units = $109,700 *(3000/2000)^0.6 = $195,000 each					
Vantage 3000 kWe FOB Purchase Price	Clean Emission Products	CEP	17	$195,000	$3,315,000
Instrumentation	Assume no cost	Assume no cost	0	0	0
Sales Tax	WA state tax	WA state tax	6.5%	--	$215,475
Shipping	0.05A	EPA Cost Manual	5.0%	--	$165,750
Subtotal Purchased Equipment Cost, PEC					$3,696,225
Direct Installation Costs					
Enclosure structural supports	From MSFT CO-3	Robinson Enclosures	0	$9,812	$0
Installation	EPA Cost Manual	EPA Cost Manual	5.0%	--	$184,811
Electrical	Assume no cost	Assume no cost	0	0	0
Piping	Assume no cost	Assume no cost	0	0	0
Insulation	Assume no cost	Assume no cost	0	0	0
Painting	Assume no cost	Assume no cost	0	0	0
Subtotal Direct Installation Costs					$184,811
Site Preparation and Buildings (SP)	Assume no cost	Assume no cost	0	0	0
Total Direct Costs, DC (PEC + Direct Installation + Site Prep)					$3,881,036
Indirect Costs (Installation)					
Engineering	0.025*PEC	1/4 of EPA Cost Manual	2.5%	--	$92,406
Construction and field expenses	0.025*PEC	1/2 of EPA Cost Manual	2.5%	--	$92,406
Contractor Fees	From DIS data center	From DIS data center	6.8%	--	$269,578
Startup	0.02*PEC	EPA Cost Manual	2.0%	--	$73,925
Performance Test (Tech support)	0.01*PEC	EPA Cost Manual	1.0%	--	$36,962
Contingencies	0.03*PEC	EPA Cost Manual	3.0%	--	$110,887
Subtotal Indirect Costs, IC					$676,163
Total Capital Investment (TCI = DC+IC)					$4,557,199
					TCI per gen
					$268,071

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Table SCR-4. Urea-SCR Nominal-Controlled BACT Cost-Effectiveness

Item	Quantity	Units	Unit cost	Subtotal
Annualized Capital Recovery				
Total Capital Cost				$4,557,199
Capital Recovery Factor, 25 yrs, 4% discount rate				0.06401
Subtotal Annualized 25-year Capital Recovery Cost				$291,706
Direct Annual Costs				
Annual Admin charges	2% of TCI (EPA Manual)		0.02	$91,144
Annual Property tax	1% of TCI (EPA Manual)		0.01	$45,572
Annual Insurance	1% of TCI (EPA Manual)		0.01	$45,572
For this screening-level analysis we assumed the lower-bound annual O&M cost of zero.				$0
Subtotal Direct Annual Costs				$182,288
Total Annual Cost (Capital Recovery + Direct Annual Costs)				**$473,994**
Uncontrolled emissions (Combined Pollutants)				21.7
Assumed Control Efficiency				Varies
Annual Tons Removed (Combined Pollutants)				14.84
Cost Effectiveness ($ per tons combined pollutant destroyed)				**$31,935**

TCI/gen	$268,071

Combined Pollutants Removal Tonnages (Nominal-Controlled)

Pollutant	PM (FH+BH)	CO	VOC	NOX
Nominal Cold-Start Uncontrolled TPY	**1.56**	**3.15**	**0.870**	**16.1**
Nominal Cold-Start Controlled TPY	**1.248**	**0.958**	**0.293**	**4.38**
Tons Removed/Year	**0.31**	**2.19**	**0.578**	**11.8**
Overall Cold-Start Removal Effcy	20%	70%	66%	73%
Indiv Poll $/Ton Removed	$1,518,616	$216,240	$820,331	$40,304

Multi-PollutantCost-Effectiveness for "Reasonable Control Cost" vs. Actual Control Cost

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (tons/yr)	Subtotal Acceptable Annual Cost ($/year)	
NOX	$10,000	11.76	$117,604	per year
CO	$5,000	2.19	$10,960	per year
VOC	$9,999	0.58	$5,778	per year
PM (FH+BH)	$23,200	0.31	$7,241	per year
Total Reasonable Annual Control Cost for Combined Pollutants			**$141,583**	**per year**
Actual Annual Control Cost			**$473,994**	**per year**
Is The Control Device Reasonable?			**NO (Actual >> Acceptable)**	

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ATTACHMENT E
3-WAY CATALYST BACT ASSESSMENT

3-WAY CATALYST PERMITTED FOR TITAN DATA CENTER

Clean Emissions Products Inc. Exhaust Purifier

Part Number *FL-35-20ASA 3-WAY x 2*

Basic Catalyst & Housing Composition

- Stainless Steel Foil (Substrate Core)
- Stainless Steel 14 Gauge, Grade 304 (Housing) containing 2 x 35” dia x 3.5” thick 3-way catalysts
- Weight = approx.. 140lbs.
- Dimensions = 35” diameter x 22” total length (approx.) – 20” ASA Flanges
- 320 CPSI
- Pressure drop across catalyst = < 3.9” w.c.

Purchase Prices

2,000 kW generator: 35" Catalyst; $56,000
2,500 kW generator: 35" Catalyst; $56,000
Est. installation cost: $6,500 each catalyst
Note, these costs do not include indirect costs for shipping, taxes, site-specific engineering, or administrative costs.

Effectiveness in Reducing Exhaust Emissions

- CO (Carbon Monoxide) up to 99%
- HC (Hydrocarbons & Odor) up to 90%
- Acrolein up to 90%
- DPM (Diesel Particulate Matter) up to 88%
- NOx Reduction ……….35% guaranteed

Lifespan of Catalyst

- For standby generator sets: Maximum 500 hours per year **(results in an average lifespan of 15 years).**
- For peak shaving gen sets: Maximum 1500 hours per year **(results in an average lifespan of 5 years).**

Installation

- Installs primarily between the muffler and the engine manifold (can be installed directly behind the muffler in most applications).
- The catalyst can be installed either vertically, horizontally or right to left.

Maintenance

- Designed to be maintenance free. Once you install the catalyst on a regularly maintained engine you should not need to maintain the catalyst at all.
- If maintenance is required simply unbolt catalyst and blow out in opposite direction of exhaust flow with high pressure air or water (maximum 1600 psi recommended).

Operating Conditions for Successful Catalyst Use

-Exhaust Temperature must be at least 250° C (482° F) and not exceed 750° C (1382° F). The hotter the exhaust temperature that reaches the catalyst the higher the reduction levels of emissions you will experience.

SKIDSTEERS • LOADERS • BACKHOES • CRANES • TRUCKS
CLEAN EMISSIONS
DOZERS • GENSETS • LIFTS
• *Clean Emissions Products Inc.* •

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Midhurst, Ontario
Canada L0L 1X0

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Toll Free: 1-866-787-2473

Catalyst Reaction Process for P/N FL-35-20ASA-3W

Catalyst Physical Description:

Brazed stainless steel element using 300 CPSI, honeycomb cell pattern.

Catalyst Chemical Description:

NSCR (non-selective catalyst reduction) composed of a Cerium based washcoating with a combination of Platinum (Pt) and Rhodium (Rh) applied.

Exhaust Emission Reductions Targeted:

CO (carbon monoxide) = up to 99%
HC (hydrocarbons) = up to 90%
DPM (diesel particulate matter) = up to 88%
NOx (oxides of nitrogen) = up to 35%

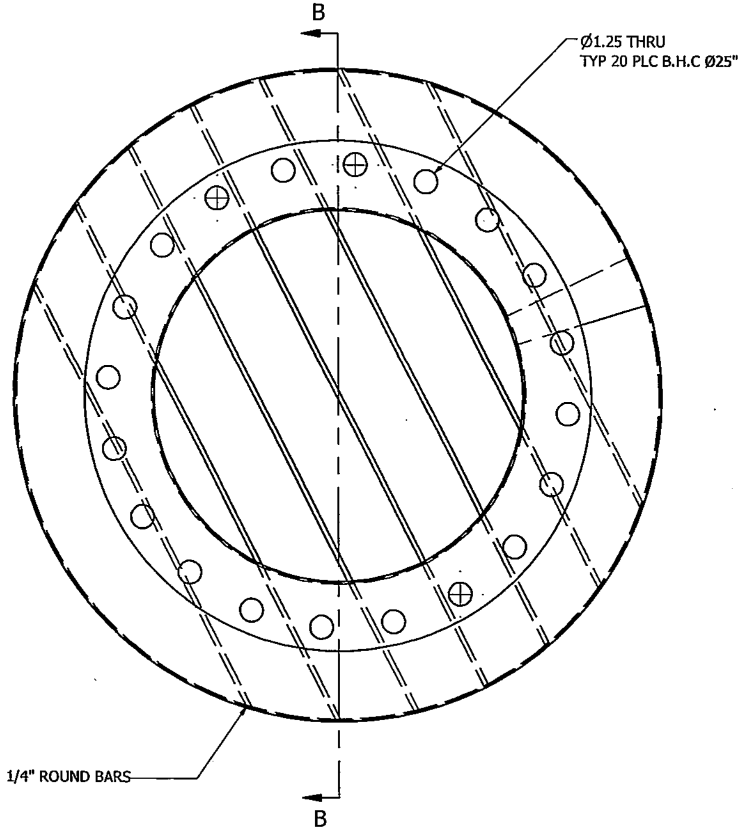
Catalyst Process Description:

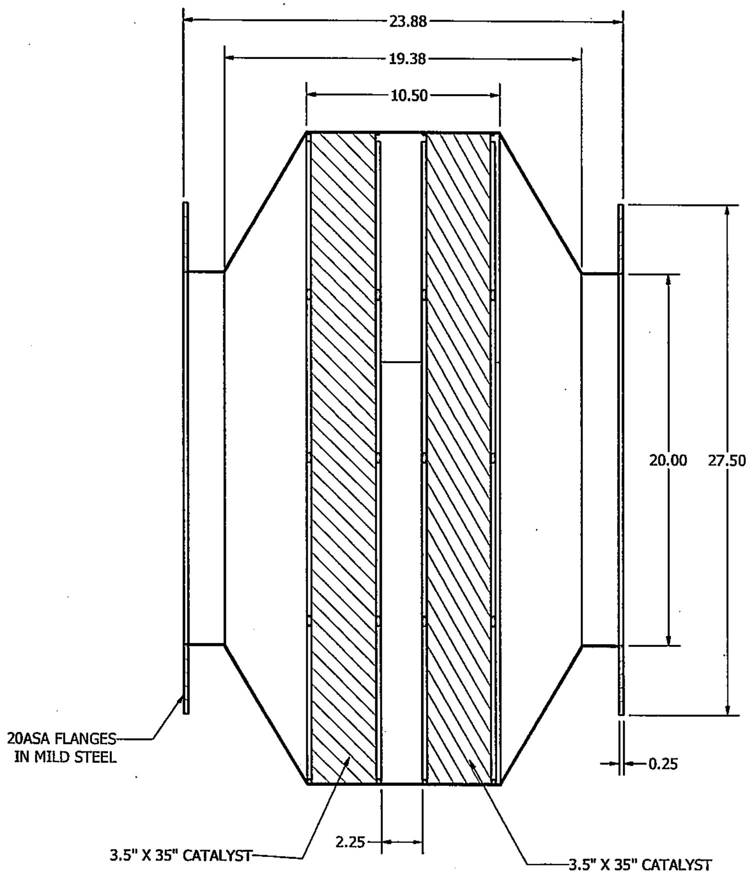
With this particular catalyst there are two (2) chemical reactions taking place: ***Oxidation*** and ***Reduction***. With the oxidation reaction oxygen (O_2) is being added to atoms to form oxide molecules. Carbon Monoxide (CO) has additional oxygen added to it to form less lethal carbon dioxide (CO_2). Hydrocarbons (HC) are fuel based molecules comprised of carbon and hydrogen atoms which are then oxidized to form CO_2 and simple water vapor (H_2O). The reduction reaction is one whereby we then remove excess oxygen from the exhaust molecules. NOx is made up of nitrogen (N) and oxygen atoms. When you remove the oxygen you end up with nitrogen gas (N_2).

When exhaust gases enter the catalyst the NOx, CO and HC molecules are attracted to the surface of the catalyst where they come into contact with the coating materials of Pt and Rh. Our NSCR catalyst washcoating contains a series of rare earth materials that working in concert with the Rh to have the ability to extract oxygen. This extracted oxygen is then donated to either CO or HC by the reaction with Pt coating.

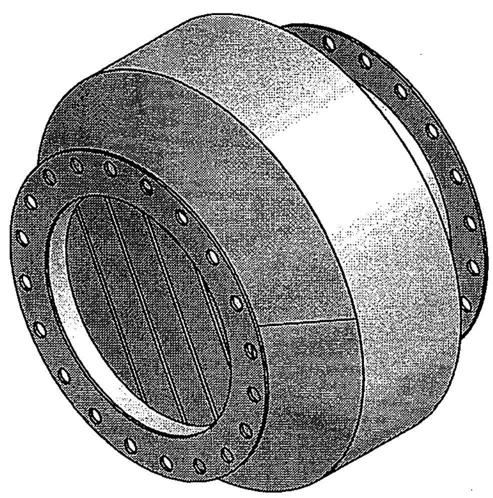
As this application is a lean burn (diesel) engine we will use the Pt coating in combination with the Rh to remove as much excess oxygen from the exhaust stream (once CO and HC have taken their required molecules to form less lethal CO_2 and water vapor) and then the remaining oxygen deprived environment (stochiometric) can react with the Rh coating to facilitate NOx reduction (as the remaining exhaust environment will be a rich burn environment which is what is required for NOx reduction).

In addition we use a combination of exhaust backpressure and exhaust temperature to trap and breakdown particulate matter (DPM) which is composed of SOF (soluble organic fraction) and carbon (i.e. soot).





SECTION B-B
SCALE 1:5



MATERIAL: 14GA 304-2B SS

DRAWN M.KAMAMI	3/31/2011	CLEAN EMISSIONS PRODUCTS INC.
CHECKED		TITLE
QA		
MFG		FL35-20ASA-3WAY
APPROVED		SIZE C — DWG NO FL35-20ASA-3WAY — REV
		SCALE — SHEET 1 OF 1

TABLE 3WC-1. 3-WAY CATALYST NOMINAL CONTROLLED (COLD-START ADJUSTED) EMISSION RATES FOR BACT ANALYSIS

Table X. Nominal-Controlled Cold-Start NOX Emissions Accounting for 3WC Delay Time

Load	Nominal Uncon.trolled NOX, lbs/hr	Minutes SCR Delay	Guaranteed Effcy (%)	Nominal Controlled CO, lbs/hr	Minutes Full SCR Control	Nominal Controlled NOX Emission, lbs/hr	Overall Cold Start % NOX Removal
10%	6.0	20	35%	3.90	40	4.60	23%
81.3%	37.2	10	35%	24.16	50	26.33	29%
90%	43.6	10	35%	28.32	50	30.86	29%
93.3%	46.1	10	35%	29.99	50	32.68	29%
100%	51.5	10	35%	33.48	50	36.48	29%

3-WAY CATALYST STEADY-STATE REMOVAL EFFICIENCIES

Pollutant	Removal Effct (%)
Nox	35%
PM (FH+BH)	88%
CO	99%
VOC	90%

Table X. Nominal-Controlled (Cold-Start Adjusted) PM Emission Rates (Includes FH+BH Factor)

Elec Load	Nominal Uncontrolled Front-Half Only Emiss Rate (lbs/hr)	Total PM to Front Half PM Ratio	Nominal Uncontrolled Total PM Emiss Rate (lbs/hr)	Guaranteed Effcy (%)	Nominal Contr Total PM (lbs/hr)	Dell 1-Hour Cold Start Factor	Nominal Controlled Total PM, lbs/hr
10%	0.43	3.38	1.45	88%	0.174	1.058	0.184
81.3%	0.83	3.08	2.55	88%	0.306	1.058	0.324
90%	0.95	3.08	2.92	88%	0.351	1.058	0.371
93.3%	0.99	3.08	3.04	88%	0.365	1.058	0.386
100%	1.08	3.00	3.24	88%	0.389	1.058	0.411

Total:FH Adjustment Factors

Load	StacktestTot PM	Stacktest FH Only PM	Total PM to Front Half PM Ratio
80%-90%			3.08
100%	0.36	0.12	3.00
50%	0.27	0.08	3.38

Table Y. Nominal-Controlled Cold-Start CO Emissions Accounting for DOC Delay Time

Load	Nominal Uncontrolled Rate, lbs/hr	Minutes DOC Delay	Guaranteed Effcy (%)	Nominal Controlled CO, lbs/hr	Minutes Full DOC Control	Wt. Average 1-Hour CO Emission, lbs/hr	Cold Start Factor	Nominal Controlled CO, lbs/hr	Overall Cold Start % CO Removal
10%	2.8	20	99%	0.03	40	0.95	1.058	1.01	66%
81.3%	5.3	10	99%	0.05	50	0.93	1.058	0.98	83%
90%	6.0	10	99%	0.06	50	1.05	1.058	1.11	83%
93.3%	6.3	10	99%	0.06	50	1.10	1.058	1.17	83%
100%	6.8	10	99%	0.07	50	1.19	1.058	1.26	83%

Table Y. Nominal-Controlled Cold-Start VOC Emissions Accounting for DOC Delay Time

Load	Nominal Uncontrolled Rate, lbs/hr	Minutes DOC Delay	Guaranteed Effcy (%)	Nominal Controlled VOC, lbs/hr	Minutes Full DOC Control	Wtd Average 1-Hour Emission, lbs/hr	Cold Start Factor	Nominal Controlled VOC, lbs/hr	Overall Cold Start % Removal
10%	1.2	20	90%	0.12	40	0.49	1.058	0.52	60%
81.3%	1.1	10	90%	0.11	50	0.28	1.058	0.29	75%
90%	1.1	10	90%	0.11	50	0.28	1.058	0.29	75%
93.3%	1.1	10	90%	0.11	50	0.28	1.058	0.29	75%
100%	1.1	10	90%	0.11	50	0.28	1.058	0.29	75%

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Table 3WC-2. 3-Way Catalyst Nominal-Controlled Facility-Wide Emissions (Basis = ELM's Nominal-Uncontrolled + Cold-Start Factors)

				Hours at Each Runtime Mode																			
Gen #	Gen Area	Elec Load	No. Gens	W	M	Q	A-F	A-Step	Correct Tests	De-En Bldg Maint	Outage or Storm Avoid	Cool	Total hrs/yr	Each Genset DPM lbs/hr	Each Genset Fuel Gal/Hr	Each Genset NOX lbs/hr	Facility Wide Total PM Tons/yr	Facility-Wide Fuel Gal/Year	Facility Wide NOX Tons/yr	Each Genset CO lbs/hr	Facility-Wide CO Tons/Yr	Each Genset HC lbs/hr	Facility-Wide VOC Tons/Yr
Unplanned Outage + Storm Avoidance								Unplanned Outage + Storm Avoidance															
1-1 to 1-5	Bldg 1	81%	5								24		24	0.32	195	26.3	0.019	23,400	1.58	0.98	0.06	0.29	0.017
2-1 to 2-3	Bldg 2	90%	3								24		24	0.37	213	30.86	0.013	15,336	1.11	1.11	0.04	0.29	0.010
3-1 to 3-3	Bldg 3	90%	3								24		24	0.37	213	30.86	0.013	15,336	1.11	1.11	0.04	0.29	0.010
ETC-1	ETC	93%	1								24		24	0.39	220	32.68	0.005	5,280	0.39	1.17	0.01	0.29	0.003
Testing at Full Outage Loads								Testing at Full Outage Loads															
1-1 to 1-5	Bldg 1	81%	5			3	6			8			17	0.32	195	26.3	0.014	16,575	1.12	0.98	0.04	0.29	0.012
2-1 to 2-3	Bldg 2	90%	3			3	6			8			17	0.37	213	30.86	0.009	10,863	0.79	1.11	0.03	0.29	0.007
3-1 to 3-3	Bldg 3	90%	3			3	6			8			17	0.37	213	30.86	0.009	10,863	0.79	1.11	0.03	0.29	0.007
ETC-1	ETC	93%	1			3	6			8			17	0.39	220	32.68	0.003	3,740	0.28	1.17	0.01	0.29	0.002
100% Load								Testing at 100% Load															
1-1 to 1-5	Bldg 1	100%	5					0.5	8				8.5	0.41	232	36.48	0.009	9,860	0.78	1.26	0.03	0.29	0.006
2-1 to 2-3	Bldg 2	100%	3					0.5	8				8.5	0.41	232	36.48	0.005	5,916	0.47	1.26	0.02	0.29	0.004
3-1 to 3-3	Bldg 3	100%	3					0.5	8				8.5	0.41	232	36.48	0.005	5,916	0.47	1.26	0.02	0.29	0.004
ETC-1	ETC	100%	1					0.5	8				8.5	0.41	232	36.48	0.002	1,972	0.16	1.26	0.01	0.29	0.001
1-6 and 1-7 Reserve	Bldg 1	100%	2					0.5	8				8.5	0.41	232	36.48	0.003	3,944	0.31	1.26	0.01	0.29	0.002
2-4 Reserve	Bldg 2	100%	1					0.5	8				8.5	0.41	232	36.48	0.002	1,972	0.16	1.26	0.01	0.29	0.001
3-4 Reserve	Bldg 3	100%	1					0.5	8				8.5	0.41	232	36.48	0.002	1,972	0.16	1.26	0.01	0.29	0.001
ETC-2 Reserve	ETC	100%	1					0.5	8				8.5	0.41	232	36.48	0.002	1,972	0.16	1.26	0.01	0.29	0.001
Idle (set to 10% for emission calculations)								Idle															
1-1 to 1-5	Bldg 1	10%	5	20	6	0	0	0	0	0	0	9.5	35.5	0.18	45	4.60	0.016	7,988	0.41	1.01	0.09	0.52	0.046
2-1 to 2-3	Bldg 2	10%	3	20	6	0	0	0	0	0	0	9.5	35.5	0.18	45	4.60	0.010	4,793	0.24	1.01	0.05	0.52	0.028
3-1 to 3-3	Bldg 3	10%	3	20	6	0	0	0	0	0	0	9.5	35.5	0.18	45	4.60	0.010	4,793	0.24	1.01	0.05	0.52	0.028
ETC-1	ETC	10%	1	20	6	0	0	0	0	0	0	9.5	35.5	0.18	45	4.60	0.003	1,598	0.08	1.01	0.02	0.52	0.009
1-6 and 1-7 Reserve	Bldg 1	10%	2	20	6	3	6			8	24	1.5	68.5	0.18	45	4.60	0.013	6,165	0.32	1.01	0.07	0.52	0.036
2-4 Reserve	Bldg 2	10%	1	20	6	3	6			8	24	1.5	68.5	0.18	45	4.60	0.006	3,083	0.16	1.01	0.03	0.52	0.018
3-4 Reserve	Bldg 3	10%	1	20	6	3	6			8	24	1.5	68.5	0.18	45	4.60	0.006	3,083	0.16	1.01	0.03	0.52	0.018
ETC-2 Reserve	ETC	10%	1	20	6	3	6			8	24	1.5	68.5	0.18	45	4.60	0.006	3,083	0.16	1.01	0.03	0.52	0.018
																	Total PM		NOX		CO		VOC
														CONTROLLED Facility-Wide Emissions			0.187	169,500	11.57		0.739		0.293
														UNCONTROLLED Facility-Wide Emissions			1.56		16.14		3.15		0.870
														Tons/Yr Removed			1.37		4.57		2.41		0.58
														Overall Removal Effcy, %			88%		28%		77%		66%

Table 3WC-3. BACT Capital Cost for 3-Way Catalysts (Based on Titan Data Center)

Vantage Data Center

Cost Category		Cost Factor	Source of Cost Factor	Quant.	Unit Cost	Subtotal Cost
Direct Costs						
Purchased Equipment Costs						
	FOB purchase price for Titan Data Center's 2000 kWe generators was $56,000. The FOB price for Vantage's 3,000 kWe generators was scaled using the "0.6 rule": Cost for 3,000 kWe units = $56,000 *(3000/2000)^0.6 = $71,400 each					
	Vantage 3000 kWe FOB Purchase Price	Clean Emission Products	CEP	17	$71,400	$1,213,800
	Instrumentation	Assume no cost	Assume no cost	0	0	0
	Sales Tax	WA state tax	WA state tax	6.5%	--	$78,897
	Shipping	0.05A	EPA Cost Manual	5.0%	--	$60,690
Subtotal Purchased Equipment Cost, PEC						$1,353,387
Direct Installation Costs						
	Enclosure structural supports	From MSFT CO-3	Robinson Enclosures	0	$9,812	$0
	Installation	1/2 of EPA Cost Manual	1/2 of EPA Cost Manual	2.5%	--	$33,835
	Electrical	Assume no cost	Assume no cost	0	0	0
	Piping	Assume no cost	Assume no cost	0	0	0
	Insulation	Assume no cost	Assume no cost	0	0	0
	Painting	Assume no cost	Assume no cost	0	0	0
Subtotal Direct Installation Costs						$33,835
Site Preparation and Buildings (SP)		Assume no cost	Assume no cost	0	0	0
Total Direct Costs, DC (PEC + Direct Installation + Site Prep)						$1,387,222
Indirect Costs (Installation)						
	Engineering	0.025*PEC	1/4 of EPA Cost Manual	2.5%	--	$33,835
	Construction and field expenses	0.025*PEC	1/2 of EPA Cost Manual	2.5%	--	$33,835
	Contractor Fees	From DIS data center	From DIS data center	6.8%	--	$110,968
	Startup	0.02*PEC	EPA Cost Manual	2.0%	--	$27,068
	Performance Test (Tech support)	0.01*PEC	EPA Cost Manual	1.0%	--	$13,534
	Contingencies	0.03*PEC	EPA Cost Manual	3.0%	--	$40,602
Subtotal Indirect Costs, IC						$259,841
Total Capital Investment (TCI = DC+IC)						$1,647,063
						TCI per gen
						$96,886

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Table 3WC-4. 3-Way Catalyst Nominal-Controlled BACT Cost-Effectiveness

Item	Quantity	Units	Unit cost	Subtotal
Annualized Capital Recovery				
Total Capital Cost				$1,647,063
Capital Recovery Factor, 25 yrs, 4% discount rate				0.06401
Subtotal Annualized 25-year Capital Recovery Cost				$105,428
Direct Annual Costs				
Annual Admin charges	2% of TCI (EPA Manual)		0.02	$32,941
Annual Property tax	1% of TCI (EPA Manual)		0.01	$16,471
Annual Insurance	1% of TCI (EPA Manual)		0.01	$16,471
For this screening-level analysis we assumed the lower-bound annual O&M cost of zero.				$0
Subtotal Direct Annual Costs				$65,883
Total Annual Cost (Capital Recovery + Direct Annual Costs)				**$171,311**
Uncontrolled emissions (Combined Pollutants)				21.7
Assumed Control Efficiency				Varies
Annual Tons Removed (Combined Pollutants)				8.94
Cost Effectiveness ($ per tons combined pollutant destroyed)				**$19,171**

TCI/gen	$96,886

Combined Pollutants Removal Tonnages (Nominal-Controlled)

Pollutant	PM (FH+BH)	CO	VOC	NOX
Nominal Cold-Start Uncontrolled TPY	**1.56**	**3.15**	**0.870**	**16.1**
Nominal Cold-Start Controlled TPY	**0.187**	**0.739**	**0.293**	**11.57**
Tons Removed/Year	**1.37**	**2.41**	**0.578**	**4.6**
Overall Cold-Start Removal Effcy	88%	77%	66%	28%
Indiv Poll $/Ton Removed	$124,740	$71,049	$296,484	$37,457

Multi-PollutantCost-Effectiveness for "Reasonable Control Cost" vs. Actual Control Cost

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (tons/yr)	Subtotal Acceptable Annual Cost ($/year)	
NOX	$10,000	4.57	$45,735	per year
CO	$5,000	2.41	$12,056	per year
VOC	$9,999	0.58	$5,778	per year
PM (FH+BH)	$23,200	1.37	$31,861	per year
Total Reasonable Annual Control Cost for Combined Pollutants			**$95,430**	**per year**
Actual Annual Control Cost			**$171,311**	**per year**
Is The Control Device Reasonable?			**NO (Actual >> Acceptable)**	

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ATTACHMENT F
DIESEL OXIDATION CATALYST BACT ASSESSMENT

DIESEL OXIDATION CATALYSTS INSTALLED AT DIS DATA CENTER IN OLYMPIA, WA

MIRATECH CORPORATION

To:	Alex Charlton EC Power (Portland) 1805 NW 21st. Ave Portland, OR 97210	**Phone:** **Fax:** **Email:**	503 220-3536 503 224-3907 alexc@e-c-co.com
CC:	Brett Fuller/MIRATECH Corporation Scott McBryde/MIRATECH Corporation Courtney McAlpine/MIRATECH Corporation		
From:	David Hammond Renosa Company 608 Joel Palmer Way Dayton, OR 97114	**Phone:** **Fax:** **Email:**	503-864-3952 503-864-9282 dhammond@renosacorp.com

Project Reference: WA DIS
Proposal Number: REN-10-0695 Rev(4)
Date: **6/21/2010**
Firm Quote For: **30 days from Proposal Date**

($22,128 including shipping)
Not Including:
- Taxes
- Installation
- Commissioning
- Vendor Support

Dear Alex:

MIRATECH Corporation welcomes the opportunity to provide you with a proposal for an NSCR system. We are confident that your organization will benefit from selecting us for this project for the following reasons:

- **Experience.**
  - MIRATECH is the leader in providing NSCR, SCR & DPF systems; having more than 17,000 successfully operating units installed in North America, South America, Europe and Asia.
- **World-Class Technology.**
  - Consistently set the standards for Best Available Control Technology (BACT)
  - Simple, user-friendly control and communication technology; connects to any building's communication systems
- **U.S.-based Field Services & Support.**
  - Fast-response field service & technical support
  - Replacement components in stock in Tulsa, Oklahoma
  - In-house engineering & product support

The system offered for this project is in accordance with the data received or estimated from your company. The system is designed to provide emission reduction for carbon monoxide (CO), hydrocarbons (NMHC), and particulate matter (PM) as listed on the System Specifications and Performance Warranty Data page. MIRATECH warrants the quoted performance based on the engine emission and operating data you have provided us and that is contained in this proposal. Please note that some engine assumptions were used and converter size may change based on actual engine data.

Once again, thank you for the opportunity to provide this proposal. If you have any questions, please do not hesitate to contact me. I will call you next week to confirm your receipt and satisfaction with this proposal.

Best Regards,

David Hammond
Renosa Company
Renosa Company

Original Proposal By: Brett Fuller/MIRATECH Corporation

Scope of Supply

MIRATECH Corporation Scope of Supply

	Model Number	Quantity per Engine
NSCR Housing & Catalyst	**SP-IQ-30-24-EL2**	**1**
NSCR Housing	SP-IQ-30-24-HSG	1
Oxidation Catalyst	IQ-RE-30EL	2
Nut, Bolt, and Gasket Set	NBG-IQ30-2	1

Customer Scope of Supply

Description
Support Structure
Attachment to Support Structure (Bolts, Nuts, Levels, etc.)
Expansion Joints
Exhaust Piping
Inlet Pipe Bolts, Nuts, & Gasket
Outlet Pipe Bolts, Nuts, & Gasket

Application Data

Project Information

Site Location:	Olympia
Project Name:	WA DIS
Application:	Standby Power
Number of Engines:	5
Operating Hours per Year:	200

Engine Specifications

Engine Manufacturer:	MTU
Model Number:	20V4000G43
Operating Load for Engine Data Provided:	100%
Power Output:	3,675 bhp
Speed:	1,800 RPM
Type of Fuel:	Number 2 Diesel
Sulfur Content:	500 ppmv or less
Fuel Consumption:	6,000 BTU/bhp-hr
Type of Lube Oil:	1.0 wt%
Lube Oil Consumption:	< 0.00027 gal/bhp-hr
Exhaust Flow Rate:	20,553 acfm (cfm)
Exhaust Temperature:	878°F

Raw Engine Emission Data

	g/bhp-hr	lb/MW-hr	ppmvd	ppmvd @ 15% O_2	lb/hr	g/kW-hr	tons/yr
CO	0.45	1.32	117	63	3.62	0.60	0.36
NMHC	1.06	3.13	484	262	8.58	1.42	0.86
PM_{10}	0.13	0.37	77.43	41.91	1.03	0.17	0.10

% O_2	10.0
H_2O Assumption	12.5

System Specifications and Performance Warranty Data

NSCR System Specifications (SP-IQ-30-24-EL2)

Design Exhaust Flow Rate:	20,553 acfm (cfm)
Design Exhaust Temperature[1]:	878°F
System Pressure Loss:	11.0 inches of WC (Fresh)
Exhaust Temperature Limits:	550 – 1250°F (catalyst inlet); 1350°F (catalyst outlet)

Post System Emission Data

	g/bhp-hr	lb/MW-hr	ppmvd	ppmvd @ 15% O_2	lb/hr	g/kW-hr	tons/yr
CO	0.04	0.13	12	6	0.36	0.06	0.04
NMHC	0.42	1.25	194	105	3.43	0.57	0.34
PM_{10}	0.10	0.28	58	31	0.77	0.13	0.08

Calculated Percent Reductions

	% Reduction	
CO	90.0	co
NMHC	60.0	nmhc
PM10	25.0	pm

Equipment Details

NSCR Housing & Catalyst Details (SP-IQ-30-24-EL2)

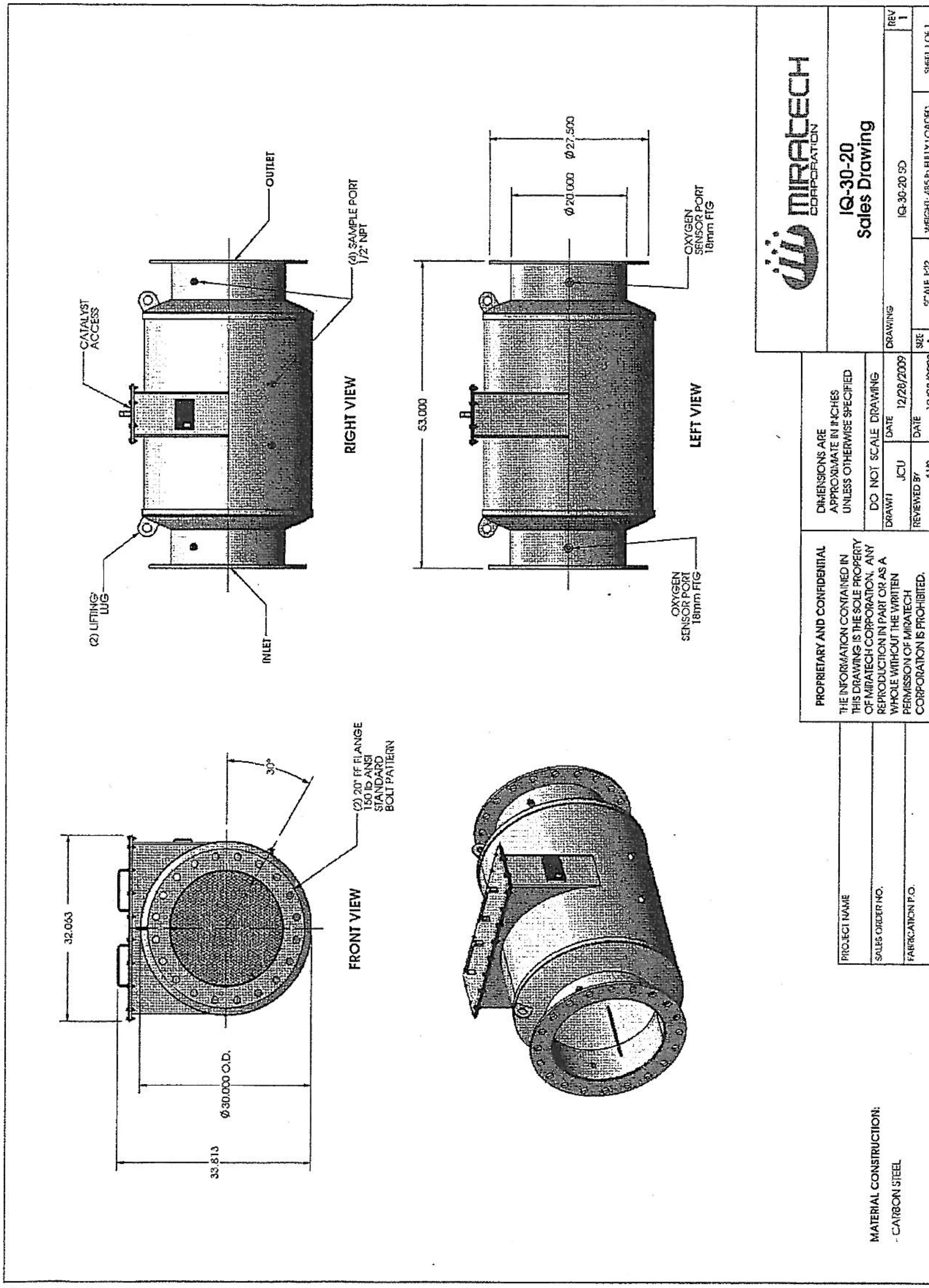
NSCR Housing Details	IQ-30-20 SD
• Model Number:	SP-IQ-30-24-HSG
• Quantity²:	1
• Material:	Carbon Steel
• Paint:	Standard High Temperature Black Paint
• Diameter:	30 inches
• Inlet Pipe Size & Connection:	24 inch FF Flange, 150# ANSI standard bolt pattern
• Outlet Pipe Size & Connection:	24 inch FF Flange, 150# ANSI standard bolt pattern
• Overall Length:	53 inches
• Weight Without Catalyst:	472 lbs
• Weight Including Catalyst:	602 lbs
• Instrumentation Ports:	2 inlet/2 outlet (1/2" NPT)
• Oxygen Sensor Ports:	1 inlet/1 outlet (18mm)
Oxidation Catalyst Details	
• Model Number:	IQ-RE-30EL
• Quantity²:	2
Nut, Bolt, and Gasket Set Details	
• Model Number:	NBG-IQ30-2
• Quantity²:	1

Special Notes/Conditions

1 Carbon steel housings are suitable for use in all applications where the housing will not be insulated. Carbon steel housings may only be insulated in applications where the exhaust temperature does not exceed 900°F. If your application requires insulation with an engine exhaust temperature exceeding 900°F, a stainless steel housing is required. Customer installed insulation on carbon steel housings in applications where exhaust temperature exceeds 900°F voids any MIRATECH product warranty.

2 Quantities are per engine.

- MIRATECH does not allow any silencer, packed or unpacked, to be installed upstream of any MIRATECH equipment. Installation of such equipment will void the warranty per MIRATECH Holdings Terms and Conditions.
- Final catalyst housings are dependent on engine output and required emission reductions. Changes may be made to optimize the system design at the time of order.
- Any drawings included with this proposal are preliminary in nature and could change depending on final product selection.



RIGHT VIEW
LEFT VIEW
FRONT VIEW
OUTLET
INLET
CATALYST ACCESS
(2) LIFTING LUG
(4) SAMPLE PORT 1/2" NPT
OXYGEN SENSOR PORT 18mm FTG
OXYGEN SENSOR PORT 18mm FTG
53.000
Ø20.000
Ø27.500
32.063
Ø30.000 O.D.
33.813
30°
(2) 20" FF FLANGE 150 lb ANSI STANDARD BOLT PATTERN
MATERIAL CONSTRUCTION:
- CARBON STEEL
PROJECT NAME
SALES ORDER NO.
FABRICATION P.O.
PROPRIETARY AND CONFIDENTIAL
THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF MIRATECH CORPORATION. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF MIRATECH CORPORATION IS PROHIBITED.
DIMENSIONS ARE APPROXIMATE IN INCHES UNLESS OTHERWISE SPECIFIED
DO NOT SCALE DRAWING
DRAWN JCU DATE 12/28/2009
REVIEWED BY JWS DATE 12/28/2009
MIRATECH CORPORATION
IQ-30-20
Sales Drawing
DRAWING IQ-30-20 SD
SIZE A
SCALE 1:22
WEIGHT - 485 lb FULLY LOADED
REV 1
SHEET 1 OF 1

MIRATECH CORPORATION

Domestic Onshore Technical Service Rate Schedule

The Day Rate is charged for supervision of work performed over and above the scope of an installation or services contract. MIRATECH standard Terms and Conditions of Sale apply to all activities.

Technical Services Supervisor Day Rate	**$1,200.00**

Additional Information

- **The standard Day Rate is for an 8-hour, onshore, non-holiday, weekday and is the minimum charge.**
- **Charges for greater than 8 hours but less than 12 hours in a single calendar day** - The number of hours of supervision in a single calendar day divided by 8 and multiplied by the standard Day Rate times any applicable multipliers for Weekends and Holidays (see below). (example - 10 hours of supervision in a single day - 10/8 x $1,200 = $1,500)
- **Charges for greater than 12 hours per day** - Actual time worked over 12 hours per day will be charged at a rate of $225.00 per hours or 1.5 times the calculated hourly rate, which ever is greatest.
- **Travel Time** - actual hours traveled each way divided by 8 and multiplied by the standard Day Rate. No multipliers are applicable. (example - 5 hours traveled to site - 5/8 x $1,200 = $750)
- **Saturday** - 1.5 times the standard Day Rate
- **Sundays** - 2 times the standard Day Rate
- **All National Holidays** - 3 times the standard Day Rate

Expense Invoicing Rates

MIRATECH Actual Cost plus 5% - Lodging, phone, meals, parking, air travel, rental cars and incidental costs.

Company Vehicle Mileage at:	**$ 1.00 per mile**
Portable Exhaust Gas Analyzer	**$ 400.00/calendar day**
Special Tools and Equipment rental	**cost plus 15%**

420 S. 145th E. Avenue, Mail Drop A, Tulsa, OK 74108-1305
Phone Number (800) 640-3141 FAX Number (918) 622-3928
www.MIRATECHcorp.com

MIRATECH Onshore Technical Service Day Rate Sheet date January 2009

ACTUAL COSTS TO INSTALL DOCs AT OLYMPIA DATA CENTER, 2010

WRIGHT RUNSTAD & COMPANY

PRINCIPALS:
H. JON RUNSTAD
GREGORY K. JOHNSON
WALTER R. INGRAM

December 17, 2010

TOTAL INSTALLED COST = $306,222 for 5 gensets = $61,200 each genset (2,500 kWe)

Sally Alhadeff
Department of Information Services, Director's Office
1110 Jefferson Street SE
P.O. Box 42445
Olympia, WA 98504

DIS - WHEELER PROJECT
CHANGE ORDER #24
DIESEL OXYDATION CATALYSTS
@ UTILITY BUILDING

Dear Sally:

Attached is Change Order #24 for your approval. The purpose of this change order is to add the Diesel Oxydation Catalysts at the generators for the Data Center in accordance with the attached proposal as required by ORCAA.

The total cost for this additional work is $306,222 and it will not impact the schedule.

If you find everything in order, please sign the attached Change Order and return one original for my files.

Please feel free to contact me with any questions or concerns.

Very truly yours,

Cindy Edens

Cindy Edens
Senior Vice President

CE/sg

Enclosures

INVESTMENT BUILDERS AND REAL ESTATE ASSET MANAGERS
SUITE 2700, 1201 THIRD AVENUE, SEATTLE, WASHINGTON 98101-3274
TELEPHONE (206) 447-9000 FAX (206) 223-8791

DIS – Wheeler Project
Tenant Change Order #24
12/17/2010

TENANT CHANGE ORDER #24

Description: Diesel Oxydation Catalysts @ Utility Building

Cost Summary:

Construction Costs		$ 268,793
Sales Tax		$ 22,847
	Subtotal	$ 291,640
Developer's Fee		$ 14,582
	TOTAL	**$ 306,222**

Total Delay for Tenant Change Order #24 **No Impact**

Please sign below approving the total cost of $306,222 for this additional work.

APPROVED BY:

Facilities Development Manager
Department of Information Services

12/21/2010
Date

Howard S. Wright Constructors

Change Proposal

DIS Wheeler Project
Jefferson St SE & 14th Avenue SE
Olympia, WA 98501

Proposal Description: Provide Diesel Oxydation Catalysts at the generators for the Data Center.

oposal Date: 11/2/10

PCO NUMBER: DCSC-0134

Item	Qty	UNITS	Hours per Unit	Units per Hour	MH	Labor Rate	Cost	Mat U.P.	Cost	Sub U.P.	Cost	Extended Totals	Division Totals
GENERAL CONDITIONS / GENERAL REQUIREMENTS													0
Project Staff:							0		0		0	0	
Sr. Project Mgr	0	MH	1.0000	1.00	0	93	0		0		0	0	
Project Mgr	0	MH	1.0000	1.00	0	93	0		0		0	0	
Project Engr	0	MH	1.0000	1.00	0	93	0		0		0	0	
BIM Detailing / MEP Coordination	0	MH	1.0000	1.00	0	93	0		0		0	0	
Project Supt.		MH	1.0000	1.00	0	93	0		0		0	0	
Foreman		MH	1.0000	1.00	0	93	0		0		0	0	
Temporary Projection & Safety		MH	1.0000	1.00	0	93	0		0		0	0	
Layout / Field Engineering		MHz	1.0000	1.00	0	93	0		0		0	0	
Cleanup		MH	1.0000	1.00	0	93	0		0		0	0	
Disposal / Dump Fee's / Eco Pans		EA	1.0000	1.00	0	93	0		0		0	0	
HSW DIRECT FIELD LABOR													0
					0		0		0		0	0	
SUBCONTRACTORS													252,209
UMCI - Install DOC's	5	ea			0		0		0	5,476	27,378	27,378	
UMCI - Store fabricated sound traps	1	ls			0		0		0	67,114	67,114	67,114	
EC - Provide DOC's w/ Insulating blankets	5	ea			0		0		0	31,543	157,717	157,717	
					0		0		0		0	0	
											0	0	
					0		0		0		0	0	
					0		0		0		0	0	
					0		0		0		0	0	
					0		0		0		0	0	
											0	0	
											0	0	
Totals					0		0		0		252,209	252,209	252,209

Total Direct 0 MH

Subguard	1.05%	2,648
Liability Insurance	1.00%	2,549
Excise - B & O Tax	0.57%	1,470
Bond	0.66%	1,709
Overhead & Profit	3.15%	8,208
SUB - TOTAL		268,793
Contingency	0.00%	0

Proposal Total $268,793

Qualifications:

1) WSST is not included
2) Proposal is valid for 10 days from when it is submitted.
3) No structural modifications are anticipated to be needed, therefore none are included.
4) Costs for storing the generator sound traps is included since this equipment had to be stored 6-7 months longer than anticipated due to the emmissions permit delay.

TABLE DOC-1. DOC NOMINAL CONTROLLED (COLD-START ADJUSTED) EMISSION RATES FOR BACT ANALYSIS

Miratech Model SP-IQ-30-24-EL2 used at DIS Data Center

Table X. Nominal-Controlled Cold-Start NOX Emissions Accounting for 3WC Delay Time

Load	Nominal Uncon.trolled NOX, lbs/hr	Minutes SCR Delay	Guaranteed Effcy (%)	Nominal Controlled CO, lbs/hr	Minutes Full SCR Control	Nominal Controlled NOX Emission, lbs/hr	Overall Cold Start % NOX Removal
10%	6.0	20	0%	6.00	40	6.00	0%
81.3%	37.2	10	0%	37.17	50	37.17	0%
90%	43.6	10	0%	43.57	50	43.57	0%
93.3%	46.1	10	0%	46.14	50	46.14	0%
100%	51.5	10	0%	51.50	50	51.50	0%

Miratech DOC STEADY-STATE REMOVAL EFFICIENCIES

Pollutant	Removal Effct (%)
Nox	0%
PM (FH+BH)	25%
CO	90%
VOC	60%

Table X. Nominal-Controlled (Cold-Start Adjusted) PM Emission Rates (Includes FH+BH Factor)

Elec Load	Nominal Uncontrolled Front-Half Only Emiss Rate (lbs/hr)	Total PM to Front Half PM Ratio	Nominal Uncontrolled Total PM Emiss Rate (lbs/hr)	Guaranteed Effcy (%)	Nominal Contr Total PM (lbs/hr)	Dell 1-Hour Cold Start Factor	Nominal Controlled Total PM, lbs/hr
10%	0.43	3.38	1.45	25%	1.088	1.058	1.152
81.3%	0.83	3.08	2.55	25%	1.914	1.058	2.025
90%	0.95	3.08	2.92	25%	2.191	1.058	2.318
93.3%	0.99	3.08	3.04	25%	2.283	1.058	2.416
100%	1.08	3.00	3.24	25%	2.430	1.058	2.571

Total:FH Adjustment Factors

Load	StacktestTot PM	Stacktest FH Only PM	Total PM to Front Half PM Ratio
80%-90%			3.08
100%	0.36	0.12	3.00
50%	0.27	0.08	3.38

Table Y. Nominal-Controlled Cold-Start CO Emissions Accounting for DOC Delay Time

Load	Nominal Uncontrolled Rate, lbs/hr	Minutes DOC Delay	Guaranteed Effcy (%)	Nominal Controlled CO, lbs/hr	Minutes Full DOC Control	Wt. Average 1-Hour CO Emission, lbs/hr	Cold Start Factor	Nominal Controlled CO, lbs/hr	Overall Cold Start % CO Removal
10%	2.8	20	90%	0.28	40	1.12	1.058	1.18	60%
81.3%	5.3	10	90%	0.53	50	1.33	1.058	1.40	75%
90%	6.0	10	90%	0.60	50	1.50	1.058	1.59	75%
93.3%	6.3	10	90%	0.63	50	1.58	1.058	1.67	75%
100%	6.8	10	90%	0.68	50	1.70	1.058	1.80	75%

Table Y. Nominal-Controlled Cold-Start VOC Emissions Accounting for DOC Delay Time

Load	Nominal Uncontrolled Rate, lbs/hr	Minutes DOC Delay	Guaranteed Effcy (%)	Nominal Controlled VOC, lbs/hr	Minutes Full DOC Control	Wtd Average 1-Hour Emission, lbs/hr	Cold Start Factor	Nominal Controlled VOC, lbs/hr	Overall Cold Start % Removal
10%	1.2	20	60%	0.49	40	0.74	1.058	0.78	40%
81.3%	1.1	10	60%	0.44	50	0.55	1.058	0.58	50%
90%	1.1	10	60%	0.44	50	0.55	1.058	0.58	50%
93.3%	1.1	10	60%	0.44	50	0.55	1.058	0.58	50%
100%	1.1	10	60%	0.44	50	0.55	1.058	0.58	50%

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Table DOC-2. DOC Nominal-Controlled Facility-Wide Emissions (Basis = Miratch DOC; ELM's Nominal-Uncontrolled + Cold-Start Factors)

Gen #	Gen Area	Elec Load	No. Gens	Hours at Each Runtime Mode: W	M	Q	A-F	A-Step	Correct Tests	De-En Bldg Maint	Outage or Storm Avoid	Cool	Total hrs/yr	Each Genset DPM lbs/hr	Each Genset Fuel Gal/Hr	Each Genset NOX lbs/hr	Facility Wide Total PM Tons/yr	Facility-Wide Fuel Gal/Year	Facility Wide NOX Tons/yr	Each Genset CO lbs/hr	Facility-Wide CO Tons/Yr	Each Genset HC lbs/hr	Facility-Wide VOC Tons/Yr
Unplanned Outage + Storm Avoidance				Unplanned Outage + Storm Avoidance																			
1-1 to 1-5	Bldg 1	81%	5								24		24	2.03	195	37.2	0.122	23,400	2.23	1.40	0.08	0.58	0.035
2-1 to 2-3	Bldg 2	90%	3								24		24	2.32	213	43.57	0.083	15,336	1.57	1.59	0.06	0.58	0.021
3-1 to 3-3	Bldg 3	90%	3								24		24	2.32	213	43.57	0.083	15,336	1.57	1.59	0.06	0.58	0.021
ETC-1	ETC	93%	1								24		24	2.42	220	46.14	0.029	5,280	0.55	1.67	0.02	0.58	0.007
Testing at Full Outage Loads				Testing at Full Outage Loads																			
1-1 to 1-5	Bldg 1	81%	5			3	6			8			17	2.03	195	37.2	0.086	16,575	1.58	1.40	0.06	0.58	0.025
2-1 to 2-3	Bldg 2	90%	3			3	6			8			17	2.32	213	43.57	0.059	10,863	1.11	1.59	0.04	0.58	0.015
3-1 to 3-3	Bldg 3	90%	3			3	6			8			17	2.32	213	43.57	0.059	10,863	1.11	1.59	0.04	0.58	0.015
ETC-1	ETC	93%	1			3	6			8			17	2.42	220	46.14	0.021	3,740	0.39	1.67	0.01	0.58	0.005
100% Load				Testing at 100% Load																			
1-1 to 1-5	Bldg 1	100%	5					0.5	8				8.5	2.57	232	51.50	0.055	9,860	1.09	1.80	0.04	0.58	0.012
2-1 to 2-3	Bldg 2	100%	3					0.5	8				8.5	2.57	232	51.50	0.033	5,916	0.66	1.80	0.02	0.58	0.007
3-1 to 3-3	Bldg 3	100%	3					0.5	8				8.5	2.57	232	51.50	0.033	5,916	0.66	1.80	0.02	0.58	0.007
ETC-1	ETC	100%	1					0.5	8				8.5	2.57	232	51.50	0.011	1,972	0.22	1.80	0.01	0.58	0.002
1-6 and 1-7 Reserve	Bldg 1	100%	2					0.5	8				8.5	2.57	232	51.50	0.022	3,944	0.44	1.80	0.02	0.58	0.005
2-4 Reserve	Bldg 2	100%	1					0.5	8				8.5	2.57	232	51.50	0.011	1,972	0.22	1.80	0.01	0.58	0.002
3-4 Reserve	Bldg 3	100%	1					0.5	8				8.5	2.57	232	51.50	0.011	1,972	0.22	1.80	0.01	0.58	0.002
ETC-2 Reserve	ETC	100%	1					0.5	8				8.5	2.57	232	51.50	0.011	1,972	0.22	1.80	0.01	0.58	0.002
Idle (set to 10% for emission calculations)				Idle																			
1-1 to 1-5	Bldg 1	10%	5	20	6	0	0	0	0	0	0	9.5	35.5	1.15	45	6.00	0.102	7,988	0.53	1.18	0.11	0.78	0.069
2-1 to 2-3	Bldg 2	10%	3	20	6	0	0	0	0	0	0	9.5	35.5	1.15	45	6.00	0.061	4,793	0.32	1.18	0.06	0.78	0.042
3-1 to 3-3	Bldg 3	10%	3	20	6	0	0	0	0	0	0	9.5	35.5	1.15	45	6.00	0.061	4,793	0.32	1.18	0.06	0.78	0.042
ETC-1	ETC	10%	1	20	6	0	0	0	0	0	0	9.5	35.5	1.15	45	6.00	0.020	1,598	0.11	1.18	0.02	0.78	0.014
1-6 and 1-7 Reserve	Bldg 1	10%	2	20	6	3	6			8	24	1.5	68.5	1.15	45	6.00	0.079	6,165	0.41	1.18	0.08	0.78	0.053
2-4 Reserve	Bldg 2	10%	1	20	6	3	6			8	24	1.5	68.5	1.15	45	6.00	0.039	3,083	0.21	1.18	0.04	0.78	0.027
3-4 Reserve	Bldg 3	10%	1	20	6	3	6			8	24	1.5	68.5	1.15	45	6.00	0.039	3,083	0.21	1.18	0.04	0.78	0.027
ETC-2 Reserve	ETC	10%	1	20	6	3	6			8	24	1.5	68.5	1.15	45	6.00	0.039	3,083	0.21	1.18	0.04	0.78	0.027

	Total PM		NOX	CO	VOC
CONTROLLED Facility-Wide Emissions	1.17	169,500	16.14	0.958	0.485
UNCONTROLLED Facility-Wide Emissions	1.56		16.14	3.15	0.870
Tons/Yr Removed	0.39		0.00	2.19	0.39
Overall Removal Effcy, %	25%		0%	70%	44%

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Table DOC-3. BACT Capital Cost for DOCs (Based on DIS Data Center)

Vantage Data Center

Cost Category	Cost Factor	Source of Cost Factor	Quant.	Unit Cost	Subtotal Cost
Direct Costs					
Purchased Equipment Costs					
Total Installed Cost for DIS Data Center's 2500 kWe generators was $306,200 for 5 gensets or $61,200 per genset, including all engineering, fees, and construction costs. The total installed price for Vantage's 3,000 kWe generators was scaled using the "0.6 rule": Cost for 3,000 kWe units = $61,200 *(3000/2500)^0.6 = $68,300 each					
Vantage 3000 kWe Total Installed Cost	DIS Data Center	DIS Data Center	17	$68,300	$1,161,100
Instrumentation	Included	Included	0	0	0
Sales Tax	Included	Included	0.0%	--	$0
Shipping	Included	Included	0.0%	--	$0
Subtotal Purchased Equipment Cost, PEC					$1,161,100
Direct Installation Costs					
Enclosure structural supports	Included	Included	0	$9,812	$0
Installation	Included	Included	0.0%	--	$0
Electrical	Included	Included	0	0	0
Piping	Included	Included	0	0	0
Insulation	Included	Included	0	0	0
Painting	Included	Included	0	0	0
Subtotal Direct Installation Costs					$0
Site Preparation and Buildings (SP)	Included	Included	0	0	0
Total Direct Costs, DC (PEC + Direct Installation + Site Prep)					$1,161,100
Indirect Costs (Installation)					
Engineering	Included	Included	0.0%	--	$0
Construction and field expenses	Included	Included	0.0%	--	$0
Contractor Fees	Included	Included	0.0%	--	$0
Startup	Included	Included	0.0%	--	$0
Performance Test (Tech support)	Included	Included	0.0%	--	$0
Contingencies	Included	Included	0.0%	--	$0
Subtotal Indirect Costs, IC					$0
Total Capital Investment (TCI = DC+IC)					$1,161,100
					TCI per gen
					$68,300

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Table DOC-4. DOC Nominal-Controlled BACT Cost-Effectiveness

Item	Quantity	Units	Unit cost	Subtotal
Annualized Capital Recovery				
Total Capital Cost				$1,161,100
Capital Recovery Factor, 25 yrs, 4% discount rate				0.06401
Subtotal Annualized 25-year Capital Recovery Cost				$74,322
Direct Annual Costs				
Annual Admin charges	2% of TCI (EPA Manual)		0.02	$23,222
Annual Property tax	1% of TCI (EPA Manual)		0.01	$11,611
Annual Insurance	1% of TCI (EPA Manual)		0.01	$11,611
For this screening-level analysis we assumed the lower-bound annual O&M cost of zero.				$0
Subtotal Direct Annual Costs				$46,444
Total Annual Cost (Capital Recovery + Direct Annual Costs)				**$120,766**
Uncontrolled emissions (Combined Pollutants)				21.7
Assumed Control Efficiency				Varies
Annual Tons Removed (Combined Pollutants)				2.97
Cost Effectiveness ($ per tons combined pollutant destroyed)				**$40,698**

TCI/gen	$68,300

DOC Combined Pollutants Removal Tonnages (Nominal-Controlled)

Pollutant	PM (FH+BH)	CO	VOC	NOX
Nominal Cold-Start Uncontrolled TPY	**1.56**	**3.15**	**0.870**	**16.1**
Nominal Cold-Start Controlled TPY	**1.170**	**0.958**	**0.485**	**16.14**
Tons Removed/Year	**0.39**	**2.19**	**0.385**	**0.0**
Overall Cold-Start Removal Effcy	25%	70%	44%	0%
Total Annual Cost	$120,766	$120,766	$120,766	$120,766
Indiv Poll $/Ton Removed	$309,535	$55,094	$313,511	#DIV/0!

Multi-PollutantCost-Effectiveness for "Reasonable Control Cost" vs. Actual Control Cost

Pollutant	Ecology Acceptable Unit Cost ($/ton)	Forecast Removal (tons/yr)	Subtotal Acceptable Annual Cost ($/year)	
NOX	$10,000	0.00	$0	per year
CO	$5,000	2.19	$10,960	per year
VOC	$9,999	0.39	$3,852	per year
PM (FH+BH)	$23,200	0.39	$9,052	per year
Total Reasonable Annual Control Cost for Combined Pollutants			**$23,863**	**per year**
Actual Annual Control Cost			**$120,766**	**per year**
Is The Control Device Reasonable?			**NO (Actual >> Acceptable)**	

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APPENDIX E
STACK TEST DATA AND VENDOR-SUPPLIED EMISSION DATA

STACK TEST GROUP, INC.
Air Quality Services

Client:	GenAcc
Project No:	11-2146
Load:	100%
Source:	MTU 3250

Test No:	T1	T2	T3	Avg.
Start Time:	08:35 AM	07:35 AM	08:52 AM	
Finish Time:	10:20 AM	08:38 AM	09:54 AM	
Date:	7/18/2011	7/19/2011	7/19/2011	
Pitot Cal. Factor:	0.84	0.84	0.84	
Meter Calibration Factor:	1.035	1.035	1.035	
Stack Length, inches:	0	0	0	
Stack Width, inches:	0	0	0	
Stack Diameter, inches:	35.5	35.5	35.5	
Nozzle Diameter, inches:	0.311	0.311	0.311	
Barometric Pressure, inches Hg:	29.20	29.10	29.10	
Static Pressure in Stack, Inches H2O:	-0.33	-0.23	-0.27	
Duration of Sample, minutes:	60	60	60	
Meter Start Volume:	487.480	874.750	914.820	
Meter Final Volume:	529.150	914.340	956.000	
Average Meter Pressure, Inches H2O:	1.6800	1.4075	1.5150	1.5342
Average Meter Temperature, degrees F:	88.21	89.9	93.52	90.5
Average Sqrt. Velocity Pressure:	0.6503	0.5990	0.6177	0.6223
Stack Gas Temperature, degrees F:	838.2	823	829.21	830.1
% Carbon Dioxide:	10.2	10.2	10.2	10.2
% Oxygen:	8.4	8.4	8.4	8.4
% Carbon Monoxide:	0.0	0.0	0.0	0.0
Liquid Volume Collected, milliliters:	102.5	100	99.5	100.7

Sample Train Calculations

Meter Volume, Actual:	41.670	39.590	41.180	40.813
Meter Volume, STP:	40.695	38.386	39.679	39.587
Volume of Water Vapor Condensed:	4.825	4.707	4.683	4.738
Total Gas Sampled:	45.520	43.093	44.362	44.325
% Moisture:	10.60	10.92	10.56	10.69
Area of Stack, Square Feet:	6.87	6.87	6.87	6.87
% Excess Air at Test Location:	64.2	64.2	64.2	64.2
Molecular Weight dry, lb/lb-Mole:	29.97	29.97	29.97	29.97
Molecular Weight wet, lb/lb-Mole:	28.70	28.66	28.71	28.69
Absolute Stack Gas Pressure, in Hg:	29.18	29.08	29.08	29.11
Isokinetic, %:	104.0	106.4	106.5	105.6

Velocity and Flow Calculations

Average Stack Gas Velocity FPS:	58.14	53.37	55.12	55.54
Stack Gas Flow Rate, ACFM:	23,965	21,999	22,720	22,895
Stack Gas Flow Rate, SCFM:	9,506	8,799	9,044	9,116
Stack Gas Flow Rate, DSCF/HR:	509,899	470,302	485,337	488,513
Stack Gas Flow Rate, DSCFM:	8,498	7,838	8,089	8,142

VOC Calculations:

PPM as Propane:	0.8	1.1	1.2	1.0
LBS/DSCF:	9.14E-08	1.26E-07	1.37E-07	1.18E-07
LBS/HR:	0.1	0.1	0.1	0.1
Brake HP:	4680	4680	4680	4680.0
Grams/Brake HP HR:	0.005	0.006	0.007	0.006

NOx Calculations:

PPMv	29.6	30.1	36.2	32.0
LBS/DSCF:	3.53E-06	3.59E-06	4.32E-06	3.82E-06
LBS/HR:	1.80	1.69	2.10	1.9
Brake HP:	4680	4680	4680	4680.0
Grams/Brake HP HR:	0.175	0.164	0.203	0.181

CO Calculations:

PPMv	2.1	1.2	1.2	1.5
LBS/DSCF:	1.53E-07	8.72E-08	8.72E-08	1.09E-07
LBS/HR:	0.08	0.04	0.04	0.1
Brake HP:	4680	4680	4680	4680.0
Grams/Brake HP HR:	0.008	0.004	0.004	0.005

STACK TEST GROUP, INC.
Air Quality Services

Client:	GenAcc
Project No:	11-2146
Load:	75%
Source:	MTU 3250

Test No:	T1	T2	T3	Avg.
Start Time:	10:45 AM	04:02 PM	05:20 PM	
Finish Time:	11:47 AM	05:06 PM	06:23 PM	
Date:	7/18/2011	7/18/2011	7/18/2011	
Pitot Cal. Factor:	0.84	0.84	0.84	
Meter Calibration Factor:	1.035	1.035	1.035	
Stack Length, inches:	0	0	0	
Stack Width, inches:	0	0	0	
Stack Diameter, inches:	35.5	35.5	35.5	
Nozzle Diameter, inches:	0.342	0.342	0.342	
Barometric Pressure, inches Hg:	29.20	29.20	29.20	
Static Pressure in Stack, Inches H2O:	-0.28	-0.26	-0.24	
Duration of Sample, minutes:	60	60	60	
Meter Start Volume:	529.400	729.950	777.840	
Meter Final Volume:	574.050	777.450	825.930	
Average Meter Pressure, Inches H2O:	2.1500	2.1042	2.1500	2.1347
Average Meter Temperature, degrees F:	94.1	94.63	97.46	95.4
Average Sqrt. Velocity Pressure:	0.5837	0.5753	0.5812	0.5801
Stack Gas Temperature, degrees F:	743.8	766.33	759.58	756.6
% Carbon Dioxide:	9.1	9.1	9.1	9.1
% Oxygen:	10.3	10.0	10.1	10.1
% Carbon Monoxide:	0.0	0.0	0.0	0.0
Liquid Volume Collected, milliliters:	99	97	99.5	98.5

Sample Train Calculations

Meter Volume, Actual:	44.650	47.500	48.090	46.747
Meter Volume, STP:	43.192	45.902	46.236	45.110
Volume of Water Vapor Condensed:	4.660	4.566	4.683	4.636
Total Gas Sampled:	47.852	50.468	50.919	49.746
% Moisture:	9.74	9.05	9.20	9.33
Area of Stack, Square Feet:	6.87	6.87	6.87	6.87
% Excess Air at Test Location:	93.8	88.0	89.9	90.6
Molecular Weight dry, lb/lb-Mole:	29.87	29.86	29.86	29.86
Molecular Weight wet, lb/lb-Mole:	28.71	28.79	28.77	28.76
Absolute Stack Gas Pressure, in Hg:	29.18	29.18	29.18	29.18
Isokinetic, %:	97.0	104.9	104.4	102.1

Velocity and Flow Calculations

Average Stack Gas Velocity FPS:	50.25	49.91	50.31	50.16
Stack Gas Flow Rate, ACFM:	20,713	20,573	20,738	20,675
Stack Gas Flow Rate, SCFM:	8,860	8,639	8,756	8,752
Stack Gas Flow Rate, DSCF/HR:	479,841	471,411	477,031	476,094
Stack Gas Flow Rate, DSCFM:	7,997	7,857	7,951	7,935

VOC Calculations:

PPM as Propane:	1.8	1.6	1.7	1.7
LBS/DSCF:	2.06E-07	1.83E-07	1.94E-07	1.94E-07
LBS/HR:	0.1	0.1	0.1	0.1
Brake HP:	3509	3509	3509	3509.0
Grams/Brake HP HR:	0.014	0.012	0.013	0.013

NOx Calculations:

PPMv	16.9	14.7	18.1	16.6
LBS/DSCF:	2.02E-06	1.75E-06	2.16E-06	1.98E-06
LBS/HR:	0.97	0.83	1.03	0.9
Brake HP:	3509	3509	3509	3509.0
Grams/Brake HP HR:	0.125	0.107	0.133	0.122

CO Calculations:

PPMv	1.3	1.1	1.0	1.1
LBS/DSCF:	9.45E-08	7.99E-08	7.27E-08	8.24E-08
LBS/HR:	0.05	0.04	0.03	0.0
Brake HP:	3509	3509	3509	3509.0
Grams/Brake HP HR:	0.006	0.005	0.004	0.005

STACK TEST GROUP, INC.
Air Quality Services

Client:	GenAcc
Project No:	11-2146
Load:	50%
Source:	MTU 3250

Test No:	T1	T2	T3	Avg.
Start Time:	12:05 PM	01:30 PM	02:47 PM	
Finish Time:	01:09 PM	02:33 PM	03:50 PM	
Date:	7/18/2011	7/18/2011	7/18/2011	
Pitot Cal. Factor:	0.84	0.84	0.84	
Meter Calibration Factor:	1.035	1.035	1.035	
Stack Length, inches:	0	0	0	
Stack Width, inches:	0	0	0	
Stack Diameter, inches:	35.5	35.5	35.5	
Nozzle Diameter, inches:	0.412	0.412	0.412	
Barometric Pressure, inches Hg:	29.20	29.20	29.20	
Static Pressure in Stack, Inches H2O:	-0.16	-0.14	-0.15	
Duration of Sample, minutes:	60	60	60	
Meter Start Volume:	577.810	627.920	679.540	
Meter Final Volume:	627.550	679.250	729.520	
Average Meter Pressure, Inches H2O:	2.4700	2.4400	2.3400	2.4167
Average Meter Temperature, degrees F:	87.65	92.9	91.63	90.7
Average Sqrt. Velocity Pressure:	0.4260	0.4212	0.4149	0.4207
Stack Gas Temperature, degrees F:	679.0	684.58	688.71	684.1
% Carbon Dioxide:	8.1	8.1	8.1	8.1
% Oxygen:	11.6	11.7	11.4	11.6
% Carbon Monoxide:	0.0	0.0	0.0	0.0
Liquid Volume Collected, milliliters:	74	66.5	63.5	68.0

Sample Train Calculations

Meter Volume, Actual:	49.740	51.330	49.980	50.350
Meter Volume, STP:	48.717	49.797	48.590	49.035
Volume of Water Vapor Condensed:	3.483	3.130	2.989	3.201
Total Gas Sampled:	52.200	52.928	51.579	52.235
% Moisture:	6.67	5.91	5.79	6.13
Area of Stack, Square Feet:	6.87	6.87	6.87	6.87
% Excess Air at Test Location:	120.8	123.5	115.7	120.0
Molecular Weight dry, lb/lb-Mole:	29.76	29.76	29.75	29.76
Molecular Weight wet, lb/lb-Mole:	28.98	29.06	29.07	29.04
Absolute Stack Gas Pressure, in Hg:	29.19	29.19	29.19	29.19
Isokinetic, %:	97.6	100.5	99.6	99.2

Velocity and Flow Calculations

Average Stack Gas Velocity FPS:	35.50	35.14	34.67	35.10
Stack Gas Flow Rate, ACFM:	14,633	14,485	14,291	14,470
Stack Gas Flow Rate, SCFM:	6,618	6,519	6,409	6,515
Stack Gas Flow Rate, DSCF/HR:	370,588	368,014	362,248	366,950
Stack Gas Flow Rate, DSCFM:	6,176	6,134	6,037	6,116

VOC Calculations:

PPM as Propane:	1.7	1.7	1.4	1.6
LBS/DSCF:	1.94E-07	1.94E-07	1.60E-07	1.83E-07
LBS/HR:	0.1	0.1	0.1	0.1
Brake HP:	2339	2339	2339	2339.0
Grams/Brake HP HR:	0.015	0.015	0.012	0.014

NOx Calculations:

PPMv	10.3	8.7	9.4	9.5
LBS/DSCF:	1.23E-06	1.04E-06	1.12E-06	1.13E-06
LBS/HR:	0.46	0.38	0.41	0.4
Brake HP:	2339	2339	2339	2339.0
Grams/Brake HP HR:	0.088	0.074	0.079	0.080

CO Calculations:

PPMv	1.2	1.3	1.1	1.2
LBS/DSCF:	8.72E-08	9.45E-08	7.99E-08	8.72E-08
LBS/HR:	0.03	0.03	0.03	0.0
Brake HP:	2339	2339	2339	2339.0
Grams/Brake HP HR:	0.006	0.007	0.006	0.006

STACK TEST GROUP, INC.
Air Quality Services

Client:	GenAcc
Project No:	11-2146
Load:	25%
Source:	MTU 3250

Test No:	T1	T2	T3	Avg.
Start Time:	06:37 PM	03:42 PM	05:00 PM	
Finish Time:	07:40 PM	04:45 PM	06:03 PM	
Date:	7/18/2011	7/19/2011	7/19/2011	
Pitot Cal. Factor:	0.84	0.84	0.84	
Meter Calibration Factor:	1.035	1.035	1.035	
Stack Length, inches:	0	0	0	
Stack Width, inches:	0	0	0	
Stack Diameter, inches:	35.5	35.5	35.5	
Nozzle Diameter, inches:	0.492	0.492	0.492	
Barometric Pressure, inches Hg:	29.20	29.10	29.10	
Static Pressure in Stack, Inches H2O:	-0.3	-0.28	-0.31	
Duration of Sample, minutes:	60	60	60	
Meter Start Volume:	826.480	956.350	6.430	
Meter Final Volume:	874.150	1005.810	54.730	
Average Meter Pressure, Inches H2O:	2.0800	2.1500	2.0700	2.1000
Average Meter Temperature, degrees F:	97.38	95.79	97	96.7
Average Sqrt. Velocity Pressure:	0.2669	0.2728	0.2682	0.2693
Stack Gas Temperature, degrees F:	595.4	605	599.79	600.1
% Carbon Dioxide:	7.7	7.7	7.7	7.7
% Oxygen:	12.6	12.6	12.6	12.6
% Carbon Monoxide:	0.0	0.0	0.0	0.0
Liquid Volume Collected, milliliters:	87	89	89	88.3

Sample Train Calculations

Meter Volume, Actual:	47.670	49.460	48.300	48.477
Meter Volume, STP:	45.832	47.536	46.312	46.560
Volume of Water Vapor Condensed:	4.095	4.189	4.189	4.158
Total Gas Sampled:	49.927	51.725	50.501	50.718
% Moisture:	8.20	8.10	8.29	8.20
Area of Stack, Square Feet:	6.87	6.87	6.87	6.87
% Excess Air at Test Location:	149.3	149.3	149.3	149.3
Molecular Weight dry, lb/lb-Mole:	29.74	29.74	29.74	29.74
Molecular Weight wet, lb/lb-Mole:	28.78	28.79	28.77	28.78
Absolute Stack Gas Pressure, in Hg:	29.18	29.08	29.08	29.11
Isokinetic, %:	100.2	102.3	101.3	101.3

Velocity and Flow Calculations

Average Stack Gas Velocity FPS:	21.49	22.10	21.68	21.75
Stack Gas Flow Rate, ACFM:	8,858	9,110	8,936	8,968
Stack Gas Flow Rate, SCFM:	4,322	4,390	4,327	4,346
Stack Gas Flow Rate, DSCF/HR:	238,060	242,038	238,112	239,404
Stack Gas Flow Rate, DSCFM:	3,968	4,034	3,969	3,990

VOC Calculations:

PPM as Propane:	1.4	0.8	0.9	1.0
LBS/DSCF:	1.60E-07	9.14E-08	1.03E-07	1.18E-07
LBS/HR:	0.0	0.0	0.0	0.0
Brake HP:	1169	1169	1169	1169
Grams/Brake HP HR:	0.016	0.009	0.010	0.012

NOx Calculations:

PPMv	14.6	9.9	7.4	10.6
LBS/DSCF:	1.74E-06	1.18E-06	8.83E-07	1.27E-06
LBS/HR:	0.41	0.29	0.21	0.3
Brake HP:	1169	1169	1169	1169
Grams/Brake HP HR:	0.161	0.111	0.082	0.118

CO Calculations:

PPMv	0.9	1.1	1.2	1.1
LBS/DSCF:	6.54E-08	7.99E-08	8.72E-08	7.75E-08
LBS/HR:	0.02	0.02	0.02	0.0
Brake HP:	1169	1169	1169	1169
Grams/Brake HP HR:	0.006	0.008	0.008	0.007

STACK TEST GROUP, INC.
Air Quality Services

Client:	GenAcc
Project No:	11-2146
Load:	10%
Source:	MTU 3250

Test No:	T1	T2	T3	Avg.
Start Time:	02:05 PM	03:42 PM	05:00 PM	
Finish Time:	03:29 PM	04:45 PM	06:03 PM	
Date:	7/19/2011	7/19/2011	7/19/2011	
Pitot Cal. Factor:	0.84	0.84	0.84	
Meter Calibration Factor:	1.035	1.035	1.035	
Stack Length, inches:	0	0	0	
Stack Width, inches:	0	0	0	
Stack Diameter, inches:	35.5	35.5	35.5	
Barometric Pressure, inches Hg:	29.10	29.10	29.10	
Static Pressure in Stack, Inches H2O:	-0.02	-0.02	-0.02	
Duration of Sample, minutes:	60	60	60	
Meter Start Volume:	55.030	99.760	141.420	
Meter Final Volume:	99.470	140.980	185.340	
Average Meter Pressure, Inches H2O:	1.7300	1.8933	1.6917	1.7717
Average Meter Temperature, degrees F:	101.17	102.12	100.67	101.3
Average Sqrt. Velocity Pressure:	0.1900	0.1752	0.1880	0.1844
Stack Gas Temperature, degrees F:	469.8	467.88	457.83	465.2
% Carbon Dioxide:	5.7	5.7	5.7	5.7
% Oxygen:	14.7	14.7	14.7	14.7
% Carbon Monoxide:	0.0	0.0	0.0	0.0
Liquid Volume Collected, milliliters:	62	63	61.5	62.2

Sample Train Calculations

Meter Volume, Actual:	44.440	41.220	43.920	43.193
Meter Volume, STP:	42.255	39.147	41.794	41.066
Volume of Water Vapor Condensed:	2.918	2.965	2.895	2.926
Total Gas Sampled:	45.174	42.112	44.689	43.992
% Moisture:	6.46	7.04	6.48	6.66
Area of Stack, Square Feet:	6.87	6.87	6.87	6.87
% Excess Air at Test Location:	232.8	232.8	232.8	232.8
Molecular Weight dry, lb/lb-Mole:	29.50	29.50	29.50	29.50
Molecular Weight wet, lb/lb-Mole:	28.76	28.69	28.75	28.73
Absolute Stack Gas Pressure, in Hg:	29.10	29.10	29.10	29.10
Isokinetic, %:	105.6	106.5	104.8	105.6

Velocity and Flow Calculations

Average Stack Gas Velocity FPS:	14.38	13.26	14.14	13.93
Stack Gas Flow Rate, ACFM:	5,927	5,466	5,829	5,741
Stack Gas Flow Rate, SCFM:	3,274	3,025	3,261	3,187
Stack Gas Flow Rate, DSCF/HR:	183,737	168,722	182,985	178,481
Stack Gas Flow Rate, DSCFM:	3,062	2,812	3,050	2,975

VOC Calculations:

PPM as Propane:	2.2	2.2	2.1	2.2
LBS/DSCF:	2.51E-07	2.51E-07	2.40E-07	2.47E-07
LBS/HR:	0.0	0.0	0.0	0.0
Brake HP:	468	468	468	468
Grams/Brake HP HR:	0.048	0.044	0.045	0.046

NOx Calculations:

PPMv	75.2	81.3	79.7	78.7
LBS/DSCF:	8.98E-06	9.71E-06	9.52E-06	9.40E-06
LBS/HR:	1.65	1.64	1.74	1.7
Brake HP:	468	468	468	468
Grams/Brake HP HR:	1.599	1.587	1.688	1.625

CO Calculations:

PPMv	2.4	2.3	2.1	2.3
LBS/DSCF:	1.74E-07	1.67E-07	1.53E-07	1.65E-07
LBS/HR:	0.03	0.03	0.03	0.0
Brake HP:	468	468	468	468
Grams/Brake HP HR:	0.031	0.027	0.027	0.028

STACK TEST GROUP, INC.
Air Quality Services

Particulate Sampling Train Calculations

Client:	GenAcc (CONTROLLED)		
Load:	100%		
Source:	MTU 3250		
Test No:	T1	T2	Avg.
Start Time:	10:33 AM	11:17 AM	
Finish Time:	11:05 AM	11:49 AM	
Date:	9/16/2011	9/16/2011	
Pitot Cal. Factor:	0.84	0.84	
Meter Calibration Factor:	1.018	1.018	
Stack Length, inches:	0	0	
Stack Width, inches:	0	0	
Stack Diameter, inches:	35.5	35.5	
Nozzle Diameter, inches:	0.384	0.384	
Barometric Pressure, inches Hg:	29.10	29.10	
Static Pressure in Stack, Inches H2O:	-0.2	-0.23	
Duration of Sample, minutes:	30	30	
Meter Start Volume:	772.120	799.890	
Meter Final Volume:	799.770	829.310	
Average Meter Pressure, Inches H2O:	2.9700	3.1800	3.0750
Average Meter Temperature, degrees F:	67.33	72.83	70.1
Average Sqrt. Velocity Pressure:	0.5610	0.5811	0.5711
Stack Gas Temperature, degrees F:	756.2	780.17	768.2
% Carbon Dioxide:	8.2	8.3	8.3
% Oxygen:	10.0	9.9	10.0
% Carbon Monoxide:	0.0	0.0	0.0
Liquid Volume Collected, milliliters:	38.5	37	37.8
Total Weight of PM, (Front 1/2) Mg:	3.4	3.0	3.2

REVISED TO INCLUDE BACK HALF PM DATA FROM PREVIOUS TESTING ON SAME ENGINE W/ CONTROLS

Sample Train Calculations

Meter Volume, Actual:	27.650	29.420	28.535
Meter Volume, STP:	27.607	29.087	28.347
Volume of Water Vapor Condensed:	1.812	1.742	1.777
Total Gas Sampled:	29.419	30.828	30.124
% Moisture:	6.16	5.65	5.90
Area of Stack, Square Feet:	6.87	6.87	6.87
% Excess Air at Test Location:	86.2	84.7	85.4
Molecular Weight dry, lb/lb-Mole:	29.71	29.72	29.72
Molecular Weight wet, lb/lb-Mole:	28.99	29.06	29.02
Absolute Stack Gas Pressure, in Hg:	29.09	29.08	29.08
Isokinetic, %:	99.6	101.9	100.7

Velocity and Flow Calculations

Average Stack Gas Velocity FPS:	48.38	50.55	49.47
Stack Gas Flow Rate, ACFM:	19,942	20,837	20,389
Stack Gas Flow Rate, SCFM:	8,418	8,622	8,520
Stack Gas Flow Rate, DSCF/HR:	473,953	488,099	481,026
Stack Gas Flow Rate, DSCFM:	7,899	8,135	8,017

Front 1/2 Particulate Calculations:

Grains Per DSCF:	0.0019	0.0016	0.0017
LBS/DSCF:	2.72E-07	2.27E-07	2.49E-07
LBS/HR:	0.13	0.11	0.12

Organics: (based on previous test results)

Grains Per DSCF:	0.0012	0.0012	0.0012
LBS/DSCF:	1.76E-07	1.67E-07	1.71E-07
LBS/HR:	0.08	0.08	0.08

Aqueos: (based on previous test results)

Grains Per DSCF:	0.0023	0.0023	0.0023
LBS/DSCF:	3.35E-07	3.22E-07	3.29E-07
LBS/HR:	0.16	0.16	0.16

Total Particulate: (revised to include back-half data from previous test results)

Grains Per DSCF:	0.0055	0.0050	0.0052
LBS/DSCF:	7.83E-07	7.16E-07	7.50E-07
LBS/HR:	0.37	0.35	0.36
Brake HP:	4680	4680	4680.0
Grams/Brake HP HR:	0.036	0.034	0.035

STACK TEST GROUP, INC.
Air Quality Services

Particulate Sampling Train Calculations

Client: GenAcc
Load: 50% (CONTROLLED)
Source: MTU 3250

REVISED TO INCLUDE BACK HALF PM DATA FROM PREVIOUS TESTING ON SAME ENGINE W/ CONTROLS

Test No:	T1	T2	Avg.
Start Time:	12:00 PM	12:44 PM	
Finish Time:	12:32 PM	01:16 PM	
Date:	9/16/2011	9/16/2011	
Pitot Cal. Factor:	0.84	0.84	
Meter Calibration Factor:	1.018	1.018	
Stack Length, inches:	0	0	
Stack Width, inches:	0	0	
Stack Diameter, inches:	35.5	35.5	
Nozzle Diameter, inches:	0.384	0.384	
Barometric Pressure, inches Hg:	29.20	29.10	
Static Pressure in Stack, Inches H2O:	-0.1	-0.09	
Duration of Sample, minutes:	30	30	
Meter Start Volume:	829.510	854.630	
Meter Final Volume:	854.420	877.350	
Average Meter Pressure, Inches H2O:	2.4500	2.0700	2.2600
Average Meter Temperature, degrees F:	75.33	76.33	75.8
Average Sqrt. Velocity Pressure:	0.4876	0.4432	0.4654
Stack Gas Temperature, degrees F:	648.7	658.67	653.7
% Carbon Dioxide:	6.0	6.1	6.1
% Oxygen:	12.7	12.6	12.7
% Carbon Monoxide:	0.0	0.0	0.0
Liquid Volume Collected, milliliters:	36.5	34	35.3
Total Weight of PM, (Front 1/2) Mg:	2.5	1.4	2.0

Sample Train Calculations

Meter Volume, Actual:	24.910	22.720	23.815
Meter Volume, STP:	24.551	22.254	23.403
Volume of Water Vapor Condensed:	1.718	1.600	1.659
Total Gas Sampled:	26.269	23.854	25.062
% Moisture:	6.54	6.71	6.62
Area of Stack, Square Feet:	6.87	6.87	6.87
% Excess Air at Test Location:	144.9	142.2	143.5
Molecular Weight dry, lb/lb-Mole:	29.47	29.48	29.47
Molecular Weight wet, lb/lb-Mole:	28.72	28.71	28.71
Absolute Stack Gas Pressure, in Hg:	29.19	29.09	29.14
Isokinetic, %:	97.0	97.6	97.3

Velocity and Flow Calculations

Average Stack Gas Velocity FPS:	40.27	36.83	38.55
Stack Gas Flow Rate, ACFM:	16,599	15,181	15,890
Stack Gas Flow Rate, SCFM:	7,712	6,967	7,340
Stack Gas Flow Rate, DSCF/HR:	432,485	389,951	411,218
Stack Gas Flow Rate, DSCFM:	7,208	6,499	6,854

Front 1/2 Particulate Calculations:

Grains Per DSCF:	0.0016	0.0010	0.0013
LBS/DSCF:	2.25E-07	1.39E-07	1.82E-07
LBS/HR:	0.10	0.05	0.08

Organics: (based on previous test results)

Grains Per DSCF:	0.0007	0.0007	0.0007
LBS/DSCF:	9.88E-08	1.04E-07	1.01E-07
LBS/HR:	0.04	0.04	0.04

Aqueos: (based on previous test results)

Grains Per DSCF:	0.0025	0.0026	0.0025
LBS/DSCF:	3.59E-07	3.67E-07	3.63E-07
LBS/HR:	0.16	0.14	0.15

Total Particulate: (revised to include back half data from previous test results)

Grains Per DSCF:	0.0048	0.0043	0.0045
LBS/DSCF:	6.83E-07	6.09E-07	6.46E-07
LBS/HR:	0.30	0.24	0.27
Brake HP:	2339	2339	2339
Grams/Brake HP HR:	0.057	0.046	0.052

Total Controlled (NTE) PM Emissions

Engine Emission Specs

Fuel Consumption	Gal/hr	Power (kW)	Power (bhp)	Exhaust Mass Flow (kg/h)	Exhaust Mass Flow (acfm)	Power Output (eKW)	Exhaust Temperature after turbine (°C)	Exhaust Temperature after turbine (°F)
100% Load	232	3490	4680	19529	22895	3256	495	923
75% Load	183	2617	3509	17631	20675	2426	431	807.8
50% Load	127	1744	2339	14079	14470	1597	386	726.8
25% Load	76	872	1169	9354	8968	768	350	662
10% Load	39	349	468	6825	5741	272	311	591.8

100%

	100% Load - Controlled emissions (NTE) @ 85% Reduction Efficiency					Stack Test Results			
Total Controlled PM emissions (NTE) **MTU 20V4000G83L 3D EPA Tier2 (1,800 rpm)**	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr	Emissions per unit of fuel consumed (lbs/gal)	Uncontrolled PM Emissions (front half) g/bhp-hr	Controlled PM Emissions (front half) g/bhp-hr	%Reduction from nominal uncontrolled	Total Controlled PM Emissions based on previous stack test data g/bhp-hr
PM	0.063	0.047	0.000103	0.484	0.00209	0.086	0.012	86.0%	0.035

90%

	90% Load - Controlled emissions (NTE) @ 85% Reduction Efficiency				
Total Controlled PM emissions (NTE) **MTU 20V4000G83L 3D EPA Tier2 (1,800 rpm)**	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr	Emissions per unit of fuel consumed (lbs/gal)
PM	0.061	0.046	0.000100	0.425	0.00183

80%

	80% Load - Controlled emissions (NTE) @ 85% Reduction Efficiency				
Total Controlled PM emissions (NTE) **MTU 20V4000G83L 3D EPA Tier2 (1,800 rpm)**	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr	Emissions per unit of fuel consumed (lbs/gal)
PM	0.059	0.044	0.000097	0.366	0.00158

75%

	75% Load - Controlled emissions (NTE) @ 85% Reduction Efficiency				
Total Controlled PM emissions (NTE) **MTU 20V4000G83L 3D EPA Tier2 (1,800 rpm)**	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr	Emissions per unit of fuel consumed (lbs/gal)
PM	0.059	0.0436	0.000096	0.337	0.00145

70%

	70% Load - Controlled emissions (NTE) @ 85% Reduction Efficiency				
Total Controlled PM emissions (NTE) **MTU 20V4000G83L 3D EPA Tier2 (1,800 rpm)**	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr	Emissions per unit of fuel consumed (lbs/gal)
PM	0.071	0.053	0.000117	0.340	0.00147

60%

	60% Load - Controlled emissions (NTE) @ 85% Reduction Efficiency				
Total Controlled PM emissions (NTE) **MTU 20V4000G83L 3D EPA Tier2 (1,800 rpm)**	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr	Emissions per unit of fuel consumed (lbs/gal)
PM	0.084	0.062	0.000137	0.344	0.00148

50%

	50% Load - Controlled emissions (NTE) @ 85% Reduction Efficiency					Stack Test Results			
Total Controlled PM emissions (NTE) **MTU 20V4000G83L 3D EPA Tier2 (1,800 rpm)**	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr	Emissions per unit of fuel consumed (lbs/gal)	Uncontrolled PM Emissions (front half) g/bhp-hr	Controlled PM Emissions (front half) g/bhp-hr	%Reduction from nominal uncontrolled	Total Controlled PM Emissions based on previous stack test data g/bhp-hr
PM	0.09	0.067	0.00015	0.345	0.0015	0.13	0.015	88.6%	0.052

40%

	40% Load - Controlled emissions (NTE) @ 85% Reduction Efficiency				
Total Controlled PM emissions (NTE) **MTU 20V4000G83L 3D EPA Tier2 (1,800 rpm)**	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr	Emissions per unit of fuel consumed (lbs/gal)
PM	0.110	0.082	0.000180	0.314	0.00230

30%

	30% Load - Controlled emissions (NTE) @ 85% Reduction Efficiency				
Total Controlled PM emissions (NTE) **MTU 20V4000G83L 3D EPA Tier2 (1,800 rpm)**	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr	Emissions per unit of fuel consumed (lbs/gal)
PM	0.130	0.097	0.000213	0.283	0.00312

25%

	25% Load - Controlled emissions (NTE) @ 85% Reduction Efficiency				
Total Controlled PM emissions (NTE) **MTU 20V4000G83L 3D EPA Tier2 (1,800 rpm)**	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr	Emissions per unit of fuel consumed (lbs/gal)
PM	0.140	0.104	0.000229	0.268	0.00352

20%

	20% Load - Controlled emissions (NTE) @ 85% Reduction Efficiency				
Total Controlled PM emissions (NTE) **MTU 20V4000G83L 3D EPA Tier2 (1,800 rpm)**	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr	Emissions per unit of fuel consumed (lbs/gal)
PM	0.177	0.132	0.00029	0.243	0.00400

10%

	10% Load - Controlled emissions (NTE) @ 85% Reduction Efficiency				
Total Controlled PM emissions (NTE) **MTU 20V4000G83L 3D EPA Tier2 (1,800 rpm)**	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr	Emissions per unit of fuel consumed (lbs/gal)
PM	0.252	0.188	0.00041	0.194	0.0050

Final Tier IV Emission Standards - Generator Sets > 900 KW [based on 5-mode average D2 cycle testing]

Pollutant	Tier IV Final Emission Standards			
NOx	0.001100352	lbs/b.h.p.-hr	0.5	gr./bhp-hr
CO	0.005721831	lbs/b.h.p.-hr	2.6	gr./bhp-hr
NMHC	0.000308099	lbs/b.h.p.-hr	0.14	gr./bhp-hr
PM	4.84155E-05	lbs/b.h.p.-hr	0.022	gr./bhp-hr

NTE Controlled

Engine Emission Specs								
Fuel Consumption	Gal/hr	Power (kW)	Power (bhp)	Exhaust Mass Flow (kg/h)	Exhaust Mass Flow (acfm)	Power Output (eKW)	Exhaust Temperature after turbine (°C)	Exhaust Temperature after turbine (°F)
100% Load	232	3010	4036	17802	22895	2800	446	834.8
75% Load	183	2257	3027	16060	20675	2084	417	782.6
50% Load	127	1505	2018	12748	14470	1370	385	725
25% Load	39	752	1008	8668	8968	654	337	638.6
10% Load	39	301	404	6643	5741	226	303	577.4

100%	100% Load - Controlled emissions (NTE) @ Reduction Efficiency Goals*					Stack Test Results	
Controlled emissions (NTE) MTU 20V4000G83L 3B EPA Tier2 (1,800 rpm)	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr	Emissions per unit of fuel consumed (lbs/gal)	g/bhp-hr	%Reduction from nominal uncontrolled
NOx	0.78	0.6	0.0013	5.2	0.022	0.181	96.89%
CO	1.08	0.81	0.001772	7.15	0.0308	0.005	98.66%
HC	0.0882	0.07	0.000145	0.58	0.0025	0.006	95.53%
PM	0.0078	0.006	0.000013	0.052	0.00022		
SO2	0.0072	0.0054	0.000012	0.048	0.00021		
CO2	628	468.3	1.03	4159.9	17.9		

90%	90% Load - Controlled emissions (NTE) @ Reduction Efficiency Goals*				
Controlled emissions (NTE) MTU 20V4000G83L 3B EPA Tier2 (1,800 rpm)	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr	Emissions per unit of fuel consumed (lbs/gal)
NOx	0.684	0.5100588	0.001122	4.2	0.0180
CO	1.2528	0.93421296	0.002056	7.30	0.0315
HC	0.09996	0.074540172	0.000164	0.58	0.0025
PM	0.00884	0.006591988	0.000015	0.052	0.00022
SO2	0.0074	0.0055	0.000012	0.044	0.00019
CO2	641.6	478.44112	1.052907	3811	16.4

80%	80% Load - Controlled emissions (NTE) @ Reduction Efficiency Goals*				
Controlled emissions (NTE) MTU 20V4000G83L 3B EPA Tier2 (1,800 rpm)	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr	Emissions per unit of fuel consumed (lbs/gal)
NOx	0.588	0.44	0.00096	3.2	0.014
CO	1.4256	1.063	0.00234	7.44	0.0321
HC	0.11172	0.083	0.000183	0.584	0.0025
PM	0.00988	0.007	0.000016	0.052	0.00022
SO2	0.0075	0.006	0.000012	0.040	0.00017
CO2	655.2	488.583	1.08	3463	14.9

75%	75% Load - Controlled emissions (NTE) @ Reduction Efficiency Goals*					Stack Test Results	
Controlled emissions (NTE) MTU 20V4000G83L 3B EPA Tier2 (1,800 rpm)	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr	Emissions per unit of fuel consumed (lbs/gal)	g/bhp-hr	%Reduction from nominal uncontrolled
NOx	0.54	0.40	0.00089	2.7	0.012	0.122	96.97%
CO	1.512	1.13	0.00248	7.51	0.0324	0.005	99.04%
HC	0.1176	0.088	0.000193	0.58	0.0025	0.013	92.74%
PM	0.0104	0.008	0.000017	0.052	0.00022		
SO2	0.0076	0.0057	0.000012	0.038	0.00016		
CO2	662	493.7	1.1	3288.1	14.2		

70%	70% Load - Controlled emissions (NTE) @ Reduction Efficiency Goals*				
Controlled emissions (NTE) MTU 20V4000G83L 3B EPA Tier2 (1,800 rpm)	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr	Emissions per unit of fuel consumed (lbs/gal)
NOx	0.504	0.376	0.000827	2.21	0.0095
CO	1.7712	1.321	0.002907	7.37	0.0318
HC	0.1274	0.095	0.000209	0.54	0.00232
PM	0.0156	0.012	0.000026	0.062	0.00027
SO2	0.0077	0.006	0.000013	0.033	0.00014
CO2	674.4	502.9	1.106734	2891	12.5

60%	60% Load - Controlled emissions (NTE) @ Reduction Efficiency Goals*				
Controlled emissions (NTE) MTU 20V4000G83L 3B EPA Tier2 (1,800 rpm)	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr	Emissions per unit of fuel consumed (lbs/gal)
NOx	0.468	0.349	0.00077	1.73	0.0075
CO	2.0304	1.514	0.00333	7.23	0.0311
HC	0.1372	0.102	0.000225	0.49	0.00213
PM	0.0208	0.016	0.000034	0.072	0.00031
SO2	0.0079	0.006	0.000013	0.029	0.00012
CO2	686.8	512.1	1.13	2494	10.7

50%	50% Load - Controlled emissions (nominal) @ Reduction Efficiency Goals*					Stack Test Results	
Controlled emissions (NTE) MTU 20V4000G83L 3B EPA Tier2 (1,800 rpm)	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr	Emissions per unit of fuel consumed (lbs/gal)	g/bhp-hr	%Reduction from nominal uncontrolled
NOx	0.45	0.34	0.0007	1.5	0.006	0.08	97.62%
CO	2.16	1.61	0.00354	7.15	0.031	0.006	99.20%
HC	0.1421	0.106	0.00023	0.47	0.002	0.014	93.53%
PM	0.0234	0.017	0.00004	0.078	0.000		
SO2	0.0079	0.0059	0.000013	0.026	0.000		
CO2	693	516.8	1.14	2295	9.9		

40%	40% Load - Controlled emissions (NTE) @ Reduction Efficiency Goals*				
Controlled emissions (NTE) MTU 20V4000G83L 3B EPA Tier2 (1,800 rpm)	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr	Emissions per unit of fuel consumed (lbs/gal)
NOx	0.446	0.33	0.00073	1.19	0.0113
CO	3.370	2.51	0.00553	7.72	0.1065
HC	0.187	0.140	0.00031	0.45	0.0055
PM	0.029	0.022	0.000048	0.071	0.00084
SO2	0.007	0.0050	0.000011	0.019	0.00015
CO2	723	539	1.2	1885	19.0

30%	30% Load - Controlled emissions (NTE) @ Reduction Efficiency Goals*				
Controlled emissions (NTE) MTU 20V4000G83L 3B EPA Tier2 (1,800 rpm)	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr	Emissions per unit of fuel consumed (lbs/gal)
NOx	0.442	0.33	0.00073	0.88	0.0162
CO	4.579	3.415	0.00751	8.29	0.1821
HC	0.232	0.173	0.00038	0.43	0.0091
PM	0.035	0.026	0.000057	0.065	0.00135
SO2	0.005	0.0041	0.000009	0.012	0.00019
CO2	752	561	1.23	1475	28.0

25%	25% Load - Controlled emissions (NTE) @ Reduction Efficiency Goals*					Stack Test Results	
Controlled emissions (NTE) MTU 20V4000G83L 3B EPA Tier2 (1,800 rpm)	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr	Emissions per unit of fuel consumed (lbs/gal)	g/bhp-hr	%Reduction from nominal uncontrolled
NOx	0.44	0.33	0.00072	0.73	0.0187	0.118	96.40%
CO	5.184	3.87	0.00851	8.58	0.2200	0.0007	99.96%
HC	0.2548	0.190	0.00042	0.42	0.0108	0.012	96.91%
PM	0.0377	0.028	0.000062	0.062	0.00160		
SO2	0.005	0.0036	0.000008	0.008	0.00021		
CO2	767	572.0	1.26	1269	32.5		

20%	20% Load - Controlled emissions (NTE) @ Reduction Efficiency Goals*				
Controlled emissions (NTE) MTU 20V4000G83L 3B EPA Tier2 (1,800 rpm)	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr	Emissions per unit of fuel consumed (lbs/gal)
NOx	1.077	0.80	0.00177	1.004	0.0258
CO	6.264	4.67	0.01028	7.579	0.1943
HC	0.289	0.216	0.00047	0.360	0.0092
PM	0.050	0.037	0.00008	0.058	0.00149
SO2	0.007	0.005	0.000012	0.008	0.00021
CO2	910	678	1.49	1110	28.5

10%	10% Load - Controlled emissions (NTE) @ Reduction Efficiency Goals*					Stack Test Results	
Controlled emissions (NTE) MTU 20V4000G83L 3B EPA Tier2 (1,800 rpm)	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr	Emissions per unit of fuel consumed (lbs/gal)	g/bhp-hr	%Reduction from nominal uncontrolled
NOx	2.35	1.75	0.0039	1.6	0.040	1.625	69%
CO	8.4	6.3	0.014	5.6	0.1431	0.028	99%
HC	0.36	0.27	0.00059	0.24	0.0061	0.046	92%
PM	0.0754	0.056	0.00012	0.050	0.0013		
SO2	0.012	0.0091	0.000020	0.008	0.00021		
CO2	1195	891	1.96	792	20.3		

AirClarity 3000 Emissions Control System for 3000-XC6DT2 engines	*REDUCTION EFF. GOALS
NOX	90%
CO	90%
HC	90%
PM	87%

SO2 Emissions Basis

SO2 emissions generated from diesel fuel consumed		100% Load	75% Load	50% Load	25% Load	10% Load
Sulfur Content of diesel fuel (ppm)	ppm (TIER 3 and Tier 4 Limit)	15	15	15	15	15
Density of Diesel Fuel (lb/gal)	lbs/gal	6.88	6.88	6.88	6.88	6.88
Gal of Diesel Fuel Consumed per hour	gal/hr fuel consumed	232	183	127	39	39
Pounds (lb) sulfur in consumed diesel fuel	lbs/hr sulfur in fuel consumed	0.024	0.019	0.013	0.0040	0.0040
Pounds SOx formed (2:1)	lbs/hr SO2 based on stoichiometric combustion	0.048	0.038	0.026	0.008	0.0080

Final Tier IV Emission Standards - Generator Sets > 900 KW

Pollutant	Tier IV Final Emission Standards			
NOx	0.001100352	lbs/b.h.p.-hr	0.5	gr./bhp-hr
CO	0.005721831	lbs/b.h.p.-hr	2.6	gr./bhp-hr
SO2	-	lbs/b.h.p.-hr	-	gr./bhp-hr
NMHC	0.000308099	lbs/b.h.p.-hr	0.14	gr./bhp-hr
PM	4.84155E-05	lbs/b.h.p.-hr	0.022	gr./bhp-hr

Uncontrolled

Engine Emission Specs

Fuel Consumption	Gal/hr	Power (kW)	Power (bhp)	Exhaust Mass Flow (kg/h)	Exhaust Mass Flow (acfm)	Power Output (eKW)	Exhaust Temperature after turbine (°C)	Exhaust Temperature after turbine (°F)
100% Load	232	3010	4036	17802	22895	2800	446	834.8
75% Load	183	2257	3027	16060	20675	2084	417	782.6
50% Load	127	1505	2018	12748	14470	1370	385	725
25% Load	39	752	1008	8668	8968	654	337	638.6
10% Load	39	301	404	6643	5741	226	303	577.4

	100% Load			
Uncontrolled emissions (nominal) **MTU 20V4000G83L 3B EPA Tier2 (1,800 rpm)**	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr
NOx	7.8	5.8	0.013	51.7
CO	0.50	0.37	0.00082	3.3
HC	0.18	0.13	0.00030	1.2
PM	0.060	0.045	0.00010	0.40
SO2	0.0072	0.0054	0.000012	0.048
CO2	628	468.3	1.03	4159.9

	75% Load			
Uncontrolled emissions (nominal) **MTU 20V4000G83L 3B EPA Tier2 (1,800 rpm)**	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr
NOx	5.4	4.0	0.009	26.8
CO	0.70	0.52	0.00115	3.5
HC	0.24	0.18	0.00039	1.2
PM	0.080	0.060	0.00013	0.40
SO2	0.0076	0.0057	0.000012	0.038
CO2	662	493.7	1.09	3288.1

	50% Load			
Uncontrolled emissions (nominal) **MTU 20V4000G83L 3B EPA Tier2 (1,800 rpm)**	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr
NOx	4.5	3.4	0.007	14.9
CO	1.0	0.75	0.00164	3.3
HC	0.29	0.22	0.00048	0.96
PM	0.18	0.13	0.00030	0.60
SO2	0.0079	0.0059	0.000013	0.026
CO2	693	516.8	1.14	2295

	25% Load			
Uncontrolled emissions (nominal) **MTU 20V4000G83L 3B EPA Tier2 (1,800 rpm)**	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr
NOx	4.4	3.3	0.007	7.3
CO	2.4	1.8	0.00394	3.97
HC	0.52	0.39	0.00085	0.86
PM	0.29	0.22	0.00048	0.48
SO2	0.005	0.0036	0.000008	0.008
CO2	767	572.0	1.26	1269

	10% Load			
Uncontrolled emissions (nominal) **MTU 20V4000G83L 3B EPA Tier2 (1,800 rpm)**	g/kWh	g/bhp-hr	lbs/bhp-hr	lbs/hr
NOx	7.0	5.2	0.011	4.6
CO	3.9	2.9	0.0064	2.6
HC	0.73	0.54	0.0012	0.48
PM	0.58	0.43	0.00095	0.384
SO2	0.012	0.009	0.000020	0.008
CO2	1195	891.1	1.96	792

SO2 Emissions Basis

SO2 emissions generated from diesel fuel consumed		100% Load	75% Load	50% Load	25% Load	10% Load
Sulfur Content of diesel fuel (ppm)	ppm (TIER 3 and Tier 4 Limit)	15	15	15	15	15
Density of Diesel Fuel (lb/gal)	lbs/gal	6.88	6.88	6.88	6.88	6.88
Gal of Diesel Fuel Consumed per hour	gal/hr fuel consumed	232	183	127	39	39
Pounds (lb) sulfur in consumed diesel fuel	lbs/hr sulfur in fuel consumed	0.024	0.019	0.013	0.0040	0.0040
Pounds SOx formed (2:1)	lbs/hr SO2 based on stoichiometric combustion	0.048	0.038	0.026	0.008	0.008

Notes:
Nominal Emissions Values based on OEM Published Uncontrolled Emissions (Nominal) Data