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GREAT OAKS SOUTH BACKUP GENERATING FACILITY
20-SPPE-01
DISCUSSION OF AMMONIA EMISSIONS
TIER 4 COMPLIANT ENGINES

Based on the data sheet included in the application, the NH3 slip will be 20 ppm (@15% O2) and 0.08 g/bhp-hr. ADI modified the emissions spreadsheet (attached) to include the new emission factors. The composite emission factor of 0.06 g/bhp-hr based on the first 15 minutes was assumed to be zero NH3 slip and the last 45 minutes was assumed to be at the 20 ppm (15 minutes assumes warmup of the SCR and no NH3 use). These assumptions were used for 20 hours of Maintenance and Readiness testing for all 36 engines and yield:

NH3

- 440 lbs/yr
- 0.61 lb/hr per engine

These emissions are far below the BAAQMD Regulation 2, Rule 5 significance thresholds of 7.1 lb/hr and 7,700 lbs/year.

NH3 is not a carcinogen but it does have both acute respiratory and eye irritation (1-hour) and chronic respiratory (annual) effects.

- Acute REL (ug/m3) = 3200
- Chronic REL (ug/m3) = 200

We know that the modeled concentration of NH3 will never approach these levels based, for example, on the NOx emission rate of 58.2 lbs/hr (100 percent load case, not the D2 cycle weighted data) produces a max impact of less than 200 ug/m3 which is way below the 3200 ug/m3 REL. Same for annual where we get around 3 ug/m3 for NOx at 20 hours of operation and the chronic REL is 200 ug/m3.

DPM has no acute or chronic impacts so the ammonia would not be additive.

Therefore, NH3 slip at 20 ppm does not represent any potential for impacts on the HRA.

Table 1A-1 Emissions Estimates for Emergency Standby Generators

Engine Mfg:	**Cummins**	# of Units:	36		Max # of Engines Tested per Day:	6		Redundant Engines:	6						
Model #:	**QSK95-G9**				*(engines are not tested concurrently)*										
Fuel:	ULSD				**Engine OPs Data**									***METRIC UNITs***	
												Stack Vel,	**Stk Diam,**	**Stk Temp,**	**Stk Vel,**
Fuel S, %wt:	0.0015	**BHP**	**kWe**	**Load %**	**RPM**	**Fuel, gph**	**Stk Ht, ft**	**Stk Diam, in**	**Stk Temp, F**	**mmbtu/hr**	**Stk ACFM**	**f/s**	**m**	**Kelvin**	**m/s**
Fuel wt, lb/gal:	7.05	4631	3250	100	1800	222	TBD	32	872	30.86	23910	71.3511	0.8128	739.82	21.7478
Btu/gal:	139000	3501	2438	75	1800	171	TBD	32	735	23.77	20454	61.0379	0.8128	663.71	18.6044
Lbs S/1000 gal:	0.10575	2371	1625	50	1800	126	TBD	32	672	17.51	16885	50.3875	0.8128	628.71	15.3581
Lbs SO2/1000 gal:	0.2115	1240	813	25	1800	72	TBD	32	643	10.01	10587	31.5932	0.8128	612.59	9.6296
EPA Tier:	4	562	325	10	1800	42	TBD	32	541	5.84	7187	21.4471	0.8128	555.93	6.5371
Turbocharged:	Yes	0	0	0	0	0	0	0	0	0.00	0	0.0000	0.0000	0	0.0000
Aftercooled:	Yes					Stack Exit Area (sq.ft) =		5.585054							

Warm-up Period, mins.	15	0.25	hrs.	0.75	Steady-state hrs		
Maintenance and Readiness Testing, hrs/yr:			20		Composite CO2e EF, lb/mmbtu:	163.052	(40 CFR 98, Subpart C, Tables C-1 and C-2)
Emergency Runtime, hrs/yr:			100				(40 CFR 98, Subpart A, Table A-1)

1. Emissions factors for engines without controls are based on D2 Cycle values for the specific engine and size.
2. Emissions factors for engine steady-state periods are based on Tier 4 values for the specific engine and size.
3. Composite warm-up/steady state hour will be based on 0.25 hr warmup (D2) and 0.75 hr steady-state (Tier 4).
4. All scenarios employ DPF (D2 Cycle and Tier 4)

			g/bhp-hr				
	Nox	**CO**	**VOC**	**SOx**	**PM10/2.5**		**NH3**
D2 Cycle EFs	4.37	0.5	0.23	0.005	0.015	with DPFs	0
T4 Steady-state EFs	0.5	0.5	0.14	0.005	0.015	with DPFs	0.08
Composite Hour EFs	1.4675	0.5	0.1625	0.005	0.015	with DPFs	0.06

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Scenario 1 CEC Emissions Evaluation

1. 20 hrs of maintenance and readiness (M&R) testing at 100% load, using D2 Cycle EFs
2. 100 hrs of emergency ops, in 3 hr blocks (1st hr composite warmup+steady state, remaining 2 hrs at steady state T4), 100% load
3. Redundant engines will not be run during emergency ops
4. Daily M&R-engines will be tested consecutively, i.e., one engine per hour

M&R Testing

Hrs/engine/yr:	20		**Nox**	**CO**	**VOC**	**SOx**	**PM10/2.5**	**CO2e**	**NH3**
	1 Engine	lbs/hr	44.62	5.10	2.35	0.05	0.15	NA	0.61
	1 Engine	lbs/day	44.62	5.10	2.35	0.05	0.15	NA	0.61
	1 Engine	TPY	0.446	0.051	0.023	0.001	0.002	50.3	0.006
	6 Engines	lbs/day	267.7	30.6	14.1	0.31	0.92	NA	3.68
	All Engines	TPY	16.06	1.84	0.85	0.02	0.06	1811	0.22

Emergency Ops

						Single Engine				
Hrs/engine/yr:	100			**NOx**	**CO**	**VOC**	**SOx**	**PM10/2.5**	**CO2e**	**NH3**
Warmup hrs:	33.3	1st Hr	lbs/yr	498.92	169.99	55.25	1.70	5.10	167548	20.40
Steady state hrs:	66.7	2 Hrs	lbs/yr	340.492185	340.492185	95.3378117	3.40492185	10.2147655	335598	54.4787495
# engines:	30	Total	lbs/yr	839.42	510.48	150.58	5.10	15.31	503146	74.88
		1 engine	Max lbs/3hr	20.09	10.21	3.09	0.10	0.31	NA	1.43
						30 Engines				
				Nox	**CO**	**VOC**	**SOx**	**PM10/2.5**	**CO2e**	**NH3**
			TPY	12.59	7.66	2.26	0.08	0.23	7547	1.12
		30 engines	Max lbs/3hr	602.63	306.29	92.65	3.06	9.19	NA	42.88
				Nox	**CO**	**VOC**	**SOx**	**PM10/2.5**	**CO2e**	**NH3**
	M&R + Emergency Ops		TPY	28.65	9.49	3.10	0.09	0.28	9359	1.34

Scenario 2 BAAQMD Emissions Evaluation

1. 20 hrs of maintenance and readiness (M&R) testing at 100% load, using D2 Cycle EFs
2. 100 hrs of emergency ops, 100% load, T4 EFs
3. Redundant engines will not be run during emergency ops
4. Daily M&R-engines will be tested consecutively, i.e., one engine per hour

M&R Testing

Hrs/engine/yr:	20		**Nox**	**CO**	**VOC**	**SOx**	**PM10/2.5**	**CO2e**	**NH3**
	1 Engine	lbs/hr	44.62	5.10	2.35	0.05	0.15	NA	0.61
	1 Engine	lbs/day	44.62	5.10	2.35	0.05	0.15	NA	0.61
	1 Engine	TPY	0.446	0.051	0.023	0.001	0.002	50.3	0.006
	6 Engines	lbs/day	267.7	30.6	14.1	0.31	0.92	NA	3.68
	All Engines	TPY	16.06	1.84	0.85	0.02	0.06	1811	0.22

Emergency Ops

Hrs/engine/yr:	100					Single Engine			
Hrs/engine/day:	24		**Nox**	**CO**	**VOC**	**SOx**	**PM10/2.5**	**CO2e**	**NH3**
# engines:	30	lbs/hr	5.10	5.10	1.43	0.05	0.15	NA	0.82
		lbs/day	122.52	122.52	34.30	1.23	3.68	NA	19.60
		TPY	0.255	0.255	0.071	0.003	0.008	251.57	0.041
					30 Engines				
			Nox	**CO**	**VOC**	**SOx**	**PM10/2.5**	**CO2e**	**NH3**
		lbs/hr	153.145	153.145	42.881	1.531	4.594	NA	24.503
		lbs/day	3675.478	3675.478	1029.134	36.755	110.264	NA	588.076
		TPY	7.657	7.657	2.144	0.077	0.230	7547	1.225
	M&R + Emergency Ops	TPY	23.72	9.49	2.99	0.09	0.28	9359	1.45

Table 1A-2 Emissions Estimates for Emergency Standby Generators

Engine Mfg:	**Cummins**	# of Units:	3		Max # of Engines Tested per Day:	3		Redundant Engines:	0					
Model #:	**QSX15-G9**				*(engines are not tested concurrently)*									
Fuel:	ULSD	**Engine OPs Data**											***METRIC UNITs***	
Fuel S, %wt:	0.0015	**BHP**	**kWe**	**Load %**	**RPM**	**Fuel, gph**	**Stk Ht, ft**	**Stk Diam, in**	**Stk Temp, F**	**mmbtu/hr**	**Stk ACFM**	**Stack Vel, f/s**	**Stk Diam, m**	**Stk Temp, Kelvins**	**Stk Vel, m/s**
Fuel wt, lb/gal:	7.05	731	500	100	1800	34	TBD	12	894	4.73	3442	73.0415	0.3048	752.04	22.2631
Btu/gal:	139000	554	375	75	1800	25.3	TBD	12	852	3.52	2771	58.8025	0.3048	728.71	17.9230
Lbs S/1000 gal:	0.10575	378	250	50	1800	18.4	TBD	12	828	2.56	2245	47.6404	0.3048	715.37	14.5208
Lbs SO2/1000 gal:	0.2115	201	125	25	1800	10.4	TBD	12	719	1.45	1418	30.0909	0.3048	654.82	9.1717
EPA Tier:	2	96	50	10	1800	5.9	TBD	12	541	0.82	955	20.2657	0.3048	555.93	6.1770
Turbocharged:	Yes	0	0	0	0	0	0	0	0	0.00	0	0.0000	0.0000	0	0.0000
Aftercooled:	Yes					Stack Exit Area (sq.ft) =		0.785398							

	Emissions Factor Scenarios (all values in g/bhp-hr)						**CO2e**
Scenarios	**NOx**	**CO**	**VOC**	**SO2**	**PM10**	**PM2.5**	**lb/mmbtu**
Declared Emergency Ops, 100 hrs/yr, D2 Cycle EFs, 100% Load	3.71	0.40	0.19	0.005	0.080	0.080	163.052
Maint/Readiness Testing, 20 hrs/yr, D2 Cycle EFs, 100% Load	3.71	0.40	0.19	0.005	0.080	0.080	163.052
	0.00	0.00	0.00	0	0.000	0.000	0

APC Installed: Diesel Particulate Filters

	Controlled Emissions Factor Scenarios (all values in g/bhp-hr)						**CO2e**
	NOx	**CO**	**VOC**	**SO2**	**PM10**	**PM2.5**	**lb/mmbtu**
Declared Emergency Ops, 100 hrs/yr, D2 Cycle EFs, 100% Load	3.71	0.40	0.19	0.005	0.015	0.015	163.052
Maint/Readiness Testing, 20 hrs/yr, D2 Cycle EFs, 100% Load	3.71	0.40	0.19	0.005	0.015	0.015	163.052
	0.00	0.00	0.00	0	0.000	0.000	0

Scenario 1: **Declared Emergency Ops, 100 hrs/yr, D2 Cycle EFs, 100% Load**

Max Hourly Runtime: 1
Max Daily Runtime: 24
Max Annual Runtime: 100

Single Engine

	Nox	**CO**	**VOC**	**SO2**	**PM10**	**PM2.5**	**CO2e**
lbs/hr	5.979	0.645	0.306	0.008	0.024	0.024	na
lbs/day	143.496	15.471	7.349	0.193	0.580	0.580	na
TPY	0.299	0.032	0.015	0.000	0.001	0.001	38.5

All Engines

	Nox	**CO**	**VOC**	**SO2**	**PM10**	**PM2.5**	**CO2e**
lbs/hr	17.937	1.934	0.919	0.024	0.073	0.073	na
lbs/day	430.487	46.414	22.047	0.580	1.741	1.741	na
TPY	0.897	0.097	0.046	0.001	0.004	0.004	115.6

All Engines

Scenario 2: **Maint/Readiness Testing, 20 hrs/yr, D2 Cycle EFs, 100% Load**

Max Hourly Runtime: 1
Max Daily Runtime: 1
Max Annual Runtime: 20

Single Engine

	Nox	CO	VOC	SO2	PM10	PM2.5	CO2e
lbs/hr	5.979	0.645	0.306	0.008	0.024	0.024	na
lbs/day	5.979	0.645	0.306	0.008	0.024	0.024	na
TPY	0.060	0.006	0.003	0.000	0.000	0.000	7.706

3 Engines

	Nox	CO	VOC	SO2	PM10	PM2.5	CO2e
lbs/hr	5.979	0.645	0.306	0.008	0.024	0.024	na
lbs/day	17.937	1.934	0.919	0.024	0.073	0.073	na

All Engines

TPY	0.179	0.019	0.009	0.0002	0.0007	0.0007	23.118

Scenario 3:

Max Hourly Runtime: 0
Max Daily Runtime: 0
Max Annual Runtime: 0

Single Engine

	NOx	CO	VOC	SO2	PM10	PM2.5	CO2e
lbs/hr	0.000	0.000	0.000	0.000	0.000	0.000	na
lbs/day	0.000	0.000	0.000	0.000	0.000	0.000	na
TPY	0.00000	0.00000	0.00000	0.00000	0.00000	0.00000	0.000

3 Engines

	NOx	CO	VOC	SO2	PM10	PM2.5	CO2e
lbs/hr	0.000	0.000	0.000	0.000	0.000	0.000	na
lbs/day	0.000	0.000	0.000	0.000	0.000	0.000	na

All Engines

TPY	0.000	0.000	0.000	0.000	0.0000	0.0000	0.000

BAAQMD M/R Testing + Emergency Emissions Totals, TPY:		**Nox**	**CO**	**VOC**	**SO2**	**PM10**	**PM2.5**	**CO2e**
QSX-15	Scenario 1 + 2	1.076	0.116	0.055	0.001	0.004	0.004	138.705