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Golder Associates

June 3, 2011

113-87509
Via Electronic Delivery

Susan Jenkins
Stationary Source Permitting Program
Georgia Environmental Protection Division
4244 International Parkway
Suite 120
Atlanta, GA 30354

RE: PSD PERMIT APPLICATION NO. 19810
MACKINAW POWER, LLC – EFFINGHAM COUNTY POWER PLANT
EMISSIONS ESTIMATES DURING OIL-FIRING STARTUP SCENARIO

Dear Ms. Jenkins:

In response to the Georgia Environmental Protection Division's (GEPD's) request for information on nitrogen oxides (NO_x) emissions estimates during the oil-firing startup scenario for the proposed Effingham Power Plant combustion turbines (CTs), Golder Associates Inc. (Golder) has performed a detailed calculation with data obtained from Mackinaw Power, LLC (see attached Table 2-3A). The calculation demonstrates that with selective catalytic reduction (SCR) operating and ammonia flow at typical level, NO_x emissions during a cold startup scenario firing fuel oil are estimated to be lower than the NO_x emissions estimated during the same scenario firing natural gas (see Table 2-3 of PSD application). The air quality modeling analysis presented with the application included the natural gas-firing startup scenario. Since the oil-firing startup emissions are estimated to be lower, the predicted impacts are also expected to be lower. As a result, a modeling analysis for the oil-firing scenario should not be required.

As currently planned, the proposed CTs will always be started with natural gas before switching to fuel oil, which can occur during the second hour of cold startup. The 5-hour cold startup scenario assumes natural gas-firing in the first hour and then fuel oil-firing for hours 2 to 5. The following assumptions and steps were used in the calculation:

- The SCR system will start to operate at about 10 minutes into the 2nd hour [ammonia (NH_3) flow will begin].
- NH_3 slip is assumed to be 10 parts per million on a dry volume basis at 15-percent oxygen (ppmvd @ 15% O_2).
- NH_3 emissions in pounds per hour (lb/hr) are calculated based on the NH_3 slip, fuel heat input, and fuel F factor.
- Pre-SCR NO_x emissions for the first hour firing natural gas are obtained from the existing CT startup data based on natural gas-firing.
- Pre-SCR NO_x emissions for fuel oil-firing for hours 2, 3, and 4 are obtained from an estimated pre-SCR NO_x concentration of 180 ppmvd @ 15% O_2. This value is a conservative (high) estimate from available GE information available on-line and prior experience with permitting GE 7FA CTs. Water injection will be started in the 5th hour of the cold startup scenario and the pre-SCR uncontrolled NO_x for the 5th hour is assumed to be 42 ppmvd @ 15% O_2. Mass emissions are calculated using the concentration data, fuel heat input, and fuel F factor.

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- Assuming almost all of the pre-SCR NO_x emissions are in the form of nitric oxide (NO), the following stoichiometric NO_x reduction equation was used to estimate the mass ratio of NO/NH_3:

$$4NO + 4NH_3 + O_2 \rightarrow 4N_2 + 6H_2O$$

- Finally, a typical NH_3 flow of 150 lb/hr within the normal operating range was assumed for hours 2, 3, and 4 to estimate the NO_x emissions from the stack. NH_3 flow for the 5th hour was assumed to be 50 lb/hr, which is the normal flow for the existing SCRs at full load.
  - NH_3 consumed in the SCR = NH_3 flow into SCR – NH_3 slip
  - NO reduced = NH_3 consumed in SCR x NO_x reduction ratio (NO/NH_3)
  - Stack NO_x emission = Pre-SCR NO_x – NO reduced

As shown in the attached calculation, maximum stack NO_x emissions were estimated to be 135.4 lb/hr.

If you have any questions, please do not hesitate to call me at (352) 336-5600.

Sincerely,

GOLDER ASSOCIATES INC.

Robert C. McCann, Jr.
Principal and Air Group Leader

Salahuddin Mohammad
Senior Project Engineer

cc: Matthew Lydon, Mackinaw Power

Enclosures

SKM/tz

TABLE 2-3a
STACK, OPERATING, AND EMISSIONS DATA FOR THE CT - SWITCHING TO FUEL OIL DURING STARTUP

Hour	Fuel	Heat Input [a] (MMBtu)	Power Output [a] (MW)	Load [a] (%)	SCR (On/Off)	(A) SCR NH_3 Flow [c] (lb/hr)	(B) Pre-SCR NO_X [b] (lb/hr) (see Table 2-3d)	(C) NH_3 Emissions (lb/hr) (see Table 2-3c)	(D) = (A) - (C) NH_3 Consumed (lb/hr)	(E) Reduction Ratio NO/NH_3 (see Table 2-3e)	(F) = (D) x (E) NO Reduced (lb/hr)	(G) = (B) - (F) Stack (post-SCR) NOx (lb/hr)
1.0	NG	529.8	13.1	8.0%	Off	0.0	129.7	0.0	0.0	2.71	0.0	129.7
2.0	NG→Fuel Oil	576.3	17.1	10.4%	On	150.0	403.1	8.3	141.7	2.71	383.5	19.6
3.0	Fuel Oil	584.1	17.5	10.7%	On	150.0	408.5	8.4	141.6	2.71	383.2	25.3
4.0	Fuel Oil	718.3	31.7	19.4%	On	150.0	502.4	10.3	139.7	2.71	378.0	124.4
5.0	Fuel Oil	1,339.5	112.2	68.5%	On	50.0	218.6	19.2	30.8	2.71	83.2	135.4

Table 2-3b
Stack Parameters

Hour	Fuel	Heat Input [a] (MMBtu)	Stack Exit Flow [a] (lb/h)	Stack Exhaust Temp [a] F	Stack Exit Flow acfm	Stack Exit Velocity (ft/s)
1.0	NG	529.8	2,258,722.7	104.9	554,519.7	32.6
2.0	NG→Fuel Oil	576.3	2,529,118.0	256.3	787,355.4	46.3
3.0	Fuel Oil	584.1	2,284,861.1	274.3	729,190.6	42.9
4.0	Fuel Oil	718.3	2,119,605.5	262.6	665,669.9	39.1
5.0	Fuel Oil	1,339.5	2,758,978.7	229.8	827,081.1	48.6

NOTES

[a] Average value for the hour, see Table 2-3 of PSD application.

[b] Pre-SCR NO_X for hour 1 is based on natural gas firing. Pre-SCR NOx for Hours 2-5 are based on assumed uncontrolled NOx concentration of 180 ppmvd @ 15% O_2 for oil firing. This value was is a conservative high estimate of uncontrolled NOx emissions during low-load operation based on GE information available on-line and prior experience with permitting GE 7FA CTs.

[c] Typical NH_3 flow assumed

Table 2-3c
Ammonia Slip Calculation

Hour	Fuel	Heat Input (MMBtu)	NH_3 Slip (ppmvd @15% O2)	Stack O_2 (Dry) (%)	NH_3 Concentration (ppmvd actual)	NH_3 Concentration (Cd, lb/dscf)	Fuel F Factor (F_d, dscf/MMBtu)	NH_3 Emission Factor (lb/MMBtu)	NH_3 Emission Rate (lb/hr)
1.0	NG	529.8	0.0	18.4	0.0	0.00E+00	8,710.0	0.0000	0.00
2.0	NG→Fuel Oil	576.3	10.0	17.7	5.4	2.38E-07	9,190.0	0.0144	8.28
3.0	Fuel Oil	584.1	10.0	17.2	6.2	2.76E-07	9,190.0	0.0144	8.39
4.0	Fuel Oil	718.3	10.0	16.3	7.8	3.42E-07	9,190.0	0.0144	10.31
5.0	Fuel Oil	1,339.5	10.0	14.9	10.2	4.50E-07	9,190.0	0.0144	19.24

Table 2-3d
Pre-SCR NOX Emissions Calculation for Oil-Firing

Hour	Fuel	Heat Input (MMBtu)	Pre-SCR NO_X (ppmvd @15% O2)	Stack O_2 (Dry) (%)	NO_X Concentration (ppmvd actual)	NO_X Concentration (Cd, lb/dscf)	Fuel F Factor (F_d, dscf/MMBtu)	NO_X Emission Factor (lb/MMBtu)	NO_X Emission Rate (lb/hr)
1.0	NG	529.8	--	--	--	--	--	--	--
2.0	NG→Fuel Oil	576.3	180.0	17.7	97.2	1.16E-05	9,190.0	0.6994	403.05
3.0	Fuel Oil	584.1	180.0	17.2	112.5	1.34E-05	9,190.0	0.6994	408.51
4.0	Fuel Oil	718.3	180.0	16.3	139.6	1.67E-05	9,190.0	0.6994	502.36
5.0	Fuel Oil	1,339.5	42.0	14.9	42.9	5.12E-06	9,190.0	0.1632	218.61

Note: Pre-SCR Nox emissions at hour 5 is based on uncontrolled NOx emissions for 50% load oil firing scenario (see Table A-10)

Table 2-3e
SCR NOX Reduction Chemistry: $4NO + 4NH_3 + O2 \rightarrow 4N_2 + 6H_2O$

NH_3 Mass (lb)	NH_3 Moles	NO Moles Reduced	NO Moles Reduced (lb)	Reduction Ratio NO/NH_3
1.0	0.059	0.059	2.71	2.71

Source: Mackinaw Power, 2011; Golder, 2011.

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