

## MEMORANDUM

**Date:** December 16, 2011

**Subject:** Emission Reduction Costs for Beyond-the-floor Mercury Rate for Existing Units Designed to Burn Low Rank Virgin Coal

**From:** Kevin Culligan, SPPD/OAQPS

**To:** EPA-HQ-OAR-2009-0234

For the final rule, EPA has recalculated the beyond the floor control costs for existing units designed to burn low rank virgin coal using a methodology similar to that used in the IPM analysis done for the MATS proposal. In the final rule, we have not recalculated control costs based on the other methodology used in the proposal which used ACI capital and operating costs provided in the ICR. We have not used that approach because it was based upon an assumption that all units would need to have a baghouse (also known as a fabric filter – FF – either existing or newly installed) in order to meet the MACT PM standard and that the ACI would be used with the baghouse. EPA has considered and used additional information demonstrating that high levels of mercury removal can be achieved with injection of brominated activated carbon and the addition of a FF is not necessary. Furthermore, based on additional analysis related to the PM standard, EPA believes that most lignite units will not need to install new FF, therefore, EPA believes a costing methodology based on this assumption would be inappropriate.

For this analysis, EPA calculated beyond-the-floor costs for mercury controls by assuming injection of brominated activated carbon at a rate of 3.0 lb/MACF for units with ESPs and injection rates of 2.0 lb/MACF for units with baghouses (also known as fabric filters). The rate of 2.0 lb/MACF for fabric filters is consistent with the rate assumed in all other IPM analyses for this rule. The rate of 3.0 lb/MACF for units with ESPs is lower than the rate of 5.0 lb/MACF assumed in the IPM analysis. EPA believes that this rate is appropriate, because a higher rate would likely result in reductions beyond those needed to meet the BTF standard of 4.0 lb/TBtu. Figure 1 in "Activated Carbon Injection for Mercury: Overview"<sup>1</sup> suggests that > 90% control can be achieved at lignite-fired units at a < 2.0 lb/MACF injection rate for units with installed FF and using treated (i.e., brominated) AC. The figure also suggests that > 90% Hg control can be achieved at lignite-fired units at < 3.0 lb/MACF injection rate for units with installed ESPs and using treated AC. As Table 1 below shows, based on the IPM analysis, all units would need to achieve reductions of less than 90%, therefore lower assumed injection rates are appropriate.

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<sup>1</sup> *Fuel Processing Technology* 89 (2010) 1310

**Table 1 – Emission Reduction Rates Required to Meet Standard of 4 lb/TBtu.**

Plant Name	Unit ID	Hg Controls	Existing Controls	Base Hg lbs/Tbtu	Reduction Required, %	Policy Hg lbs/Tbtu
Big Brown	1	ACI	Cold-side ESP + Fabric Filter + SNCR	9.09	55.98	1.01
Big Brown	2	ACI	Cold-side ESP + Fabric Filter + SNCR	9.09	55.98	1.01
Lewis & Clark	B1	ACI	Wet Scrubber	7.68	47.92	0.75
Martin Lake	1	ACI	Cold-side ESP + Wet Scrubber	5.41	26.09	0.56
Martin Lake	2	ACI	Cold-side ESP + Wet Scrubber	5.41	26.09	0.56
Martin Lake	3	ACI	Cold-side ESP + Wet Scrubber	5.41	26.09	0.56
Monticello	3	ACI	Cold-side ESP + SNCR + Wet Scrubber	6.30	36.53	0.96
R M Heskett	B1		Cold-side ESP	7.81	48.77	0.45
R M Heskett	B2		Cold-side ESP + Cyclone	4.76	16.00	0.75
Leland Olds	1		Cold-side ESP	7.68	47.93	0.77
Leland Olds	2		Cold-side ESP	7.81	48.77	0.78
Milton R Young	B1		Cold-side ESP + SCR + Wet Scrubber	4.21	4.93	0.75
Milton R Young	B2		Cold-side ESP + SCR + Wet Scrubber	4.21	4.93	0.75
Stanton	1		Cold-side ESP	7.81	48.77	0.78
Stanton	10		Fabric Filter + Dry Scrubber	7.51	46.76	0.75
Limestone	LIM1		Cold-side ESP + Wet Scrubber	6.75	40.76	1.13
Limestone	LIM2		Cold-side ESP + Wet Scrubber	6.75	40.76	1.13
Dolet Hills	1		Cold-side ESP + Wet Scrubber	8.33	51.98	1.35
Coal Creek	1		Cold-side ESP + Wet Scrubber	4.21	5.07	0.76
Coal Creek	2		Cold-side ESP + Wet Scrubber	4.21	5.07	0.76
Laramie River Station	1		Cold-side ESP + Wet Scrubber	5.31	24.71	0.56
Laramie River Station	2		Cold-side ESP + Wet Scrubber	5.31	24.71	0.56
Antelope Valley	B1		Fabric Filter + Dry Scrubber	7.51	46.76	0.75
Antelope Valley	B2		Fabric Filter + Dry Scrubber	7.51	46.76	0.75
Twin Oaks Power One	U1		Fabric Filter	5.82	31.33	1.35
Twin Oaks Power One	U2		Fabric Filter	5.82	31.33	1.35
Pirkey	1		Cold-side ESP + Wet Scrubber	7.59	47.27	1.35
Coyote	B1		Fabric Filter + Dry Scrubber	7.64	47.66	0.75
Great River Energy Spiritwood Station	1		Cold-side ESP + Fabric Filter + SNCR + Dry Scrubber	7.68	47.92	0.75

EPA also assumed a disposal cost of \$25/ton for ash comingled with activated carbon. This cost is consistent with a range of studies. DOE/NETL, in a recent study examining the costs of ACI, assumed total disposal costs of \$17/ton for non-hazardous fly ash. They assumed \$35/ton for fly ash that would have otherwise been sold for beneficial reuse (lost revenue of \$18/ton plus disposal costs of \$17/ton for non-hazardous fly ash).<sup>2</sup> In an EPA study, \$25 - \$30 per ton were assumed as total disposal costs.<sup>3</sup>

EPA recently modeled site-specific disposal costs for the RIA<sup>4</sup> for the proposed rule regulating coal combustion residuals (CCRs), including fly ash. Those costs were examined for units burning low rank virgin coal. The disposal costs varied by state/region. For Texas the incremental costs attributable to Hg control were \$18.13/ton, while for North Dakota and Montana, the incremental costs attributable to Hg control were \$32.31/ton.

<sup>2</sup> *Environmental Sci. Technol.* 2007, 41, 1365].

<sup>3</sup> *Environmental Sci. Technol.* 2006, 1385

<sup>4</sup> Regulatory Impact Analysis For EPA's Proposed RCRA Regulation Of Coal Combustion Residues (CCR) Generated by the Electric Utility Industry. Prepared by US Environmental Protection Agency Office of Resource Conservation & Recovery (ORCR) (formerly Office of Solid Waste) 1200 Pennsylvania Avenue NW (Mailstop 5305P) Washington DC, 20460 USA. Available at <http://www.regulations.gov/> docket number EPA-HQ-RCRA-2009-0640-0003, Appendix H.

Based on these key assumptions, EPA projects an average reduction cost of \$27,017 per pound of Hg removed. Unit by unit costs are provided in Table 2.

**Table 2 – Unit by unit cost estimates for achieving an emission rate of 4 lb/TBtu Hg**

Plant Name	Unit ID	Capacity (MW)	Heat Rate (Btu/kWh)	Existing PM Controls	(Base to Policy) Hg remv'd (lbm)	(2007\$) unit S/lbm Hg	Total Cost
Big Brown	1	575	11001	Cold-side ESP + Fabric Filter + SNCR	-396	3954	1565723
Big Brown	2	575	10931	Cold-side ESP + Fabric Filter + SNCR	-393	3980	1565723
Lewis & Clark	B1	52.3	13787	Wet Scrubber	-31	22920	704682
Martin Lake	1	750	11512	Cold-side ESP + Wet Scrubber	-332	32175	10671737
Martin Lake	2	750	11202	Cold-side ESP + Wet Scrubber	-323	32174	10383770
Martin Lake	3	750	10784	Cold-side ESP + Wet Scrubber	-311	32309	10038209
Monticello	3	750	11246	Cold-side ESP + SNCR + Wet Scrubber	-359	29249	10487787
R M Heskett	B1	29.37	11985	Cold-side ESP	-17	38871	652353
R M Heskett	B2	75.5	11386	Cold-side ESP + Cyclone	-22	53992	1206545
Leland Olds	1	221	11404	Cold-side ESP	-109	25792	2812406
Leland Olds	2	448	11021	Cold-side ESP	-217	23822	5176973
Milton R Young	B1	250	10661	Cold-side ESP + SCR + Wet Scrubber	-64	51542	3272935
Milton R Young	B2	455	10661	Cold-side ESP + SCR + Wet Scrubber	-116	49018	5665257
Stanton	1	130.3472	10990	Cold-side ESP	-77	26601	2050240
Stanton	10	57.35278	10320	Fabric Filter + Dry Scrubber	-31	30538	935770.1
Limestone	LIM1	831	10102	Cold-side ESP + Wet Scrubber	-372	29034	10797351
Limestone	LIM2	858	10108	Cold-side ESP +	-384	28982	11134608

				Wet Scrubber			
Coal Creek	1	554	11219	Cold-side ESP + Wet Scrubber	-162	48056	7781365
Coal Creek	2	560.3	10818	Cold-side ESP + Wet Scrubber	-158	47982	7576786
Laramie River Station	1	565	11312	Cold-side ESP + Wet Scrubber	-235	34742	8170580
Laramie River Station	2	570	10953	Cold-side ESP + Wet Scrubber	-230	34737	7980115
Antelope Valley	B1	450	10988	Fabric Filter + Dry Scrubber	-264	22315	5888636
Antelope Valley	B2	450	11206	Fabric Filter + Dry Scrubber	-269	22269	5993120
Twin Oaks Power One	U1	152	9497	Fabric Filter	-50	38215	1900963
Twin Oaks Power One	U2	153	10364	Fabric Filter	-55	37778	2064287
Coyote	B1	427	11639	Fabric Filter + Dry Scrubber	-228	22122	5043515
Pirkey	1	675	10693	Cold-side ESP + Wet Scrubber	-349	26185	9140141
Great River Energy Spiritwood Station	1	99	8937	Cold-side ESP + Fabric Filter + SNCR + Dry Scrubber	-46	11694	535381.6
Dolet Hills	1	650	10674	Cold-side ESP + Wet Scrubber	-351	27064	9500464
				Total	-5948		1.61E+08
				Average		27016	