April 6, 2009

Via e-mail (rmeyer@amp-ohio.org)

R·W·BECK

Mr. Randy Meyer
AMP-Ohio, Inc.
2600 Airport Drive
Columbus, OH 43219-2277

Subject: **Mercury Emissions Control Costs**

Dear Mr. Meyer:

The control of mercury emissions from new coal-fired power plants such as the American Municipal Power Generating Station ("AMPGS") Project ("the Project") is dependent on many factors including fuel type and chemical composition, control equipment, and the resulting speciation of mercury after the combustion of the fuel. Furthermore, mercury speciation, the split amongst chemical forms of mercury species, has a great influence on the control of mercury emissions and the environmental fate of mercury emissions resulting from coal combustion. In estimating the level of expected mercury emissions from a coal-fired power plant, these important factors must be evaluated in concert with one another. It is also fair to say that although there has been data collected from existing coal-fired power plants over the last several years, most of the data collected are characteristic of the particular plant being tested and may not be universally applicable to other power plants. However, certain general observations can be made based on the existing data as follows:

- Mercury emissions are primarily speciated into three basic forms, elemental, particulate, and oxidized form.
- The oxidized form of mercury is water soluble and can readily be removed in a wet scrubber device used to control sulfur dioxide ("SO_2").
- There is a higher degree of oxidized mercury resulting from the combustion of coals with higher chlorine contents such as eastern bituminous coals.
- Particulate mercury can be effectively removed in particulate collection devices such as baghouses and electrostatic precipitators.
- Elemental mercury is not effectively removed by the scrubber devices used to control SO_2 since it is not water soluble.
- A certain amount of elemental mercury is controlled by the particulate control devices and the wet scrubber, by either adsorption onto ash or further oxidation across the control devices.
- The use of Selective Catalytic Reaction ("SCR") systems to control nitrogen oxides aid in the further oxidation of elemental mercury resulting in greater amounts of oxidized mercury that can be removed by the wet scrubber.

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The Project is equipped with an SCR for nitrogen oxides control, a baghouse for particulate control, and a wet scrubber system for the control of SO_2. The Project is being designed to use a blend of eastern bituminous coals with higher chlorine content, as compared to subituminous coal, which will result in higher amounts of oxidized mercury which will be removed by the wet scrubber. This combination of fuel type and air pollution control equipment is expected to promote mercury oxidation in the flue gas from approximately 70 to 95 percent prior to the baghouse.[1] Due to the water solubility of oxidized mercury indicated above, nearly all of the oxidized mercury is expected to be removed from the flue gas stream in the wet scrubber. Therefore, it is not unreasonable to expect that approximately 80 percent of the mercury in the coal would be removed by the baghouse and wet scrubber.

When evaluating the use of additional controls such as an Activated Carbon Injection ("ACI") system, both the absolute cost of the system as well as the incremental benefits in terms of incremental costs and incremental mercury removals must be assessed. The installation costs of ACI are estimated from approximately $4 million to $5 million (2009$). Due to the uncertainties regarding mercury speciation indicated above, the necessary ACI rate could range from 2 to 4 pounds carbon/million actual cubic feet of flue gas. The first year cost to purchase brominated activated carbon would vary from approximately $3.3 million to $6.6 million (2009$).[2] In total, the levelized annual capital cost and cost of carbon would vary from $4.3 million to $8.5 million (2009$) (assuming an interest rate of 5.0 percent, discount rate of 5.5 percent, inflation rate of 2.4 percent, and a 30-year operating time frame).

The incremental costs of ACI are difficult to calculate since details on the mercury speciation and overall mercury control from the SCR, baghouse, and wet scrubber (without ACI) are not known for the Project. However, based on the assumption that 80 percent of the mercury emissions would be oxidized and removed from the AMPGS facility stack (without ACI), the incremental control cost to achieve additional mercury control with the addition of the ACI system would be approximately $54,000 per pound to $106,000 per pound.

Please note that these costs do not include the following additional costs:

- Capital costs include anticipated equipment and installation costs, but do not include any owner's cost.
- Suppliers of activated carbon have indicated that the cost of activated carbon will likely increase significantly in the coming years as the market for activated carbon increases due to the increased usage for mercury control at coal fired generation facilities.
- O&M costs do not include manpower or occasional repair and replacement costs associated with the ACI system.

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[1] Gretta, William; Morita, Isato; and Moffett, John; Mercury Oxidation Across SCR Catalyst at LG&E's Trimble County Unit 1, Hitachi Power Systems

[2] ACI System and carbon cost data from budgetary estimates provided by phone from two ACI technology and carbon supply vendors.

- We are of the understanding that for relatively high sulfur coals, the ACI vendor will not offer mercury emission reduction guarantees if the SO_3 concentration at the point of ACI injection exceeds five parts per million ("ppm"). In order to reduce SO_3 concentrations, a trona injection system or equivalent may be necessary upstream of the ACI injection point. The installation of a trona injection system would significantly increase the capital cost and O&M costs provided above.

The utilization of ACI for mercury control from coal fired facilities will likely have a negatively impact on the fly ash such that it may not be utilized as a component for mixing cement (a common practice for utilizing fly ash from coal fired facilities). In response to this issue, certain concrete-friendly activated carbon sorbents have recently been developed.[3] Considering the maturity of this technology, the overall impact on mercury control cost and the fly ash marketability is not known at this time.

Best Regards,

R. W. BECK, INC.

Brian E. Nelson, P.E.
Senior Environmental Consultant

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ec: April Bott, Bott Law Group
Evis Couppis, R.W. Beck, Inc.
Ivan Clark, R. W. Beck, Inc.

3 Lockert, Charles; Zhou, Qunhui; Zhang, Yinzhi; and Nelson, Sid Jr.; Further Progress toward Concrete-Friendly Mercury Sorbents, Air Quality V Symposium, September 2005