UARG COMMENTS ON PROCESS INPUTS FOR EPA'S PLANNED IPM MODELING RUNS

This document identifies several changes necessary to the input process conditions that will be used by EPA in IPM modeling.

EPA has not explicitly identified the source of the performance and cost algorithms, but they appear to be derived from two recent EPA publications. These documents are:

> *Performance and Cost of Mercury Emission Control Technology Applications On Electric Utility Boilers*, R.K. Srivastava et. al., September 2000 (EPA-600/R-00-083), and
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> *Control of Mercury Emissions from Coal-fired Electric Utility Boilers: Interim Report*, J.D. Kilgroe et. al., December 2001, EPA-600/R-01-109. Specifically, Chapter 8 of this latter document contains this information and is entitled "Cost Evaluation of Retrofit Mercury Controls for Coal-fired Electric Utility Boilers".

The cost and performance algorithms contained in these reports, if used for IPM modeling, will underestimate control technology cost and overcredit mercury removal. Accordingly, the following changes should be made to reflect authentic utility application of mercury control equipment:

(a) <u>The mercury removal schedule</u> defined in Table 1 should be utilized. This schedule defines mercury removal for various combinations of particulate control, flue gas desulfurization, and SCR process equipment; each as a function of coal type.
(b) <u>spray cooling should not be considered</u> a viable technology at present,
(c) regarding <u>activated carbon injection (ACI)</u> in a cold-side ESP:
    a. *mercury removal efficiency* should be limited to 65%, per results from the Wisconsin Energy Pleasant Prairie (PP4) demonstration, achievable at a carbon injection rate of 12 lbs/MACF
    b. *ESP capital cost* must include an allowance for upgrade for small SCA units,
    c. *operating costs* must include a charge for loss of ash reuse/resale
(d) <u>ACI mercury removal performance</u> should follow the guidelines in Table 2, for various combinations of control equipment.
(e) <u>The capital and operating cost of a fabric filter</u> (e.g. Toxecon) is adjusted to account for a lower air/cloth ratio (per Gaston results), and disposal of spent

sorbent as hazardous material.

(f) The capital recovery factor should be consistent with either the EPRI Technical Assessment Guide, or DOE economic premises. The application of a simple interest and principal recovery does not completely reflect indirect charges of ownership.

Details of these comments are described as follows:

Mercury Removal Schedule

Table 1 summarizes a proposed mercury removal schedule for various combinations of environmental control equipment. This table reflects data from recent pilot-scale and in-situ probe results that suggest SCR increases the oxidation of elemental mercury for bituminous coal, but not for subbituminous or lignite. Accordingly, the broad 35% increase in oxidation of elemental mercury assumed by EPA for SCR for all coals is replaced by a modest increase in mercury removal, but only for bituminous coals.

Spray Cooling

A key assumption adopted by EPA is the ability to deploy water injection for spray cooling of flue gas to within 40°F of saturation. EPA cites minimal capital cost for this concept ($2-4/kW), but more importantly EPA does not recognize that spray cooling may be impractical due to corrosion induced from wetted surfaces, or the deposition of solids that interfere with process operation. More importantly, EPA assumes the lower process temperature (to < 300°F in some cases) allows achieving high mercury removal (~90%) at low carbon injection rates. Further, PP4 data showed that cooling of ESP inlet gas did not increase mercury removal. This observation is significant as spray cooling, according to EPA analysis can be broadly applied for 80-90% removal, at a cost of less than 1 mill/kWh.

Given the uncertainty regarding the feasibility of spray cooling, this option should not be included as a control option in IPM modeling runs.

Activated Carbon Injection (ACI) with Cold-Side ESP

Mercury Removal Efficiency. EPA has developed mercury removal correlations that describe the percent removed as a function of carbon injection rate and flue gas temperature. These correlations were derived based on various pilot plant studies and are adjusted for the inherent mercury removal documented in ICR testing. EPA's correlations project ACI with an ESP can deliver mercury removal up to 90% (at carbon injection rates of > 20 lbs/MACF).

Mercury removal efficiency for this case is based on results from long-term data from PP4 testing. The PP4 demonstration represents favorable process conditions for mercury removal - a large size ESP and extended ductwork residence time, and extremely low inherent ash carbon content. At these extremely favorable process conditions, a maximum of 65% mercury removal was observed, for a carbon injection rate of approximately 12 lbs/MACF. These results are believed to represent the best-case mercury removal efficiency and perhaps carbon utilization.

For these reasons, mercury removal from a cold-side ESP is capped at 65%, and requires a carbon injection rate of 12 lbs/MACF.

Capital Cost for ESP. Capital costs assigned to ACI systems are assumed to depend on the ESP specific collecting area (SCA). This assumption is based on the observation of increased opacity with higher ash carbon content, under upset firing conditions, and the premise that additional collection surface will mitigate increases in opacity. For application of ACI to ESPs with smaller SCA, an additional 1-2 fields should be added to provide additional collection surface that can mitigate the impact of injected carbon. A capital cost algorithm is presented (see Cost Summary, item 2a) to reflect this additional capital cost. If the IPM model cannot reflect this degree of design detail at the unit level, then as a surrogate for ESP SCA the unit startup dates can be utilized (See Cost Summary, Item 2b).

Ash Revenue/Disposal Costs. The compromised ability to reuse/resell ash should be accounted for.

The impact of higher carbon content on ash reuse and disposal options is not clear. As indicated by the Wisconsin Energy PP4 demonstration, the ability to reuse/resell ash can be compromised, requiring disposal by the operator. Approximately 30% of all fly ash collected in the U.S. is sold for reuse, thus only this fraction of operators could be affected.

The cost impact can be nationally assessed by applying a $12/ton net charge to reflect both lost revenue and disposal costs to all units. This cost reflects 30% of the approximate $40/ton charge cited for several units in Wisconsin for this impact.

Maximum COHPAC/Pulse-Jet FF Mercury Removal

Capital Cost. Commercial scale tests at Gaston with long-term data (in this case 5 days) suggest 78% mercury removal is the maximum that can be achieved with a retrofit pulse-jet fabric filter design (Toxecon). Removal of mercury at approximately 90% was observed, but at higher carbon injection rates that could not be sustained without incurring unacceptable flue gas pressure drop.

Mercury removals of 90% can only be achieved with a baghouse that features a lower air/cloth ratio. Accordingly, for the IPM modeling runs, an increase in baghouse size and cost by 20% of the "reference" case is necessary. The cost algorithms in Table 3 reflect this necessity.

Fate Of Solid Byproducts/Waste. The spent reagent from "Toxecon" and similar devices will feature high carbon and mercury content. It is possible this material will be required to be treated as a hazardous waste. Accordingly, a hazardous waste disposal charge ($1200/ton) should be assessed.

Capital Recovery Factor

The use of a capital recovery factor that reflects both interest/principal recovery, as well as indirect charges should be included. Ignoring the latter lowers the fixed cost for capital recovery by approximately 25%. Both the EPRI Technical Assessment Guide and DOE economic premises (as well as published studies by ICF for commercial clients) utilize this methodology. Also, the operating lifetime for this class of retrofit equipment should not exceed 20 years.