VOTE YES ON HB 455 (Rep. Paul Clark)

EXHIBIT 7
DATE 2.4.05
HB 455

Technology for Mercury Removal

Technology for emission controls has improved dramatically in the past decade. Controls for nitrogen oxides (NO_x), sulfer dioxide (SO_2), and fine particulate matter are already in place at many coal fired power plants. Some technology is considered a multipollutant control technology because it removes mercury along with NO_x, SO_2, and particulates. In general, there are two types of technology that remove mercury: post combustion and precombustion controls. If both of these methods are used together, even greater mercury control can be achieved. The following fact sheet outlines the most current and available technologies for mercury reduction.

PRECOMBUSTION CONTROL TECHNOLOGY

K-FUEL®[1]

Description: Developed by KFx Corporation, K-Fuel® is a precombustion technology that raises the Btu-value of subbituminous coal and lignite while simultaneously removing significant amounts of mercury, sulfur dioxide and nitrogen oxide.

Costs: K-Fuel® will be sold at $33 per ton which includes transportation costs. KFx is building a production facility in Gillette, WY, which is expected to be in operation by the summer of 2005. The current price of Powder River Basin Coal is $9.27 per ton.[2]

Removal Efficiency: K-Fuel® can remove more than 70% of the mercury in subbituminous coal and when burned in plants equipped with fabric filters, even higher overall reductions will be achieved. This type of fuel also reduces emissions of SO_2 and NO_x.

INTEGRATED GASIFICATION COMBINED CYCLE

Description: This is an innovative technology that converts coal into a gaseous component by applying heat under pressure in the presence of steam in a gasifier. This gasification process differs from a combustion process in that the fuel is not burned completely. A mixture of coal/water slurry is heated in a gasifier. The coal components are broken apart by heat and pressure, initiating a chemical process that produces "syngas." Syngas is mostly hydrogen and carbon monoxide with a few other gaseous constituents. The mineral components of the coal (ie, rocks and dirt) separate and leave the bottom of the gasifier as slag that is marketable. Only very small amounts of mineral matter are blown out as fly ash. Sulfur is easily extracted in this process along with ammonia (both valuable byproducts). Ammonia forms from nitrogen-hydrogen reactions, thus eliminating nitrogen oxide pollutants. The syngas is further cleaned of pollutants before it is burned as fuel in a combustion turbine. A steam turbine is also utilized to make electricity from the steam created from the cooling of the syngas and the heating of the coal slurry.[3] (See Figure1)

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[1] KFx website: www.kfx.com
[2] Blend, Jeff et al."Understanding Energy in Montana." DEQ report for the EQC. October 2004.
[3] U.S. Dept. of Energy Office of Fossil Energy. "How Gasification Power Plants Work." http://www.fossil.energy.gov/programs/powersystems/gasification/howgasificationworks.html

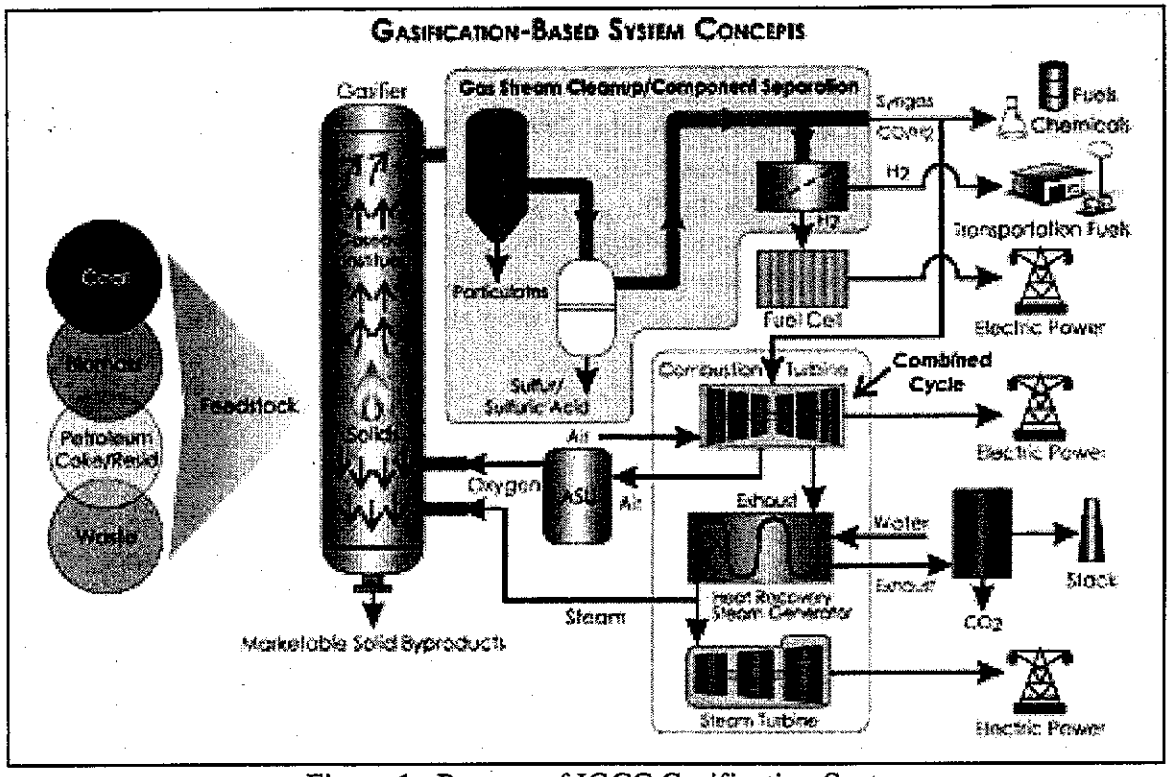

Figure 1. Process of IGCC Gasification System

Reduction Efficiencies: Tampa Electric Company has built a 250 MW IGCC plant in Polk County near Tampa, FL. It is one of the cleanest coal-based power plants in the world with SO_2 reductions of 95% and over 90% reductions in mercury emissions.
The Department of Energy (DOE) released a report in September of 2002 stating that IGCC plants have been commercially demonstrated to remove greater than 90% of the mercury from emissions. The DOE also stated that mercury removal in an IGCC plant can be expected to be very high in removal effectiveness, low in cost, and reliable in design. [4]

Costs: The Dept. of Energy has estimated the total capital cost of equipment at about $3.34 per kW.[5]

[4] Parsons Infrastructure and Technology Group Inc. "The Cost of Mercury Removal in an IGCC Plant." The U.S. Dept. of Energy National Energy Technology Laboratory. Sept. 2002.
[5] See note 4.

POST COMBUSTION CONTROL TECHNOLOGY

SORBENT INJECTION TECHNOLOGY

This type of mercury removal involves a system where a ***sorbent*** such as powdered activated carbon (***PAC***), bromine, or polysulfide is injected into the flue gas duct, which is located between the air preheater and a particulate collecting device. This collecting device can either be an electrostatic precipitator (ESP), Spray Dryer Absorber (SDA), or a bag house with fabric filters (FF). (See Figure 2) The sorbent adsorbs the mercury and then is collected by the collection device as particulates. The different types of activated carbon injections are as follows:

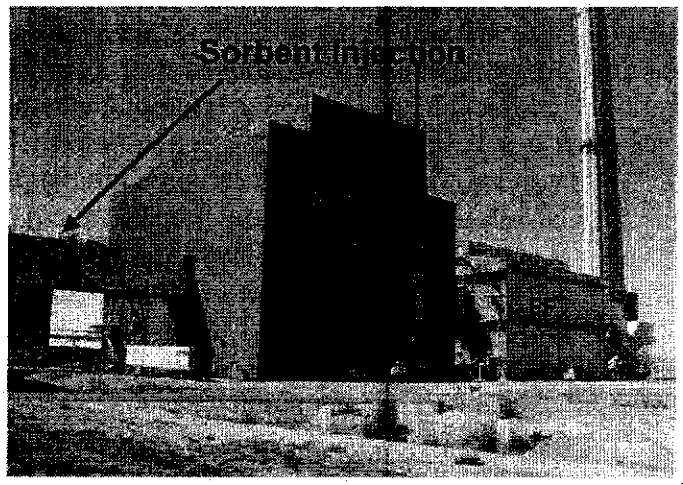

Figure 2: Sorbent Injection Equipment with a Spray Dryer Absorber (SDA) and a Fabric Filter (FF). The SDA and FF were already in place at this plant for other pollution controls. The injection equipment is smaller and less expensive than the other emission control equipment.

Activated Carbon Injection (ACI):

Description: This technology uses activated carbons as the sorbent to adsorb mercury. ACI is commercially available and can be used on all coal types. For example, an Iowa plant called MidAmerican was issued a permit in June 2003 for a new subituminous coal-fired boiler that will reduce mercury emissions by more than 80% by using ACI with conventional controls.[6]

Costs: This technology is economical because it utilizes existing emission control infrastructure that is in place to control NO_x, SO_2, and particulates. Capital costs for ACI average around $1.50 to $3.00 per kW. The operation and management costs range from $0.0012 to $0.0054 per kWh.[7] In addition, the EPA assumes costs of sorbent technologies will decrease with time due to equipment/technology innovation, improvements in sorbent removal efficiencies, and the reduction in sorbent production costs.

Reduction efficiency: Reduction efficiencies for ACI vary depending on the plant configuration and the type of coal burned.

Type of Coal Burned:

The burning of eastern bituminous coal tends to achieve higher levels of mercury control than the burning of western subbituminous coals. This is because western coals have lower concentrations of halogens such as chlorine, bromine, and fluorine. New technology that uses PAC combined with one of these halogens has been proven to reduce mercury emissions from western coals by 80 to 90%.[8] One of these technologies, Brominated PAC, is described in the next section.

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[6] Iowa Dept. of Nat. Resources Air Quality Bureau, 2003. Air Quality PSD Construction Permit Notice of MACT Approval (June 17, 2003) Mid American Energy Company Council Bluffs Energy Center Unit 4.

[7] Institute of Clean Air Companies. "Letter to Michael Leavitt, Administrator of U.S. Environmental Protection Agency." January 3, 2005.

[8] ADA Environmental Solutions. "Progress made during 2004 on activated carbon injection technology for control of mercury from coal-fired boilers." Dec. 30, 2004.

Plant Configuration:
90% mercury removal can be achieved for a unit burning subbituminous coal with a fabric filter such as a compact hybrid particulate collector (COPAC).[9] These bag houses are much more efficient at removing mercury than an ESP and the capital costs are much lower because COPAC bag houses are smaller. Also, COPAC bag houses that are injected with activated carbon are usually placed downstream from an ESP. This is beneficial because it allows the ESP to collect fly ash that remain suitable for sale and reuse in concrete. At Otter Tail Power Company's Big Stone plant in South Dakota, 90% of the mercury produced from burning subbituminous coal was captured from using a COPAC fabric filter.[10]
Only 70% mercury removal can be achieved with an ACI system that uses only an ESP when burning subbituminous coal.

Brominated-Powdered Activated Carbon:

Description: Brominated PAC works in the same way that plain carbon works in the activated carbon injection method. However, it achieves higher reduction rates at lower injection rates. This means it takes less sorbent to remove more mercury.

Reduction Efficiency: Subbituminous coal and lignites are low in halogens such as chlorine, bromine, fluorine, and iodine making the ACI technology less effective at adsorbing mercury. Sorbent Technology Corp. estimates that only 50% to 70% mercury reductions were observed with lignites and subbituminous coals with injection rates of 10 lb or more of powdered activated carbon per million cubic feet of flue gas.[11] New technology using pre-brominated carbons rather than plain carbons can achieve mercury reductions as high as 90% to 95% with injection rates of only 3 lbs per million cubic feet of flue gas.

Costs: Two types of brominated PAC are available on the market today. Sorbent Technology Corp. developed B-PAC™ at the cost of $0.75/lb while E-3 was developed by Norit Americas and costs about $0.65/lb. These prices are only a fraction higher than plain PAC which runs at $0.50/lb.[12]

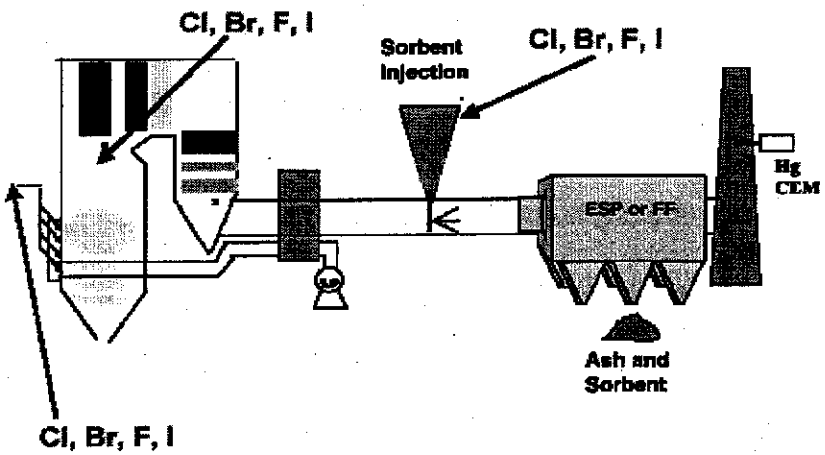

Figure 3. Halogen impregnated sorbent is injected upstream from the Fabric Filter.

[9] Banerjee, Shilpi and Vicki Stamper. "Mercury Air Pollution." Rocky Mountain Office of Environ. Defense. May 2003.
[10] U.S. Dept. of Energy, 2002. Mercury control with the advanced hybrid particulate collector. Technical progress report. November.
[11] Nelson, Sid. "The Current State of Activated Carbon Injection Technology" Sorbent Technology Corporation. Dec. 30, 2004.
[12] See note 11.

ELECTRO-CATALYTIC OXIDATION® (ECO)[13]

Description: Developed by Powerspan Corp., ECO is an integrated multi-pollutant control technology that reduces emissions in NO_x, SO_2, fine particulate matter, and mercury. This technology also reduces acid gases such as arsenic, lead, and hydrochloric acid. The ECO process is built downstream of the ESP or fabric filter and it involves a three step process. (See Figure 4) The first chamber is the ECO reactor which oxidizes NO_x, SO_2, and Hg. The second chamber is the absorber vessel which removes NO_x, SO_2, and oxidized Hg creating an ammonium sulfate nitrate solution. The final chamber of the ECO process is the wet ESP which captures acid aerosols, fine particulate matter, and oxidized Hg. The ammonium sulfate nitrate solution that is produced from the absorber vessel is sent to a co-product recovery system that removes ash, mercury, and spent activated carbons. The mercury and activated carbons are disposed of as hazardous waste and the treated co-product can be used as liquid fertilizer or can be processed to form crystalline or granular ammonium sulfate nitrate fertilizer.

Costs: This process is currently being demonstrated at FirstEnergy Corp.'s 50-MW R.E. Burger Plant in Shadyside, OH. Based on this project, ECO systems should be commercially available with industry standard guarantees by the beginning of 2006. The estimated capitol costs are $225/kW and the operation and maintenance costs will be $0.0027/kWh. The cost of mercury removal is about $800/lb of mercury but this cost is expected to decline over time.

Reduction Efficiency: ECO systems can reduce NO_x emissions by 90%, SO_2 emissions by 98%, and Hg emissions by 80-90%.

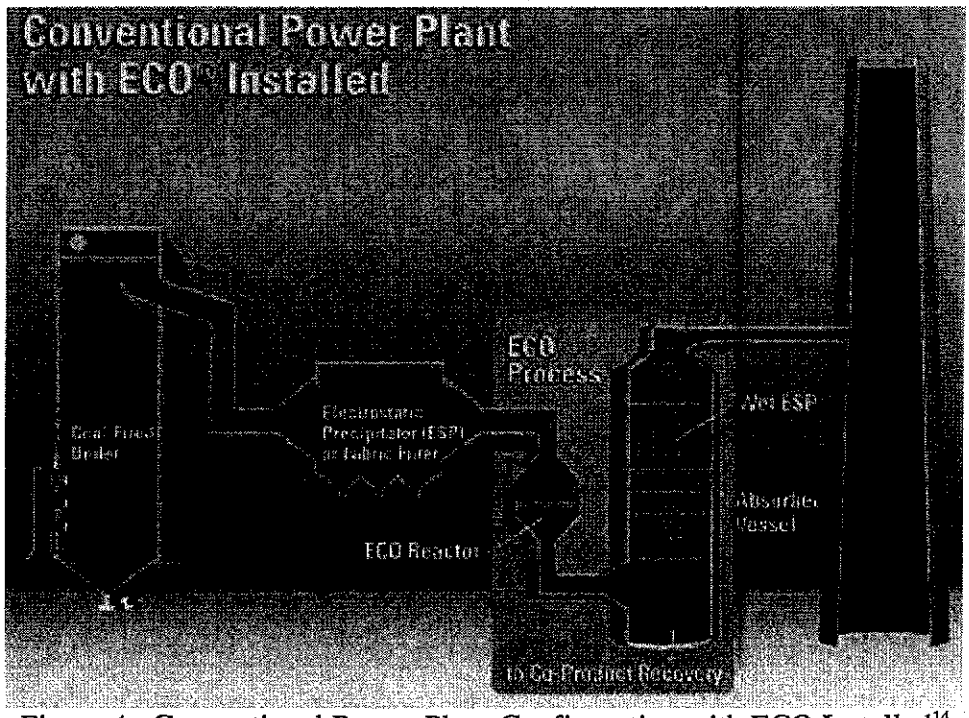

Figure 4: Conventional Power-Plant Configuration with ECO Installed[14]

[13] Powerspan website: www.powerspan.com

[14] See note 13.