Minnesota Pollution Control Agency

MPCA Review of Xcel Energy's Allen S. King Mercury Reduction Plan

June 18, 2008

Minnesota Pollution Control Agency
520 Lafayette Road North
Saint Paul, MN 55155-4194
http://www.pca.state.mn.us
651-296-6300 or 800-657-3864 toll free
TTY 651-282-5332 or 800-657-3864 toll free
Available in alternative formats

Authors and Contributors

For more information

Contact any of the following MPCA staff members for more information about the preparation of this report as well as other questions related to environmental controls for energy production:

Policy

Todd Biewen
Manager, Air Assessment and Environmental Management Section
Environmental Analysis and Outcomes Division
651-296-8156

Technical, Regulatory and Cost Assessments

Anne M. Jackson, P.E.
Principal Engineer
Environmental Analysis and Outcomes Division
651-296-7949

Economic analysis

Robert McCarron
Economist
Policy and Planning Division
651-296-7324

g-82-02

MPCA Review of Xcel Energy's Allen S. King Plan Under the Mercury Emissions Reduction Act of 2006

1.0 Introduction

On December 21, 2007, Xcel Energy submitted an emission reduction proposal, the Mercury Control Plan for its Allen S. King generating station in Oak Park Heights, pursuant to Minn. Stat. § 216B.682. [1] The proposal is to install a sorbent injection system on Unit 3 to control mercury emissions to meet the statutory goal of controlling mercury by 90 percent.

This project, when implemented as proposed, will reduce mercury emissions from King by up to 56 pounds per year, resulting in annual mercury emissions of 34 pounds or less.

In this report, the Minnesota Pollution Control Agency (MPCA) provides the analysis of Xcel Energy's proposal that is required under the Mercury Emissions Reduction Act of 2006. Specifically, Minn. Stat. § 216B.684 tells the MPCA to advise the Minnesota Public Utilities Commission (PUC) as to the following:

- evaluate the environmental and human health benefits of the proposed mercury emissions-reduction project
- assess the technical feasibility and cost-effectiveness of the proposed mercury emissions-reduction project
- determine whether the plan meets the requirements of Minn. Stat. § 216B.682
- advise the Public Utilities Commission on the appropriateness of the plan

[Minn. Stat. § 216B.684]

The Mercury Emissions Reduction Act also encourages a utility to submit mercury-control plans that address controls of multiple pollutants (Minn. Stat. § 216B.686). Because Xcel Energy has not included in this plan air pollution control equipment to control pollutants other than mercury, the MPCA has not undertaken additional evaluations requested by Minn. Stat. § 216B.686, subd. 3.

Order of Document

To address each requirement of the Mercury Emissions Reduction Act, this document in Section 2.0 assesses the technical feasibility and cost-effectiveness of the mercury-reduction plan. We review estimated construction costs in Section 3.0, and then in Section 4.0 discuss environmental and health benefits. Lastly, in Section 5.0 we discuss the plan's overall appropriateness and whether it meets the requirements as described in the statute.

[1] The complete text of the statute is available at http://ros.leg.mn/bin/getpub.php?type=law&year=2006&sn=0&num=201.

2.0 Technical assessment and cost-effectiveness of Xcel Energy's King reduction plan

Xcel Energy's Allen S. King station has a single cyclone boiler burning Powder River Basin sub-bituminous coal with a generating capacity of 620 megaWatts (MW). Emission controls were recently upgraded as a result of Xcel's Metropolitan Emissions Reduction Project (MERP). The MERP project for King involved reconstruction of the boiler and installation of a selective catalytic reduction system for No_x control, a spray dryer/fabric filter air-pollution-control system for sulfur dioxide (SO_2) emissions and particulate matter.

2.1 Description of Xcel Energy's mercury emissions control plan

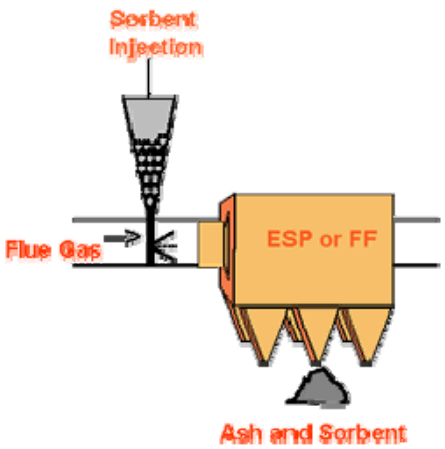
Xcel Energy proposes to use sorbent injection for removing mercury from King's combustion flue gases, and is currently proposing to use brominated, powdered activated carbon (B-PAC) as the sorbent of choice. This method of removing mercury involves injecting the chemically treated carbon into cooled flue gases, allowing carbon to absorb mercury. B-PAC is captured along with coal fly ash and lime from the spray dryer in the fabric filter. A diagram of the technology is shown below in Figure 1. Mercury captured in the ash will be collected and trucked to existing landfills.

Implementation of the technology involves constructing sorbent storage, piping, metering and injection equipment, and instrumentation and controls. Installation will occur during scheduled outages of several weeks. While an important pollution-control device, installation of this technology is not nearly as complicated or involved as past pollution-control projects completed at King.

The selection of B-PAC was made after completing a technology feasibility and cost-effective analysis, described in the next section. B-PAC is described by Xcel in its filing as removing from 80.6 to 90 percent of mercury found in the coal ("fuel basis"), or 77.1 to 88.2 percent of the mercury in the flue gas ("stack emissions basis"). The range results from uncertainties in two key areas — selection of an appropriate carbon injection rate, as well as the ability to measure very low emissions with a continuous emissions monitor. Other uncertainties exist, but will be addressed through the shakedown and longer-term use of the control technology.

Continuous mercury monitors have been installed and are collecting mercury emissions data, as required by Minn. Stat. § 216B.681. At least six months of monitoring data must be used to establish a baseline from which mercury emission reductions will be measured to determine whether the removal goals have been achieved as required by the Mercury Emissions Reduction Act.

Figure 1. Schematic of sorbent injection systems for controlling mercury[2]



[2] www.epa.gov/mercury/control_emissions/tech_merc_specific.htm. Accessed March 21, 2007.

2.1.1 Technical feasibility of Xcel Energy's mercury-control plan

Xcel Energy prepared an assessment of mercury control technologies for King to determine the method most likely to achieve the goal of removing at least 90 percent of the mercury emitted from King. Xcel submitted to the MPCA its technical assessment study[3] of King which is the basis of the mercury control plan being proposed in this filing.

In the process of selecting technologies to control mercury emissions, the following issues were considered:

- technical feasibility
- cost of compliance
- energy and non-air quality environmental impacts of compliance
- other existing pollution-control equipment in use or installed at King
- the remaining useful life of the unit

The analysis methodology consisted of the following steps:

- Develop the design basis.
- Identify all available retrofit control technologies.
- Eliminate technically infeasible options.
- Evaluate control effectiveness of remaining control options.
- Evaluate impacts and document results.

The design basis included assessing the technical characteristics of the flue gases from the boiler through the air-pollution-control equipment, including mercury inputs.

Xcel and its consultant identified a total of 22 retrofit technologies that can be classified into three general mercury-control technology groups — "reagent-based," "multi-pollutant" and "emerging." Reagent-based mercury-control technologies are those that introduce a reagent into the boiler or flue gas to capture or enhance mercury removal. Multi-pollutant controls involve applying sorbents and new technologies that remove mercury in addition to other regulated pollutants at power plants. Emerging technologies are those that are in development but have not progressed beyond pilot-scale demonstration.

Identified control technologies were assessed to determine whether the technology was both feasible and applicable to King. At the completion of the technology assessment, four control schemes remained feasible for application at King. The mercury-control effectiveness of each of these technologies at King was evaluated, and a cost-effective analysis of the technologies conducted.

Mercury-reduction potential of selected technologies

Four technologies were selected for further evaluation to control mercury emissions at King: powdered, activated carbon injection (PAC); brominated or halogenated powdered, activated carbon injection (B-PAC); coal-cleaning with brominated activated carbon injection; and MinPlus sorbent injection.

[3] Black and Veatch, Allen S. King Generating Plant Mercury Technology Assessment Study, December 18, 2007.

Activated carbon injection

Three technologies, PAC, B-PAC and coal-cleaning with B-PAC injection, rely wholly or in part on carbon injection for the control of mercury. A recently published survey of mercury-control projects show that of the 65 commercial bookings for retrofit utility-mercury-control projects, 64 rely on activated carbon injection[4].

PAC injection (that is, "plain carbon") is not expected to improve mercury-removal efficiency at King. The cyclone boiler at King has "inherent" carbon remaining in the fly ash after it exits the combustion chamber that is caught in the baghouse. This inherent carbon acts in the same way as PAC injection by providing enough carbon to absorb mercury present in the flue gases. Previous testing at King has shown approximately 68 percent removal before any additional control for mercury is used at the unit.

Therefore, halogenated carbons appear to present the best means of achieving the goal of 90 percent reduction at King when using activated carbon injection. The "outstanding performance" of chemically treated carbons, and in particular bromine-treated carbons, has reduced the amount of carbon injected into flue gases, resulting in lower operating cost for achieving a given level of control of mercury.

Minn. Stat. 216B.682, subd. 1 requires "removal of at least 90 percent of the mercury emitted from the unit." The current air-pollution-control equipment at King is providing about 68 percent control of total mercury emissions. Xcel emphasizes that carbon injection vendors are willing to provide performance guarantees of 90 percent removal based on the amount of mercury in the coal, but not on reductions from current stack emissions. That is, vendors will not guarantee a further reduction of 90 percent from stack emissions.

The MPCA does not rely on vendor guarantees to set permit limits, rather it relies on actual emissions data to determine achievable performance standards. Therefore, the MPCA asked Xcel whether there are existing plant conditions that would prevent achieving removal efficiencies greater than 90 percent. Xcel replied that provided emissions can be properly measured (that is, are not too low to confound monitoring) and provided that a reasonable injection rate of brominated carbon that is not too costly can be achieved, then Xcel is optimistic that higher mercury-removal efficiencies are achievable.[5]

Table 1 describes the range of mercury emissions expected with each of the evaluated carbon injection technologies. The "low" expected removal of 80 percent is a result of vendors' concerns with the ability of continuous mercury monitors to accurately measure low emissions. In this case, vendors offered guarantees to achieve a specific mercury emissions rate (1 ng/dscm).

Table 1. Mercury emissions from A. S. King activated-carbon-injection control alternatives

	Coal input	Stack	Mercury removal		Mercury at stack	
	Mercury in fuel	Baseline emissions	Fuel basis		Low % removal	High % removal
	lb./TBtu	lb./TBtu	Low %	High %	lb./TBtu	lb./TBtu
Existing conditions	6.66	2.13				2.13
B-PAC	6.66		87%	90%	0.90	0.67
Coal cleaning with B-PAC	6.66		80%	90%	1.33	0.67

[4] C. Wedig, W. Frazier; E. Begg, referencing Institute of Clean Air Companies' Commercial Electric Utility Mercury Control Technology Bookings in "Future of national mercury rule now uncertain" Power, Vol. 152, No. 5 May 2008. http://www.icac.com/files/public/Commercial_Hg_Equipment_050808.pdf Accessed May 21, 2008.

[5] Xcel Reply, Information Request 1-2. April 21, 2008.

Minplus

Xcel included in its site analysis the use of Minplus, a clay-based sorbent, as a technically feasible alternative for mercury control.

The first full scale application of Minplus has been attempted at Minnesota Power's Taconite Harbor plant as part of its Arrowhead Region Emissions Abatement (AREA) project. Minnesota Power described its experience with the use of the sorbent in its Petition to Implement AREA Rider for Unit 1[6]. Minnesota Power reports several concerns: there was considerable difficulty handling the sorbent but more importantly, mercury-emission testing has shown Minplus unable to achieve any mercury removal. Minnesota Power is now testing other means of controlling mercury emissions at Taconite Harbor. Given that the Minplus technology has not performed well enough to meet statutory reduction goals and has considerable operating difficulties, the MPCA believes that at this time, the technology has not been determined to be feasible as a full-scale technology and has excluded this technology in its cost-effective assessment of mercury controls.

Summary of Technical Assessment

The MPCA believes that Xcel and its engineering consultant conducted its technology assessment in an appropriate manner. Site and technology limitations appear to have been weighed appropriately. While the mercury removal efficiencies of each technology identified were described based on vendor guarantees and not on actual performance data, given the number of uncertainties, they are appropriately described.

2.2 Cost-effectiveness analysis of mercury controls

The technologies found to be feasible at King were evaluated in the cost-effective analysis prepared for Xcel. As discussed previously, only two technologies appear to be technically feasible in achieving a 90 percent reduction. Their costs are presented below.

Table 2. MPCA assessment of cost-effectiveness of mercury control alternatives at King

Mercury Control Technology	Total Annual Cost (1,000s)	Mercury Removed at the minimum expected mercury % removal Lb/yr	$/lb Mercury Removed, at the minimum expected mercury removal	Mercury Removed at 90% mercury removal Lb/yr	$/lb Mercury Removed, at 90% mercury removal
B-PAC	$3,762	47.3	$79,535	56	$66,821
Coal cleaning with B-PAC	$35,122	30.7	$1,144,039	56	$623,837

Total annual costs include operating cost (sorbent purchase, specially-prepared coal purchase in the case of coal-cleaning), fixed annual costs and capital recovery. A range of cost is due to the range in expected removal of mercury. It is evident that B-PAC injection (without coal cleaning) is the least-cost plan for achieving the goal of 90% reduction of mercury.

2.3 Summary

The MPCA concurs with Xcel Energy's technical assessment of mercury controls. Xcel Energy has accurately described the current status of control development in its filing. There are two technologies available at King that have been demonstrated to achieve the very high mercury removal set as a goal by the Mercury Emissions Reduction Act for subbituminous coal-fired boilers.

Xcel has selected the least-cost alternative that has the greatest potential of achieving the statutory goal of 90 percent reduction of mercury emissions at King.

[6] Minnesota Power, Petition to Implement AREA Rider (Taconite Harbor Unit 1) Docket No. E015/M-05-1678, March 31, 2008.

3.0 Estimated capital and annual cost of the proposals

The MPCA reviewed the cost of the proposed project and alternatives to determine whether the estimated costs are reasonable. Both annual and capital costs were reviewed to determine whether they are within a reasonable range for the size and nature of the project.

3.1 Method of analysis

The Mercury Emissions Reduction Act requires the MPCA to assess the cost-effectiveness of mercury controls. In section 2.0, we examined the cost-effectiveness of mercury reduction, as required by M.S. § 216B.684, item (3).

It is noted that the construction industry continues to experience ongoing increases in costs of nearly all inputs: energy (both equipment manufacture and transport), cement, and steel, and specialized skilled labor. Xcel reports that estimates are to be considered "order of magnitude" only.

3.2. Assessment of King cost estimate

Cost estimates were prepared on Xcel's behalf by an engineering consultant. Capital cost estimates include all costs related to the project, including engineering, contingencies, and allowance for funds during construction. Annual costs include additional ash disposal albeit very small, some auxiliary power for pumps, meters, fans, reagent purchases (activated carbon, for instance) and emissions testing. Vendors provided estimates of capital and certain annual costs; Xcel's consultant made some adjustments based on experience with past projects. The estimates are order of magnitude, meaning that costs could change as engineering continues or volatility in costs continues. Xcel did not use retrofit multipliers to account for complicated construction conditions.

Three of the four alternatives rely on activated carbon injection prior to the fabric filter; the third (Minplus) also injects sorbent into the flue gases, but the sorbent has different physical characteristics requiring a different material handling system. The capital cost for the three carbon injection alternatives are identical; they differ due to their operating costs. Total annual costs vary due to the cost of differing sorbents, or proprietary fuel (coal cleaning).

Table 3. Capital and annual costs of mercury-control alternatives at King

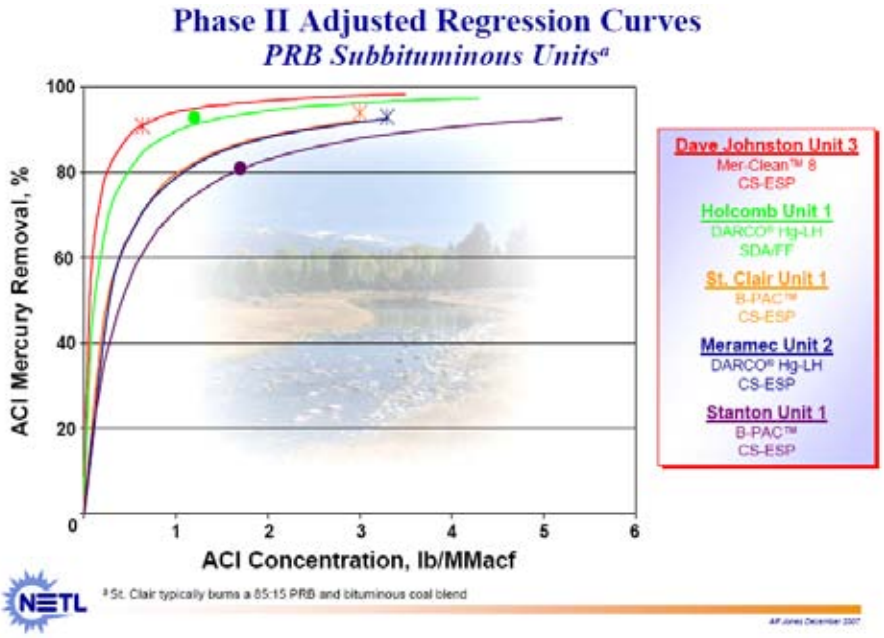
Mercury-control Technology	Total Capital Cost (1,000s)	$/kW	Total Annual Cost (1,000s)
B-PAC	$4,419	$7.2	$3,762
Coal cleaning with B-PAC	$4,419	$7.2	$35,122

Due to the recent commercialization of mercury-control technologies, there are few published studies of the implementation costs for them. U.S. Department of Energy's Energy Information Agency estimated in 2007 that the cost of installing activated-carbon-injection systems would be about five dollars per kW. A recent National Energy Technology Laboratory presentation describes sorbent storage and injection systems as "not a very capital-intensive process."[7].

The primary component of the annual cost is the quantity of sorbent used. Figure 2 shows the performance of different reagents at subbituminous units with differing air-pollution-control equipment. Note that with a spray dryer/fabric filter system (SDA/FF, the pollution-control system in place at King), removal efficiencies greater than 80 percent are quickly achieved with small amounts of sorbent (Holcomb Unit 1). Using more sorbent will achieve 90 percent reduction and greater, but at some point, the removal efficiency no longer improves significantly with the use of more sorbent.

[7] A.P. Jones, DOE/NETL's Mercury Control Technology R&D Program Review, December 12, 2007, Pittsburgh, PA. www.netl.doe.gov/publications/proceedings/07/mercury/presentations/Jones_pres.pdf Accessed April 7, 2008.

Figure 2. ACI injection rates at units burning Powder River Basin coals from DOE National Energy Technology Laboratories[8]



Cost analyses for King assume a fixed injection rate to achieve the 90 percent removal of mercury contained in the coal burned. Xcel estimated the annual cost of sorbent injection by relying on vendor estimates of sorbent injection rates for achieving 90 percent removal. Improvements in both removal efficiencies and sorbent use will develop from long-term performance assessment of the mercury-control technology.

The MPCA notes that Minn. Stat. § 216B.685, subd. 5, directs the Commission to include in orders approving the mercury-reduction plan and rate rider a requirement that Xcel optimize the system to maximize mercury reductions and report the efforts and results annually to the MPCA. These reports will be a useful avenue for Xcel to report on its efforts to optimize mercury control, in terms of both achieving the goal of 90 percent reduction in mercury and any developments related to types and amounts of sorbent being used to achieve reductions.

3.3 Summary

Cost estimates for the King project prepared by Xcel Energy and its consultant appear to be reasonable. The estimates were generated using reliable data sources and standard estimating procedures and tools. The MPCA believes that Xcel Energy has used best available information to estimate capital and annual costs of these pollution-control projects and at this time are appropriate estimates of the projects.

[8] See footnote 7.

4.0 Assessment of benefits of King mercury-control plan

The Mercury Emissions Reduction Act requires that the MPCA evaluate the environmental and public health benefits related to the mercury-control project. Minn. Stat. § 216B.684, item (2).

Mercury emissions contribute to fish consumption advisories and water-quality impairment via atmospheric deposition on lakes, rivers and contributing watersheds. The MPCA's 2004 impaired waters list identifies 419 river reaches and 820 lakes[9] in Minnesota that are considered impaired because the fish in them are contaminated with mercury. While much has been done in Minnesota and nationally to reduce mercury emissions, coal-burning power plants remain a major contributor to environmental mercury contamination. The Mercury Emissions Reduction Act begins to address the potential contribution of Minnesota's coal-fired boilers to fish contamination.

The selection of sorbent injection technology results in likely reductions of mercury at the King generating station as described in the table below. Mercury emissions from electric generating units are reported annually to the MPCA as required by Minn. Stat. § 116.925. Emissions in Table 4 reflect the mercury emissions if the unit is operated at 85 percent capacity.

Table 4. Annual mercury emissions for Xcel Energy King generating station[10]

	Mercury (lb.) Before Mercury Controls	**Mercury (lb.)** After Mercury Controls
King	81	25.6 to 34
King Emissions Change		-47 to -56
Percent Reduction King		-57 to -68%

Benefits related to criteria pollutant reductions [particulate matter, nitrogen oxides (NO_x), sulfur dioxide (SO_2)] have been evaluated with reasonable confidence. The MPCA's most recent assessment of the benefits of reductions in power plant emission was its 2007 evaluation of Minnesota Power's plan for air pollution controls at Boswell generating station Unit 3, where reductions in criteria pollutants along with mercury controls are planned. A computer model was used to develop the value of health benefits, and that value was compared to annual costs. The assessment did not quantify benefit estimates for mercury-related impacts.[11]

The MPCA cannot yet give the Commission a reasonable reasonable quantifiable estimate of benefits from mercury reductions as can be done for reductions in nitrogen oxides, for example. Rather, the MPCA discusses the benefits of mercury reductions in terms of their types and rates. This will not allow a direct comparison of site-specific benefits and costs, but it will suggest useful relative values.

The Mercury Emissions Reduction Act does not require either the MPCA or the Commission to conduct a formal benefit-cost analysis. Although past evaluations of emission-reduction plans have made quantified benefit estimates when they are practical and reasonable, we and others have taken care to note that a number of environmental benefits cannot be quantified because available information does not support reasonable estimates.

[9] MPCA, 2004. www.pca.state.mn.us/publications/wq-iw4-01a.pdf

[10] Assuming operation at 85 percent capacity

[11] "MPCA Review of Minnesota Power's Boswell 3 Emission Reduction Plan," (pp. 21-24). http://www.pca.state.mn.us/hot/mnpower-boswell.html

Since our benefit estimates are necessarily incomplete and uncertain in some respects, we have considered them as informative and advisory discussions, rather than evidence of whether a plan meets a legislated standard. This position fits well with conventional practice in benefit-cost analysis.

> …[N]o CBA (cost-benefit analysis) can by itself capture all factors relevant to all decisions. Data will be missing or of questionable validity. Uncertainty about the future will exist. There will be effects that are difficult to quantify. The decision may be one in which the role of CBA is limited as there are fundamental value questions at stake not best addressed by CBA. Finally, decisions are the responsibility of those elected or appointed to make them, and not the responsibility of an economic algorithm. For these reasons, the proper view of CBA is that of furnishing information to the decision process and not as providing the decision.[12]

Our discussion of mercury benefits is based on a set of recent studies:

Northeast States for Coordinated Air Management (NESCAUM)	Glenn Rice and James Hammitt: "Economic Valuation of Human Health Benefits of Controlling Mercury Emissions from U.S. Coal-Fired Power Plants," February 2005 www.nescaum.org/documents/rpt050315mercuryhealth.pdf/
National Institutes of Health	Leonardo Trasande et. al.: "Public Health and Economic Consequences of Methymercury Toxicity to the Developing Brain," February 2005 www.ehponline.org/docs/2005/7743/abstract.html
Resources for the Future	Karen Palmer et. al.: "Reducing Emissions from the Electricity Sector: The Costs and Benefits Nationwide and in the Empire State," June 2005 www.rff.org/rff/Documents/RFF-DP-05-23-Exec-Sum.pdf
U.S. Environmental Protection Agency	Douglas Rae and Laura Graham: "Benefits of Reducing Mercury in Saltwater Ecosystems," January 2004 www.cleanairnow.org/pdfs/officewatermerc.pdf
U.S. Environmental Protection Agency	Charles Griffiths et. al.: "A Comparison of the Monetized Impact of IQ Decrements from Mercury Emissions," June 2007 www.ehponline.org/docs/2007/9797/abstact.html

These studies vary with respect to methods and scope. Their benefit estimates differ because, although general understanding of mercury in the environment is reasonably clear, the specific details of cause and effect are uncertain. Some things are known beyond a reasonable doubt:

- Mercury is a potent neurotoxin.
- Mercury is deposited in Minnesota lakes and — while undergoing a complex environmental cycle — is converted to methylmercury which bioaccumulates in aquatic food chains.
- The predatory fish favored by fishermen have relatively high concentrations of mercury in their muscle tissue.
- Methylmercury transfers from pregnant women to their developing fetuses.
- Neural damage occurs with fetal exposure to methylmercury.

[12] R.O. Zerbe, 2007. "The Legal Foundation of Cost-Benefit Analysis" ExpressO Available at: http://works.bepress.com/richard_zerbe/2

Other aspects of benefit estimates are more uncertain, requiring analysts to make assumptions about significant values such as:

- dose-response relationships that describe the connection between mercury exposure and declines in children's IQ scores
- mercury exposure rates in general populations and in distinctive subgroups
- lags in bioaccumulation of methylmercury in fish.

Finally, some elements of benefit estimates fall into a "suspected, but not fully supported" category. These are the elements often referred to as unquantified benefits:

- reduced heart attacks, both fatal and otherwise
- minimized damage to fish and fish-eating wildlife (loons, kingfisher, eagle, otter, mink and others).

Given variance in study methods, it is not unusual to learn that studies vary with respect to their findings. All of the listed studies estimate total values for benefits under different scenarios. Four of them base their scenario analyses on assumed amounts of emission reductions. For example, each study estimates that if mercury emissions are reduced by *x* pounds, positive health effects will result with benefits valued in the billions of dollars. We can calculate rates, in dollars per pound for each estimate that make their findings somewhat comparable.[13] See Table 5.

Table 5. Estimated benefits of reduced mercury emissions

	Benefits related to avoiding declining IQ in children ($/lb.)		Benefits related to reductions in heart attacks ($/lb.)	
	Low	**High**	**Low**	**High**
Rae & Graham	$ 1,346	$1,368	$9,063	$ 9,437
Palmer et. al.	$ 2,000	$ 5,050	$500	$ 86,150
Rice & Hammitt	$ 1,630	$ 4,235	$ 1,043	$ 72,059
Griffiths et. al.	$4,038	$ 7,000		

The U.S. Environmental Protection Agency (EPA) and others regard IQ-related benefits as having the best support. These benefits are generally modeled as changes in the IQ scores of children in affected communities. Benefit estimates in this category range from about $1,300 to $7,000/lb.

Another group of estimates relate mercury emission changes to heart attacks, both fatal and nonfatal. Studies supporting these estimates are more recent and less thoroughly tested than IQ-related studies. Benefit estimates related to cardiovascular effects are not considered as reliable as IQ-related estimates. When heart-related effects are taken into account, benefit estimates range from $500 to $86,000/lb. The wide range results because estimating models depend significantly on assumptions that vary quite a lot. Moreover, medical researchers debate whether avoiding the consumption of fish to avoid ingesting contaminants is sound health advice, given the benefits of eating fish.

On balance, we find that the weight of evidence supports a general finding that reducing mercury emissions will lead to economic benefits in terms of health improvements. However, the precise value of these benefits remains uncertain. Although available research shows estimates that present a range of values, methodological idiosyncrasies mean that each point between studies has a more or less equal likelihood. Comparisons based on the range of values between studies would not have strong foundations. Note also that, although benefit estimates remain uncertain, researchers continue to study all aspects of mercury's environmental impacts. As time goes by, we expect that uncertainties will decline to the point that we can endorse reasonable value estimates.

[13] Specific differences remain with respect to methods (e.g., dose-response functions, unit values for lost IQ points, monetary bases, assumptions about the value of a "statistical-life") and scope (e.g., national versus regional). These differences mean benefit rates should be viewed as informative rather than directly comparable.

5.0 Appropriateness of the proposed project

The MPCA is required by Minn. Stat. 216B.684, item (4), to describe the overall appropriateness of a utility's plan for reducing mercury. We describe in this part our assessment of the applicable federal power-plant-emission-control programs and how Xcel Energy's King plan addresses those program requirements. We also describe why the project qualifies for the rate consideration provided by the Mercury Emissions Reduction Act.

5.1 Minnesota's mercury total maximum daily load Limit

Section 303(d) of the federal Clean Water Act requires every state to prepare a list of impaired waters. Minnesota's 2004 303(d) List ("Impaired Waters List") includes water-quality impairments in 1,892 lakes and river reaches. Two-thirds of those waters are impaired because of mercury. The 1,239 impairments by mercury consist of 820 lake impairments and 419 river impairments. Twelve lakes and 20 river reaches are impaired for mercury in fish tissue and in the water column; 808 lakes and 399 river reaches are impaired for fish tissue only.

Each impaired water is required to have a total maximum daily load (TMDL) study. The TMDL is an evaluation of (1) pollutant sources, (2) pollutant load reduction needed to meet water-quality standards and (3) allocation of the acceptable load to all sources. The source of essentially all mercury in Minnesota waters is atmospheric. 70 percent of atmospheric mercury deposition is from anthropogenic sources (i.e., from human activities) and the remaining 30 percent is from natural sources, such as volcanoes. Minnesota's TMDL mercury emissions goal is to lower mercury emissions from Minnesota sources to 789 pounds. per year. Atmospheric mercury emissions in 2005 are estimated to be 3,314 pounds per year, from all sources in Minnesota. The EPA approved Minnesota's TMDL study for mercury-impaired waters on March 27, 2007.

The MPCA and a stakeholder group have just completed the development of strategies to reduce emissions of mercury to the atmosphere from sources within Minnesota to achieve the reduction goal established in the TMDL by 2025. A key component of achieving the EPA-approved reduction goal is the control of mercury emissions from electric-generating units. Emissions in 2005 from Sherco 3 represent ten percent of mercury emissions from electric-generating units, and nine percent of all mercury emissions in Minnesota. Implementing this proposal will result in considerable progress in achieving the TMDL reduction goal.

5.2 Federal emission-control regulations

In 2005, the EPA promulgated the Clean Air Mercury Rule (CAMR), a mercury cap-and-trade program, to reduce mercury emissions by 70 percent from electric-generating units (EGUs) in the United States. In March 2008, the U.S. Court of Appeals vacated the standard, determining that the EPA failed to use procedures required by the Clean Air Act to "delist" EGUs from standards of performance for hazardous air pollutants. The vacatur leaves coal-fired EGUs unregulated until EPA can promulgate performance standard to replace CAMR.

EPA has not yet announced its strategy for developing standards to replace CAMR, however the MPCA expects that EPA evaluations of achievable mercury control standards will rely primarily on the performance of carbon injection systems like this proposal for Sherco 3.

This proposal implements a technology that the generating industry is favoring for mercury control, for new units as well as a retrofit technology, and represents a very low-cost investment. Given the continuing requirement under future federal regulations to control mercury, the minimal disruption and capital cost that this proposal represents, and the likelihood that this technology will meet future federal standards, the MPCA believes this plan is an appropriate means of meeting the goals of the Mercury Emissions Reduction Act.

5.3 Qualification of the project

The Mercury Emissions Reduction Act in Minn. Stat. § 216B.684 directs the MPCA to assess whether the utility's plan meets the requirements of Minn. Stat. § 216B.682.

Minn. Stat. § 216B.682, subd. 3(a) states:

> In each plan submitted under this section, a utility shall present information assessing that plan's ability to optimize human health benefits and achieve cost efficiencies. Each plan must provide the cost, technical feasibility, and mercury emissions reduction expected for the utility's preferred technology option and each alternative considered. The utility shall demonstrate that it has considered achieving the mercury emissions reduction required under this section through multiple pollutant control technology.

Xcel interprets the statute's requirement to "optimize human health benefits and achieve cost efficiencies" as achievement of the 90 percent reduction goal. In other words, health benefits are optimized when planners identify control systems that will reduce mercury emissions by 90 percent. This interpretation is more or less the same as the interpretation Minnesota Power made in its recent plan for mercury reductions at its Boswell plant.

The Legislature did not define "optimize" in the MERA. However, because Xcel's preferred option represents the least-cost method most likely to achieve the reduction goal that was set by the legislature out of concern for human health, we find that Xcel Energy has met its responsibility for optimization under Minn. Stat. § 216B.682.

Xcel evaluated the cost, technical feasibility and emissions reduction for its preferred option and alternatives. The MPCA believes that Xcel has met the requirements of Minn. Stat. § 216B.682.

5.4 Summary

The MPCA believes that Xcel Energy's plan for reducing mercury at King is appropriate. The mercury reduction is substantial and will help achieve the mercury reductions needed to address contamination of fish in Minnesota lakes. The project represents a low-cost means of achieving that reduction and will likely meet, and potentially exceed, the Mercury Emissions Reduction Act's goal of 90 percent reduction of mercury from King.