Mercury Reduction Program

Progress Report
to the
Minnesota Legislature

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Minnesota Pollution
Control Agency

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Section 1. Summary, Introduction and Recommendations

Report is required by the Mercury Reduction Law.

In 1999, the legislature passed Minn. Stat. § 116.915 to help reduce mercury contamination in Minnesota fish. The statute (1) sets state mercury release goals, (2) lists Minnesota Pollution Control Agency (MPCA) contamination-reduction strategies, (3) requires the MPCA to solicit voluntary reduction agreements, and (4) requires reports in 2001 and 2005. This is the 2001 report.

Problem: Eating mercury-contaminated fish may harm developing nerve systems.

Recent information reaffirms that methylmercury-contaminated fish, when eaten by children and expectant mothers, may be causing subtle but widespread neurological damage in children in the United States. In Minnesota, mercury levels in fish are starting to drop, but contamination remains widespread. Continued efforts to reduce mercury releases and to better understand other factors leading to mercury contamination in fish are needed.

State mercury releases have dropped by two-thirds since 1990; recent progress has been slower.

The MPCA estimates that mercury releases in Minnesota dropped about 68 percent between 1990 and 2000, nearing the 70 percent state reduction goal for 2005. The statewide reductions are due almost entirely to efforts taken before the 1999 legislation — specifically, banning or restricting mercury use in products such as paint and batteries in the early 1990s, as well as controls on incinerators. In large part, the percentage reductions reflect increased estimates of the 1990 baseline mercury inventory. (A dynamic research system supports emission estimates. That is why emission inventories have and will continue to change.) Emissions from most industrial sources, such as coal-fired power plants, have remained relatively constant since 1990. This report summarizes the complex, indirect relationship between mercury releases and contamination in fish, and concludes that further state release reductions are needed.

Voluntary agreements provide valuable information, but direct reductions or specific commitments are limited.

This report summarizes and evaluates state mercury-reduction programs, including voluntary agreements. The 1999 legislation did not establish clear evaluation goals or criteria for the voluntary agreements, so their success is difficult to judge definitively. Fifteen agreements are in place. Most participants have developed important new information that may lead to future reductions. However, with some notable exceptions, the agreements have produced few measurable mercury reductions or long-term reduction commitments to date.

Recommendations: new legislation to establish clearer voluntary goals, develop clearer expectations for voluntary agreement participants and better linkages between regulatory and voluntary efforts

The MPCA recommends new legislation to revise the overall mercury-reduction goals to recapture the spirit and intent of the 1999 legislation and develop clearer expectations and clearer benefits for voluntary agreement participants.

Revise mercury-reduction goals; continue Voluntary Agreement Program. The following recommendations are made to improve reduction goals and the Voluntary Agreement Program:

1. Future legislation should be enacted to revise the overall mercury-reduction goals to recapture the intent of the 1999 legislation. The MPCA recommends establishing a clearer goal that is not subject to revisions of the baseline inventory. The 70 percent reduction goal in the 1999 legislation translated to total statewide releases of about 2,500 pounds per year by 2005 (using the figures for the inventory estimated in 1999). Under the latest MPCA estimates, coal and taconite emissions would need to drop by 10 to 20 percent below their 1990 levels to reach the 2,500-pounds-per-year figure by 2005. Therefore, we recommend that the reduction goals for both coal and taconite emissions be set at no less than 10 percent below their 1990 levels by 2005.
2. Continue the voluntary agreement program until at least October 15, 2005, when the program will be reevaluated in light of federal regulatory developments in both air and water. Annual progress reports and public presentations by participants will continue.

Develop clearer expectations. Based on program results to date and the results of other voluntary agreement programs in Europe and Canada, specific, measurable targets are a prerequisite to a successful nonregulatory effort. Therefore:

3. By October 31, 2002, the MPCA will develop standardized measurement, verification and reporting protocols, based on available information, for the voluntary agreements.
4. By December 31, 2002, the MPCA will develop voluntary targets for each relevant sector and for each facility that releases more than 50 pounds of mercury per year. Reduction efforts will consider several factors, including the environmental significance of the sector or facility, the availability of technology, and economics. The MPCA recommends that future legislation reference the sector- and facility-specific goals.

Develop a coordinated regulatory and voluntary mercury-reduction program. To develop clearer benefits for participants, including better permitting predictability, the following efforts are recommended:

5. For coal-fired power plants and taconite-processing firms, the MPCA will work with the U.S. Environmental Protection Agency (EPA) and other states to advocate for federal recognition of early reductions. The MPCA's efforts will include exploring the establishment of systems that will satisfy federal authorities' concerns that local emission reductions are "surplus, quantifiable, enforceable and permanent." As part of this, the MPCA will investigage establishing a state registry for emission reductions (including funding options for maintaining such a registry).
6. For municipalities and industries that discharge wastewater to impaired waters, the MPCA will advocate for federal recognition of reductions. Depending on future federal total maximum daily load (TMDL) policy, this may become part of future Minnesota TMDL implementation.

The following recommendations are made to improve the general Mercury Reduction Program:

1. Improve public communication and coordination efforts, and improve access to mercury-reduction best practices information for sources. This can be achieved, in cooperation with the EPA and other partners, through the expanded, Internet-based Great Lakes Mercury pilot project.
2. Participate with the Environmental Council of States to encourage the EPA to better coordinate the many federal programs and forums that are in place to address various aspects of the mercury problem.
3. Participate actively in federal efforts to regulate mercury emissions from coal-fired power plants, with a preference for allowing flexibility and trading if structured to protect local impacts.
4. Continue evaluation and potential use of a generic, statewide TMDL for mercury as a vehicle for developing a more coherent framework of specific expectations and reduction schedules for all state mercury sources.
5. Collaborate with the Department of Commerce and the Public Utilities Commission to actively support and advocate for energy conservation and construction of energy sources that do not emit mercury.

Section 2. Human Health Risk and Fish Contamination

This section outlines health risks, appropriateness of state reduction goals.

This section summarizes the following four topics:
- health risks of eating mercury-contaminated fish;
- mercury contamination and deposition trends;
- the relationship between statewide releases and fish contamination; and
- appropriateness of statewide reduction goals.

The problem: Mercury, a potent nerve toxin, accumulates in fish.

Mercury is a naturally occurring metal that is also a potent nerve toxin. Human exposure occurs through two main routes:
- by breathing elemental mercury vapors, and
- by eating methylmercury-contaminated fish.

Breathing too much elemental mercury — the kind used in some thermometers and switches — can cause lung damage, nausea, skin damage, permanent nerve damage and even death under certain circumstances.

More commonly, low-level human exposure occurs through eating mercury-contaminated fish. Small amounts of mercury in lakes and rivers are transformed into methylmercury, primarily by bacteria. Methylmercury then accumulates up the aquatic food chain to reach high levels in fish and fish-eating wildlife. Predatory fish — bass, walleye and northern pike — tend to have the highest concentrations of mercury because they are at the top of the food chain.

Methylmercury may cause widespread, subtle developmental damage in children.

In 2000, the National Academy of Science's National Research Council (NRC) published a report that evaluated several epidemiological studies on the human health impacts of eating methylmercury-contaminated fish. The NRC report indicates that few adults eat enough contaminated fish to be at direct risk of mercury poisoning. Mercury, however, selectively harms developing nervous systems. The NRC report reinforced previous conclusions that low-level methylmercury exposure through fish consumption may be causing subtle, but widespread, neurological damage in fetuses and young children. Communities that rely on fishing for a large part of their diet have had to reduce their fish consumption because of mercury contamination.

Federal study shows elevated methylmercury levels in 10 percent of U.S. women.

Another study recently released by the Centers for Disease Control (CDC), titled the National Health and Nutrition Examination Survey (NHANES), indicates that 10 percent of their sample of women of childbearing age had been exposed to levels of methylmercury close to that suspected of causing adverse effects. Using this information and the number of births registered in the United States in 1998, the U.S. Environmental Protection Agency (EPA) has estimated that as many as 400,000 newborns are at risk of elevated methylmercury exposure. Methylmercury exposure levels estimated in a recent study of fish consumption in Minnesota and North Dakota (Energy and Environmental Research Center, 2001) support the results of the CDC's NHANES study.

Mercury contamination of fish in selected lakes has dropped about 12 percent since 1990, but contamination is still widespread.

Methylmercury concentrations in Minnesota fish appear to be declining, but gradually. In lakes for which the MPCA has three or more years of data, methylmercury concentrations in fish have, on average, declined about 12 percent over the last 10 years. However, this subset of lakes may not be representative of all lakes statewide.

Despite substantial reductions in mercury releases over the last 20 years (described below), the fish in many lakes and rivers remain contaminated with methylmercury. The Minnesota Department of Health continues to publish annual fish consumption advisories on how often various types of fish from Minnesota water bodies may be safely eaten. Parents and expecting parents should be particularly careful to monitor the frequency and type of fish that they and their children eat.

In addition, negative developmental effects due to methylmercury on loons and other fish-eating wildlife have been documented in some parts of North America.

Deposition rates show some decreases, some increases.

The amount of mercury entering our lakes can be estimated by (a) measuring the mercury that accumulates in sediment layers on lake bottoms or (b) direct measurements of the mercury falling in rain and dry particles. Sediment coring studies indicate that mercury deposition in Minnesota has declined since the 1970s in some areas, but has not declined in others. More recent (since 1990) measurements of the mercury in rainfall, show slight increases or slight decreases, depending on location and data analysis technique used.

Seventy to 90 percent of mercury comes from air pollution sources located outside the state.

For a variety of complex reasons, there is not a direct relationship between (1) state mercury releases, (2) the level of mercury entering our lakes, and (3) the concentration of methylmercury in fish.

In most areas of Minnesota, up to 90 percent of the mercury entering our waters comes from a wide variety of natural and man-made air pollution sources located throughout North America and the rest of the world. When it is washed out of the atmosphere, this airborne mercury falls on or near our lakes.

Conversely, most of the mercury from our air emission sources tends to be transported outside the state. Some in-state mercury releases, such as mercury in wastewater discharges and certain air emissions that tend to fall near their source, do affect Minnesota waters more directly. However, releases from most of these sources have been reduced substantially in Minnesota since 1990.

Contamination of fish depends on mercury inputs, other factors.

Surprisingly, some of our most pristine lakes contain our most contaminated fish. But fish from nearby lakes with similar mercury inputs can have lower methylmercruy levels. This is because the pathways between mercury releases and fish contamination are complex and vary between water bodies. Fish mercury levels depend not only on mercury loading from the atmosphere and watershed but also on such factors as the fish population and the rate at which the mercury is converted into methylmercury (which in turn is related to sulfate concentrations and other factors).

Mercury is a national and global pollutant, but state-level reduction efforts are important.

Although the relationship between Minnesota mercury air emissions and contamination of Minnesota fish is often indirect, continued local and statewide reduction efforts are important:

- to help reduce contamination in our own lakes, and to do our part to reduce global mercury emissions. (Our emissions contribute to the contamination of ocean fish, which we eat.) and
- to help develop innovative, cost-effective solutions.

Continued reductions in state mercury releases are necessary.

In conclusion, based on the most recent evidence of human and ecological health impacts of low-level methylmercury exposure, further efforts to reduce mercury contamination in fish are necessary. Minnesota, with its many lakes, is among those states at greatest risk. In addition, Minnesotans believe they have a right to expect fish to be safe to eat without consulting a fish consumption advisory.

Section 3. Progress Toward Meeting State Mercury-reduction Goals

Mercury is released from many sources, including consumer and industrial products.

In Minnesota, mercury is released by a wide variety of sources, including incinerators, fossil fuel combustion, iron-ore processing and products that contain mercury, such as paint, batteries, electrical switches and thermometers. (More than 350 tons of elemental mercury are still used in products manufactured in the United States every year.)

Much of the mercury used in products is recycled and reused, or remains relatively safe. Some, however, is released when it is spilled or when it is thrown down the drain or into the garbage. This mercury is commonly referred to as "product-related."

Mercury releases have dropped two-thirds since 1990 due to product bans, incinerator controls, new information.

The amount of mercury used and released in Minnesota and the United States has been cut dramatically over the last 20 years. Annual mercury releases in Minnesota are about one-third what they were in 1990, according to the latest MPCA estimates.

The statewide mercury reduction goal set in Minn. Stat. § 116.915 is to reduce annual mercury releases 60 percent by 2000 and by 70 percent by 2005, compared to 1990 levels. Current MPCA estimates indicate that statewide releases in 2000 were about 3,800 pounds, 68 percent below estimated 1990 levels and 2 percent short of the 2005 goal.

Nearly all reductions since 1990 are due to banning or restricting the intentional use of mercury in products like paint (where it was used as a fungicide), batteries and electrical equipment — as well as emission controls on waste-combustion facilities.

New estimates increase 1990 baseline, complicate use of percent reduction goal.

The mercury inventory is dynamic and changes to reflect new scientific information and changes in technology and industry.

The single largest recent change in the state mercury inventory is due to better information about past releases, not new reductions. The MPCA now estimates that over 3,000 pounds more mercury were released from paint in 1990 than was previously estimated (500 pounds had been the previous estimate). As a result, the estimated total 1990 emissions rose from about 8,450 pounds to 11,700 pounds. The result is that, compared to earlier estimates, the percent decline in mercury emissions between 1990 and 2000 is much greater (compare figures 1 and 2). So, this essentially means that we had met our 2000 reduction goal (and came within 2 percent of the 2005 goal) stated in the 1999 legislation before the legislation even took effect.

Coal, taconite emissions are flat, represent an increasingly large percentage of total.

Mercury releases from products have declined since 1990. However, emissions from harder-to-control industrial sources have remained constant or increased slightly. As a result, direct emissions from coal combustion and taconite processing now constitute a higher percentage of total emissions. (Coal's share increased from 13 percent to 43 percent of total emissions and taconite's share increased from 6 percent to 20 percent.) Many of these industrial sources have, however, helped reduce product-related releases by replacing mercury-bearing equipment and related efforts. (See figures 3 and 4.)

Under the MPCA's latest inventory, the state could reach its 70 percent goal set for 2005 without significant, direct reductions in emissions from coal-fired power plants and taconite facilities. To maintain statewide progress, direct emission reductions will be needed from electrical utility and taconite firms because product-related reductions will become increasingly difficult over the next decade.

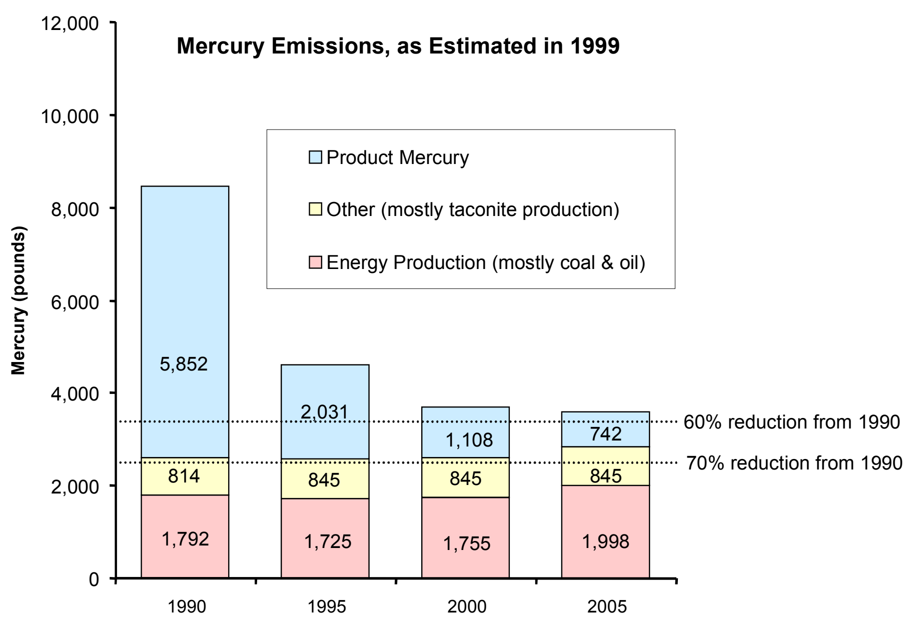

Figure 1. Statewide mercury release inventory, as understood during the discussions leading up to the 1999 legislation that set the statewide 60% and 70% reduction goals from the 1990 baseline.

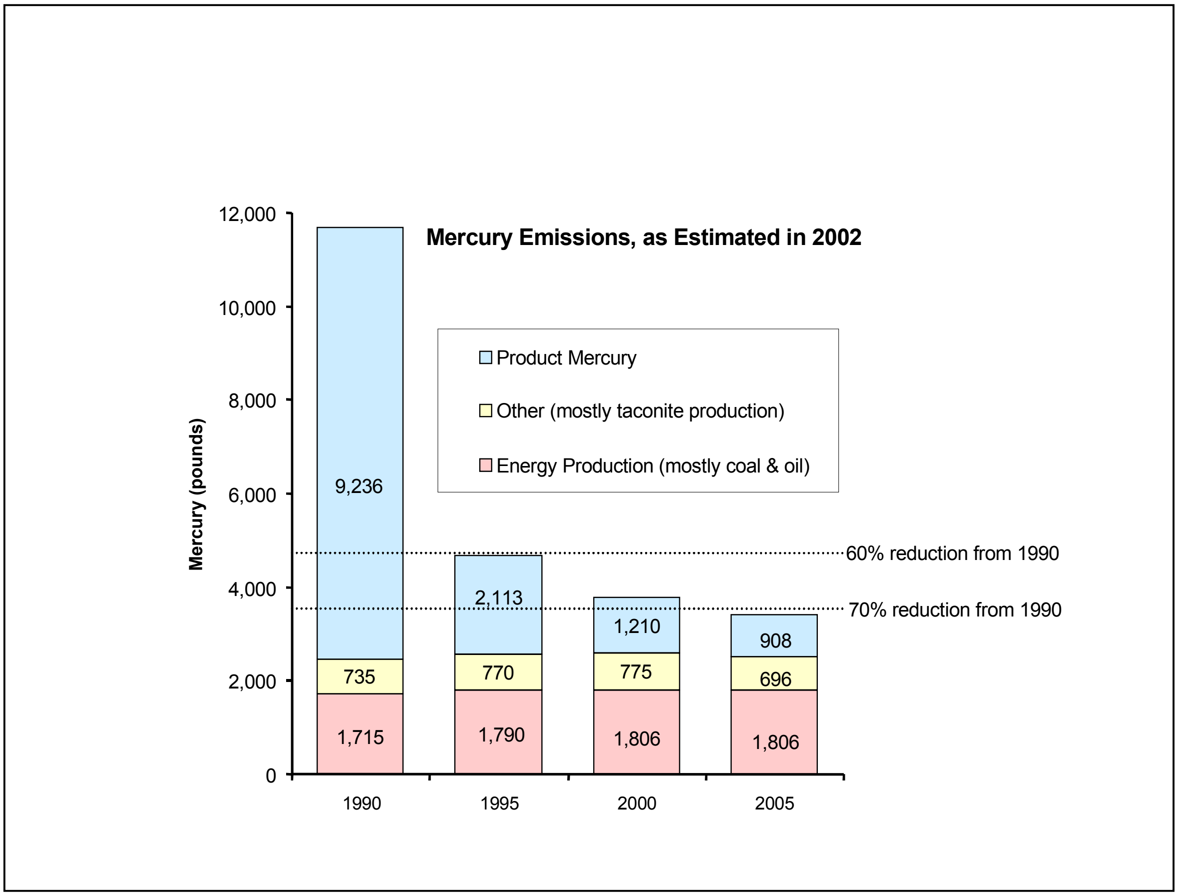

Figure 2. Statewide mercury release inventory, as updated in this report, with 60% and 70% statewide reduction goals.

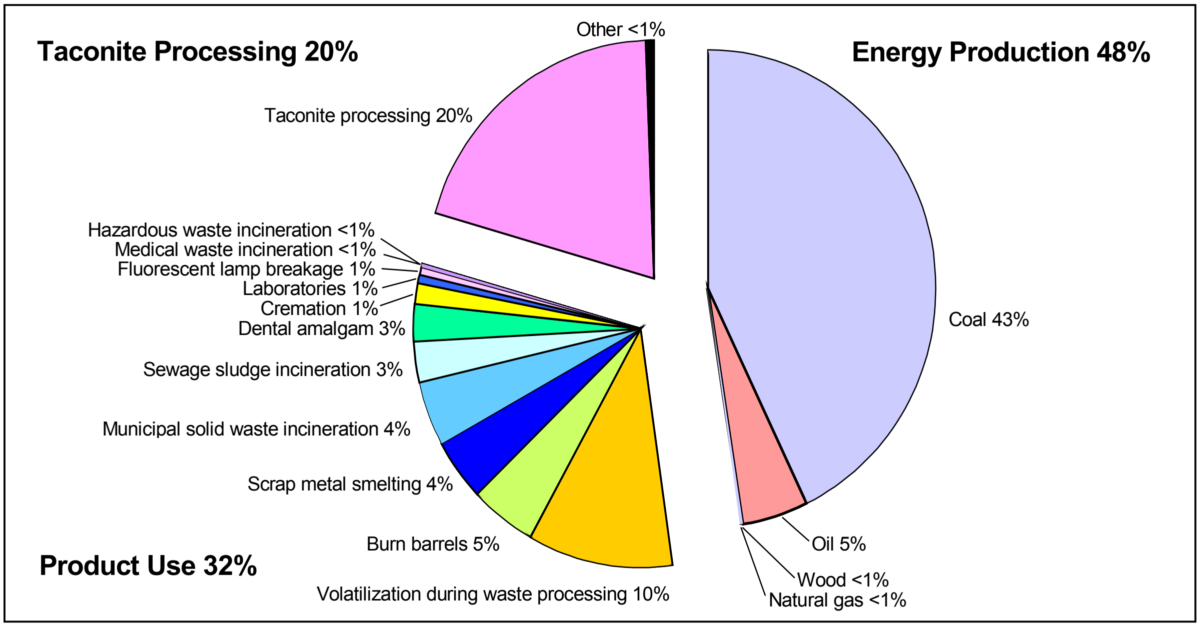

Figure 3. Estimated statewide mercury releases by source, for year 2000.

State options are constrained by global air pollutant problem, regulatory uncertainty.

Emission reductions from coal combustion and taconite processing, however, will be more difficult and expensive than has been the case with most product-related mercury reductions. In addition, the EPA is now developing nationwide draft regulations that will limit mercury air emissions from coal-fired power plants, due to be published in 2003. Taconite emissions may fall under federal regulation by the end of the decade.

Therefore, as with other regional or global air pollutant issues, affected states are presented with the problem of how or where to move forward at the state level in the face of federal and international regulatory uncertainty. While Minnesota has chosen to move forward with a nonregulatory program for mercury for major air sources at this time, other concerned states are either trying to develop regulations (Wisconsin) or are considering regulations or legislation (Massachusetts).

Further efforts under the voluntary agreements are needed.

The MPCA believes that major air sources should further develop and implement plans to reduce mercury releases over the next three to five years — even if their emissions have a limited direct effect on methylmercury concentrations in Minnesota fish. Even over the short term, targets are needed for these sources in order to provide continuing incentives for developing potential low-cost breakthroughs in mercury-reduction technologies.

The challenge has been — and still is — to determine how to best quantify and track these and other mercury-reduction efforts, and to define what a reasonable level of effort would be for all sources for the next years. The next sections of this report describe such efforts to date, and provide recommendations for next steps.

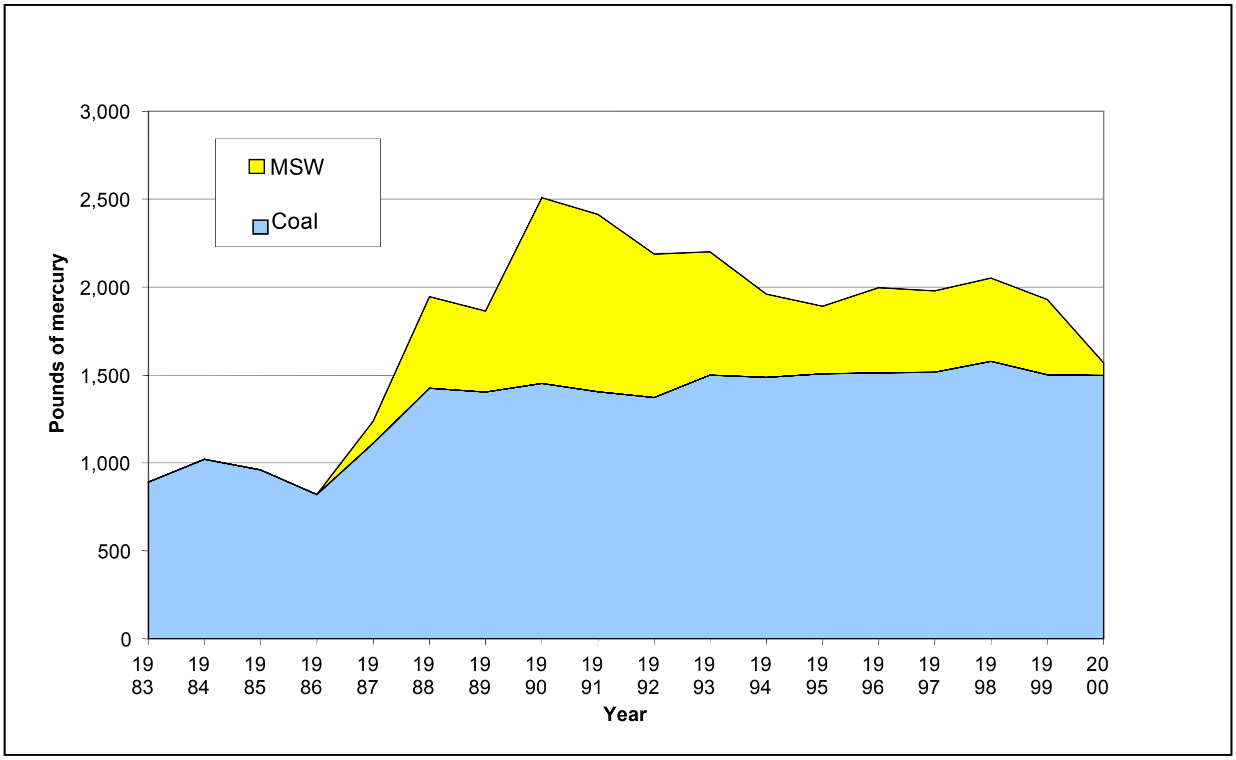

Figure 4. Estimated mercury emissions in Minnesota associated with electrical production from coal and municipal solid waste (MSW) combustion.

Section 4. Mercury Reduction Program Evaluation

This section outlines ongoing program difficulties.

This section first evaluates existing state regulatory tools used to reduce mercury contamination, including some long-standing difficulties with existing mercury regulations.

Problems with Minnesota's statewide reduction goals are then described.

Next, two important pending federal regulations are summarized.

Finally, other MPCA and Office of Environmental Assistance (OEA) mercury-reduction programs, most implemented since 1999, are described briefly.

Minnesota's voluntary mercury reduction agreement program is discussed separately in Section 5.

Existing regulations are complex and disconnected.

Since 1980, federal and state mercury regulations have limited wastewater discharges to state waters and reduced air emissions from some sources, such as waste incinerators. These regulatory controls have proven effective in many cases.

However, the current federal and state regulations are also complex and disconnected; they separately cover air, water and waste disposal without considering their interactions. Since mercury is an element, it does not break down. So, regulations covering waste disposal may, for example, end up encouraging releases of mercury back into the air.

The next section of this report describes two ongoing problems with the existing regulations: fairness and predictability.

Fairness problem is described.

Regulating some mercury sources but not others creates fairness issues. For example, new or expanding wastewater discharges are strictly regulated. And some existing wastewater discharges will need difficult-to-meet permit limits after about 2005 under current federal regulations. However, wastewater discharges represent a small percentage of total mercury input to most Minnesota waters compared to the amount delivered by air pollution. At the same time, air emissions of mercury from coal-fired power plants and some other sources are not specifically regulated.

Predictability problem is described.

The major air sources in Minnesota tend to emit elemental mercury, a form that tends not to fall nearby. So the facilities generally do not create a local health risk, but they do contribute to the general mercury problem in Minnesota and the rest of the world.

Nevertheless, any proposed new air source in Minnesota, even if its mercury releases are not specifically regulated, faces controversy when it reaches the MPCA during environmental review or permitting. At that point, without any clear criteria for "how much is too much," MPCA decisions are made case-by-case, as new projects come up.

Value of state goals is hampered by shifting baseline, lack of facility-specific information.

Minn. Stat. § 116.915 did establish a statewide mercury-reduction goal, as well as a voluntary agreement program initially targeted at major air emission sources. Minnesota also participates in regional compacts, like the Lake Superior Binational Agreement, which has its own regional mercury release inventory and reduction goal.

Using these goals to help guide decisions on specific projects, however, has been limited by three general problems:

1. *The shifting baseline is problematic for goal-setting.* Statewide or regional release inventories mix relatively accurate estimates for some mercury sources (such as incinerators), with less accurate estimates (for example, releases from products). As a result, the overall inventory (including past releases) continues to be subject to change, as much due to improved information as from actual reductions.
2. *More facility-specific information is needed.* Combining source categories creates an "apple-to-oranges" problem. The statewide inventory, while adequate for measuring general progress, is not a good benchmark for individual source categories or reduction programs. Therefore, more facility-specific information is needed to measure individual progress.
3. *There is no specific state implementation plan*. The statewide or regional goals are not broken down by source or source sector. Therefore, without more specific expectations for individual sources or source categories, state decision makers, industry and the public are still left uncertain about "how much is too much" when projects come before the MPCA for permits. A statewide goal without an implementation plan also tends to create a "free rider" problem among mercury sources.

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Pending federal coal, TMDL rules create additional uncertainty for states and industry.

Two particularly important federal decisions are pending that will affect state-level mercury-reduction efforts. First, the EPA plans to regulate air emissions from coal-fired power plants — either through existing authority or through new, "three-pollutant" legislation (limiting mercury, sulfur dioxide and nitrogen oxides). Under existing regulations, the EPA will issue draft regulations by December 2003, final regulations by the end of 2004, with controls for existing plants required to be in place by the end of 2007. In the meantime, until federal standards are promulgated, any new coal-fired power plants are subject to case-by-case, state-level performance standards for mercury emissions.

Second, the EPA is again beginning the process of revising its controversial Total Maximum Daily Load (TMDL) rule. This is likely to affect water discharges and possibly other mercury sources.

Uncertainty creates disincentives for state-level commitments.

The MPCA supports federal power plant air emission regulations and revising the federal TMDL rule. The agency is participating in federal development of both. But continuing uncertainty surrounding feasible technology, economics and final forms of regulation is creating short-term problems for state-level mercury initiatives. As described in Section 5 below, Minnesota electric utilities are reluctant to invest in mercury-control technologies in part due to these uncertainties.

MPCA's reduction programs focus on finding, disposing of, reducing mercury used in products.

To supplement existing laws and regulations, Minn. Stat. § 116.915 directs the MPCA to implement a variety of new and existing strategies to reduce mercury contamination in fish. Since 1999, in addition to implementing the voluntary agreement program (described in Section 5, below), the MPCA and the OEA have continued or initiated a number of mercury-reduction programs. These include:

- the Mercury-Free Zone Program, in which a specially trained detector dog is used to search schools and other facilities for spills and other "hidden" mercury;
- a project to reduce and recover mercury in automotive switches;
- a statewide mercury thermometer ban and swaps;
- health care program;
- community mercury-reduction projects;
- improved estimates of releases from mercury in products;
- ongoing labeling law enforcement;

- ongoing efforts to recover mercury at demolition sites;
- waste incinerator and combustor regulations;
- integrated state/federal Internet pilot project;
- the Minnesota/North Dakota Fish Consumption Survey;
- low-level monitoring for wastewater discharges; and
- continued monitoring of, and research into, mercury releases and deposition.

These MPCA and MOEA programs rely significantly on support from other organizations, both public and private.

Some of these programs are described briefly in Appendix C. Full program descriptions, results and plans will be available through *www.pca.state.mn.us/air/mercury.html* or through Minnesota's new mercury Internet site at *www.mnmercuryinfo.org* , which is expected to be available by by February 1, 2002.

Section 5. Voluntary Agreement Program

This section summarizes, evaluates the voluntary agreements.

This section covers the following three topics:

1. Voluntary Agreements: Description and Background;
2. Program Results: Pro and Con; and
3. Implementation Problems.

Voluntary mercury-reduction agreements are described.

Minn. Stat. § 116.915 requires the MPCA to solicit voluntary agreements from major air emission sources in the state. ("Voluntary agreement" is a general term for a variety of optional pollution-reduction efforts — from public challenges to complex negotiated agreements, such as the EPA's Project XL.) The program is an experimental alternative to "command-and-control" regulation. Although focused initially on major unregulated air emission sources, smaller air sources and facilities with wastewater discharges are invited to participate as well.

With voluntary agreements, maximum flexibility is intended.

The MPCA has implemented the voluntary agreement program to allow maximum flexibility, with minimal negotiating. In most cases, sources are challenged to develop their own reduction efforts, to use trial and error, and to conduct innovative research. Sources can work with other industrial, governmental or nonprofit partners to reduce mercury releases.

One purpose of the program is to provide a simple, cost-effective mechanism for mercury sources to contribute to state reduction goals, particularly whether reducing their own stack emissions might not be feasible in the short-term.

The MPCA has not required specific reduction commitments or specific reporting formats. The MPCA's role is largely to verify any quantified release reductions, publicize results and provide technical or other assistance.

State-level mandatory requirements remain in place.

To help "make room" for the experimental program, the MPCA assured participants that it would not propose new state-level regulations covering mercury air emissions while the voluntary agreement program was in place and deemed to be successful. However, all existing federal and state regulatory requirements are still in force. In addition, case-by-case mercury permit-limits or other conditions are possible for particular facilities, even if the permittee was participating in the voluntary agreement program.

Potential conflicts with federal wastewater regulations arise.

In early 2000, two federal regulations affecting wastewater discharges created unanticipated effects. First, the EPA determined that waters with fish-consumption advisories were "impaired" under the Clean Water Act, triggering new regulatory requirements for discharges to those waters. Second, the EPA approved a new, much more sensitive analytical technique for measuring mercury in wastewater.

As a result, at the same time that mercury in wastewater discharges could be accurately measured, many more wastewater discharges became subject to increasingly strict discharge limits. One effect of these changes was that some otherwise voluntary pollution-prevention efforts were now potentially mandatory. This caused additional confusion as to the role of the voluntary agreement program and potential benefits for participants with wastewater discharges.

Federal uncertainty, lack of early reduction credits for utilities constricts "voluntary" state program.

In addition, the EPA determined in December 2000 that federal regulation of air emissions from coal-fired power plants was appropriate, with regulations to be issued by 2003. The MPCA supports federal draft regulation of power plant emissions.

However, there are no legal guarantees that early reductions will be recognized or otherwise rewarded at the federal level. Therefore, state utilities are reluctant to make significant investments in control technologies in the short term or otherwise commit to trying to reduce their emissions over specific time frames. Therefore, utilities tend to see the voluntary agreement program as a limited, "bridge" effort covering the period between now and when federal regulatory requirements are finally in place.

Other conflicts or potential conflicts arose between regulatory and nonregulatory programs. These types of conflicts have proven to be common in U.S. regulatory innovation efforts.

Results:
high participation, new information, research

Fifteen agreements are in place, including nearly all companies or public agencies with in-state emissions of more than 50 pounds of mercury per year. These facilities include electric utilities, taconite plants, an oil refinery, major municipal wastewater-treatment plants, and the state's only steel mini-mill. Some smaller sources, and one major electricity cooperative with power plants located out-state have submitted agreements also.

Quantifiable mercury reductions have been limited so far to Minnesota Power, using lower-mercury coal (annual reduction about 60 pounds). The Western Lake Sanitary District has reduced its mercury releases since 1999 as well, but its program was under way before the voluntary agreements program began. Notably, Metropolitan Council Environmental Services has made a long-term commitment to use new emission controls to reduce emissions from its sludge incinerator by 70 percent by 2005. In 2002, Xcel Energy's plan to repower its Black Dog plant has the potential to lower annual mercury emissions by as much as 35 pounds. (The amount of the actual reduction depends on how electricity output is distributed.)

Benefits:
flexibility, useful information

The voluntary agreements do show some limited progress. Firms have reported that they have collected and managed hundreds of pounds of mercury in switches and other products. Minnesota Power has switched to lower-mercury coal; Xcel Energy plans to repower its Black Dog plant; and many participants are collecting elemental mercury from various products. Metropolitan Council Environmental Services (MCES) has committed to a long-range reduction target.

Virtually all the participants have developed and shared useful information on the amount, type and potential controls on emissions from their facilities, information that was not previously available. As part of their voluntary agreements, North Star Steel, Koch Industries and others have made nationally groundbreaking efforts to better understand their mercury inputs, flows and releases. Great River Energy, Minnesota Power and Xcel Energy have developed varied research programs that test emission-control systems.

In addition, most participants have made substantial efforts to find new ways to reduce their mercury releases through research on control technologies and pollution-prevention alternatives. Although difficult to document, the MPCA believes that the program has produced this new information faster than would have otherwise occurred. Participants cannot yet make quantitative estimates of the effects many programs have on mercury emissions. However, they believe their programs put Minnesota ahead of other states in mercury-control efforts.

Drawbacks:
limited reductions, lack of specific commitments

The voluntary agreements have the following drawbacks:

1. *Lack of significant, measurable reductions or reduction commitments.* With the exception of MCES, participants have not committed to specific, long-range reduction targets.
2. *Perception that the agreements are largely public relations efforts.* The lack of specific, measurable performance targets in the agreements tends to erode program credibility.

3. *Fairness and predictability problems.* The voluntary agreement program, by itself, has not made state permit decisions more predictable. Without specific, measurable expectations for individual participants, the program has mostly only added a new element of uncertainty for both the public and the facilities during review and permitting by the MPCA.
4. *Lack of standardized, transparent reporting, measurement and verification protocols*. Without standardized protocols, the agreements are difficult to evaluate or compare.

Contributing problems: lack of clear expectations, benefits to participants

Contributing problems of the Voluntary Agreement Program include:

1. *Lack of clear, measurable performance targets for individual participants or sectors*. There is only one, general criterion in place to evaluate the Voluntary Agreement Program: whether the statewide reduction goals are being met. At best, this is only an indirect measure of voluntary agreement success. As described in Section 4, above, the voluntary agreements have not been the source of most of the reductions that have allowed the state to approach the state 70 percent reduction goal.
2. *Lack of clear benefits for participants*. Potential conflict with current or future federal regulations reduces incentives for participants to commit to specific reduction schedules, disclose certain information, or invest in control technologies in the short-term. This is particularly true for coal-fired power plants due to pending federal regulations or legislation. Even for other sources, however, information developed through voluntary research or studies could potentially be used to develop future federal or state permit requirements. This creates a potential "catch-22" disincentive for aggressive voluntary efforts by participants.
3. *Lack of agency resources*. Nonregulatory efforts are not necessarily less staff intensive than "command and control" approaches. More technical staff time should ideally be devoted to the program, but this would require additional funding.
4. *Measurement Problems.* There is not yet a generally accepted, quantified method to measure or "credit" research efforts, mercury-in-products collection efforts, or reductions by out-of-state sources owned by participants (some of which are owned by multi-state or multinational corporations).

Metropolitan Council Environmental Services, wastewater dischargers have measurable performance targets.

The voluntary agreement program has at least one example of a measurable, specific air emission reduction target. MCES has developed a 70 percent reduction commitment for its new sludge incinerator, negotiated as part of its air permit.

In addition, although the voluntary agreement program was set up primarily for air emission sources, it is wastewater discharges that currently have clearer, measurable targets and incentives. Under the MPCA's current approach, most existing wastewater dischargers are allowed to use their next five-year permit cycle to use voluntary efforts to meet state water quality standards in their discharges.

If wastewater dischargers are able to establish that mercury concentrations in their effluents are below the applicable standard, they can avoid mercury permit limits and conditions. This is an example of a measurable, specific goal, with benefits to participants if the target is met. In this case, the means to the end is voluntary, not the end itself.

However, wastewater-treatment plants are already under increasing financial and regulatory pressure on a number of fronts, and their wastewater discharges are usually (but not always) minor contributors to the mercury loading in the affected water body.

Summary of Human Health Risks from Methylmercury Consumption

(by Hillary Carpenter and Patricia McCann, Minnesota Department of Health)

Summary of Human Health Risks from Methylmercury Consumption[1]

As outlined in the original Mercury Contamination Reduction Initiative Advisory Council's Report[2], mercury released to the atmosphere is problematic for human health because it can be converted to methylmercury, which can then accumulate in fish that are subsequently consumed by humans.

Several well-documented human exposure episodes have proven beyond a doubt that mercury is a very effective neurotoxin. Mercury has dose-related effects that range from an alteration in the ability of nerves to conduct impulses to changes in the way nerve cells divide and differentiate. This makes mercury particularly dangerous to the developing nervous systems of fetuses and young children. It also means that the impacts of mercury can range from the subtle, such as altered cognitive and motor function that can only be observed with sophisticated testing techniques, to cerebral palsy, profound mental retardation, and even death.

As with all toxic materials there is a question of dose — what type of exposure to methylmercury is needed before damage will be apparent. The U.S. Environmental Protection Agency (EPA) established a reference dose (RfD)[3] of 0.1 microgram (µg) of methylmercury per kilogram (kg) per day for pregnant women and young children based on the neurological effects that were seen following an accidental exposure that occurred in Iraq. Shortcomings in the Iraq data set resulted in controversy regarding the adequacy of this approach. Adding to the controversy was the fact that two large-scale epidemiological studies examining the low dose effects of methlmercury were nearing completion. These factors led the U.S. Congress to direct the EPA to contract with the National Academy of Science's National Research Council (NRC) to evaluate the available data and assess the adequacy of the EPA's RfD for methylmercury.

The NRC's report[4] evaluated the results of several epidemiologic studies and reinforced previous conclusions that small amounts of mercury have the ability to cause subtle neurological damage to human fetuses. The report also outlined evidence that suggested that, in addition to its neurotoxicity, methylmercury can have adverse impacts on both the developing and adult cardiovascular systems (blood-pressure regulation, heart-rate variability, and heart disease) and that the adverse cardiovascular effects may occur at or below methylmercury exposures that cause neurotoxicity. The NRC report supported the EPA's RfD of 0.1 µg/kg/day for methylmercury but suggested that the RfD be based on results from the Faroe Islands or New Zealand studies rather than on the Iraq data set. The EPA subsequently developed a RfD for methylmercury that was based on modeling done with data from the Faroe Island study.

Adding to the concerns regarding the safety of eating fish containing methylmercury are the results from a recently released CDC-NHANES report[5] that indicated that 10 percent of their sample of women between 16 and 49 years of age had been exposed to levels of methylmercury that are close to those which have observable adverse effects[4]. Using this information and the number of births registered in the United States in 1998, the EPA has estimated that as many as 400,000 newborns each year are at risk of elevated methylmercury exposure. Methylmercury exposure levels estimated in the recent North Dakota EERC Fish Consumption Survey Project[6] support those reported by CDC's NHANES.

There is obviously a concern about exposure of infants and children to mercury. A report recently released by the American Academy of Pediatrics[7] included the following statement: "the developing fetus and young children are thought to be disproportionately affected by mercury exposure, because many aspects of development, particularly brain maturation, can be disturbed by the presence of mercury. Minimizing mercury exposure is, therefore, essential to optimal child health." The Minnesota Department of Health (MDH) continues to provide advice on eating fish based on mercury levels in fish. In 2001, the MDH began providing advice for all lakes and rivers based on mercury levels measured in fish throughout the state.

There are benefits associated with eating fish. Fish is an excellent low-fat source of protein. The optimal situation would be a reduction in the levels of mercury in fish tissue that would lead to a relaxation or elimination of the need for fish consumption advisories. Until this goal is reached, the MDH will continue to provide the public with information that allows the consumer to limit exposure to mercury by selecting fish that have the lowest concentrations of mercury.

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[1] This summary was provided by Hillary Carpenter, toxicologist, and Patricia McCann, research scientist, Minnesota Department of Health, St. Paul.

[2] *Report on the Mercury Contamination Reduction Initiative Advisory Council's Results and Recommendations, March 1999*. Minnesota Pollution Control Agency.

[3] A reference dose is defined as an estimate (with an uncertainty spanning perhaps an order of magnitude) of daily exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious effects during a lifetime.

[4] *Toxicological Effects of Methylmercury*, 2000, National Research Council, National Academy Press, Washington, D.C.

[5] *National Report on Human Exposure to Environmental Chemicals*, 2001, Centers for Disease Control and Prevention.

[6] EERC report.

[7] *Mercury in the Environment: Implications for Pediatricians,* 2001, American Academy of Pediatrics Technical Report.

Executive Summary from
Toxicological Effects of Methylmercury

(National Research Council, 2000)

This executive summary is from the report, *Toxicological Effects of Methylmercury* (© 2000 The National Academy of Sciences). It is included here with permission of the National Academy Press. The executive summary was printed from the Webpage *http:www.nap.edu/openbook/0309071402/html/1.html*. The entire report may be accessed on the Internet at *http://books.nap.edu/books/0309071402/html/index.html*.

Executive Summary

MERCURY (Hg) is widespread and persistent in the environment. Its use in many products and its emission from combustion processes have resulted in well-documented instances of population poisonings, high-level exposures of occupational groups, and worldwide chronic, low-level environmental exposures. In the environment, Hg is found in its elemental form and in various organic compounds and complexes. Methylmercury (MeHg), one organic form of Hg, can accumulate up the food chain in aquatic systems and lead to high concentrations of MeHg in predatory fish,[1] which, when consumed by humans, can result in an increased risk of adverse effects in highly exposed or sensitive populations. Consumption of contaminated fish is the major source of human exposure to MeHg in the United States.

In recent years, the U.S. Environmental Protection Agency (EPA) has issued two major reports on Hg to the U.S. Congress on Hg—the *Mercury Study Report to Congress* (issued in December 1997) and the *Utility Hazardous Air Pollutant Report to Congress* (issued in March 1998). In those reports, fossil-fuel power plants, especially coal-fired utility boilers, were identified as the source category that generates the greatest Hg emissions, releasing approximately 40 tons annually in the United States. EPA is currently considering rule-making for supplemental controls on Hg emissions from utilities. However, because of gaps in the

[1]In this report, the term fish includes shellfish and marine mammals, such as pilot whales, that are consumed by certain populations.

scientific data regarding Hg toxicity, Congress directed EPA, in the appropriations report for EPA's fiscal 1999 funding, to request the National Academy of Sciences to perform an independent study on the toxicological effects of MeHg and to prepare recommendations on the establishment of a scientifically appropriate MeHg exposure reference dose (RfD).[2]

THE CHARGE TO THE COMMITTEE

In response to the request, the National Research Council (NRC) of the National Academies of Sciences and Engineering convened the Committee on Toxicological Effects of Methylmercury, whose members have expertise in the fields of toxicology, pharmacology, medicine, epidemiology, neurophysiology, developmental psychology, public health, nutrition, statistics, exposure assessment, and risk assessment. Specifically, the committee was assigned the following tasks:

1. Evaluate the body of evidence that led to EPA's current RfD for MeHg. On the basis of available human epidemiological and animal toxicity data, determine whether the critical study, end point of toxicity, and uncertainty factors used by EPA in the derivation of the RfD for MeHg are scientifically appropriate. Sensitive subpopulations should be considered.
2. Evaluate any new data not considered in the 1997 *Mercury Study Report to Congress* that could affect the adequacy of EPA's MeHg RfD for protecting human health.
3. Consider exposures in the environment relevant to evaluation of likely human exposures (especially to sensitive subpopulations and especially from consumption of fish that contain MeHg). The evaluation should focus on those elements of exposure relevant to the establishment of an appropriate RfD.
4. Identify data gaps and make recommendations for future research.

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[2]A reference dose is defined as an estimate of a daily exposure to the human population (including sensitive subpopulations) that is likely to be without a risk of adverse effects when experienced over a lifetime.

THE COMMITTEE'S APPROACH TO ITS CHARGE

To gather background information relevant to MeHg toxicity, the committee heard presentations from various government agencies, trade organizations, public interest groups, and concerned citizens. Representatives from the offices of Congressman Alan Mollohan (West Virginia) and Senator Patrick Leahy (Vermont) also addressed the committee.

The committee evaluated the body of evidence that provided the scientific basis for the risk assessments conducted by EPA and other regulatory and health agencies. The committee also evaluated new findings that have emerged since the development of EPA's current RfD and met with the investigators of major ongoing epidemiological studies to examine and compare the methods and results.

The committee was not charged to calculate an RfD for MeHg. Instead, in its report, the committee provides scientific guidance to EPA on the development of an RfD. To develop such guidance, the committee reviewed the health effects of MeHg to determine the target organ, critical study, end point of toxicity, and dose on which to base the RfD. Because various biomarkers of exposure (i.e., concentrations of Hg in hair and umbilical-cord blood) have been used to estimate the dose of MeHg ingested by individuals, the committee evaluated the appropriateness of those biomarkers for estimating dose and the extent to which individual differences can influence the estimates. Other sources of uncertainty in the MeHg data base that should be considered when deriving an RfD were also evaluated. To estimate the appropriate point of departure[3] to use in calculating an RfD, the committee statistically analyzed available dose-response data. A margin-of-exposure[4] analysis was also performed to assess the public-health implications of MeHg.

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[3]The point of departure represents an estimate or observed level of exposure or dose which is associated with an increase in adverse effect(s) in the study population. Examples of points of departure include NOAELs, LOAELs, BMDs, and BMDLs.

[4]A margin-of-exposure analysis compares the levels of MeHg to which the U.S. population is exposed with the point of departure to characterize the risk to the U.S. population. The larger the ratio, the greater degree of assumed safety for the population.

THE COMMITTEE'S EVALUATION

Health Effects of Methylmercury

MeHg is rapidly absorbed from the gastrointestinal tract and readily enters the adult and fetal brain, where it accumulates and is slowly converted to inorganic Hg. The exact mechanism by which MeHg causes neurotoxic effects is not known, and data are not available on how exposure to other forms of Hg affects MeHg toxicity.

MeHg is highly toxic. Exposure to MeHg can result in adverse effects in several organ systems throughout the life span of humans and animals. There are extensive data on the effects of MeHg on the development of the brain (neurodevelopmental effects) in humans and animals. The most severe effects reported in humans were seen following high-dose poisoning episodes in Japan and Iraq. Effects included mental retardation, cerebral palsy, deafness, blindness, and dysarthria in individuals who were exposed in utero and sensory and motor impairment in exposed adults. Chronic, low-dose prenatal MeHg exposure from maternal consumption of fish has been associated with more subtle end points of neurotoxicity in children. Those end points include poor performance on neurobehavioral tests, particularly on tests of attention, fine-motor function, language, visual-spatial abilities (e.g., drawing), and verbal memory. Of three large epidemiological studies, two studies—one conducted in the Faroe Islands and one in New Zealand—found such associations, but those effects were not seen in a major study conducted in the Seychelles islands.

Overall, data from animal studies, including studies on nonhuman primates, indicate that the developing nervous system is a sensitive target organ for low-dose MeHg exposure. Results from animal studies have reported effects on cognitive, motor, and sensory functions.

There is also evidence in humans and animals that exposure to MeHg can have adverse effects on the developing and adult cardiovascular system (blood-pressure regulation, heart-rate variability, and heart disease). Some research demonstrated adverse cardiovascular effects at or below MeHg exposure levels associated with neurodevelopmental effects. Some studies demonstrated an association between MeHg and cancer, but, overall, the evidence for MeHg being carcinogenic is inconclusive. There is also evidence in animals that the immune and reproductive systems are sensitive targets for MeHg.

On the basis of the body of evidence from human and animal studies, the committee concludes that neurodevelopmental deficits are the most sensitive, well-documented effects and currently the most appropriate for the derivation of the RfD.

Determination of the Critical Study for the RfD

The standard approach for developing an RfD involves selecting a critical study that is well conducted and identifies the most sensitive end point of toxicity. The current EPA RfD is based on data from a poisoning episode in Iraq. However, MeHg exposures in that study population were not comparable to low-level, chronic exposures seen in the North American population, and there are a number of uncertainties associated with the Iraqi data. In light of those considerations and more recent epidemiological studies, the committee concludes that the Iraqi study should no longer be considered the critical study for the derivation of the RfD.

Results from the three large epidemiological studies — the Seychelles, Faroe Islands, and New Zealand studies—have added substantially to the body of knowledge on brain development following long-term exposure to small amounts of MeHg. Each of the studies was well designed and carefully conducted, and each examined prenatal MeHg exposures within the range of the general U.S. population exposures. In the Faroe Islands and New Zealand studies, MeHg exposure was associated with poor neurodevelopmental outcomes, but no relation with outcome was seen in the Seychelles study.

Differences in the study designs and in the characteristics of the study populations might explain the differences in findings between the Faroe and the Seychelles studies. Differences include the ways MeHg exposure was measured (i.e., in umbilical-cord blood versus maternal hair), the types of neurological and psychological tests administered, the age of testing (7 years versus 5.5 years of age), and the patterns of MeHg exposure. When taking the New Zealand study into account, however, those differences in study characteristics do not appear to explain the differences in the findings. The New Zealand study used a research design and entailed a pattern of exposure similar to the Seychelles study, but it reported associations with Hg that were similar to those found in the Faroe Islands.

The committee concludes that there do not appear to be any serious flaws in the design and conduct of the Seychelles, Faroe Islands, and New Zealand studies that would preclude their use in a risk assessment. However, because there is a large body of scientific evidence showing adverse neurodevelopmental effects, including well-designed epidemiological studies, the committee concludes that an RfD should not be derived from a study, such as the Seychelles study, that did not observe any associations with MeHg.

In comparing the studies that observed effects, the strengths of the New Zealand study include an ethnically mixed population and the use of end points that are more valid for predicting school performance. The advantages of the Faroe Islands study over the New Zealand study include a larger study population, the use of two measures of exposure (i.e., hair and umbilical-cord blood), extensive peer review in the epidemiological literature, and re-analysis in response to questions raised by panelists at a 1998 NIEHS workshop and by this committee in the course of its deliberations.

The Faroe Islands population was also exposed to relatively high levels of polychlorinated biphenyls (PCBs). However, on the basis of an analysis of the data, the committee concluded that the adverse effects found in the Faroe Islands study, including those seen in the Boston Naming Test,[5] were not attributable to PCB exposure and that PCB exposure did not invalidate the use of the Faroe Islands study as the basis of risk assessment for MeHg.

The committee concludes that, given the strengths of the Faroe Islands study, it is the most appropriate study for deriving an RfD.

Estimation of Dose and Biological Variability

In epidemiological studies, uncertainties and limitations in estimating

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[5]The Boston Naming Test is a neuropsychological test that assesses an individual's ability to retrieve a word that appropriately expresses a particular concept.

exposures can make it difficult to quantify dose-response associations and can thereby lead to inaccuracies when deriving an RfD. An individual's exposure to MeHg can be estimated from dietary records or by measuring a biomarker of exposure (i.e., concentration of Hg in the blood or hair).

Dietary records, umbilical-cord-blood Hg concentrations, and maternal-hair Hg concentrations all provide different kinds of exposure information. Dietary records can provide information on Hg intake but depend on accurate knowledge of Hg concentrations in fish. The records also might be subject to problems with estimating portion size and capturing intermittent eating patterns. Umbilical-cord-blood Hg concentrations would be expected to correlate most closely with fetal-brain Hg concentrations during late gestation and correlate less well with Hg intake than do the other measures (e.g., dietary records and maternal-hair Hg concentration). Maternal-hair Hg concentrations can provide data on Hg exposure over time, but they might not provide as close a correlation with fetal-brain Hg concentrations as umbilical-cord-blood Hg concentrations, at least during the latter period of gestation. Use of data from two or more of these measurement methods increases the likelihood of uncovering true dose-response relationships. The use of either umbilical-cord-blood or maternal-hair Hg concentrations as biomarkers of exposure is adequate for estimating a dose received by an individual.

Individual responses to MeHg exposure are variable and a key source of uncertainty. Factors that might influence the responses include genetics, age, sex, health status, nutritional supplements, nutritional influences, including dietary interactions, and linking the time and intensity of MeHg exposure to the critical periods of brain development. In addition, people exposed to the same amount of MeHg can have different concentrations of Hg at the target organ because of individual variability in the way the body handles MeHg. Individual differences that affect the estimation of dose can be addressed in the derivation of the RfD by applying an uncertainty factor to the estimated dose. If an RfD is based on a Hg concentration in maternal-hair or umbilical-cord blood, adjusting by an uncertainty factor of 2-3 would account for individual differences in the estimation of dose in 95% to 99% of the general population.

Modeling the Dose-Response Relationships

An important step in deriving an RfD is choosing an appropriate dose to be used as the "point of departure" (i.e., the dose to which uncertainty factors will be applied to estimate the RfD). The best available data for assessing the risk of adverse effects for MeHg are from the Faroe Islands study. Because those data are epidemiological, and exposure is measured on a continuous scale, there is no generally accepted procedure for determining a dose at which no adverse effects occur. The committee concludes, therefore, that a statistical approach (i.e., calculation of a benchmark dose level, BMDL[6]) should be used to determine the point of departure for MeHg instead of identifying the dose at which no adverse effects occur or the lowest dose at which adverse effects occur. The committee cautions, however, that the type of statistical analysis conducted (i.e., the model choice—K power, logarithmic, or square root) can have a substantial effect on the estimated BMDL. The committee recommends the use of the K-power model with the constraint of $K \geq 1$, because it is the most plausible model from a biological perspective and also because it tends to yield the most consistent results for the Faroe Islands data. It should be noted that, for the data from the Faroe Islands study, the results of the K-power model with the constraint of $K \geq 1$ are equivalent to the results of the linear model.

The adverse effects observed in the Faroe Islands study were most sensitively detected when using cord blood as the biomarker. Based on cord-blood analyses from the Faroe Islands study, the lowest BMD for a neurobehavioral end point the committee considered to be sufficiently reliable is for the Boston Naming Test. Thus, on the basis of that study and that test, the committee's preferred estimate of the BMDL is 58 parts per billion (ppb)[7] of Hg in cord blood. To estimate this BMDL, the

[6]A benchmark dose level is the lowest dose, estimated from the modeled data, that is expected to be associated with a small increase in the incidence of adverse outcome (typically in the range of 1% to 10%).

[7] The BMDL of 58 ppb is calculated statistically and represents the lower 95% confidence limit on the dose (or biomarker concentration) that is estimated to result in a 5% increase in the incidence of abnormal scores on the Boston Naming Test.

committee's calculations involved a series of steps, each involving one or more assumptions and related uncertainties. Alternative assumptions could have an impact on the estimated BMDL value. In selecting a single point of departure, the committee followed established public-health practice of using the lowest value for the most sensitive, relevant end point.

In addition to deriving a BMDL based on the Faroe Islands study, the committee performed an integrative analysis of the data from all three studies to evaluate the full range of effects of MeHg exposure. The values obtained by the committee using that approach are consistent with the results of the benchmark analysis of the Boston Naming Test from the Faroe Islands study. Because an integrative analysis is not a standard approach at present, the committee does not recommend that it be used as the basis for an RfD.

Public-Health Implications

The committee's margin-of-exposure analysis based on estimates of MeHg exposures in U.S. populations indicates that the risk of adverse effects from current MeHg exposures in the majority of the population is low. However, individuals with high MeHg exposures from frequent fish consumption might have little or no margin of safety (i.e., exposures of high-end consumers are close to those with observable adverse effects). The population at highest risk is the children of women who consumed large amounts of fish and seafood during pregnancy. The committee concludes that the risk to that population is likely to be sufficient to result in an increase in the number of children who have to struggle to keep up in school and who might require remedial classes or special education. Because of the beneficial effects of fish consumption, the long-term goal needs to be a reduction in the concentrations of MeHg in fish rather than a replacement of fish in the diet by other foods. In the interim, the best method of maintaining fish consumption and minimizing Hg exposure is the consumption of fish known to have lower MeHg concentrations.

In the derivation of an RfD, the benchmark dose is divided by uncertainty factors. The committee identified two major categories of uncertainty, based on the body of scientific literature, that should be considered when revising the RfD: (1) biological variability when estimating dose and (2) data-base insufficiencies. On the basis of the available scientific data, the committee concludes that a safety factor of 2-3 will account for biological variability in dose estimation. The choice of an uncertainty factor for data-base insufficiencies is, in part, a policy decision. However, given the data indicating possible long-term neurological effects not evident at childhood, immunotoxicity, and cardiovascular effects, the committee supports an overall composite uncertainty factor of no less than 10.

RESEARCH NEEDS

To better characterize the health effects of MeHg, the committee recommends further investigation of the following:

- The impacts of MeHg on the prevalence of hypertension and cardiovascular disease in the United States. Such data should be considered in a re-evaluation of the RfD as they become available.
- The relationships between low-dose exposure to MeHg throughout the life span of humans and animals and carcinogenic, reproductive, neurological, and immunological effects.
- The potential for delayed neurological effects resulting from Hg remaining in the brain years after exposure.
- The emergence of neurological effects later in life following low-dose prenatal MeHg exposure.
- The mechanisms underlying MeHg toxicity.

To improve estimates of dose and to clarify the impact of biological variability and other factors on MeHg dose-response relationships, the committee recommends the following:

- The analysis of hair samples to evaluate the variability in short-term exposures, including peak exposures. Hair that has been stored from the Seychelles and the Faroe Islands studies should be analyzed to determine variability in exposures over time.
- The collection of information on what species of fish are eaten at

specific meals to improve estimates of dietary intakes and temporal variability in MeHg intake.

- The assessment of factors that can influence individual responses to MeHg exposures in humans and animals. Such factors include age, sex, genetics, health status, nutritional supplement use, and diet. Food components considered to be protective against MeHg toxicity in humans also deserve closer study (e.g., wheat bran and vitamin E).

To determine the most appropriate methods for handling model uncertainty in benchmark analysis, the committee recommends that further statistical research be conducted.

To better characterize the risk to the U.S. population from current MeHg exposures, the committee recommends obtaining data on the following:

- Regional differences in MeHg exposure, populations with high consumptions of fish, and trends in MeHg exposure. Characterization should include improved nutritional and dietary exposure assessments and improved biomonitoring of subpopulations.
- Exposure to all chemical forms of Hg, including exposure to elemental Hg from dental amalgams.

RECOMMENDATIONS

On the basis of its evaluation, the committee's consensus is that the value of EPA's current RfD for MeHg, 0.1 μg/kg per day, is a scientifically justifiable level for the protection of public health. However, the committee recommends that the Iraqi study no longer be used as the scientific basis of the RfD. The RfD should still be based on the developmental neurotoxic effects of MeHg, but the Faroe Islands study should be used as the critical study for the derivation of the RfD. Based on cord-blood analyses from the Faroe Islands study, the lowest BMD for a neurobehavioral end point the committee considered to be sufficiently reliable is for the Boston Naming Test. For that end point, dose-response data based on Hg concentrations in cord blood should be modeled using the K-power model ($K \geq 1$). That approach estimates a BMDL of 58 ppb of Hg in cord blood (corresponding to a BMDL of 12 ppm of Hg in hair) as a reasonable point of departure for deriving the RfD. To calculate the RfD, the BMDL should be divided by uncertainty factors that take into consideration biological variability when estimating dose and MeHg data-base insufficiencies. As stated earlier, given those considerations, an uncertainty factor of at least 10 is supported by the committee.

The committee further concludes that the case of MeHg presents a strong illustration of the need for harmonization of efforts to establish a common scientific basis for exposure guidance and to reduce current differences among agencies, recognizing that risk-management efforts reflect the differing mandates and responsibilities of the agencies.

“Blood and Hair Mercury Levels in Young Children and Women of Childbearing Age — United States, 1999”

(from March 2, 2001
***Morbidity and Mortality Weekly Report*)**

(This document, taken from the March 2, 2001 Centers for Disease Control and Prevention's *Morbidity and Mortality Weekly Report*, is available on the Internet at *www.cdc.gov/mmwr/preview/mmwrhtml/mm5008a2.htm*).

CDC *MMWR Weekly* **March 02, 2001 / 50(08); 140-3**

Blood and Hair Mercury Levels in Young Children and Women of Childbearing Age -- United States, 1999

Mercury (Hg), a heavy metal, is widespread and persistent in the environment. Exposure to hazardous Hg levels can cause permanent neurologic and kidney impairment (1-3). Elemental or inorganic Hg released into the air or water becomes methylated in the environment where it accumulates in animal tissues and increases in concentration through the food chain. The U.S. population primarily is exposed to methylmercury by eating fish. Methylmercury exposures to women of childbearing age are of great concern because a fetus is highly susceptible to adverse effects. This report presents preliminary estimates of blood and hair Hg levels from the 1999 National Health and Nutrition Examination Survey (NHANES 1999) and compares them with a recent toxicologic review by the National Research Council (NRC). The findings suggest that Hg levels in young children and women of childbearing age generally are below those considered hazardous. These preliminary estimates show that approximately 10% of women have Hg levels within one-tenth of potentially hazardous levels indicating a narrow margin of safety for some women and supporting efforts to reduce methylmercury exposure.

CDC's NHANES is a continuous survey of the health and nutritional status of the U.S. civilian, noninstitutionalized population with each year of data constituting a representative population sample. A household interview and a physical examination were conducted for each survey participant. During the physical examination, blood was collected by venipuncture for all persons aged >1 year and hair samples, consisting of approximately 100 strands, were cut from the occipital position of the head of children aged 1-5 years and women aged 16-49 years. Whole blood specimens were analyzed for total Hg and inorganic Hg for children aged 1-5 years and women aged 16-49 years by automated cold vapor atomic absorption spectrophotometry in CDC's trace elements laboratory. The detection limit was 0.2 parts per billion (ppb) for total Hg and 0.4 ppb for inorganic Hg (4). Hairs of 0.6 inches (1.5 cm) closest to the scalp (approximately 1 month's growth) were analyzed for total Hg concentration using cold vapor atomic fluorescence spectroscopy (5). The limit of detection for total Hg in hair varied by analytic batch; the maximum limit of detection (0.1 parts per million [ppm]) was used in these analyses. Blood Hg levels less than the limit of detection were assigned a value equal to the detection limit divided by the square root of two for calculation of geometric mean values.

The geometric mean total blood Hg concentration for all women aged 16-49 years and children aged 1-5 years was 1.2 ppb and 0.3 ppb, respectively; the 90th percentile of blood Hg for women and children was 6.2 ppb and 1.4 ppb, respectively (Table 1).

Almost all inorganic Hg levels were undetectable; therefore, these measures indicate blood methylmercury levels. The 90th percentile of hair Hg for women and children was 1.4 ppm and 0.4 ppm, respectively. Geometric mean values were not calculated for hair Hg values.

Reported by: Center for Food Safety and Applied Nutrition, Food and Drug Administration. US Environmental Protection Agency. National Energy Technology Laboratory, Dept of Energy. National Marine Fisheries Laboratory, National Oceanic and Atmospheric Administration. National Center for Health Statistics; National Center for Environmental Health, CDC.

Editorial Note:

The NHANES1999 blood and hair Hg data are the first nationally representative human tissue measures of the U.S. population's exposure to Hg. Previous estimates of methylmercury exposure in the general population were based on exposure models using fish tissue Hg concentrations and dietary recall survey data (1). The NRC review provided guidance to the Environmental Protection Agency (EPA) for developing an exposure reference dose for methylmercury (*i.e.,* an estimated daily exposure that probably is free of risk for adverse effects over the course of a person's life) (3). The NRC report recommended statistical modeling of results from an epidemiologic study conducted in the Faroe Islands near Iceland, where methylmercury exposures are high because of the large amount of seafood eaten by the local population. Results of this study were used to calculate a benchmark dose (BMD), an estimate of a methylmercury exposure in utero associated with an increase in the prevalence of abnormal scores on cognitive function tests in children. The lower 95% confidence limit of the BMD (BMDL*) was recommended to calculate the EPA reference dose. The NRC committee recommended a BMDL of 58 ppb Hg in cord blood (corresponding to 12 ppm Hg in maternal hair) (3). In the HANES 1999 sample, there were no measurements of blood values >58 ppb or hair values >12 ppm. A margin-of-exposure analysis (*i.e.,* an evaluation of the ratio of BMDL to estimated population exposure levels) showed ratios of <10 when comparing BMDL with NHANES 1999 estimates of the 90th percentile for blood and hair Hg levels in women of childbearing age. Margin-of-exposure measures of this magnitude indicate a narrow margin of safety (3) and suggest that efforts aimed at decreasing human exposure to methylmercury should continue.

The findings in this study are subject to at least three limitations. First, the ratio of Hg in cord and maternal blood is uncertain. The NRC committee summarized some studies that suggest that cord blood values may be 20%-30% higher than corresponding maternal blood levels. However, other studies suggest that the ratio is closer to 1:1 (3); therefore, the NHANES values may not be directly comparable to BMDL recommended by NRC. Second, NHANES cannot provide estimates of Hg exposure in certain highly exposed groups (*e.g.,* subsistence fishermen and others who eat large amounts of fish). Published data from studies of highly exposed U.S. populations indicated that some persons attain Hg tissue levels above BMDL (1). Third, the sample size of NHANES 1999 was small and the 1999 survey was conducted in only 12 locations. More data are needed to confirm these findings.

The long-term strategy for reducing exposure to Hg is to lower concentrations of Hg in fish by limiting Hg releases into the atmosphere from burning mercury-containing fuel and waste and from other industrial processes. On the basis of data from EPA's National Toxics Inventory, air emissions of Hg decreased approximately 21% during 1990-1996, largely because of regulations for waste incineration (7). EPA expects this trend to continue as regulations are implemented for waste incineration and chlorine production facilities and are developed for electric power utilities (8,9). Fish is high in protein and nutrients and low in saturated fatty acids and cholesterol and should be considered an important part of the diet. The short-term strategy to reduce Hg exposure is to eat fish with low Hg levels and to avoid or to moderate intake of fish with high Hg levels. State-based fish advisories and bans identify fish species contaminated by Hg and their locations and provide safety advice (http://www.epa.gov/ost/fish[†]). The Food and Drug Administration advises that pregnant women and those who may become pregnant should not eat shark, swordfish, king mackerel, and tile fish known to contain elevated levels of methylmercury. Information is available at *http://www.fda.gov/bbs/topics/ANSWERS/2001/advisory.html*[†].

U.S. population estimates of Hg tissue levels by race/ethnicity, region, and fish consumption will become available after 2 additional years of NHANES data collection. NHANES will provide the opportunity to measure tissue Hg levels and to monitor the effectiveness of continuing efforts to reduce methylmercury exposure in the U.S. population.

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*A BMD of 85 ppb Hg in cord blood or 17 ppm Hg in maternal hair was estimated to result in an increase in the proportion of abnormal scores on the Boston Naming Test for children exposed in utero from an estimated background prevalence of 5% to a prevalence of 10% (6). BMDL recommended by NRC is the lower 95% confidence bound of the BMD.

† References to sites of nonCDC organizations on the World-Wide Web are provided as a service to *MMWR* readers and do not constitute or imply endorsement of these organizations or their programs by CDC or the U.S. Department of Health and Human Services. CDC is not responsible for the content of pages found at these sites.

TABLE 1. Selected percentiles and geometric means of blood and hair mercury (Hg) concentrations for children aged 1-5 years and women aged 16-49 years, National Health and Nutrition Examination Survey, United States, 1999

		Geometric		Selected percentiles (95% CI)*				
	No.	mean	95% CI	10th	25th	50th	75th	90th
Blood Hg†								
Children	248	0.3	(0.2-0.4)	<LOD§	<LOD	0.2 (0.2-0.3)	0.5 (0.4-0.8)	1.4 (0.7-4.8)
Women	679	1.2	(0.9-1.6)	0.2 (0.1-0.3)	0.5 (0.4-0.7)	1.2 (0.8-1.6)	2.7 (1.8-4.5)	6.2 (4.7-7.9)
Hair Hg¶								
Children	338	—**		<LOD	<LOD	<LOD	0.2 (0.1-0.4)	0.4 (0.3-1.8)
Women	702	—		<LOD	<LOD	0.2 (0.2-0.3)	0.5 (0.4-0.8)	1.4 (0.9-1.7)

* Confidence interval
† Parts per billion
§ Limit of detection
¶ Parts per million
** Not calculated. Proportion <LOD too high to be valid.

Summary of Results from

Fish Consumption Survey: Minnesota and North Dakota

Fish Consumption Survey: Minnesota and North Dakota

Summary of Results

During the fall of 2000, the Energy & Environmental Research Center (EERC) conducted a survey to determine the fish-eating habits of residents of Minnesota and North Dakota as part of a research project entitled Fish Consumption Survey: Minnesota and North Dakota. Researchers used consumption information from the survey to estimate potential mercury exposure from fish.

The health benefits of eating fish have been widely studied and accepted by the medical and scientific communities. However, all fish contain some mercury, a naturally occurring element that exists in air, water, and soil. The mercury exposure estimated from the survey results indicate that some residents of both states may be eating enough fish to be exposed to more mercury than recommended by the U.S. Environmental Protection Agency (EPA). The benefits of fish consumption outweigh the risks as long as a person's exposure is below EPA's recommended level. To determine if you need to make changes in your fish-eating habits, consult the fish consumption guidelines enclosed. In particular, women who are or may become pregnant and young children should follow the guidelines.

Who Responded to the Survey?

Nine hundred eighty-eight households in Minnesota and 577 households in North Dakota responded to the request for information. Their answers to questions about purchased, restaurant, sport-caught, and netted fish meals, fish consumption advisory awareness, age, gender, and weight were entered into a database. Respondents' names are held confidential and will not be made public. Comparison of the age and race information to U.S. Census data suggests that survey respondents were of similar makeup to the white and American Indian populations for both Minnesota and North Dakota. African and Asian Americans (who make up 4.7% of the population in Minnesota and 1.1% of the population in North Dakota) were not well represented by the respondents.

Survey Results

Researchers looked at the fish consumption of all respondents as a whole (called general population) and sorted responses into the following groups: children aged 0-14, men older than 14, women aged 15 to 44, and women older than 44.

How Often Are Fish Eaten? The general population of both states eats fish at levels similar to national averages. The respondents ate fish, on average, about once every 8 days (based on a 4-ounce portion). About 5% of residents eat an average of 2 ½ ounces of fish daily or about one meal every other day.

Approximately 4% of the Minnesota respondents and 4% of the North Dakota respondents reported eating no fish. Of those who reported eating fish, some ate only store-bought and restaurant fish, some ate only sport caught and netted fish, and others ate both. Two tables at the end of this summary show the breakdown of fish meals. Table 1 shows how often respondents reported eating fish. Table 2 shows that distribution by percentages.

Respondents were also asked how many sport-caught fish meals they ate each month of the past year. The results show that people eat the most sport-caught fish in the summer (the average was more than two meals per month in June and July) and the least meals in October and November (about one meal per two months). Seasonality is an important component in assessing whether mercury exposure levels vary during the year. Knowing the seasonal pattern of fish meals may help researchers determine whether some residents may be at risk for short-term exposure to high levels of mercury from intense consumption versus spreading consumption out over several months. The survey did not include questions about seasonal variation in purchased or restaurant fish consumption to compare with sport-caught fish consumption.

Who's Eating What Fish? About two-thirds of the fish eaten come from a store or restaurant; one-third comes from fishing and netting. While the total amount of fish meals is similar to results from surveys in other parts of the United States, the level of sport-caught and netted meals was lower than in other studies. Walleye and panfish were the two sport-caught meals eaten most often. Nearly 10% of respondents reported eating walleye 1 to 3 times per month. Of the purchased fish meals, tuna was reported consumed the most, often 1 to 3 times per month. Shellfish was reported consumed at least once in the last year by 75% of respondents. Only 10% of respondents reported eating swordfish in the last year.

Mercury Exposure: Estimated from Fish Consumption Survey Responses One of the ways people are exposed to mercury is through eating fish. One outcome of this investigation of fish-eating tendencies was an estimate of mercury exposure. All fish have some mercury, but some species, and older, larger fish have more mercury than others. Exposure to mercury from eating fish was estimated using the fish consumption (species, size of fish and meal frequency) reported in the survey, data on mercury levels measured in fish from Minnesota and North Dakota, and mercury in marine fish data published by the U.S. EPA.

Mercury Exposure: Estimated from Analysis of Hair Some of the mercury a person ingests ends up in their hair. The amount of mercury in hair can be used to estimate a person's exposure. The EERC research project analyzed hair samples from 80 respondents for mercury to see if the amount of mercury in the hair correlated with the estimated amount of mercury respondents might have been exposed to based on their reported fish consumption. None of the samples contained mercury at levels to raise health concerns. These results suggest that the women who donated hair were not exposed to an excessive amount of mercury from all sources.

Relationship of Mercury in Hair and Mercury Exposure Estimated from the Survey Responses The estimated mercury exposures determined from the hair samples were compared to the mercury exposures estimated from the fish consumption survey responses. Statistical analysis of the data suggests that a strong correlation exists between the values from the hair-based to the survey-based calculations. That suggests that hair mercury levels will increase with increasing reported fish consumption. However, the survey-based estimated mercury exposure is much higher than the hair-based calculation. More research in this area is needed to understand why the values are not more closely matched and to determine whether surveys of fish consumption could be used with data on mercury levels in fish to estimate mercury exposure.

More Information Is Available

For more information on this research, contact Steven Benson [(701) 777-5177] or Charlene Crocker [(701) 777-5018] at the EERC. For information on fish consumption advisories, contact Patricia McCann of the Minnesota Department of Health at (651) 215-0923 or Francis Schwindt of the North Dakota Department of Health at (701) 328—5152. The fish advisories of the Departments of Health are available at Web sites: *http://www.health.state.mn.us/divs/eh/fish/* and *http://www.ehs.health.state.nd.us/ndhd/environ/wq/fish/fishadvisory.pdf* .

Acknowledgements

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Minnesota Power
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U.S. Department of Energy

Enclosures

MN or ND DH Fish Consumption Advisory Guide
MN An Expectant Mother's Guide to Eating Minnesota Fish

TABLE 1. Respondents were separated by age and gender to examine how often residents ate all kinds of fish. For most groups, nearly two thirds of the respondents ate at least two fish meals per month.

		Ate no fish	Less than 1 meal/month	1 meal/month	2 or more meals/month
Minnesota	Children (0-14)	11%	19%	16%	54%
	Women (15-44)	4%	15%	21%	60%
	Women (older than 44)	2%	9%	16%	74%
	Men (older than 14)	1%	8%	16%	75%
	Composite	4%	12%	17%	67%
North Dakota	Children (0-14)	8%	12%	15%	66%
	Women (15-44)	5%	10%	18%	67%
	Women (older than 44)	2%	12%	18%	68%
	Men (older than 14)	1%	9%	17%	72%
	Composite	4%	11%	17%	69%

TABLE 2. The responses of residents that ate fish were separated by where the fish came from. Less that 10% of the respondents ate only sport caught or netted fish. In all categories except for children in Minnesota, at least two thirds of the fish-eating respondents ate both purchased and sport caught fish.

		% Purchased Only	% Sport Caught/Netted Only	% Both
Minnesota	Children (0-14)	31%	7%	62%
	Women (15-44)	26%	5%	69%
	Women (older than 44)	19%	5%	76%
	Men (older than 14)	17%	6%	77%
	Composite	22%	6%	72%
North Dakota	Children (0-14)	26%	5%	69%
	Women (15-44)	25%	5%	70%
	Women (older than 44)	22%	7%	72%
	Men (older than 14)	15%	7%	79%
	Composite	21%	6%	73%

Why Do Fish Contain Mercury? (To be included only in the ND mailings)
Mercury enters aquatic (natural water) systems from surface water run off, shoreline vegetation, and atmospheric deposition. That is, mercury enters the atmosphere and is deposited on soils by precipitation, taken up by plants and washed into rivers and lakes. There are many sources of the mercury in the atmosphere. Natural sources include active volcanoes, vaporization from soils, and forest fires. Some anthropogenic (human) sources of mercury in the air are waste incinerators, landfills, and power generation facilities. In homes, businesses, and schools, mercury can be found in thermometers, fluorescent lamps, watch batteries, thermostat switches, old chemistry kits, and laboratory chemicals. Small organisms ingest the mercury present in lakes and streams passing it to the larger animals that eat them. In this manner, mercury bio-accumulate through the food chain; that is, mercury is absorbed by each animal that eats smaller mercury-storing animals. When humans eat fish, they become part of this process.

State Mercury Release Inventory, October 2001

10/28/2001 update: Minnesota Mercury Emissions

Prepared by Edward Swain, MPCA 651-296-7800

	confidence level	1990	1990	1990	1995	1995	1995	2000	2000	2000	2005	2005	2005
		(best)	Min.	Max.	(best)	Min.	Max.	(best)	Min.	Max.	(best)	Min.	Max.
Incidental to Energy Production													
Coal combustion (total) (1)	high	1,566	1,410	1,723	1,623	1,460	1,785	1,621	1,459	1,783	1,621	1,459	1,783
electric utility coal	high	1,445	1,301	1,590	1,505	1,355	1,656	1,509	1,358	1,660	1,509	1,358	1,660
commercial/industrial coal	high	121	109	133	118	106	130	112	101	123	112	101	123
residential coal	high	0	0	0	0	0	0	0	0	0	0	0	0
Petroleum, including refining and combustion of petroleum products (2)	low	136	68	204	156	78	234	175	88	263	175	88	263
Wood combustion(3)	high	13	11	14	10	9	12	10	9	11	10	9	11
Natural gas combustion(4)	low	0.2	0.1	0.5	0.28	0	1	0.28	0	1	0.28	0	1
Subtotal incidental with energy production		1,715	1,489	1,941	1,790	1,548	2,031	1,806	1,556	2,057	1,806	1,556	2,057
% of total state emissions		15%			38%			48%			53%		
Largely Resulting from the Purposeful Use of Mercury													
Latex paint volatilization (5)	medium	3,800	2,850	4,750	0	0	0	0	0	0	0	0	0
Municipal solid waste combustion (6)	high	1,806	1,626	1,987	634	570	697	161	145	177	87	78	96
On-site household waste incineration (7)	low	666	333	999	270	135	405	180	90	270	126	63	189
Medical waste combustion (8)	high	516	464	568	36	464	568	8	464	568	0.4	464	568
Sewage sludge incineration (9)	med.	247	185	309	160	120	200	112	84	140	45	34	56
Fluorescent lamp breakage (10)	low	330	165	495	83	41	124	20	10	30	10	5	15
Class IV incinerators (11)	low	55	28	83	28	14	42	0	0	0	0	0	0
Crematories (12)	low	24	12	36	35	18	53	51	25	76	64	32	96
General laboratory use (13)	low	44	22	66	44	22	66	22	11	33	22	11	33
Dental preparations (14)	low	103	52	155	99	50	149	95	48	143	84	42	126
Hazardous waste incineration (15)	medium	5	4	6	5	4	6	5	4	6	5	4	6
Landfill volatilization (16)	low	13	6	19	3	2	5	13	6	19	13	6	19
Recycling mercury from products within MN (17)	medium	4	3	4	35	26	44	50	38	63	65	49	81
Smelters that recycle cars and appliances (18)	medium	171	128	214	171	128	214	164	123	205	164	123	205
Volatilization from dissipative use (29)	low	2	1	3	2	1	3	2	1	3	2	1	3
Fungicide volatilization (20)	low	86	43	129	25	13	38	5	3	8	5	3	8
Volatilization from spills and land dumping (21)	low	55	27	82	48	24	72	32	16	48	21	11	32
Volatilization during solid waste collection & processing (22)	low	1,304	652	1,955	432	216	648	288	144	432	192	96	288
Volatilization: land application of compost (23)	low	2	1	2	1	0	1	1	1	2	1	1	2
Volatilization: land application of sludge (24)	low	4	2	5	2	1	3	2	1	3	2	1	3
Subtotal associated with purposeful use of mercury		9,236	6,603	11,868	2,113	1,849	3,336	1,210	1,213	2,224	908	1,023	1,825
% of total state emissions		79%			45%			32%			27%		
Emissions Incidental to other Activities:													
Taconite processing (25)	high	718	646	790	753	678	828	758	682	834	679	611	747
Pulp and paper manufacturing (26)	low	4	2	7	4	2	7	4	2	7	4	2	7
Soil roasting (27)	low	13	7	27	13	7	27	13	7	27	13	7	27
Subtotal emissions incidental to other activities		735	655	823	770	686	862	775	691	867	696	620	781
% of total state emissions		6%	7%	6%	16%	17%	14%	20%	20%	17%	20%	19%	17%
GRAND TOTAL =		11,685	8,747	14,632	4,672	4,083	6,229	3,791	3,459	5,148	3,411	3,198	4,663
Percent Reduction since 1990					60%			68%			71%		

NOTES

1 Coal combustion. Based on data submitted by facilities with stack tests (Xcel, Minnesota Power) and extrapolated to other coal combustors. For this 2001 update, constant emission factors submitted for 2000 for each unit are applied back in time, except for MP's use of lower-mercury coal in 2000.

2 Petroleum, including refining and combustion. Based on a limited number of analyses and a mass balance analysis performed by Koch.

3 Wood combustion. From Pang, S.M. 1997. Mercury in wood and wood fuels. Thesis. Master of Science. University of Minnesota.

4 Natural gas combustion. Assumes the EPRI emission factor of 0.0008 lb/trillion Btu.

5 Latex Paint Volatilization Based on "Substance Flow Analysis of Mercury in Products" (August 2001). *www.pca.state.mn.us/air/mercury-mn.html#publications*

6 Municipal solid waste combustion. Based on stack tests submitted to the MPCA.

7 On-site household waste incineration (burn barrels, etc.). Quantity is based on Office of Environmental Assistance (OEA) estimates. Mercury content in municipal solid waste (MSW) is assumed to be 3.7 ppm in 1990, 1.5 ppm in 1995, 1.0 in 2000, and 0.7 in 2005.

8 Medical waste combustion. Based on stack tests submitted to the MPCA.

9 Sewage sludge incineration. Based on data provided by Metropolitan Council.

10 Fluorescent lamp breakage. Based on the proportion not recycled and industry figures on mg/lamp, assuming 25% is volatilized.

11 Class IV incinerators. All of these small incinerators associated with grocery stores, etc., about 1,000, closed by January 1996. It is assumed that they mostly burned cardboard with mercury at 0.2 ppm.

12 Crematories based on "Substance Flow Analysis of Mercury in Products" (August 2001). *www.pca.state.mn.us/air/mercury-mn.html#publications*

13 General laboratory use. Estimate in the U.S. EPA Mercury Report to Congress.

14 Dental preparations based on "Substance Flow Analysis of Mercury in Products" (August 2001). *www.pca.state.mn.us/air/mercury-mn.html#publications*

15 Hazardous waste incineration. Estimate from Minnesota's only hazardous waste incinerator, 3M Chemolite.

16 Landfill volatilization. One-tenth of 1% (0.1%) of landfilled MSW is assumed to volatilize to the air per year (based on studies of MSW emissions in Florida by S.E. Lindberg and J.L. Price, 1998).

17 Recycling mercury from products within Minnesota. Estimate from Brian Golob, pers. com.

18 Smelters that recycle cars and appliances. Based on report from North Star Steel.

19 Volatilization from dissipative use. Use of mercury that dissipates into the environment (excluding fungicides): ritual uses, pharmaceuticals, etc.)

20 Fungicide volatilization. Estimate of volatilization from fungicides applied to golf courses.

21 Volatilization from spills and land dumping. Estimate assumes that 8% of mercury removed from service each year is spilled on the ground, and that 5% of that amount volatilizes.

22 Volatilization from solid waste collection and processing. Assumes the 5% of the mercury in solid waste is volatilized during collection, transportation and mechanical processing. (Includes demolition, industrial, and MSW landfills, MSW and medical waste incineration, MSW compost, backyard burn barrels, and steel-recycling facilities; fluorescent lamps calculated separately).

23 Volatilization: land application of compost. Assumes that 1.0% of mercury applied to the surface of the land volatilizes within a year.

24 Volatilization: land application of sludge. Assumes that 1.0% of mercury applied to the surface of the land volatilizes within a year.

25 Taconite processing. From Jiang *et al.* 2000. Mercury Emissions from Induration of Taconite Concentrate Pellets – Stack Testing Results from Facilities in Minnesota. A presentation at the U.S. EPA conference, "Assessing and Managing Mercury from Historic and Current Mining Activities," San Francisco, Calif., Nov. 28-30, 2000

26 Pulp and paper manufacturing. From voluntary reports to the MPCA.

27 Soil roasting. An average of 83,000 tons of surface soil is heated annually in Minnesota to remove organic contaminants. A background concentration of 0.08 ppm mercury is assumed.

Summary of selected Minnesota Pollution Control Agency and Office of Environmental Assistance mercury-reduction programs

Summary of selected Minnesota Pollution Control Agency and Office of Environmental Assistance mercury-reduction programs

Mercury-Free Zone Program

The statewide Mercury-Free Zone Program is an expansion of a regional Minnesota Pollution Control Agency (MPCA) project that began in seven northeastern Minnesota counties. In the statewide program, 70 schools have so far pledged to become Mercury-Free Zones, and elemental mercury, mercury-containing chemicals and mercury-bearing equipment have been removed from 60 of these schools. This has effectively prevented about 114 pounds of elemental mercury from ever polluting the environment. Helping to find hidden mercury and to publicize the effort is Clancy, the only mercury-detecting dog in the nation and one of three in the world, and his trainer and handler, MPCA mercury educator Carol Hubbard.

Goals of the program are:

1. to reduce the risk of potential mercury exposure to students and school staff,
2. to prevent releases of mercury to the environment by eliminating mercury from schools, and
3. to educate students and staff about the dangers that mercury poses.

For more information, go to:
http://www.pca.state.mn.us/programs/mercury-free/index.html .

Mercury Switches in State Vehicles

The Office of Environmental Assistance (OEA), the MPCA and the nonprofit group INFORM worked with the Department of Administration, Materials Management Division, to include a mercury component disclosure requirement in the 2002 Vehicle Request for Bids. The state intends to require the vehicles it buys to be mercury free in future model years, and will use this year's information disclosure to develop future bid specifications. The Travel Management Division, OEA and MPCA are also cooperating on a pilot project to remove, recycle and replace mercury switches in TMD vehicles being withdrawn from state service.

Mercury Switches in Steel Scrap Project

The MPCA and OEA are working on a cooperative project with Ramsey County, North Star Steel and other counties to reduce the amount of mercury that is released when scrap steel is recycled. The MPCA has provided ready-to-mail containers for mercury switches to scrap yards, and North Star Steel has started paying a bonus to scrap suppliers who remove mercury switches from vehicles before crushing them. The OEA and Ramsey County are active in national efforts to reduce the use of mercury switches in vehicles and appliances and in the collection of mercury already in these products.

Mercury Thermometer Sales Ban

The Office of Environmental Assistance developed a 2001 Session legislative proposal to prohibit the sale of most mercury thermometers in Minnesota. Two legislators also introduced mercury thermometer sales prohibitions. The legislature passed the most comprehensive language from these proposals. With a few narrow exemptions to cover legally required uses, products with no available alternative, and primary calibration standards, the sales prohibition became effective January 1, 2002.

Dental Amalgam Waste Management

Through a grant to the Minnesota Dental Association, the OEA supported the development of a dental amalgam management training video and associated Continuing Dental Education credit for all dental office staff.

Health Care Workshops and Mercury Reduction

The OEA and the Minnesota Technical Assistance Program (MnTAP) conducted three health care workshops in 2001. Additional workshops will be held in the first half of 2002. These workshops introduced the Hospitals for a Healthy Environment (H2E) training materials, including mercury reduction and elimination, to Minnesota health-care industry professionals. H2E training materials were developed pursuant to the memorandam of agreement between the American Hospital Association and U.S. Enivronmental Protection Agency (EPA).

HealthSystems Minnesota Mercury Reduction Intern

The MnTAP funded a summer 2000 intern project at HealthSystems Minnesota to identify all mercury-containing materials and develop a mercury-elimination plan. The final intern project report is an excellent model for other health-care facilities and organizations.

Internet-based Mercury Information Management Pilot Project

The mercury contamination problem spans so many technical and regulatory areas — air, water, waste disposal and others — that tracking and understanding even a small part can be expensive and time consuming. The MPCA and the OEA, in cooperation with the EPA, U.S. Department of Energy and Environment Canada, are cooperating on a pilot project to develop new ways to integrate and organize widely dispersed mercury information. The project is also intended to improve citizen access and understanding of this information. The Minnesota pilot project is scheduled to be launched by February 1, 2002.

Low-level Wastewater Monitoring Training

Each March, the Minnesota Wastewater Operators Association holds its annual meeting. This meeting would serve as the opportunity to provide training annually to facility personnel in procedures to collect low-level mercury samples. Ultimately these personnel would be collecting samples at their respective facilities as part of permit-monitoring requirements. These samples would then be sent to laboratories certified for low-level mercury analysis.

Estimating Releases from Products That Use Mercury

The MPCA commissioned a study in 2001 to better quantify mercury releases from various product lines that intentionally use mercury, such as electrical switches, dental amalgam, and many other products. (More than 300 tons of mercury are still used in the manufacture of various products in the United States each year.) The purpose of the study was to improve statewide inventory estimates, and to better quantify and "credit" the release reductions associated with efforts to collect and properly dispose of mercury in products or forgotten on shelves or in drains. Product lines evaluated include lamps, thermostats, automotive switches and other relays, thermometers, batteries, measurement devices, paint, dental amalgam and others. A quantitative flow diagram was developed for each product line showing the fate of mercury during product use and disposal, including points at which mercury may be released to air, water or land.

Mercury research at the Minnesota Pollution Control Agency

Mercury research at the Minnesota Pollution Control Agency

2000-2003 Research Activities

EPA Science To Achieve Results (STAR) Grant:
Methylmercury sources to lakes in forested watersheds: Has enhanced methylation increased mercury in fish relative to atmospheric deposition? (1999-2002)

The purpose of this research is to explore the potential of local approaches to alleviate mercury consumption advisories in fish. From previous work, we know that mercury deposition to lakes in Minnesota has increased by three to four times since presettlement times. We also have evidence that fish mercury levels have increased up to 10 times in several lakes since the 1930s based on mercury analysis of museum fish. Why would a discrepancy exist between increases in deposition and mercury levels in fish? The reason is that mercury may be methylated to form methylmercury (MeHg) before it can accumulate in fish. Local factors may increase the efficiency of MeHg formation in lakes, resulting in increased levels of mercury in fish without increasing the load of mercury to a lake. We are exploring the reverse effect, potentially decreasing mercury levels in fish, in lieu of reductions in loading.

This study includes laboratory studies performed at the University of Minnesota and field studies conducted at the Marcell Experimental Forest near Grand Rapids. The field studies focus on quantifying the major sources of MeHg to lakes; including wetland transport, formation/export from lake sediments, and deposition from the air. Most of the focus is on wetlands and lakes sediments. Air deposition, despite being the major source for mercury to lakes, is a minor direct source of MeHg (Important note: The air still provides the mercury that is methylated in sediments and wetlands.). The lab studies complement the field studies by determining whether MeHg formation can be enhanced in lake sediments or different types of wetlands. Additions of sulfate, nitrogen and organic matter (to simulate the impacts of acid rain, agriculture or sewage runoff, eutrophication, mine tailings discharge, etc.) will be made at increasing levels to observe under what conditions methylation is enhanced.

Voyageurs National Park Mercury Studies:
Which factors are causing large variability in mercury levels in Minnesota fish?

Two small lakes in Voyageurs National Park have the highest levels of mercury in fish when standardized to a 55-cm northern pike (Ryan Lake Hg NP_{55} = 2.4 ppm; Tooth Lake Hg NP_{55} = 1.8 ppm). Other inland lakes in Voyageurs National Park have NP_{55} Hg levels ranging from 0.1 to 1.1 ppm. What is the cause of the extreme variation in the fish from Voyageurs National Park? By understanding which factors lead to lakes with high fish mercury levels, we can better manage our lakes by determining which lakes are sensitive to mercury deposition.

Several hypotheses are simultaneously being tested to determine what causes the large variability in mercury methylation efficiency in Voyageurs National Park lakes. Mercury methylation efficiency is important because methylmercury (MeHg) is the form of mercury that accumulates in fish. Indicators being explored are MeHg in the water, the fraction of sediment mercury that is MeHg, and MeHg levels in one-year-old yellow perch. To investigate the effects lake food chain structure has on mercury levels in fish, one-year-old yellow perch mercury levels are being compared to mercury levels in game fish. In the simplest scenario, if all lakes have similar mercury levels in one-year-old yellow perch, then variation in mercury levels in game fish are due to food web effects or variation in the growth rate of northern pike. Mercury loading from the watershed has been investigated previously by dating sediment cores from five interior lakes and measuring mercury accumulation in the cores. Current work is being conducted measuring mercury levels in soils in several lake watersheds that vary in underlying geology. The major mercury-removal process that is being studied is the variability in volatilization of mercury from lake surfaces back to the atmosphere.

Mercury Trends in Fish

The State of Minnesota first collected fish for mercury analysis in 1969. From 1969 to 1981 spotty collections of fish for mercury analysis were made as part of special studies. Since 1982, regular funding has come from the U.S. Environmental Protection Agency (EPA) or the Minnesota Legislature to collect fish for the purpose of issuing fish consumption advisories. From this historic database, MPCA scientists have attempted to quantify long-term trends in mercury levels by two methods. The first method simply looked at mean mercury levels (expressed as a standard-size, 55 cm northern pike) collected in the Northern Lakes and Forests ecoregion. The selection of lakes each year was not random, but in general mercury levels increased to the mid-/late 1980s and possibly have decreased since then. The second method compared mercury levels in lakes that have been sampled more than once. This set consists of 101 lakes and only includes lakes last sampled in 1995 or later and with the first and last collection greater than five years apart. Fifty-one of the lakes have experienced decreased mercury levels in fish, while 22 increased, and 25 showed no statistical change ($p < 0.05$).

MPCA scientists plan to monitor fish mercury levels in a more consistent set of lakes and in yearling prey species which are not impacted as greatly by food chain dynamics as are predator game fish. Historic fish mercury concentrations were not collected with the intent of constructing trends, but rather for human health protection. Ecoregion reference lakes, long-term acid rain study lakes, 55 lakes from a statewide mercury in sediments project, and selected heavily fished lakes will be sampled more consistently (about every five years). A smaller set of lakes in Voyageurs National Park and five other lakes in Minnesota are also being sampled on an annual basis.

Investigations with Tekran Mercury Vapor Analyzers (2000-2001)

Under a joint EPA grant written by Michigan, Wisconsin and Minnesota, the MPCA has occasional access to two Tekran mercury vapor analyzers. The Michigan Department of Environmental Quality equipped a mobile trailer with a 5-kilowatt propane generator to power the Tekran analyzers; a meteorological boom that can be swung up, in the air, to measure wind speed and direction; a computer for logging and analyzing data; and air conditioning and heat so the equipped trailer can be used year-round. One of the Tekrans can be used as a mobile unit.

The ability to measure mercury accurately in outdoor air is being used by MPCA research staff in several ways:

1. MPCA staff used the mobile Tekran on small lakes in Voyageurs National Park to measure the volatilization rate of mercury from the lake back to the atmosphere.
2. MPCA staff parked the trailer near suspected atmospheric mercury sources, and measured increases in mercury when the wind was directly from the source. Such data, when combined with wind direction and speed, can be used to estimate the mercury emission rate of the source. The mobile Tekran can be located on the other side of the suspected source to confirm that upwind air is not the source of the mercury.
3. MPCA staff estimated the rate that mercury is released from land-applied wastes by measuring the increase in mercury vapor under a chamber pressed into the soil.
4. MPCA staff quantified the difference in mercury concentrations between urban air in Minneapolis-St. Paul and more rural areas. In general, mercury is higher and more variable in the urban area.

These investigations provide a more detailed inventory of sources so that customized mercury-reduction strategies can be considered and developed.

Mercury in Waste Water Treatment Plant Effluent (2001)

The amount of mercury that comes from waste water treatment plants is relatively low compared to the amount that comes from air sources. However, waste water treatment plants discharge directly to waterways and ,therefore, may have significant impacts. Waste water treatment plants must meet water quality standards of 6.9 ng (nanograms) per liter (1.3 ng/l in the Lake Superior Basin) set by the MPCA. Waste water treatment plants that discharge more than 1 million gallons a day must monitor their effluents quarterly for five years using trace-level sampling techniques and certified laboratories that meet low part per trillion detection limits. The MPCA also plans to randomly sample 40 “minor” facilities this winter to determine the monitoring requirements needed for smaller plants.

Evaluating Voluntary Agreements

Evaluating Voluntary Agreements

When the Minnesota Pollution Control Agency's (MPCA's) Mercury Contamination Reduction Initiative Advisory Council (hereafter referred to as the "Advisory Council") first considered voluntary agreements, it had only a general understanding of what a voluntary agreement should be. Advisory Council members decided to include voluntary agreements almost as an afterthought. An Advisory Council subcommittee asserted that the most cost-effective mercury reduction strategies were those that focused on mercury in products. However, the committee also realized that reliance on product-related strategies would not meet the Advisory Council's comprehensiveness criterion. ("Comprehensiveness" was used as a proxy for equity in Advisory Council evaluations.) If the committee had recommended only product-related strategies, the recommendations would have excluded entire sectors that contribute significantly to the state's mercury emissions inventory. A strategy known as "voluntary reduction agreements" was added to the committee's recommendations so that source operators in the electrical utilities and iron-mining sectors would be covered.

Even after considerable discussion the Advisory Council's final description of voluntary agreements remained vague.

The Advisory Council recommends use of voluntary agreements between the MPCA and mercury sources. The goal of such voluntary agreements is to promote reduced use and release of mercury. The Advisory Council accepted the following proposals related to voluntary agreements:

Affected sources: Who would participate?

Participation would be open to any interested source. However, priority would be given to sources with releases in excess of 50 lb. per year that are not already expected to significantly reduce their mercury use or release based on existing programs, such as regulations, initiatives or permits. Priority would be based also on the amount of mercury released by a source. Priority means that MPCA staff would focus implementation efforts on, and solicit plans from, priority sources first.

Voluntary vs. Mandatory Participation

Participation would be voluntary. Incentive for participation would be provided through the following factors:

- Voluntary participation provides the best opportunity for cost-effective actions.
- Participation would be beneficial to a sector or a company's image.
- Lack of participation would increase the chances of mandatory reductions being required in the future due to failure of the strategy package to meet measurable reduction goals.
- The MPCA could, as its part of the voluntary agreement, attempt to reduce uncertainty regarding possible new regulations for a participating source. Conversely, the agency would be more likely to enact at the state level, or promote at the federal level, new mercury-related regulations for a source that does not participate. Participation improves the ability to document reductions achieved through voluntary actions.

(from *Report on the Mercury Contamination Reduction Initiative Advisory Council's Results and Recommendations, March 1999*, p. 39.)

The Advisory Council's recommendations have no specific terms for voluntary agreements. There are no criteria to evaluate voluntary agreements individually or as a group. The Advisory Council's only specific recommendations covered MPCA responsibilities. The most specific element of the Advisory Council's voluntary agreement recommendations was a negative one. Advisory Council members insisted that there should be no state mandates. No firm should be forced to:

a) develop a voluntary agreement;
b) follow voluntary agreement reporting standards or schedules;
c) include in its voluntary agreement any terms specified by the state;
d) meet data collection, maintenance or reporting requirements; or
e) incur penalties for not developing a voluntary agreement according to state guidelines.

Although the Advisory Council was vague in its voluntary agreement recommendations, it did adopt 13 evaluation criteria for mercury-reduction strategies. Some criteria developed by the Advisory Council could be used to evaluate voluntary agreements.

Criterion	Advisory Council definition
1. Feasibility	Professional judgement and available information related to: • Technical capability ≡ availability of the physical means to reduce mercury releases • Economic prospects ≡ ability to compete economically • Reduction potential ≡ the option's likely effect on mercury releases • Social factors ≡ political acceptability, with "set asides" subject to Advisory Council approval
2. Cost-effectiveness	(Total annualized cost)/(total annual reductions)
3. Reduction potential	• Annual reductions of mercury releases • Total reductions over 20 years • Potential effects that reductions of mercury releases will have on mercury contamination in fish
4. Permanence	The duration of mercury reduction options, taking into account: (a) re-emission possibilities and (b) the transfer of mercury from one medium to another (*e.g.,* air to water).
5. Compatibility	Consistency with other programs and initiatives. A negative measure of compatibility might be the degree to which a mercury-reduction strategy conflicts with other programs and initiatives.
6. Flexibility	a) Can the strategy itself be readily changed in the future (*i.e.,* is it responsive to change)? *and* b) Does it allow affected sources to decide site-specific details regarding what actions to take?
7. Comprehensiveness	The extent to which a mercury contamination reduction strategy applies to all emission sources.
8. Economic impact	The net effects of a strategy on regional jobs, personal income, etc.
9. Cost/benefit ratio	The cost of reducing mercury releases divided by the value of the damage caused by mercury contamination.
10. Fairness	The distribution of the economic burdens among affected sectors
11. Political and social concerns	Qualitative evaluations of political factors and social acceptance, such as impacts on sensitive populations and minority communities.
12. Transferability	The extent to which a system can be adapted readily in other states
13. Verifiability	Data availability (cost and timeliness of data collection).

The Advisory Council's criteria were to be applied to all mercury reduction strategies. They were for use in evaluating statewide programs that have interstate and, sometimes, international effects.

Effectiveness (or "reduction potential," in the Advisory Council's list) is a basic criterion used in nearly all evaluation systems. Analysts compare program results to program goals and determine whether the goals were met. Voluntary agreement goals in Minnesota were defined by each firm. None of the voluntary agreement firms set a quantitative goal. Most voluntary agreements consisted of plans that had no estimate of expected results. Some mercury reductions are estimated in last year's progress reports. However, the reports do not support estimates of total mercury reductions because the Advisory Council disapproved of standardized reporting.

	Reduction estimates (1990-2000)		
Firm	**Direct**	**Indirect**	**Other**
Alliant Energy	10 pounds per year	59 pounds	
Great River Energy	1.5 pounds per year	685 pounds	
Hibbing Taconite	92 pounds, total*	70 pounds	
Ispat-Inland Mining		2 pounds	
Koch Refining	5 pounds, total		
LTV Steel	7 pounds, total	1,440 pounds	
Metropolitan Council Environmental Services (MCES)	1 pound, in 2000	30 pounds	1.75 mg/kilo of mercury in sludge
Sewage sludge			"Local limit" reduced by 98 µg/l
"			4,229 lamps
"Local limit"			288 thermometers
Minnesota Power	57 pounds per year, (started in 2000)	3,600 pounds	10,000 lamps per year
National Steel Pellet	47 pounds, total*	69 pounds	1,850 pounds of lamps per year
North Star Steel	2 pounds per year	9 pounds per year	1,200 lamps/year
Northshore Mining		1,000 pounds	7,748 lamps in 2000
Otter Tail Power		351 pounds	373 thermometers
Xcel Energy	380 pounds**	10,781 pounds	649,000 lamps
repowering Black Dog	up to 35 pounds		
NSP – Wisconsin		700 pounds	
NRG			1,500 thermometers
Western Lake Superior Sanitary District (WLSSD)	95 pounds		

* Reductions derive from a change in estimating methodology. A new "emission factor" was used to estimate mercury emissions in 2000.

** Emission reductions estimated to result from "demand-side management" programs that operated from 1985 to 1999.

Notes:
1. Direct reductions are estimates of lowered mercury releases to air or water. Some are reported as rates (*i.e.,* pounds per year) and some are reported as total amounts.
2. Indirect reductions are estimates of mercury removed from equipment or consumer products and recycled.

3. "Other" refers to estimates made in units other than pounds of mercury.
4. Values in the table summarize separate entries from the voluntary agreements and progress reports. Considerable detail is available in the individual voluntary agreements and progress reports, which can be reviewed at *http://www.pca.state.mn.us/air/mercury-mn.html#agreements*.
5. EVTAC (Eveleth Taconite) has a voluntary agreement, but provided no estimates in its voluntary agreement or in its progress report.

With no overall goal for voluntary agreements and no individual goals for different plans, the most that can be said for the agreements' effectiveness is that it appears some progress was made.

Other Advisory Council criteria are used by European agencies that have evaluated their own voluntary systems. European governments in the past 10 years or so have adopted over 300 voluntary agreement-like programs. Their goals and specifications vary widely. Recently, some European agencies evaluated their voluntary programs. Using criteria comparable to — but more detailed than — the Advisory Council's criteria, the European agencies looked at the strengths and weaknesses of various voluntary agreement systems.

An organization known as NEAPOL (Negotiated Environmental Agreements: Policy Lessons to be Learned) developed the most comprehensive of voluntary agreement evaluation systems. NEAPOL's criteria address the Minnesota Advisory Council's concerns and more. NEAPOL's criteria are defined so that they are easy to use and interrelated, which makes comprehensive evaluation easier. Other European organizations have also evaluated voluntary systems. Their criteria tend to be more general, harder to use, and less supportive of recommendations for change. Our evaluation this year will begin with the NEAPOL criteria and then consider whether other criteria might lead us to different results.

NEAPOL applied its criteria by presenting them as a questionnaire to analysts familiar with the programs under study. For example, criteria related to environmental targets were presented as characteristics with respect to which different programs could be ranked:

	The agreement contains a well-defined environmental performance objective (or objectives).
Scoring guide	5 The performance measure is defined precisely; the objective is quantified, and intermediate milestones are specified. 3 The performance measure is ambiguous, and /or the objective is not quantified. 1 No environmental performance objective has been defined
Remarks	The environmental performance objective defines what the agreement is intended to achieve in terms of environmental improvement. It can be expressed in terms of an absolute value, a performance rate (e.g. recycling rate), or a % change versus a base year value. Example: an objective of "a 20% reduction in primary energy consumption per tonne of output in 1995 versus 1990" would score 5, while an objective of "a substantial improvement in energy efficiency" would only score 3.

	The objective (or objectives) represents a meaningful improvement in environmental performance.
Scoring guide	5 The objective represents a significant improvement over the expected outcome under business-as-usual. 3 The objective represents a slight improvement over the expected outcome under business-as-usual. 1 The objective does not represent any improvement over the expected outcome under business-as-usual.
Remarks	a) If it is not possible to establish a quantified business-as-usual counterfactual, a qualitative judgement should be made (and a brief explanation given in "Additional Comments" at end of this section) b) If the agreement does not contain an environmental performance objective, then score "n/a".

Using the NEAPOL scores, Minnesota's voluntary agreement system gets a "5" with respect to the first criterion and a "4" with respect to the second.

A complete NEAPOL evaluation has 22 elements. Numerical scores related to each question are compiled into a composite value. Evaluated systems are ranked according to their composite scores. A copy of the full questionnaire is attached to the end of this appendix.

NEAPOL's evaluation covered 12 voluntary systems. Environmental goals of the evaluated systems varied widely, from disposal and recycling of solid wastes to the reduction of emissions classified as criteria pollutants in the United States. Legal and procedural features also varied. Some European voluntary systems resemble contracts between business firms and government agencies. Other systems feature arrangements like ours in Minnesota, under which representative groups agree to goals and a timetable.

An evaluation by the MPCA staff, using NEAPOL's questionnaire, yielded a score for Minnesota's voluntary agreement system that was about average. Compared to the evaluated European systems, Minnesota's system ranks about in the middle with respect to its impacts and its effectiveness.

Another set of NEAPOL evaluations looked at the institutional context in which voluntary systems are developed. Analysts considered the political, legal and economic factors that are likely to encourage or inhibit voluntary systems. When NEAPOL's policy context criteria are applied to the Advisory Council setting, Minnesota's score is relatively low. You could say that, because the institutional context was somewhat unfavorable, the voluntary agreements' average level of performance could be considered something of an accomplishment. Think of it as over-achieving in the context of environmental policy. Independent analysts have made similar findings, noting that U.S. conditions make it difficult to develop effective voluntary systems (known as NAs, or negotiated agreements, in this context):

> … the ability of regulators to commit to the objectives of NAs, and to be credible in their commitment, is a key factor explaining the national differences in the use of the agreements. By "credible regulatory commitment" we refer to the ability of the regulator to negotiate and implement NAs, and to subsequently guarantee that the rules of the game will not be changed once the parties have reached and implemented the agreement. (p. 3)
>
> Elements such as fragmentation of power limit regulatory discretion and make more difficult the implementation of NAs. The United States provides an example of such a case. High fragmentation and easy access for third parties to enter the game via courts limits EPA's ability to commit credibly to NAs. As a result, the very few NAs found in the U.S. are fraught with problems.[*] (p. 27)

When you take into account the relative advantages that European systems enjoy, it is not surprising that voluntary systems are more popular in Europe and that they are considered to be more effective in Europe. All things considered, Minnesota's voluntary agreements may have taken voluntarism about as far as it can go in America.

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[*] Delmas, Magali and Ann Terlaak, "Regulatory Commitment to Negotiated Agreements: Evidence from the United States, Germany, The Netherlands, and France," Donal Bren School of Environmental Science and Management, University of California at Santa Barbara, April 2001, pages 3 and 27.

Other agencies' evaluations of European systems are not as extensive as NEAPOL's. Nearly all analysts use at least one criterion that considers performance with respect to a specified environmental target. After considering basic effectiveness, other evaluations look at varied features of voluntary agreement systems:

Economic criteria	Other criteria
Administrative cost (government)	Consumer demand and information
Compliance cost (private)	Equity
Cost-effectiveness	Government relations
Market structure effects	Monitoring and reporting
Regional economic impacts	Public attitudes and awareness
Technical change and innovation	Risk reduction
	Third party involvement
	System viability

NEAPOL's criteria cover most of those used by other analysts. However, two factors not included in NEAPOL's evaluations are significant. NEAPOL's system does not consider regional economic impacts. These are factors, such as employment and competition, that mattered significantly to the Advisory Council. An economic impact analysis, made for the Advisory Council in 1998, found that the whole array of strategies under Advisory Council consideration was unlikely to have a significant impact on Minnesota's economy. Voluntary agreements were included as one element of that analysis.

Third-party involvement, another factor excluded from the NEAPOL analysis, also was significant for the Advisory Council. Although the Advisory Council debated this issue at length, it never reached consensus on the appropriate role for third-party organizations. Some Advisory Council members thought third parties should be involved planning, implementing and evaluating voluntary agreements. Others thought third parties had no role to play in voluntary agreements. This disagreement remains as strong now as it was during Advisory Council meetings. It may be that the Advisory Council's disagreement indicates just how important third-party participation is. It was clearly regarded as significant by most European evaluators:

> Voluntary approaches offer benefits in the form of flexibility to the participating firms and to government, relative to the traditional command and control regime. This flexibility, however, comes at the expense of reduced access of third parties to the policy-making process. The effects of this reduced third party participation may well be that voluntary approaches present the danger of lower environmental targets, and reduced environmental effectiveness, generally. While mechanisms for correcting the risk of less stringent environment protection certainly exist, they are expensive, and may seriously reduce the flexibility of the instrument. So, a clear trade-off emerges between *flexibility* on the one hand, and *environmental effectiveness* on the other.[*]

Third party participation was among the features of "good practice" recommended at a recent conference of European and American analysts. European policy makers have

[*] CAVA (Concerted Action on Voluntary Approaches), International Policy Workshop on the Use of Voluntary Approaches, Feb. 1, 2001, (p.9)

developed a list of the measures that contribute to the success of voluntary agreements:

- clearly defined performance goals
- government policy supports (*e.g.,* interactions with other supporting policies, such as technical assistance, financial or regulatory relief incentives, etc.)
- credible baselines
- reliable monitoring and reporting mechanisms
- sanctions for non-compliance
- effective participation of third parties
- contextual factors (*e.g.,* institutional elements, national circumstances, etc.) that improve the performance of voluntary programs

Suggestions from European experience indicate policy changes that could improve the performance of Minnesota's voluntary agreement system. Note that these suggestions do not apply only to state government. Some changes could be made solely on the initiative of private firms. Our Minnesota system has some of the features that encourage successful voluntary agreements; namely, clear goals and a credible baseline. (Note that the "clear goals" feature only applies to statewide goals. Minnesota's voluntary agreements have no goals for individual firms.) However, our system either lacks or has just a hint of the other features that encourage success. Reviewers who want to improve Minnesota's voluntary agreement system should consider first the recommendations that derive from Europe's experience.

We do not yet have all the information we need to make a final evaluation of voluntary agreements. Indeed, our Advisory Council specifically suggested a report in 2001 so that a preliminary evaluation would give the MPCA and others a chance to recommend changes before 2005. Although experience or principle sometimes tempts reviewers to make quick judgements, a more careful approach is called for. Overly optimistic evaluations can interfere with necessary decisions and pessimism can force decisions before they really have to be made. The MPCA's goal for this report is to make careful evaluations that take into account all available information. This course is most likely to meet Advisory Council criteria and the intentions of the 1999 Legislature.

A preliminary evaulation of voluntary agreements shows that it is important to take into account the interests of those who operate mercury emission sources. Incentives always affect the administration of environmental policy, but they seem to matter more in the voluntary agreement context. Compare our voluntary agreement system's incentives with those of conventional regulatory systems:

Voluntary Agreements	Conventional regulations
Action by voluntary agreement firms depends on their public virtue and their evaluation of public opinion.	Legal sanctions compel firms to operate within regulatory limits.
The goal is clear, but it is also communal. There is no penalty for nonparticipation.	Each firm has standards that are specified for every "facility."
The Advisory Council's ground rules favored free or low-cost initiatives.	Statutory orders often disregard or discount cost issues.
Federal initiatives may render local programs moot.	Federal rules often set minimum standards for state regulations.
Reporting and monitoring arrangements are made by each voluntary agreement firm. They are idiosyncratic.	Reporting and monitoring requirements are specified and included in regulations. They are usually comparable for all firms.

Consider the position of a manager who must decide how much effort to put into reaching an environmental target. Nearly all pollution-control programs are costly. (The occassional pollution-prevention, or P2, activity that yields net savings encourages P2 proselytes, but available data show that these "win-win" cases are neither widespread nor dependable.) Under a conventional system, the manager must compare compliance and noncompliance costs. As compliance costs become imminent, the manager has to decide when they exceed the cost (and risk) of enforcement action.

However, there is no threat of enforcement under a voluntary system. So, the costs incurred to reach an environmental target have to be justified in terms of ambiguous benefits that are very hard to estimate. Performance could be improved if individual benefits became as tangible as individual costs. Federal regulation may soon develop the performance incentives that our voluntary agreement system lacks. At that time, we can probably expect clearer program evaluations and better program results.

Attachment 1 to Appendix D

NEAPOL Questionnaire

Attachment 1 to Appendix D

NEAPOL Questionnaire

NEAPOL

closing conference

November, 30 – December, 1 2000

A conference on the results of the NEAPOL project, a research project financed by the EC-DG XII in respect of Community activities in the field of Research and Technological Development (Environment and Climate Programme 1994-1998 - Theme 4)

ENV4-CT97-0560

A COMPARATIVE STUDY OF ENVIRONMENTAL NEGOTIATED AGREEMENTS

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A COMPARATIVE STUDY OF ENVIRONMENTAL NEGOTIATED AGREEMENTS

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I. THE METHODOLOGICAL FRAMEWORK

This study is based on a comparative evaluation of a number of individual case studies. During the theoretical phase of the NEAPOL project (Negotiated Environmental agreements: Policy Lessons to be Learned), a theoretical framework was designed, based on the existing literature on voluntary agreements. This framework led to the postulation of 4 hypotheses concerning the influence of the socio-economic context on the performance of negotiated agreements. To provide for data for this comparative analysis, 12 European negotiated agreements were selected.

Table 1: The selected negotiated environmental agreements

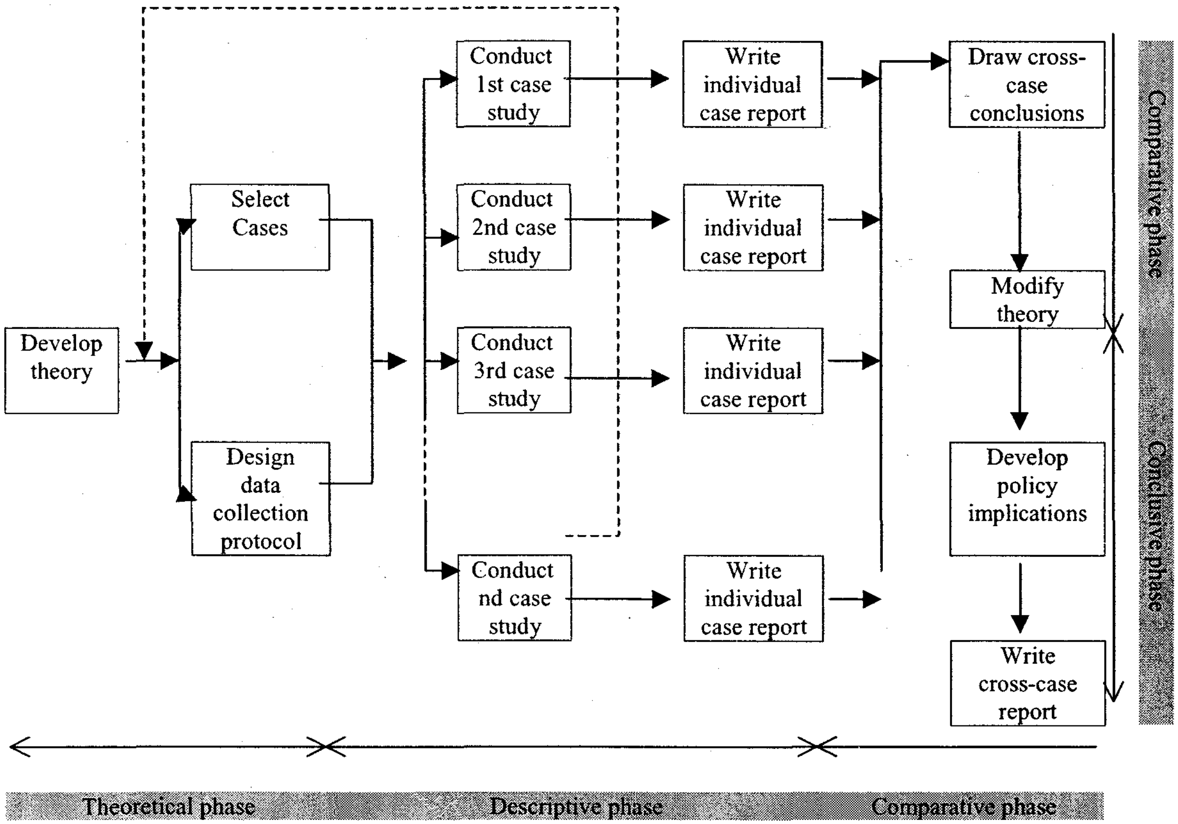
Abbreviation	Country	Description of the agreement
GBAT	Germany	Agreement to reduce the mercury-content in batteries and to collect used batteries separately.
GELV	Germany	Agreement to maximise the recycling rate of end-of-life vehicles.
FCFC	France	Agreement to eliminate the use of CFC's in the industry.
FECO	France	Agreement upon the collection and recycling of packaging waste, to maximise the valorisation rate.
BBAT	Belgium	Agreement upon the private separate collection and recycling of used batteries.
BELE	Belgium	Agreement to reduce the emission of SO_2 and NO_X in power plants.
DSO2	The Netherlands	Agreement upon the reduction of the SO_2-emission of power plants
DWHI	The Netherlands	Agreement upon the take back of worn household appliances by their producers ('white and brown goods').
IVIC	Italy	Regional agreement upon the improvement of the environmental quality in the province of Vicenza.
IAGI	Italy	Agreement upon the improvement of gasoline quality
EFAR	UK	Agreement upon the collection from farms of waste plastic films used in the production ('farm films')
EEFF	UK	Agreement to improve the energy efficiency in the chemical industry.

Each agreement was analysed following a common case study design, in order to be able to extract as much comparative data as possible. During this descriptive phase, each project partner undertook in fact two case studies, resulting in 12 case studies at the end of this phase, each containing the elements needed to perform the cross-case comparison.

Consequently, the aims of the comparative phase are to

- Analyse and compare the performance of the different agreements studied;
- Analyse and compare the socio-economic context wherein each agreement existed;
- Analyse and compare the influence of the socio-economic context on the performance of negotiated agreements.

Figure 1: The different phases of a multiple case study research



II. ASSESSING THE AGREEMENTS' PERFORMANCE AND TESTING THE HYPOTHESES.

II.1. Introduction

The central question of the NEAPOL research programme is the following: '**Which specific characteristics of negotiated agreements and which factors within the institutional-economic context wherein a negotiated agreement is used, influence the performance of this negotiated agreement?**'

Based on theoretical insights gained during the theoretical phase, four hypotheses were postulated regarding the relation between the elements that constitute the institutional-economic context and the performance of the negotiated agreement. This led to the following hypotheses:

1. <u>Policy hypothesis</u>: The fact that the public environmental policy evolves in a tradition and in a climate of consensus seeking, joint problem solving, mutual respect and trust is a crucial positive factor for the performance of negotiated agreements.

2. <u>Instrumental hypothesis</u>: The fact that the public policy makers show readiness to use alternative policy instruments, as a stick behind the door to deal with the environmental problems, in case the negotiated agreement fails, is a crucial positive factor for the performance of negotiated agreements.

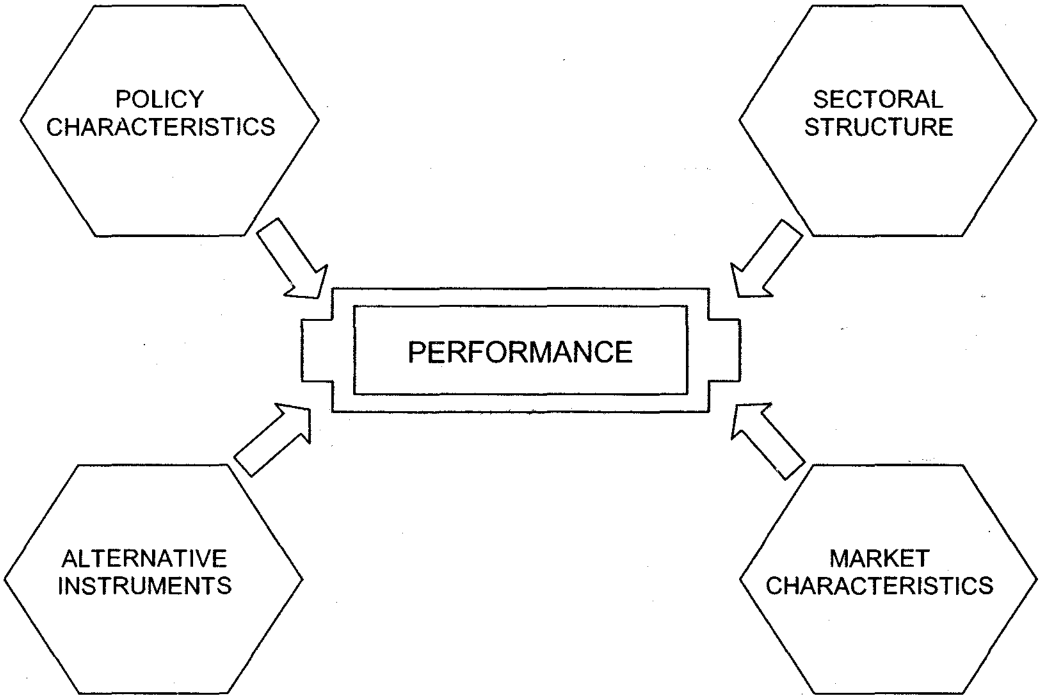
3. <u>Sectoral hypothesis</u>: The fact that the industry sector involved is homogeneous, has a small number of players and is dominated by one or two players, or has a powerful industry association that can speak for all its members, is a crucial positive factor for the performance of negotiated agreements.

4. <u>Competition hypothesis</u>: The fact that firms can gain competitive advantages by co-operating in the negotiation and by compliance of a negotiated agreement, is a crucial positive factor for the performance of negotiated agreements, due to the consumer pressure.

To test these hypotheses, we first have to assess the performance or success of the negotiated agreements studied. We will do this by using the performance indicators set out in the theoretical part.

Secondly, we need to assess to what extent the conditions of each of the four hypotheses were fulfilled in each particular case. When we can make an assessment on the success of the NA, and on the presence of the conditions in the hypotheses, we can examine whether there is in fact a relationship between the institutional-economic context wherein a NA is used and the performance of that NA.

Figure 2: the performance of negotiated agreements and the socio-economic context



II.2. Assessing the performance of a negotiated agreement

The central question in this part is: '*How can the performance or successfulness of a negotiated agreement be measured?*'. The answer to this question is not simple, because the definition of 'performance' can vary. We will try to measure the performance of a negotiated agreement, using four evaluation dimensions, mentioned in the theoretical study of the NEAPOL project:

- Feasibility;
- Capability, further divided into two aspects: specification and application;
- Impact, and;
- Resource development

In fact, we argue that these dimensions will allow us to evaluate the performance of the negotiated agreements. First of all, we will take a closer look at the meaning of these four dimensions.

'**Feasibility**' addresses the question whether the negotiation process did result in the signing of the agreement. Since the dimension 'feasibility' is of a binary nature, it doesn't give us a lot of useful information on the degree of performance or successfulness of the (feasible or unfeasible) agreement. When it appears that an agreement was not feasible, it will not be applied and will therefore have no environmental or economic impact. However there might have been negotiations between the different parties before it became clear the agreement was not feasible. These negotiations may influence the resource base (the relations between the parties, the trust or mutual respect, the reduction of information asymmetries between the private sector and the authorities, learning…) in a positive way.

'**Capability**' has two aspects: the first relates to the **specification** of the agreement in terms of its consistency (or "fit") with the underlying policy objectives, and its compatibility with national and international law on trade and competition. The second relates to the **application** of the agreement in practice, and the extent to which this reinforces, or erodes, the original agreement.

The **specification** of an agreement can be assessed under three separate headings:

Figure 3: the sub-dimensions of the dimension 'specification'

A. Environmental Performance	**B. Learning**
How is the environmental target defined?	What is the learning objective?
What mechanism will be used to achieve it?	How will this objective be realised?
Is there an adequate control system?	Is there an adequate co-ordination system?

C. Economic Efficiency
How will burden-sharing be achieved?
How will free-riding be dealt with?
Will it create any competitive distortions?

If every single one of those elements is clearly present in the specification of an agreement, the agreement is, according to us, well specified.

Most agreements will have both an environmental performance objective and a learning objective, although the latter may not be identified explicitly. The potential for learning is a feature that distinguishes negotiated agreements from other policy instruments. Of course, the two objectives may be closely linked, particularly if learning is a prerequisite for improved environmental performance (learning – in the form of reduced information asymmetries – may also improve the cost efficiency of the agreement). However, the relative emphasis is likely to vary from case to case, with some agreements placing much greater emphasis on environmental performance, while others focus more on learning.
The **application** of the agreement refers to the compliance of the parties with respect to the targets and obligations specified in the agreement. A distinction between the 'targets' and the 'obligations' should be made: a good performance on the environmental targets defined in the

agreement can influence the environment, while the performance on the other obligations (such as reporting, control, monitoring...) can e.g. influence the cost-effectiveness and the (policy) resource base, and not the environment.

Figure 4: the sub-dimensions of the dimension 'application'

A. Environmental targets	**B. Other obligations** Concerning cost-efficiency Concerning resource development Concerning competition

The dimension '**impact**' does not only concern the environmental effectiveness of the agreement, but also incorporates the economic impacts of the performance. Consequently, the total impact of an agreement, as we define it, consists of

- an environmental impact, not only taking into consideration whether the parties have fulfilled the prescribed targets, but also whether achieving of those targets has led to an actual improvement over the business-as-usual scenario;
- an economic impact, taking into consideration any impacts on cost- efficiency and competition;

Figure 5: the sub-dimensions of the dimension 'impact'

A. Environmental impact Is there an improvement over the business-as-usual scenario?	
B. Cost-Efficiency Are the private costs low and efficiently shared? Are the administration costs low?	**C. Competition** How is free-riding being dealt with?

We can assume that the impact on those four elements will also depend on the way in which these topics were included in the specification of the agreement.

Finally, '**resource development**' refers to the improvements in the policy resource base resulting from negotiating and implementing the agreement.

After explaining the meaning of the four dimensions, it should be clear that measuring the performance of any agreement will depend heavily on which dimensions will be taken into account. Several options are possible here:

- One could take into account only the **specification** of a negotiated agreement, arguing that, when an agreement is well specified, with quantified targets, clearly defined burden sharing and learning mechanisms, the chance that it will be successful increases. This approach is however questionable: although a good specification is an important precondition, it is no guarantee for a good performance.
- Another interpretation of the performance of an agreement could be to take only into account the degree of **application** of the agreement: an agreement would then be considered successful when the targets defined in the agreement are reached. This is a rather narrow interpretation on 'performance', since the targets mentioned in the agreement can be (lower than) business-as-usual targets. Moreover, this interpretation requires a good specification of the agreement: the targets and milestones have to be quantified. If there are no targets specified, how will the performance then be measured?
- Another option is to consider only the **impact** of the agreement: did the existence of the agreement lead to a substantial environmental impact, without leading to substantial economic disadvantages for the stakeholders? This seems to be a valid reasoning, since the impact of the agreement is what is important in the end. But also this approach is problematic: often, it will be difficult to determine whether an environmental or economic impact is solely due to the existence of the agreement, let alone to measure that impact. E.g. is the substantial reduction in SO_2- and NO_x-emissions in Belgium in the recent years only due to the existence of the negotiated agreements with the power plants, or is this evolution merely the consequence of technological progress and existing legislation or initiatives at the European level? Whatis the contribution of the agreement to the reduction in these emissions?
- Combining the above two approaches (measuring application and impact) will probably result in more detailed and nuanced results: the question on whether the agreement's targets are reached, is combined with the question on whether the reaching of the targets has had an environmental and/or economic impact. However, in this case, we do not take into account the development of the resource base, which is a feature important for negotiated agreements.

This reasoning leads us to conclude that the four evaluation dimensions all play a certain, but different role in the performance of a negotiated agreement. It is not recommendable to look only at one or two of the four dimensions (e.g. application or impact).

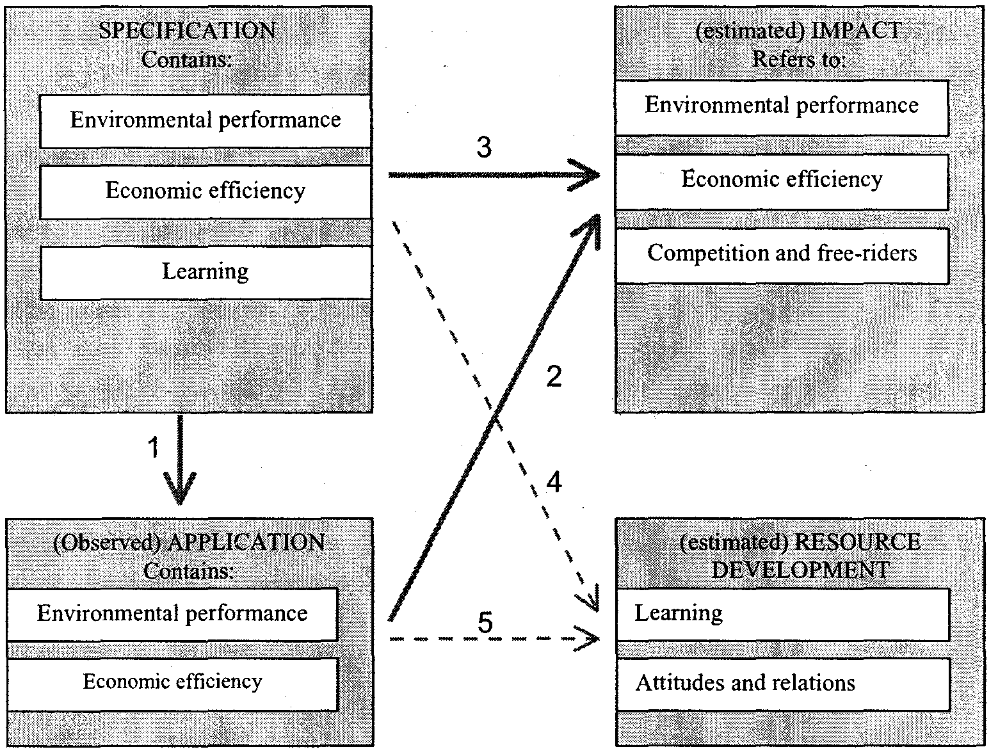
If we on the other hand take into account all four dimensions in measuring the performance of a negotiated agreement, we cannot treat them as independent and additive pieces of the 'performance total'. Often there will be an interaction between them, although this is not necessarily the case. E.g. the fact that an agreement has a good application with respect to its environmental target does not evidently mean that there will be an actual impact on the environment, or that the agreement is cost-efficient. On the other hand, an agreement with a good environmental and economic impact, but with an insufficient resource development, can be considered inferior to an agreement with the same impacts but with a better development of the resource base.

In addition, the impact and the resource development are sometimes difficult to measure. An agreement can contribute to the environmental quality, though the precise extent of this contribution is difficult to assess. Also the resource base is influenced by different factors. Therefore, it is difficult what the precise contribution of each factor is.

The figure below explains visually what relations can exist between the different dimensions of an agreement.

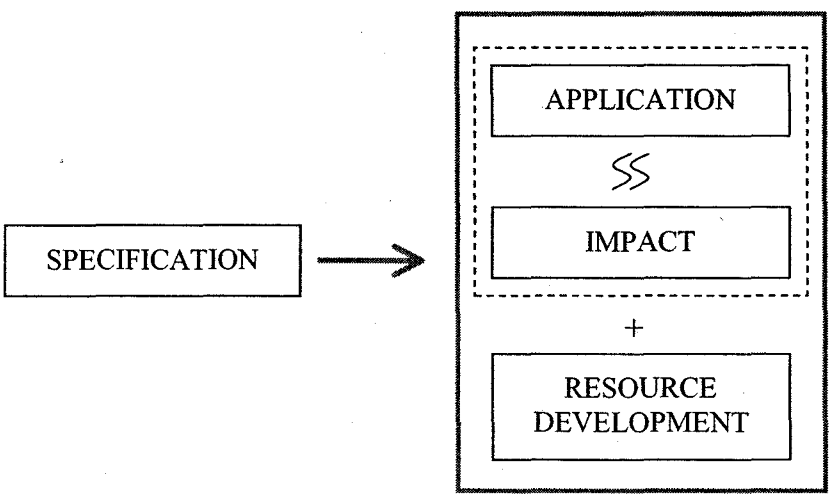
- The specification can influence the application, the impact and the resource development. The influence on the application is direct (1), while the influence on impact is both direct (3) and indirect (2): clear targets, burden sharing mechanisms, and clauses to prohibit free-riding affect the application of the agreement (1), which in turn has a positive influence on the environmental and economic impact (3). The direct influence on impact (2) refers to the ambition of the targets: if these are set too low, the specification of the agreement directly influences the possible impact, no matter if the application is in accordance with these targets. The specification can also influence the resource base through different channels. The resource development can be indirectly influenced through the inclusion in the agreement of clauses to promote technological research among the subscribers, clauses that set regular meeting dates between policy makers and private parties,... if of course what is specified is applied in practice (1 and 5). The resource development is directly influenced by the specification in the sense that a good specified agreement will mostly be the consequence of fruitful negotiations, during which the resource base can be influenced positively (4). We have to mention however that the influence on resource development of both specification and application could be rather small, given the fact that most agreements are primarily aimed at implementation rather than innovation and resource development.
- The application of the agreement can have an influence on the impact (2), and is moreover a proxy for the more difficultly measurable impact. As stated in the previous point, the application can also influence the resource development.
- Finally, we think that the impact of an agreement, will have no effect on the resource development, since the impact is only the final result of the agreement, and the resource base is mainly affected during the negotiation and application phase.

Figure 6: The dimension 'specification' as a precondition for the performance of an agreement



Of the four dimensions, clearly it is the impact and the resource development that in the end will determine the performance of an agreement. The dimension application is too narrow as a judgement base, and the dimension specification is in fact a precondition for the performance of an agreement. The dimension application can however provide for a good estimate of the difficult to measure dimension impact. We will therefore define the performance of any agreement to be a mix of the degree of application, impact and resource development. This measured performance should show a positive correlation with the degree of specification, which is an internal precondition for a good performance.

Figure 7: the performance of a negotiated agreement



What we will do now is try to measure all four evaluation dimensions. Application, impact and resource development will be measured and aggregated to obtain a 'total performance score'. The dimension 'specification' will be measured to check the validity of this total performance score. There should in fact be a positive relationship between the score for the specification of an agreement and its performance, as we noted that the degree of specification is a precondition for the performance of an agreement.

The assessment of the evaluation dimensions is done by means of a grading scale technique. This technique is used to be able to measure the extent of the contribution of each evaluation dimensions to total the performance of the agreement. Later we will use the same technique to test possible correlations with the proposed hypotheses. Therefore a whole series of statements has to be assessed for each agreement, by giving them a grade from 1 to 5, showing to what extent the statement is valid.

The individual grades of each statement do not necessarily have to be added to obtain one overall grade for the dimension. They are merely indicators that the respondents can rely on to give an overall score for each dimension. Adding the grades together to obtain a mean for each dimension could be done if each statement (W, X, Y and Z) added an equal part of explanation for the performance of the dimension (F) in question, i.e. if the statements and the criterion form an additive model.

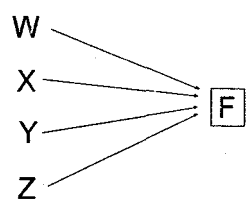


Figure 8: An additive model

This is however not always the case. In a particular case e.g., the validity of one statement (W) can be dominant, while the others (X, Y and Z) can help to assess the dimension, but play a clearly inferior role. Adding the scores for these statements together would undervalue the importance of the most important statement.

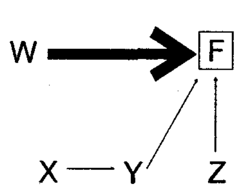


Figure 9: A model with one dominant statement

In other cases, some of the statements (W, X) can contain elements that contribute to the idea behind the main statement, while others can be the consequences (Y, Z) of the idea behind the main statement.

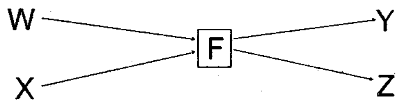


Figure 10: A model with contributors and consequences

Finally, the statements can consist of a chain of necessary conditions to assess the idea behind the main statement. We call this a multiplicative model.

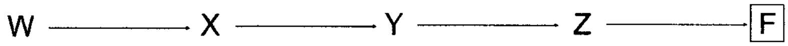


Figure 11: A multiplicative model

In the following we will postulate and explain all statements that need to be assessed in order to have a clear view on the performance of an agreement. What contribution each score has for the dimension in question, depends on the particularities of each case and should be judged by the respondents themselves. To avoid a too subjective evaluation, the survey has to be filled in separately by all two members of the team that studied a particular case. After that, they can compare their answers, discuss dissimilarities and change certain scores if desired, make additional comments, etc., to fill in a definite survey on which the cross-case evaluation will be based.

Where necessary, the statements are accompanied by a scoring guide, and some explanatory notes. If the scoring guide only explains score 5 and score 1, that statement can also score e.g. 2.

II.2.1. SPECIFICATION

We set up 10 statements to assess the specification of the agreement, keeping in mind the four headings we mentioned earlier: specification relating to the environmental performance, to the economic efficiency, to competition and free-riding, and to learning.

a) Environmental performance

Four statements try to capture how well the agreement is specified with respect to the environmental targets it has to reach.

I.1	**The agreement contains a well defined environmental performance objective (or objectives)**
Scoring guide	5 *The performance measure is defined precisely; the objective is quantified, and intermediate milestones are specified.* 3 *The performance measure is ambiguous, and / or the objective is not quantified.* 1 *No environmental performance objective has been defined.*
Remarks	a) The environmental performance objective defines <u>what</u> the agreement is intended to achieve in terms of environmental improvement. It can be expressed in terms of an absolute value, a performance rate (e.g. recycling rate), or a % change versus a base year value. b) Example: an objective of "a 20% reduction in primary energy consumption per tonne of output in 1995 versus 1990" would score 5, while an objective of "a substantial improvement in energy efficiency" would only score 3.

I.2	**The objective (or objectives) represents a meaningful improvement in environmental performance**
Scoring guide	5 *The objective represents a significant improvement over the expected outcome under business-as-usual.* 3 *The objective represents a slight improvement over the expected outcome under business-as-usual.* 1 *The objective does not represent any improvement over the expected outcome under business-as-usual.*
Remarks	a) If it is not possible to establish a quantified business-as-usual counterfactual, a qualitative judgement should be made (and a brief explanation given in "Additional Comments" at end of this section) b) If the agreement does not contain an environmental performance objective, then score "n/a".

I.3	**The agreement contains a credible mechanism for achieving the environmental performance objective (or objectives)**
Scoring guide	5 *The mechanism for implementing the agreement is clearly stated, and is capable of achieving the aggregate objective.* 3 *The agreement gives only a general indication of how it will be implemented, and / or there are doubts over the capability of the mechanism to achieve the objective.* 1 *The agreement does not provide any indication of how it will be implemented.*
Remarks	a) The implementation mechanism defines how the environmental performance objective will be achieved. Potential approaches include the setting up of a collective scheme; the setting of individual performance targets; the provision of encouragement, technical support and advice by the sector association, etc. b) The credibility of a collective implementation scheme is undermined if the agreement does not define how it will be funded. If a funding mechanism is included then the scheme would score 4 (subject to it being capable of achieving the objective). However, if no funding mechanism is included, it would only score 2. c) The capability of the implementation mechanism must be judged in relation to the stringency of the environmental performance objective. For example, if the objective requires only the implementation of all cost effective measures (i.e. those with a positive NPV), the provision of encouragement, technical support and advice by the sector association may be all that is needed.

I.4	**The agreement contains a credible system for monitoring performance against the specified objective (or objectives)**	
Scoring guide	5	*Performance data are collected according to a specified schedule, and is verified by an independent body. Aggregate performance data is made available to the public.*
	3	*Performance data are collected, but is not verified by an independent body and is only made available to the parties to the agreement.*
	1	*The agreement makes no provision of the collection and reporting of performance data.*
Remarks	a)	Performance data refers only to the information that is required to assess progress towards the environmental performance objective (i.e. control information). If additional information is generated, this would be classified as a "learning output" (see statement B.1).

Since we believe that the relevance each of those four statements is of an equal importance, we will take an arithmetic mean of the four statements to arrive at a mean score for the specification regarding the environmental performance.

Score SP/ep	(I.1 + I.2 +I.3 + I.4) / 4

b) Learning

Three statements try to measure to what extent learning is incorporated into the specification of the agreement. First of all, the explicitness of the learning objective is important. Next to this, the learning objective can be reached more easily if there is a mechanism provided in the agreement. Finally, the learning objective is easier to attain when the learning mechanisms can be monitored.

I.5	**The agreement contains a clear objective (or objectives) with respect to learning.**
Scoring guide	5 *The agreement contains an explicit objective with respect to learning.* 3 *The agreement contains an implicit objective with respect to learning.* 1 *The agreement contains no objectives or provisions with respect to learning.*
Remarks	a) Learning could relate to the reduction of information asymmetries (e.g. the dissemination of current best practice, or the collation of existing information and knowledge), or the reduction of shared uncertainties (e.g. the identification of new technical and managerial solutions, or the generation of new information). b) If an agreement does not contain an explicit learning objective, but includes provisions for the collection of new information, sharing of existing knowledge, etc, then this should be interpreted as an implicit learning objective, and would score 2.

I.6	**The agreement contains a credible mechanism to support and encourage learning.**
Scoring guide	5 *The agreement states clearly how the learning activities will be implemented, and / or supported.* 3 *While there is no explicit framework to support learning, other aspects of the agreement provide opportunities for learning to occur.* 1 *The agreement does not provide any support for learning – either explicitly or implicitly.*
Remarks	a) An implementation mechanism for learning should stipulate how the learning is expected to occur. For example, a programme of individual site visits could be used to disseminate existing best practice; a co-operative R&D programme could be set up to identify new technologies and processes, etc. b) The credibility of the support framework must be judged in relation to the nature of the learning objective (either explicit or implicit). c) If there is no learning objective (either explicit or implicit), then score "n/a"

I.7	The agreement contains an adequate monitoring system for co-ordinating learning activities.
Scoring guide	5 *There is a formal monitoring system that enables the learning activities to be managed and co-ordinated effectively.* 3 *While there is no formal monitoring system, established relationships between the actors should facilitate the co-ordination of learning activities.* 1 *There is no mechanism – either formal or informal – for co-ordinating learning activities.*
Remarks	a) The detailed requirements of a monitoring system will depend on the nature of the learning objective and the implementation mechanism that is adopted. However in general terms, the co-ordination of learning requires the tracking of initiatives / projects, and the collation and dissemination of the results of these activities. b) If there is no learning objective (either explicit or implicit), then score "n/a"

Again here we believe that these scores for these statements can be added together to become a mean score for the presence of learning in the specification in the agreement.

Score SP/le	(I.5 + I.6 +I.7) / 3

c) Economic efficiency

I.8	**The agreement contains a burden-sharing mechanism that is consistent with a cost-efficient outcome.**
Scoring guide	*5 There is an explicit (ex ante) burden-sharing mechanism that differentiates between actors in order to reduce the aggregate cost of the achieving the objective.* *3 The agreement relies on the monitoring of individual actors during its operation to identify those that have the lowest cost opportunities (i.e. ex post burden-sharing).* *1 There is no burden-sharing mechanism, or if it exists, it takes no account of the potential differences between actors (e.g. all have to make the same contribution).*
Remarks	a) The burden-sharing mechanism defines who is responsible for achieving the environmental performance objective. b) For an "individual action" agreement, the responsibilities for action and payment coincide (i.e. those actors that take the actions bear the costs). In this case, burden sharing relates to the apportionment of the aggregate environmental performance objective (e.g. the amount of SO_2 that each firm can emit, or the % improvement in energy efficiency that they must make). Cost efficiency will usually require that individual targets be differentiated.

I.9	**The agreement contains a credible mechanism to prevent free-riding by participants.**
Scoring guide	*5 The agreement assigns specific responsibilities to individual firms. Individual performance is monitored, and the financial penalty for non-compliance is high.* *3 Individual responsibilities are only defined loosely, and / or monitoring is relatively weak. While sanctions for non-compliance exist, the expected cost is not high.* *1 The agreement does not assign individual responsibilities, and there is no monitoring of individual performance. The expected cost of non-compliance is zero.*
Remarks	a) Individual responsibilities may be defined in terms of performance targets, financial contributions, or management actions (e.g. introduction of environmental management systems). b) Sanctions for non-compliance could include pre-defined financial penalties, or expulsion from the agreement (and / or industry association). However, the latter would only be meaningful if non-participants are subject to an alternative regulation or tax (that imposes a real cost), or if the impact on the company's reputation would result in a loss of sales. c) This statement relates only to free riding by participants in the agreement (i.e. non-compliance). It does not relate to the free riding of firms that choose to remain outside the agreement (i.e. non-participation). As such the credibility of an alternative instrument is not relevant, unless the penalty for non-compliance is expulsion from the agreement. d) If the achievement of the objective requires only that firms implement measures that satisfy normal investment criteria (e.g. positive NPV, payback < 3 years, etc.) then the issue of free riding does not arise as it is in the firms' own interests to take the necessary actions. In this case score "n/a".

I.10	The agreement does not create any barriers to new entrants.
Scoring guide	5 *The agreement is open to all national and overseas companies on equal terms.* 3 *While the agreement is not open to all companies on equal terms, it does not create substantial barriers to new entrants in the sector covered.* 1 *The agreement prevents other companies from joining.*
Remarks	a) If an agreement has been notified to the relevant national and European competition authorities, then it would score 5.

Both free-riding and market distortions can occur during he application of the agreement. For simplicity reasons we will just ad the scores for the three statements together and consider this mean score as the degree of economic efficiency.

Score SP/ec	(I.8. + I.9 + I.10) / 3

For a total score on specification, we now take the average of each subscore for specification. This means that the total score for specification can be calculated as:

Score SP	[Score SP/ep + Score SP/le + Score SP/ec] / 3

II.2.2. APPLICATION

To assess the performance of an agreement with respect to its application, we make a distinction between the environmental performance of the agreement, and the fulfilment of the individual obligations by the parties.

The degree in which the parties reach the prescribed environmental targets is a necessary condition for assessing the environmental performance of the (application of the) agreement. Since it is possible that agreements are broken down before the intended ending date, we included a statement to take this possibility into account. There is a difference between an agreement that is not broken down, but doesn't reach the environmental targets, and an agreement that is broken down for some reason, but has reached the environmental targets during its existence.

On the other hand, most of the negotiated agreements also contain individual obligations beside the aggregate environmental target(s). These can be monitoring obligations by the authorities, the obligation of the private parties to provide data, the obligation to set up a research programme, the individual environmental target(s) if the aggregate target has been divided into individual targets, etc. The fulfilment of the individual obligations do not directly tell us something about the environmental performance of the agreement, but can tell us something about the economic efficiency of the agreement and the resource development. An agreement where the aggregate target has been met, but where a deficient burden sharing mechanism led to economic inefficiency, is not as successful as an agreement that reaches the aggregate target due to an efficient burden sharing mechanism. Likewise, an agreement where the environmental target was reached, but the other obligations (monitoring, reporting, learning) were not, will perform lower on resource development.

II.1	**Compliance with (interim) environmental performance targets is good.**
Scoring guide	5 *The target group reaches the environmental targets impeccably.* 1 *The target group fails completely to comply with the targets.*
Remarks	a) If the agreement has not come to the end of his term, then compliance should be assessed against the intermediate targets or milestones. b) If the targets are not equally important, attention should be paid to the most important target.

II.2	**The agreement is not broken down or eroded substantially during its intended life span.**
Scoring guide	5 *The agreement has been or is still being carried out during its intended life span in accordance with its original content.* 3 *The agreement has not been broken down during its intended life span, but its contents have been eroded during its application.* 1 *The agreement has been broken down after only a short application.*
Remarks	a) If the agreement is replaced by a more recent voluntary agreement, and the replacement is not the result of the unsuccessfulness of the original one, this should be written down in the additional comments. b) The erosion of the contents could be the (formal or informal) adaptation of the agreement to make it less demanding or a changed interpretation on the targets and obligations for the sector covered.

II.3	**Compliance with the individual obligations is good.**
Scoring guide	5 *The individual parties fulfil their individual obligations impeccably.* 1 *The individual parties fail completely to comply with their individual obligations.*
Remarks	a) Individual obligations could be the providing of funding, the participation in programmes, reaching an individual environmental target, if the aggregate target has been broken down.

Calculating the total score for application is done in a specific manner. The interpretation of the score for statement II.1 and II.3, depends on the fact whether the agreement was broken down or eroded during its existence (statement II.2). We use therefore a multiplicative model.

Moreover, we think that the compliance with the environmental targets is more important than the compliance with the individual targets or obligations. We decided to give statement II.1 a weight of 2/3 and statement II.3 a weight of 1/3.

Score AP	2/3 * Square root of (II.1 * II.2) + 1/3 * Square root of (II.3 * II.2)

II.2.3. IMPACT

While the assessment of the application of an agreement is limited to explicit and implicit policy objectives, the assessment of the impact of an agreement implies a broader view on the performance of the agreement: next to the environmental impact, also economic efficiency and wider economic impacts, such as competition distortion are taken into account.

a) Environmental performance

III.1	**There is a significant improvement on the target environmental variable, compared to the business as usual situation.**
Scoring guide	5 *The improvement of the target environmental variable is drastic.* 1 *The target environmental variable has not improved at all.*
Remarks	a) This statement should be judged apart from the fact whether the agreement has reached its prescribed targets. An agreement can lead to a significant improvement of the target environmental variable without reaching its prescribed targets. b) The target environmental variable is the variable specified in the agreement to be improved. c) The business as usual situation for this question is the situation in which there would be no agreement signed. Since there are no data on this situation, one should make a personal appraisal.

Score IM/ep	III.1

b) Economic efficiency

III.2	**The application of the agreement is cost-efficient with respect to compliance.**
Scoring guide	5 *The application of the agreement is very cost-efficient.* 1 *The application of the agreement is not cost-efficient.*
Remarks	a) This statement relates to the costs that are made by the private parties to (try to) reach the prescribed objectives. It has to be evaluated along personal appraisal, since measuring cost-efficiency is difficult and since mostly there is no counterfactual evidence to compare with. b) When the prescribed objectives aren't reached, this statement can still score a 5 when the failure of reaching the objectives is not caused by cost-inefficiency. c) When the non-compliance is only due to cost-inefficiency, this statement scores a 1.

III.3	The administration cost of the agreement is fairly low.
Scoring guide	5 *The administration of the agreement creates no or very small additional administrative costs for the private parties* **and** *for the public authorities.* 3 *The administration of the agreement creates substantial additional administrative costs for the private parties* **or** *for the public authorities.* 1 *The administration of the agreement creates substantial additional administrative costs for the private parties* **and** *for the public authorities.*
Remarks	a) It may not be easy to calculate this cost. However they can be estimated by considering factors such as the type and amount of additional information, the complexity and rigour of monitoring and enforcement mechanisms, the synergy with existing activities,... of the controlling units. b) Again this statement has to be judged keeping in mind the counterfactual.

Score IM/ec	(III.2 +III.3) / 2

c) Competition

III.4	There is no negative impact on competition due to the application of the agreement.
Scoring guide	5 *The application of the agreement doesn't create any negative impact on competition* 3 *The application of the agreement creates a minor negative impact on competition* 1 *The application of the agreement creates substantial competition distortions*
Remarks	a) Here one has to consider both competition between the private parties in the agreement and competition between parties in the agreement and parties outside the agreement.

Score IM/co	III.4

Since it is difficult to measure the precise contribution of each of those sub-dimensions to the total impact of any agreement, we suppose that they contribute proportionally to the total impact. Therefore, we also make use of the additive model. The total score for impact is then:

Score IM	[Score IM/ep + Score IM/ec + Score IM/co] / 3

II.2.4. RESOURCE DEVELOPMENT

The enhancement of the policy resource base again is interrelated with the specification, application and impact of the agreement. The policy resource base can be enhanced during each of those phases. In this context, we distinguished three (overlapping) sub-dimensions for resource development: learning, relations between actors and general attitudes. Relations between actors e.g. can improve through contacts during the specification of the agreement, or through monitoring meetings during the application phase. The impact the agreement has on e.g. the economic efficiency can affect the relations between private parties and the authorities with respect to further negotiations,...

A very important feature of resource development is its dynamics, as the word 'development' indicates. Relations, learning and attitudes can change over time. It is therefore even more difficult to evaluate it. The statements below all reflect the idea of a certain improvement in relations, learning and attitudes.

A non-successful agreement with respect to the environmental impact or target compliance can still have favourable effects on the resource development.

IV.1	**The agreement led to an important improvement in the attitudes of the parties concerning environmental issues.**
Scoring guide	5 *The attitudes of the parties changed dramatically concerning environmental issues, also those not covered by the agreement.* 3 *The parties only changed their attitudes towards the environmental problem covered by the agreement.* 1 *The parties didn't change their attitude towards environmental problems.*
Remarks	a) The improvement of the attitudes might be a higher awareness of environmental problems in general, increased participation in voluntary schemes, changes in management structures and practices...

IV.2	The agreement led to an important improvement in learning.
Scoring guide	5 *The agreement has substantially reduced the uncertainties of the actors, or has led to a significant dissemination of knowledge between them.* 1 *The agreement has not reduced the uncertainties of the actors, or hasn't led to a dissemination of knowledge between them.*
Remarks	a) In case of an innovation-oriented agreement, learning relates primarily to a reduction in shared uncertainties of all actors regarding the scale of the environmental problem, the appropriate responses and the potential solutions that might be adopted. In case of an implementation-oriented agreement, the focus is on the dissemination of knowledge in order to reduce the level of information asymmetries between the actors regarding existing technological or managerial possibilities.

IV.3	The learning has led to substantial innovation in policy-making in this area.
Scoring guide	5 *The agreement has led to other innovative initiatives in policy-making in the area covered by the agreement.* 1 *There was learning, but the agreement has not led to any further innovative approaches in policy-making due to this learning.*
Remarks	a) If the agreement indeed led to an improvement in learning, one can ask if these learning effects are being reflected in the policy style of the authorities towards the private parties. b) Is statement IV.2 scored 0, one should answer n/a to this statement.

IV.4	The agreement led to greater trust and more productive relationships between parties.
Scoring guide	5 *The agreement led to greater trust and more productive relationships between parties.* 1 *The agreement led to distrust and less productive relationships between parties.*
Remarks	a) An improvement in relations may be brought about by a range of different factors: new channels of communication, an improved understanding of respective perceptions, intensified or institutionalised contact between parties,...

IV.5	The agreement has generated product- or process-related innovations and/or market opportunities.
Scoring guide	5 *The agreement has led to radical innovations and substantial market opportunities.* 1 *There were neither innovations nor new market opportunities thanks to the agreement.*
Remarks	a) Radical innovations and/or market opportunities can include the creation of new products or product processes, the adaptation of new management or development techniques, the creation of new market shares...

For the same reason as we took the arithmetic mean to measure the total impact of an agreement, we will do the same here.

Score RD	(IV.1 + IV.2 +IV.3 + IV.4 + IV.5) / 5

II.2.5. Measuring the average performance of the studied agreements

After assessing all the statements necessary to measure the performance of agreements, we will now look at all the results of this analysis for each agreement that was studied. To obtain the average performance of each agreement, we have taken the arithmetic mean of the scores on the three dimensions 'application', 'impact' and 'resource development').

Performance Score	[Score AP + Score IM + Score RD] / 3

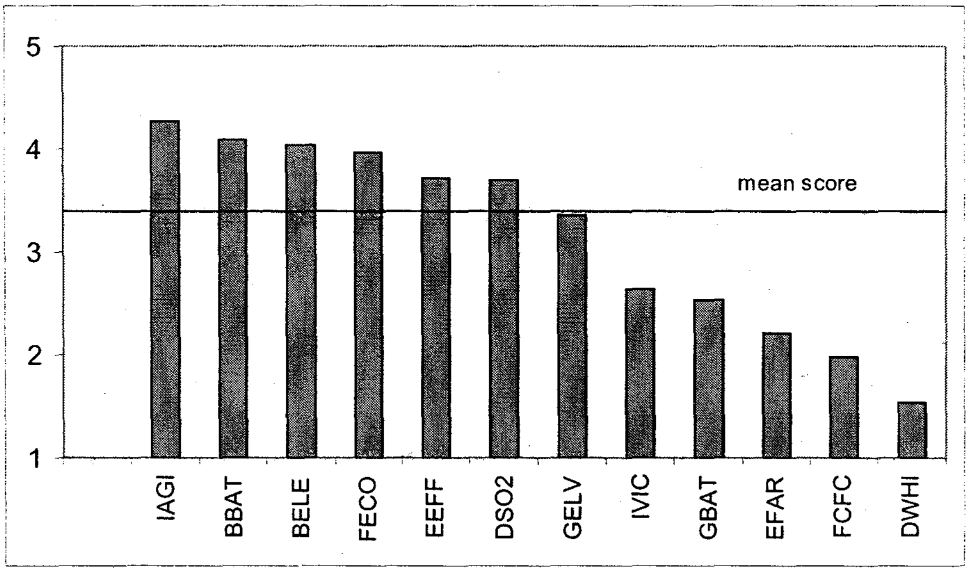
This calculation leads to the following results:

Table 2: the scores for the different dimensions of the studied agreements

	Specification	*Application*	+ *Impact*	+ *Resource development*	= *Average performance*
GBAT	2,03	2,09	2,42	3,10	2,54
GELV	3,22	3,67	3,42	3,00	3,36
FCFC	2,17	1,41	2,33	2,20	1,98
FECO	3,72	3,87	3,00	5,00	3,96
BBAT	3,89	4,74	4,42	3,10	4,08
BELE	3,25	5,00	4,50	2,60	4,03
DSO2	3,50	5,00	3,67	2,40	3,69
DWHI	1,00	1,00	1,00	2,60	1,53
IVIC	2,72	1,73	3,00	3,20	2,64
IAGI	3,40	4,91	4,50	3,40	4,27
EFAR	2,67	1,77	2,50	2,40	2,22
EEFF	3,76	5,00	2,92	3,20	3,71

GBAT: German batteries agreement; GELV: German End-of-life vehicles agreement; FCFC: French CFC agreement; FECO: French Eco-emballages agreement; BBAT: Belgian batteries agreement; BELE: Belgian electricity agreement; DSO2: Dutch SO2 agreement; DWHI: Dutch white and brown goods agreement; IVIC: Italian Vicenza agreement; IAGI: Italian Agip agreement; EFAR: English farm films agreement; EEFF: English Efficiency agreement.

graph 1: the average performance of the studied agreements

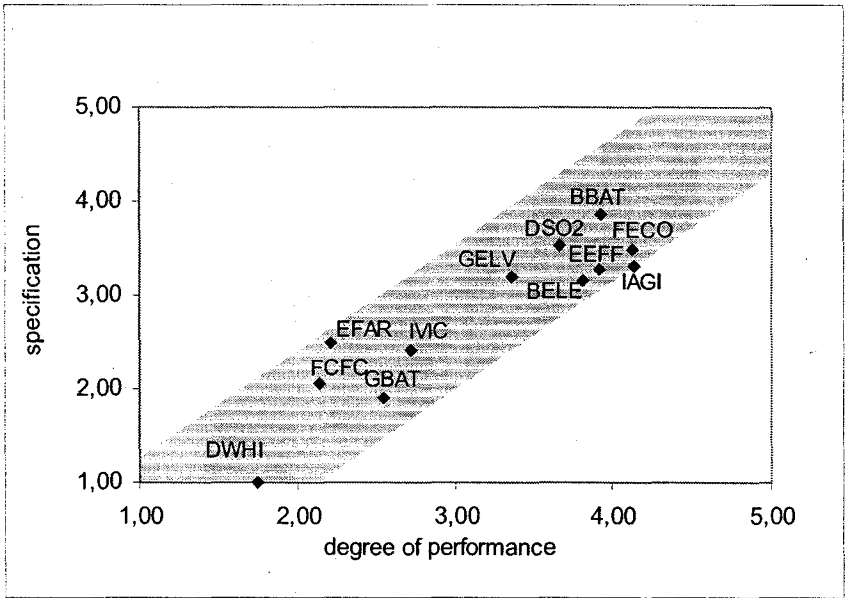


The ranking of the agreements based on their average performance score is shown in the above graph. We can see that five of the agreements score well below average (GBAT, IVIC, FCFC, DWHI and EFAR). Three agreements have a score that is near the total average of 3.37 (GELV, EEFF and DSO2). Finally, four agreements score well above the average (FECO, BBAT, BELE and IAGI).

II.2.6. The specification of an agreement as the precondition for its performance

As we said earlier, the average performance score should reflect the degree of specification and vice versa. If this is true, we may say that our average performance score is a fairly good approximation of the actual performance of an agreement.

graph 2: The performance of negotiated agreements and the specification

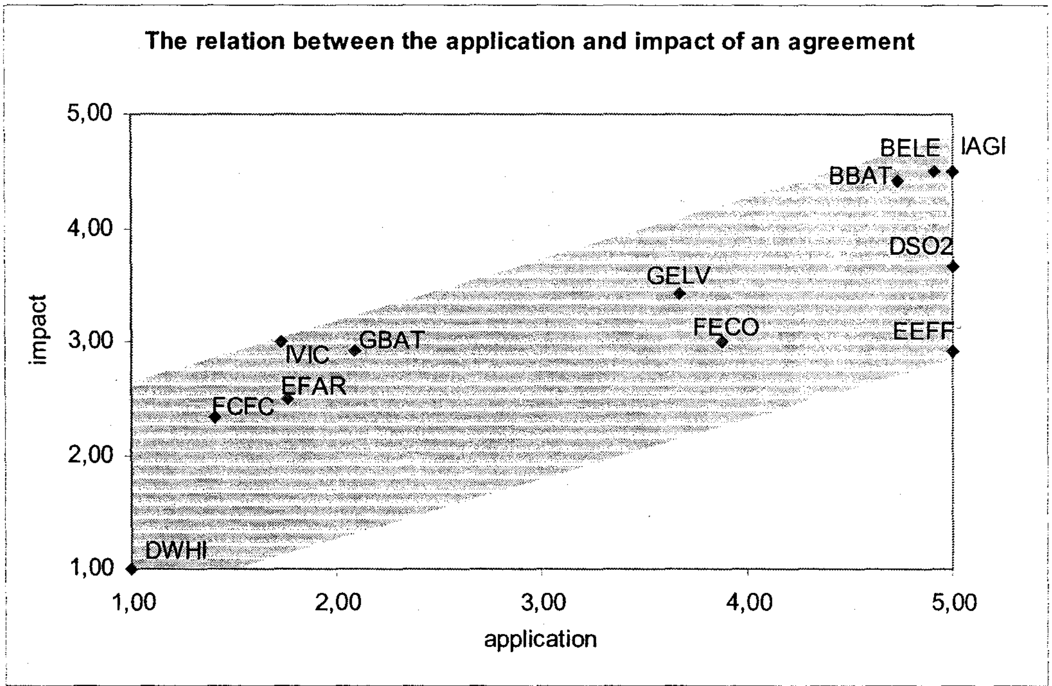


The above graph clearly shows that there is in fact a positive relationship between the specification of an agreement and its performance. This shows what we already expected: the degree of specification of an agreement is an important precondition for the performance of an agreement.

II.2.7. The interrelations between the 'performance' dimensions

Next to the relation between the specification of an agreement and its average performance, we have also mentioned that the separate 'performance' dimensions (application, impact and resource development) can influence each other. As the graphs show, there is primarily a positive relationship between the application and the impact of a negotiated agreement. This is easy to explain: the impact of an agreement depends on the application of this agreement. If an agreement is badly applied, chances that there will be a substantial environmental or economic impact are small. This does not mean however that a good application of the agreement is a sufficient precondition for a substantial environmental impact. If the targets are merely representing a 'business as usual' situation, then a good application of those 'weak' targets will not cause a great deal of impact.

graph 3: The relation between the application and impact of an agreement



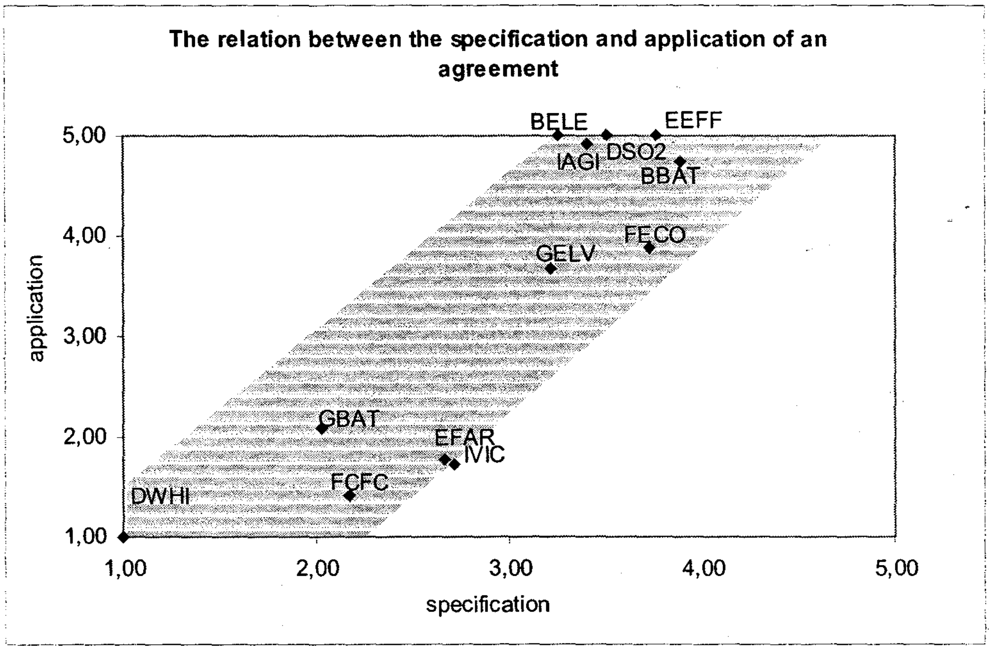
For agreements that score high on statement I.2, the relation between impact and application should be stronger than for those agreements in which the targets are less ambitious.
If we take a look at the different scores for statement I.2., we can find 5 agreements with a 4 or 5 score: GELV, FECO, BBAT, EFAR and IAGI. Plotting a graph for the relation between application and impact for these agreements only, yields less disperse results than plotting the graph for the whole set of agreements, as carried out above.

Between impact and application on the one hand, and resource development on the other hand, there seems to be no distinct relation. This we already presumed earlier.

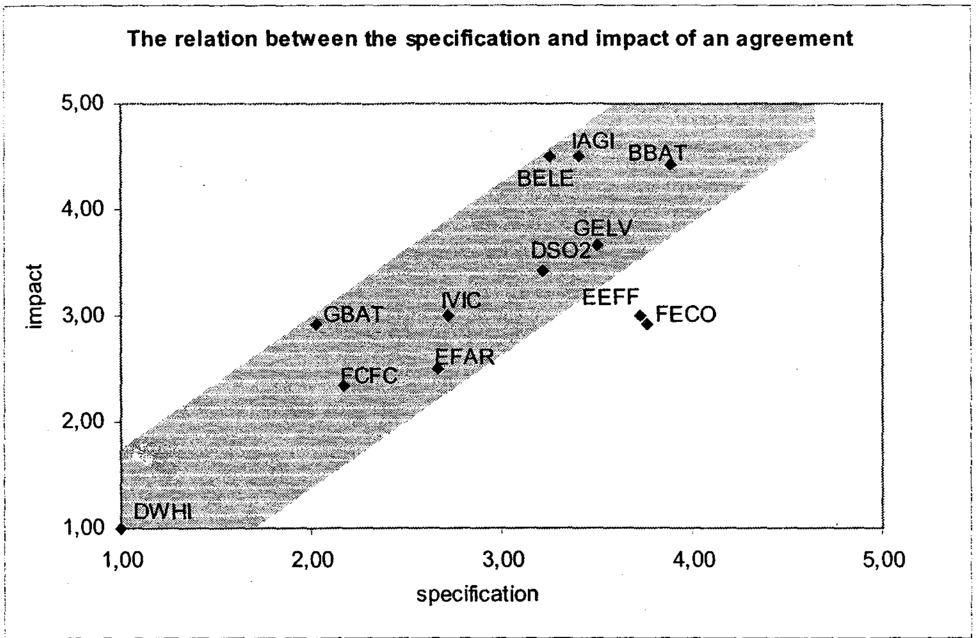
II.2.8. The influence of the specification on the separate performance dimensions

Next to the question whether the 'performance' dimensions influence each other, we can also analyse how the specification influences these three dimensions separately, rather than the aggregate of them (as in II.2.6.). The results we obtained can again be explained logically: specification influences the average performance of an agreement primarily through its influence on the application of the agreement. There is a clear positive relationship between specification and application. Through the application of the agreement, the specification also influences the impact of an agreement, although here the positive relationship is not as steep as the one before. Finally, there seems to be no clear relationship between the specification and the resource development. It seems as if statements written in the agreement about learning and resource development have in fact no strong influence on the actual resource development or learning.

graph 4: the relation between the specification and application of an agreement



graph 5: the relation between the specification and impact of an agreement

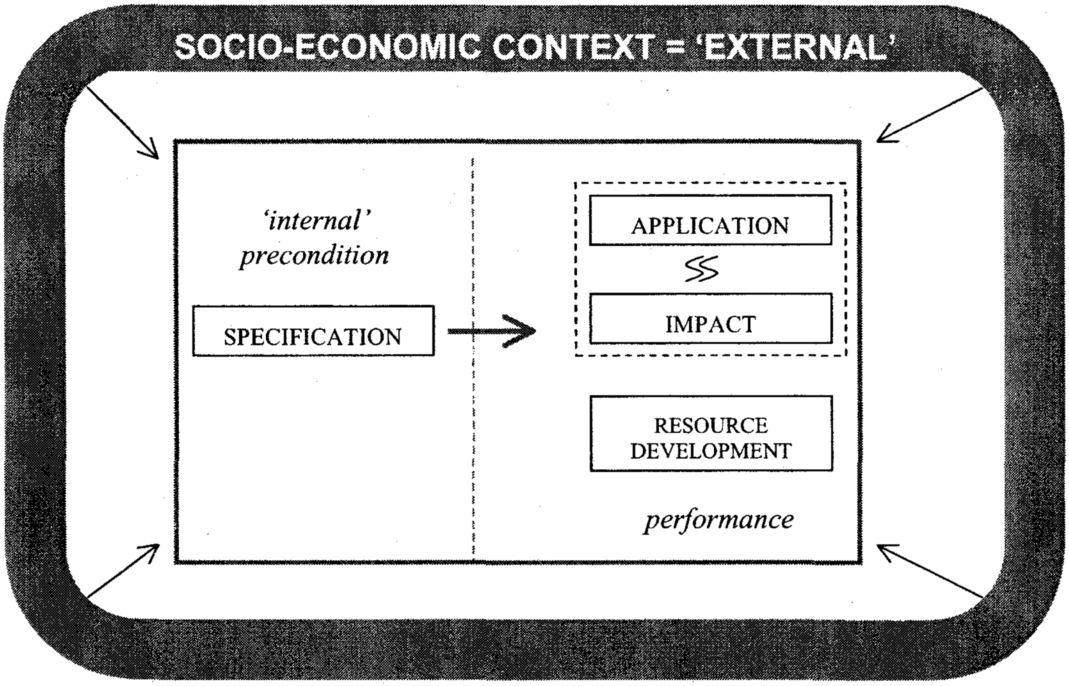


In the following, we will try to explain why certain agreements performed well and other badly, using information on the socio-economic context the agreement was reached in. This information is obtained through a survey having a similar structure compared with the one used to obtain information on the performance of the agreements.

II.3. Assessing the hypotheses' socio-economic context

After assessing the performance, the socio-economic context of each agreement is analysed. In our definition, the socio-economic context is an important precondition for the final outcome of each agreement.

Figure 12: the influence of the socio-economic context on the performance of agreements



Through four hypotheses, we will consider four different socio-economic aspects and their expected influence on the performance of negotiated agreements.

Hypothesis 1: The fact that the public environmental policy evolves in a tradition and in a climate of consensus seeking, joint problem solving, mutual respect and trust is a crucial positive factor for the performance of negotiated agreements.

Hypothesis 2: The fact that the public policy makers show readiness to use alternative policy instruments, as a stick behind the door to deal with the environmental problems, in case the negotiated agreement fails, is a crucial positive factor for the performance of negotiated agreements.

Hypothesis 3: The fact that the industry sector involved is homogeneous, has a small number of players and is dominated by one or two players, or has a powerful industry association that can speak for all its members, is a crucial positive factor for the performance of negotiated agreements.

Hypothesis 4: The fact that industries are close to the final markets is a crucial positive factor for the performance of negotiated agreements, due to the consumer pressure.

We do however not deny that there can be other socio-economic impacts besides those included in our hypotheses, that have an influence on the performance.

To gain information on the socio-economic context, we have carried out an analysis, using the same technique as for the performance evaluation. Different statements were judged for each agreement studied, by giving them a 1 to 5 score. Using these scores, we then will try to measure how favourable each of the four socio-economic aspects is with respect to the agreement's performance.

II.3.1. The policy style: is there a tradition of consensus-seeking and joint problem solving?

Three statements have to be assessed to be able to gain insight in the policy style in the country of the agreement and to test for the policy hypothesis. The first one considers the general policy style, while the second and third statement focus on respectively mutual trust and self-responsibility within the sector considered. If all those statements receive a high score, we consider this policy context to be favourable for the performance of the agreement considered.

We have to note that these external factors can change over time. If there are sudden changes in e.g. the climate of trust, this should be reflected in the score for the policy hypothesis.

I.1	**Environmental policy evolves in a tradition of consensus seeking and joint problem solving apart from the conclusion of the agreement.**
Scoring guide	5 *Environmental policy is characterised by a long tradition of consensus seeking and joint problem solving.* 1 *Apart form the agreement, there has been no examples of consensus seeking or joint problem solving in environmental policy.*
Remarks	a) The presence of consensus seeking and joint problem solving can e.g. be measured by the presence of interactive forms of environmental policy making: unilateral commitments, negotiated agreements, public voluntary schemes,...

I.2	**Apart from the process leading to the conclusion of the agreement, policy making in the area covered by the agreement is characterised by a climate of mutual trust.**
Scoring guide	*5* Policy making in the area covered by the agreement has always been characterised by mutual trust. *1* There are no signs of mutual trust in the policy making in the area covered by the agreement.

I.3	**Apart from the process leading to the conclusion of the agreement, the private sector(s) covered by the agreement show(s) a clear readiness to self-responsibility with respect to the environmental problem.**
Scoring guide	5 *The private sector covered by the agreement has always taken responsibility with respect to the environmental problem.* 1 *The private sector covered by the agreement has never taken any responsibility with respect to the environmental problem.*
Remarks	a) The self-responsibility of the private sector could already have led to unilateral commitments, negotiations with policy-makers, the application of public voluntary schemes…

The average score for the policy hypothesis is calculated as follows:

Score POL	(I.1 + I.2 +I.3) / 3

II.3.2. The use of an alternative instrument: is there a stick behind the door?

This hypothesis concentrates on the readiness of the policy makers to use an alternative instrument in case of non-compliance to the agreement by the private parties. The readiness of the policy makers however has to be combined with the severity of this alternative when applied. When the threat of the alternative instrument is credible, and this instrument has more stringent or costly consequences for the companies involved, they should have a bigger incentive to make the agreement succeed.

II.1	**The chances that public authorities will use an alternative instrument in case of non-success or non-conclusion of the agreement are high.**
Scoring guide	5 *The public authorities are ready, credible and capable to use an alternative instrument in a well-specified case of non-success.* 1 *The chance that public authorities will use an alternative instrument is non-existent.*
Remarks	a) Features to be taken into consideration here are: the readiness of the authorities to use an alternative instrument, the capability of the authorities to install the alternative instrument, the specificity of the definition of non-success, the credibility of the authorities using the alternative instrument... This statement scores 4 when e.g. the alternative instrument is formally defined and comes into force without prior action of the policy makers.

II.2	**If applied, the alternative instrument has more severe consequences for the target group than those resulting from the application of the agreement.**
Scoring guide	5 *The alternative instrument has severe consequences for the target group, both for the short and the long term.* 1 *The alternative instrument has no other consequences then those resulting from the application of the agreement.*
Remarks	a) Short-term consequences are e.g. the condemnation to pay a fine or the adaptation to the alternative instrument. Long term consequences can be the application of the alternative instrument or bad publicity. Both can be severe (a huge fine, a more severe policy regime, a public blame) or of minor importance (a small fine, an internal blame,...).

Here, the calculation of the score for the instrumental hypothesis differs from that for the policy hypothesis, since the two statements are not independent from each other (e.g. the severity of the alternative instrument becomes nearly irrelevant when the chance that this instrument is used is non-existent.) We therefore use a multiplicative approach and we will multiply the scores for both statements instead of adding them. By taking the square root of this multiplication, we again obtain a score between 1 and 5.

Score INS	Square root of (II.1 * II.2)

A high the score for INS means that there is in fact a credible and severe alternative instrument present, and this should refrain the companies in the agreement to forsake their duties described in the agreement.

II.3.3. The sectoral structure: is the sectoral structure fit for an agreement?

The first two statements here reflect the idea that an agreement will have more chance in succeeding if the target group can negotiate as one collective actor and thereby make it easier for the authorities to apply a negotiated agreement approach. The chance that the target group will be able to negotiate as one actor will depend primarily on the existence of a powerful player or association, and on the fact that the private parties belong tot the same industrial sector.

Once the agreement is concluded, free-riding can prevent the participants from complying with the targets and obligations of the agreement.

III.1	**There is already a dominant interest of a major player / a small number of players or a powerful and representative industry association in the area covered by the agreement.**
Scoring guide	5 *The area covered by the agreement is characterised by a dominant interest of a major player or a small number of players or a powerful and representative industry association.* 1 *The area covered by the agreement is characterised by a wide heterogeneity of small players that have no representative industry association.*

III.2	**The private parties tot the agreement belong to the same industrial sector.**
Scoring guide	5 *All private parties belong to the same industrial sector* 3 *The private parties belong to industrial sectors that are linked closely with each other.* 1 *The private parties belong to industrial sectors that are totally different.*
Remarks	a) The definition of the industrial sector can be different depending on the digit level one uses. Which digit level to use is left to the personal appraisal of the respondent, but it should be in accordance with the nature of the agreement.

III.3	**The potential for significant free riding between the members of the targeted sector covered by the agreement, is low.**
Scoring guide	5 *There is no possibility to commit free riding by the members of the targeted sector.* 1 *There exists a big potential for free riding by the members of the targeted sector.*

Again, in order to obtain a total score for the instrumental hypothesis, we do not merely add the scores for the three statements together. Statement III.3 is crucial in our opinion. It could outnumber the positive effects of the features described in the two statements below: even if there is either a dominant major player/a small number of players or a homogeneous sector, the existence of free-riding could break down the agreement. In a situation where there is no free-riding possible, the first two statements can explain the effect of the sectoral structure on the performance of the agreement. For that reason, the average score for the sectoral hypothesis is calculated as follows:

Score SEC	(Sq. root of (III.1 * III.3) + Sq. root of (III.2 * III.3))/2

II.3.4. The competitive structure: Is there a competitive incentive?

The central idea behind this hypothesis is that an agreement will be more feasible when the companies have a certain competitive incentive vis-à-vis the other companies in the area covered by the agreement, to distinguish themselves, e.g. through a green image. A higher participation in the (future) agreement will be more probable if the companies know that

a) Buyers will be able to distinguish which companies are performing environmentally better (by co-operating in the agreement), and
b) Buyers are sensitive to the environmental quality of the products these companies sell. This sensitivity can be the consequence of pressure by green movements, press attention, etc.

IV.1	**Buyers can distinguish the difference in environmental quality performance of the firms in the participating sector(s)**
Scoring guide	5 *Buyers can distinguish the difference in environmental quality at an information cost of zero.* 1 *Buyers cannot distinguish the difference in environmental quality.*
Remarks	a) The fact that buyers can or cannot distinguish the difference in environmental quality performance of firms can be the consequence of the distance to the buyers, the reliability of the information on the environmental performance of the firms, the association of products with environmental performance,... of the firms that produce them.

IV.2	**Buyers value environmental sound products in the area covered by the agreement.**
Scoring guide	5 *Buyers are very sensitive to the environmental quality of the products in the area covered by the agreement.* 1 *Buyers are not sensitive at all to the environmental quality of the products.*
Remarks	a) Signs of this valuation can be found in press coverage, NGO interventions during the negotiations...

The score for the competition hypothesis is calculated as follows, because the two ideas behind the statements are interrelated:

Score COM	Square root of (IV.I * IV.2)

II.3.5. Evaluating the socio-economic environment of the agreements

Just like we measured the average performance of each agreement, we can now turn to the socio-economic context wherein each agreement was concluded by checking to what extent this context is in accordance with the ideal situation brought forward in the four hypotheses. Calculating these scores each of the respondents gave, gives us the following results.

Table 3: the scores for the different socio-economic aspects

	Policy hypothesis	*Instrumental hypothesis*	*Sectoral hypothesis*	*Competition hypothesis*
GBAT	2,67	3,24	2,70	2,83
GELV	3,00	3,24	3,30	2,00
FCFC	2,33	1,00	1,73	3,00
FECO	3,00	1,73	2,24	3,87
BBAT	2,17	5,00	3,95	3,46
BELE	3,00	5,00	5,00	1,00
DSO2	4,00	5,00	5,00	1,50
DWHI	1,83	1,87	2,47	3,00
IVIC	1,67	1,00	3,70	1,00
IAGI	1,17	5,00	4,62	3,15
EFAR	3,00	2,12	3,16	3,15
EEFF	3,67	2,96	2,81	2,28

GBAT: German batteries agreement; GELV: German End-of-life vehicles agreement; FCFC: French CFC agreement; FECO: French Eco-emballages agreement; BBAT: Belgian batteries agreement; BELE: Belgian electricity agreement; DSO2: Dutch SO2 agreement; DWHI: Dutch white and brown goods agreement; IVIC: Italian Vicenza agreement; IAGI: Italian Agip agreement; EFAR: English farm films agreement; EEFF: English Efficiency agreement.

II.4. Evaluating the hypotheses quantitatively

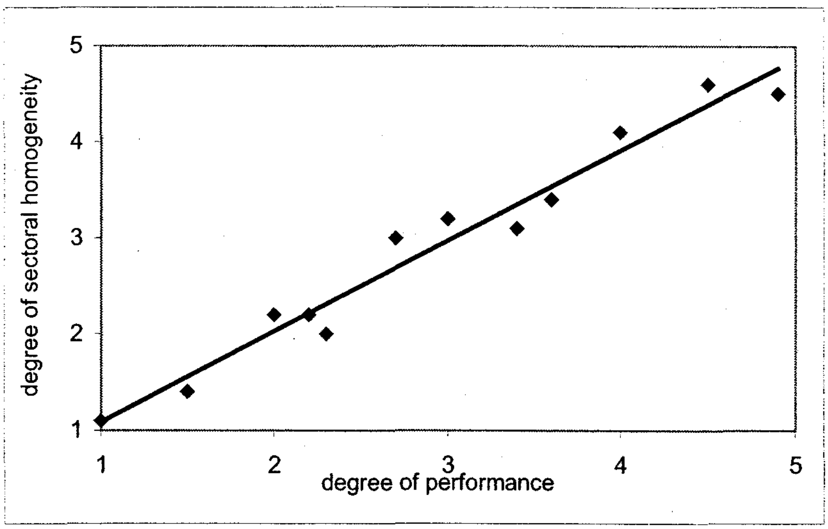
II.4.1. METHODOLOGICAL FRAMEWORK

The survey above allowed us to do a quantitative evaluation of each agreement and of the socio-economic context wherein it was concluded. This quantitative evaluation is based on the scores given by the respondents.

Now that we have an aggregate score for the average performance of each agreement, and a score for the policy style, the threat of an alternative instrument, the sectoral and the competitive structure, we are able to look at the relation between the performance of each agreement and the hypotheses. Does a high score on e.g. the sectoral structure, which means that the agreement is concluded within a homogeneous sector, correlate with the success or performance of the agreement?

We can do this for each case study and for each hypothesis. Having a whole series of data, we should be able to represent the validity of each hypothesis graphically in the following way:

graph 6: an example of a possible outcome



Obtaining e.g. this graph for the sectoral hypothesis would mean that this hypothesis is valid in most cases, since we can see a clear positive trendline: agreements concluded with a heterogeneous sector tend to have a low performance, and agreements concluded with a homogeneous sector tend to perform rather well.

II.4.2. Results

In the following part we will combine the results of the performance of the agreements with the results obtained from the analysis of the socio-economic context wherein these agreements were concluded. We already mentioned that the aspects of the socio-economic context that we studied, can be a precondition for the performance of negotiated agreements. These aspects will therefore function as independent variables that can explain the dependent variable, i.e. the performance of an agreement. This will allow us to check the four hypotheses put forward in our theoretical analysis. The (absence of a) relation between the performance and the favourability of the socio-economic context will be represented graphically, for each of the hypotheses postulated.

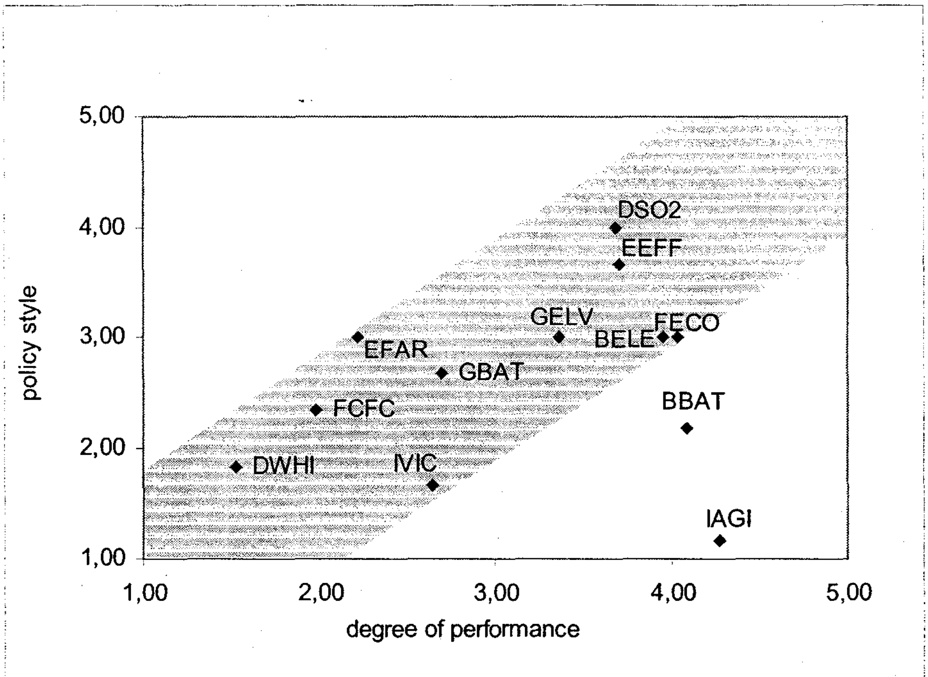
On these graphical representations, the horizontal axis measures the performance of the agreement, which we calculated above as an average for the scores on application, impact and resource development. The vertical axis represents the different scores on the socio-economic aspect considered.

II.4.2.1. The Policy Hypothesis

The fact that the public environmental policy evolves in a tradition and in a climate of consensus seeking, joint problem solving, mutual respect and trust is a crucial positive factor for the performance of negotiated agreements.

Plotting the data gave us the following graphical representation. Except for the BBAT and the IAGI agreement, we can see a clear positive relation between the degree of consensus seeking, respect and trust in the policy, and the performance of agreement. Since there are no scatter points in the upper left corner, we can consider this hypothesis as not rejected by our data. Agreements that are situated in the lower right corner, might by agreements that, despite the policy climate, are successful because of other beneficial socio-economic aspects, such as the existence of an alternative threat. We will discuss this possibility later on in this paper.

graph 7: the relation between the policy style and the average performance of the studied agreements

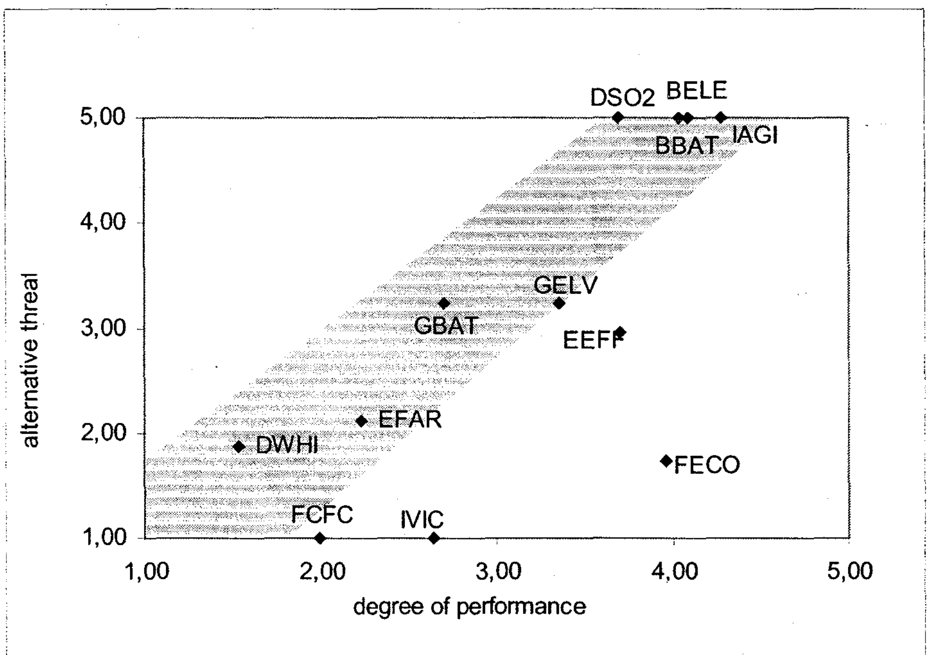


It is clear that the policy style is not the only precondition for a successful implementation of environmental agreements. For that reason further, more important features for a successful implementation of environmental measures must exist. Nevertheless it is possible that a consensus-oriented policy climate increases the chances for a good implementation in certain cases.

II.4.2.2. Instrumental Hypothesis

The fact that the public policy makers show readiness to use alternative policy instruments, as a stick behind the door to deal with the environmental problems, in case the negotiated agreement fails, is a crucial positive factor for the performance of negotiated agreements.

graph 8: the relation between the existence of an alternative threat and the performance of the agreements studied

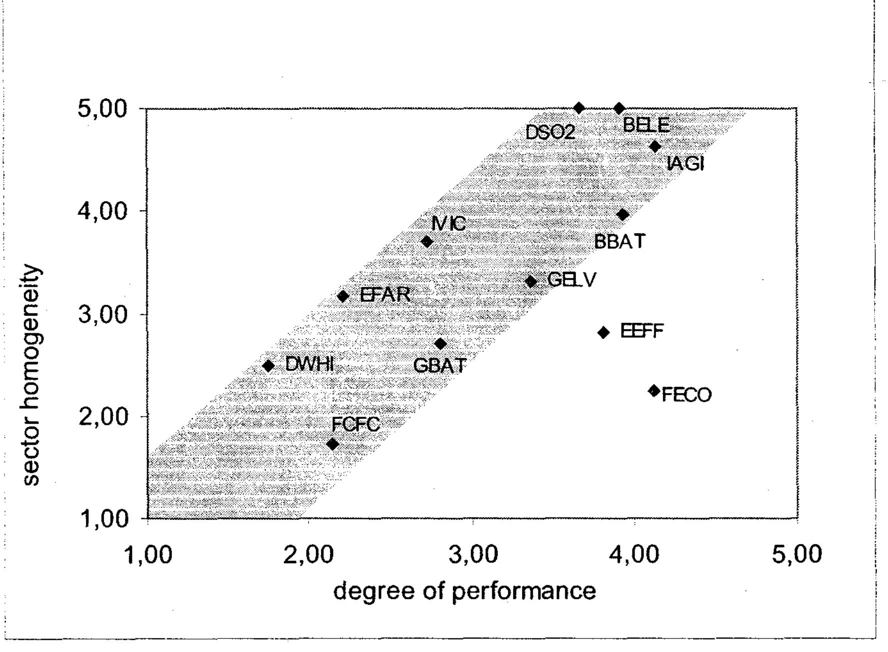


Four agreements were concluded in a context where there was a very strong and severe alternative threat (DSO2, BELE, BBAT and IAGI). All those cases were also evaluated as rather successful ones. Particularly these agreements support the validity of the instrumental hypothesis. Besides these successful agreements there are also two cases, which are assessed with the lowest grade possible (1.00). These two cases are the French CFC agreement and the Italian Vicenza agreement. It is again important to notice that the upper left part of the scatter graph remains almost empty. Here, this means that there are no low-performance agreements when a strong alternative threat was present. In the lower right area, we can detect some agreements, which again contribute their high performance to another aspect. We can conclude by saying that, while a strong alternative threat is not necessary, it can clearly contribute to the performance of any agreement.

II.4.2.3.Sectoral Hypothesis

The fact that the industry sector involved is homogeneous, has a small number of players and is dominated by one or two players, or has a powerful industry association that can speak for all its members, is a crucial positive factor for the performance of negotiated agreements.

graph 9: the relation between the sectoral structure and the average performance of the agreements studied

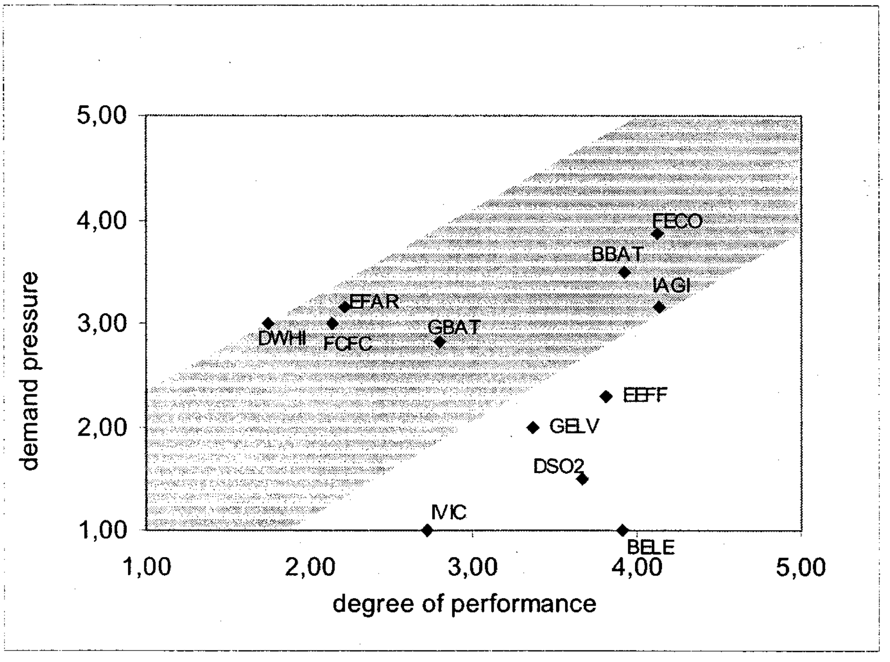


Again, a positive relationship emerges from the graph. Only two agreements break this positive trend, i.e. the British energy efficiency agreement (EEFF) and the French eco-emballages agreement (FECO). All other agreements seem to be in line with expectations.

II.4.2.4 Competition Hypothesis

The fact that industries are close to the final markets is a crucial positive factor for the performance of negotiated agreements, due to the consumer pressure.

graph 10: the relation between the demand pressure and the average performance of the studied agreements



Whereas the previous three hypotheses seemed to be confirmed, there is less clarity here: the scatterpoints are dispersed throughout the entire graph. The theoretical idea that firms will be prone to a good performance when there is demand pressure from green consumers is not confirmed by our agreements. On the one hand, we have a few agreements concluded with firms or in sectors where there is demand pressure, that performed badly (DWHI, EFAR, FCFC), and on the other hand, we have agreements with a rather good performance in markets where demand pressure was not strong (DSO2, BELE, EEFF).

II.4.2.5. The influence of the combined socio-economic context on the performance of negotiated agreements

We now have looked at the different hypotheses separately, and we have mentioned already that the absence of a relation between one socio-economic aspect and the performance of an agreement, can be due to the fact that this performance if positively or negatively influenced by another socio-economic aspect, diluting the influence of the first socio-economic aspect.

Looking at the different hypotheses together, can bring us more insight in the possible existence of a 'combined (un)favourable socio-economic context'. In the table we define the hypotheses to be 'not rejected' for an agreement, when the agreement is situated within the grey area of the above graphs.

Table 4: the validity of the different hypotheses for the agreements studied

	Policy hypothesis	*Instrumental hypothesis*	*Sectoral hypothesis*	*Competition hypothesis*
GBAT				
GELV				✗
FCFC		✗		
FECO		✗	✗	
BBAT	✗			
BELE				✗
DSO2				✗
DWHI				
IVIC		✗		✗
IAGI	✗			
EFAR				
EEFF		✗	✗	✗

Legend: : not rejected, ✗:rejected

The IAGI agreement e.g., which is relatively successful in its application and impact, does not support the policy hypothesis. The reason for its performance had to be sought in the existence of a strong alternative threat and in the homogeneous sectoral structure, which made negotiations easily. Therefore, the influence of the rather unfavourable policy climate did not play a major role in the performance of the agreement. We can make an analogue reasoning for e.g. the BBAT agreement.

For the GELV, FCFC, BELE, DSO2, DWHI and the EFAR agreement, the (absence of) demand pressure could not outweigh the influence of the other three socio-economic aspects.

Based on the above argumentation, that the influence of certain socio-economic aspects can be outweighed by the influence of other aspects, we could argue that the 'combined' context (all of the four separately studied aspects together) will provide a favourable or unfavourable climate.

For all agreements, at least two hypotheses are not rejected, except from the IVIC agreement. For nine of the twelve agreements, at least three hypotheses are not rejected. This could lead us to conclude that most of the agreements studied were negotiated and applied within a rather favourable combined socio-economic context or within a rather unfavourable combined socio-economic context, leading to a relative good resp. bad performance.

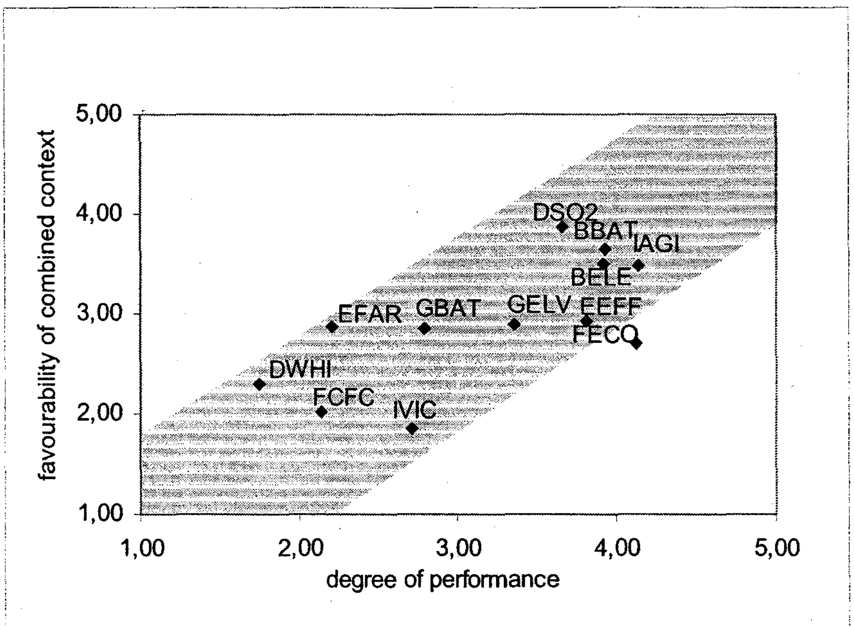
In the graph below, we show the relationship between the average performance of the negotiated agreements and the 'combined' socio-economic context where they were concluded in. This combined context was quantified by taking the average of the scores for each of the four socio-economic aspects considered.

Table 5: the calculation of the favourability of the combined socio-economic context

	Policy hypothesis	*+ Instrumental hypothesis*	*+ Sectoral hypothesis*	*+ Competition hypothesis*	*= Combined context*
GBAT	2,67	3,24	2,70	2,83	2,86
GELV	3,00	3,24	3,30	2,00	2,89
FCFC	2,33	1,00	1,73	3,00	2,02
FECO	3,00	1,73	2,24	3,87	2,71
BBAT	2,17	5,00	3,95	3,46	3,64
BELE	3,00	5,00	5,00	1,00	3,50
DSO2	4,00	5,00	5,00	1,50	3,88
DWHI	1,83	1,87	2,47	3,00	2,29
IVIC	1,67	1,00	3,70	1,00	1,84
IAGI	1,17	5,00	4,62	3,15	3,48
EFAR	3,00	2,12	3,16	3,15	2,86
EEFF	3,67	2,96	2,81	2,28	2,93

It is remarkable that the outliers in each of the four previous graphs have disappeared. The unfavourable policy style for the IAGI agreement was compensated by the sector homogeneity and the existence of a strong alternative threat. The absence of a strong alternative threat in the FECO agreement and the sector heterogeneity were offset by the high demand pressure and the favourable policy climate, etc....

graph 11: the relation between the combined socio-economic context and the average performance of the agreements studied



This leads us to conclude that the favourability of each of the socio-economic aspects we studied is not a necessary condition for the good performance of a negotiated agreement. Moreover, the fact that one socio-economic aspect is unfavourable towards a negotiated agreement, can be outweighed by the positive influence of other socio-economic aspects.

II.5. Qualitative evaluation of the validity of the hypotheses

Following the quantitative analysis of the different relations between the hypotheses and the individual cases, we will now attempt to draw some more definitive conclusions regarding the validity of the different hypotheses. As the previous discussion made clear, the quantitative results alone provide too little information to assess whether a hypothesis is supported or not. We therefore only evaluated the hypotheses as being 'not rejected' or 'not supported'. Thanks to a further qualititative analysis, we can see more clearly which aspects of the socio-economic context actively contributed to the (non)-performance of an agreement. The fact that a certain aspect does not actively contribute to the (non)performance, does however not mean that the hypothesis in question can be rejected. For example, the absence of an alternative threat in a relatively successful agreement does not reject the instrumental hypothesis. The agreement could have performed as good or better if an alternative threat would have been present. Similarly, the fact that a successful agreement was concluded in a homogeneous sector, does not automatically support the sectoral hypothesis. The success of the agreement could be attributed solely to the existence of an alternative threat. Moreover, in some cases, different hypotheses can be clearly supported, while the exact contribution of one socio-economic aspect is more clear than the contribution of other ones.

In the following, we will back the above findings with some qualitative, in depth explanations, hypothesis per hypothesis.

II.5.1. The policy hypothesis

In the quantitative evaluation, the agreements that most clearly did not reject the policy hypothesis, were the DSO2, the EEFF (both successful agreements) and the DWHI agreement (unsuccessful).

The Dutch SO2 case

In policy making in the Netherlands, you can certainly speak of a tradition of consensus seeking, joint problem solving and mutual respect. The Netherlands is well known for this approach all over the world. Policymakers have experience in working with the instrument of negotiated agreements. More specifically, the relationship between the Dutch government, in particular the ministry of Environment, and the power generators goes back to the seventies when the idea of one emission ceiling for the whole sector was discussed. Relationships between the provinces and the power generation companies existed longer resulting from the discussions on the permits given by the provinces.

The English energy efficiency case

The evolution of environmental policy in the UK reflects a long tradition of pragmatism, voluntarsim, and discretion. Historically, the general policy style has been one of consultative and negotiated consensus, involving close-knit and tightly drawn policy communities with significant industrial representation. However, since the mid-80s there has been a move towards a more open and independent style of regulation. Also the strong trend towards deregulation of industry – reflecting the dominant neo-liberal political ideology of the 90s – has provided an important impetus to experiment with new, market-oriented policy tools such as economic instruments and negotiated agreements. The Chemical Industries Association already had well-established relationships with Government departments, and had participated in a Sector Dialogue with the Government in the year before the negotiations commenced. Furthermore, both sides were positively predisposed towards the idea of an agreement, and both were keen that the negotiations should reach a successful conclusion.

The Dutch white and brown goods case

At a national scale the Netherlands can be considered a consensus-oriented country. Also its policy style and government – private sector interaction often reflect this. On the level of this sector however the interactions between the Ministry of the Environment and the sector had not been very intensive previous to this agreement. So on that level there could have been not much opportunity to build a climate of trust etcetera.

There seem to be two agreements that do not support this policy hypothesis in the quantitative evaluation: the BBAT and the AGIP agreement. These agreements are both relatively successful, while the policy climate was rather unfavourable.

The Italian AGIP Case

Concerning this condition only one case exists which performed relatively well (average performance rate: 3.89) although its policy context was assessed extremely badly. The bad evaluation of the policy hypothesis seems to contradict the qualitative analysis given: several features indicate efforts to realise such a policy approach. In fact, a climate of consensus seeking, joint problem solving and trust was developed during the negotiation process. It must be pointed out that this policy style only developed after the beginning of the negotiations but did not exist before. Before the negotiations the different actors did not have a relationship based on consensus seeking or trust. Since the evaluation survey only took into account the situation that existed before the conclusion of the agreement, the Italian Agip Case does not support the validity of the policy hypothesis. It should be taken into consideration that the development of a consensus-oriented policy style through the negotiation might have supported the good performance of this case.

The Belgian Battery Case

In the Belgian environmental policy a tradition of consensus-seeking, joint problem-solving and climate of trust has only started to emerge in the last few years. For that reason there must have been other reasons driving this agreement to success. Mainly there are two factors which describe the success: One is a very strong stick behind the door. In this case it was the threat to issue a ecotax on batteries. The other factor is the homogeneous structure of the factor: The Belgium battery market is dominated by two producers which, together with the FEE – the Belgian Federation of Electronic Producers – led the negotiations with the ecotax commission.

II.5.2. The instrumental hypothesis

The quantitative evaluation showed that four agreements seem to perform very well, and have a very strong stick behind the door: DSO2, BBAT, BELE and IAGI. One agreement performs rather badly in the absence of such an alternative threat. Does this imply a causal relation between the performance and the (non)existence of this threat?

The Dutch SO_2 and NO_x agreement

This agreement is evaluated as a success. It was capable to achieve the defined targets, mainly to reduce SO_2 and NO_x emissions. Although some criticism remains to which decree the reductions achieved are due to the covenant. This issue is difficult to assess, but it must be pointed out that the covenant made the most cost-efficient achievement of the objectives possible.

In the Dutch SO_2 and NO_x case a credible threat was clearly present, namely the Decree Emission Requirements Combustion Plants (BEES). If the negotiations for an agreement had failed, the government would have revised this ordinance in order to tighten up the emission limits for SO_2 and NO_x. For NO_x it would have meant that the industry branches would have been forced to make expansive investments for technical installations to keep the regulations. While the government started to prepare for a serious revision of the BEES-Ordinance the power generating industry requested to reopen the discussion for the agreement that later became a success.

The Belgian Electricity Case

The agreement concerning the reduction of SO_2 and NO_x emissions to be achieved by the Belgian electricity producers contains an unclear instrumental threat if the objectives should not be achieved. It explicitly states that the government can make an end to the agreement if the private sector does not succeed in attaining the proposed reduction targets. What the alternative legislation then would be, is however not specified.

The foundation for possible reduction targets is laid down in the Flemish Environmental Policy Plan. During the time frame of this policy plan (1997-2001) the Flemish government wants to reduce the total acidifying deposition by 39 % in 2002 compared to 1990. The Flemish government developed the following strategy to attain these objectives: Besides a more intensified international co-operation on this matter these targets should mainly be achieved by the implementation of negotiated agreements and by the investments the electricity sector was supposed to undertake. If the industry would not succeed in achieving the reduction targets one possibility to force them to compliance would have been the tightening up of respective regulations. E.g. for the Flemish Region this could have meant a stricter regulation in the permission procedure concerning the limit values for emissions (VLAREM II).

The Italian AGIP Case

The Italian Agip case, consisting of three negotiated agreements, which were signed to improve the quality of gasoline, represents successful cases. The objectives described in all the agreements can be considered as fulfilled. The content of benzene in gasoline could be decreased to 1.3% of the volume for unleaded gasoline and to 1.4% of the volume for leaded gasoline in the period considered. The improvement of the quality of gasoline was still in progress at that time: during the last three months of 1996, the average percentage of benzene even decreased to 1.2% of the volume.

One reason for this success is the existence of a very efficient alternative threat. In the Italian Agip Case the oil industry was in big fear that the government would tighten up legislation on benzene stricter than in other European countries. In this context the agreements of 1989 and 1991 emerged principally from the sector's consideration to avoid the imposition of much stricter regulation obligating it to a specified "maximum" content of benzene in fuel and providing for sanctions if this "maximum" limits were not respected. Already in the beginning of the 90s it was emerging that in the year 2000 the share of benzene permitted would be reduced to 1%. For that reason the Italian oil industry feared the possibility of being regulated by law imposing this standard in 1992, eight years before other countries would be obliged to realise the reduction objectives. In other words, the Italian oil industry feared market distortions discriminating them against foreign oil companies, since it would be very expansive to realise the reduction objectives as proposed by different social groups.

The Belgian Battery Case

The Belgian Electricity Case can be evaluated as a success. The capability to achieve its targets has been assessed very well. Concerning its impact it was environmentally effective (it even outnumbered the objectives defined), could be implemented in an economically efficient way (freedom to chose the most cost-efficient path to realise the targets) and finally effected resource development positively.

The Belgian Battery Case explains clearly the effects of a credible governmental threat on the outcome of an agreement. In this case the stick was the passing of an ecotax on all sold batteries (16/7/93) which should come into effect on 1/1/94. Although there was already a European Directive concerning batteries the Belgian government intended to subject all sold household batteries to an environmental tax of 20 BEF until a deposit refund system was set up. For that reason the battery industry started negotiations with the ecotax commission even in 1993, trying to find a more appropriate solution. By this, the battery industry tried to avoid the ecotax, first by minimising its application field (to differentiate between labelled and unlabelled batteries), later on by proposing a voluntary scheme organised by the industry.

Although the demand of batteries is relatively price-inelastic, the imposition of an ecotax would have decreased battery sales in Belgium drastically. The reasons for this would on the one hand be the extent of the price increase (30% or 20 BEF on an average price of 60 BEF per battery) and on the other the small amount of used batteries per capita per year: each person consumes on average 7 batteries in one year. As a consequence to this consumers would probably buy their yearly stock abroad. For that reason the Belgian battery industry asked for a voluntary agreement. Once the agreement was concluded, the imminent existence of the ecotax forced the battery sector to do everything to comply with the targets in the agreement.

The Dutch white and brown goods case

During the negotiations for a covenant, the stick behind the door was definitely there. The threat of legislation was supposed to put the actors under pressure to gain agreement. And probably it did: in the absence of such a threat, there may well have been no negotiations at all.

But the stick behind the door at least did not push the negotiators far enough to reach a covenant. An important factor here is also the role that the ministry of Economic Affairs played. This ministry supported a less broad implementation of producers responsibility and weakened the position of the Ministry for Environment in this question. The government did not strive for a joint solution. For that reason the stick behind the door was not that strong. After it became clear that the sector was not going to sign a covenant or come up with plans for the disposal of goods themselves, the ministry of Economic Affairs shifted position and worked with the Ministry of Environment on the drafting of regulation: the *White and Brown Goods Disposal Order*.

It is interesting to pay some attention to the possible explanation for this deviation. Our suggestion is that this case shows a limitation of the hypothesis. The hypothesised relationship considers the logic of the game at one level. What happened here is that the policy process proved to be a multi-level game. The European policy making level interacted here with the national one. The effect of the threat with alternative policy instruments at a national level was fuzzy because of the expectation of a European wide policy that, for better or worse, in any case would be equal to all countries. This provided a great incentive to delay, rather than proceed with the negotiations and – later - the implementation.

The case shows a – rather slow – race in time of two policy levels, one preferred by the national government (obviously the national level) and the other preferred by the sector (the European level).

Three agreements seemed to reject the importance of an alternative threat.

The Italian Vicenza Case

Although this agreement scored high in the performance evaluation, it remains controversial if it can be evaluated as a successful one. A more in-depth study of this agreement shows it performed rather badly. If this case will be assessed as a relatively successful one, one explanation for this outcome may be its limited scope of application. Its total environmental impacts are rather limited. The only clearly visible impact is an increase of knowledge gained through the studies carried out on atmospheric emissions in the tanning industry and the experiments carried out in the marble sector. As a credible threat is missing in this case the apparent failure of the agreement seems to support the instrumental hypothesis.

The British Energy Efficiency Case

In the British Energy Efficiency case, instrumental pressure to conclude a substantial agreement was rather ambiguous. The original interest in the idea of a negotiated agreement can be traced back to 1991 and the publication of the European Commission's proposals for a combined carbon/energy tax. However, by 1995 these proposals had been shelved, and the UK Government showed little interest in the idea of a tax, although a revised proposal was still being promoted by the Commission. Thus while there was no immediate threat of a tax being introduced, it was always likely to return to the political agenda at some point of time in the future. A desire to pre-empt any future tax was one of the main motivations for the Chemical Industries Association entering into the negotiations. However, the Government was not prepared to close off its options for the future, and the final agreement explicitly allows for the introduction of a tax (or other instrument), even if the agreement is successful.

One of the main reasons for the relative success of the agreement is the inclusion of a support programme aimed at SMEs to disseminate best practice in relation to energy management. This programme was financed by the Government, with the funds being reallocated from an existing support programme. Thus – at least to a certain extent – the performance of the agreement can be explained by the presence of a "carrot" to encourage improvement, rather than a "stick" to punish failure. It should also be noted that the performance of the agreement is likely to have been affected by its high score in relation to the policy hypothesis (the score for the policy style was 3.67).

The French Eco-Emballage Case

The French Eco-Emballage case is a successful one although there was no strong stick behind the door. On the one hand the driving factor for the success of this agreement was its positive influence on the policy resource base. Another explanation for the success of this agreement might be specific features relating to the inclusion into the international market of consumer goods. The French industry was forced to sign its products since in Germany and in other countries similar efforts were made to finance the recycling and disposal of packages (e.g. in Germany: 'Duales System Deutschland'). A further explanation for the success of this agreement, consists of its good competitive structure.

II.5.3. The sectoral hypothesis

5 agreements do not reject the sectoral hypothesis, if we base our decision on the quantitative analysis.

The Dutch SO_2 and NO_x Case

The Dutch SO_x and NO_x agreement has been assessed as successful case. The sectoral context supports this outcome: it was evaluated with the maximum grade possible (5.00). This is a consequence of the fact, that in 1990 the industry sector concluding the agreement was very homogeneous, had only a small number of players (four large producers of energy) and a powerful association (SEP), too. The electricity sector was rather special compared with others: it was a very protected market with a low degree of competition. As a consequence extra costs could easily be included in the prices consumers pay for electricity.

The homogeneous nature of the power generation sector made the various aspects of the agreement relevant to all members. The dominant position of SEP put it into the central position as negotiation partner for the government and increased the 'accessibility' of the sector for a negotiated agreement approach. The fact, that SEP was so powerful to coordinate and control the implementation of the agreement played a crucial role for its successful performance.

The Belgian Electricity Case

The Belgian Electricty case has been described as success. This outcome is supported by the maximum grade of five for the sectoral hypothesis. Even if the Belgian electricity sector can be characterised as being very homogeneous during the 80s, this homogeneity intensified in 1990, when the three remaining private producers (Ebes, Intercom and Unerg) merged into one private company, Electrabel. This merger resulted in a quasi private monopoly for Electrabel. Electrabel and SPE together have a market share of 96.7% of the total electricity-producing sector.

As a consequence to this fact only a small group of negotiators were involved into the negotiations for this agreement, namely the three regions, Electrabel and SPE. This considerably simplified the negotiation process. Since mainly one producer, namely Electrabel, dominates the electricicty sector the successful implementation of the agreement could not be threatened by free-riders.

The Italian AGIP Case

Amongst other reasons the success of the Italian Agip case can be explained by its best performance as possible of the sectoral hypothesis. The main players of the Italian oil market consist of one market leader and eight other smaller operators. With respect to the final product this market has a very homogeneous character. This fact is intensified by the existence of a powerful association in this sector: the Unione Petrolifera. This association represents a well-organised industrial organisation capable of speaking for all of its members. For these reasons the sectoral hypoyhesis gets the highest scores possible: The case sustains its validity.

The Dutch white and brown goods case

The sector analysed involves many product groups ranging from refrigerators and freezers (white goods) and televisions and videorecorders (the brown goods). The interests of the white and brown goods sector differed on the issues discussed in the context of the covenant. Therefore the sector can be considered to be heterogeneous.

Two organisations, Vlehan and Fiar represented the sector, the producers and importers of white and brown goods. They incorporate most of the sector in the Netherlands and could speak for their members.

The power of the industry associations to represent their members has two sides. On the one hand the legitimacy of the association to present the opinions of the members is at stake. There are not many indications that these organisations were not legitimate in this respect. On the other hand also the power of the associations to make a deal that binds their members to a compromise in which they also have "to deliver" is of crucial importance in negotiations. Here the forced withdrawal of the association from the negotiations shows that the power of the association over its members has been rather weak.

The French CFC case

Apparently the quantitative results confirm the hypothesis according to which the degree of concentration in a sector affects positively the willingness for signing an agreement. In effect, homogeneous sectors (aerosols, automobile) seem to have had less difficulties to comply with the agreement than atomistic ones (refrigeration) where free-riding problems have occured among small firms. However, we have no indications that the negotiations leading to the agreements were more difficult in the more heterogeneous sectors than in the homogeneous sectors. One explanation for this may be the absence of an alternative threat that made most of the possible stakeholders indifferent to the conclusion of an agreement.

The FECO and EEFF agreement are however quite successful, while the sector concluding the agreement was a rather diverse collection of participants. Why did this heterogeneity not affect the good performance of those agreements?

The French Eco-Emballages Case

This case is not distinctly successful or unsuccessful. But the performance has been improved recently. The rate of recycling and the development of separate collection are in progress. Furthermore in the meantime a better knowledge of technologies, constraints and most cost-efficient organisation forms

for adequate solutions has been generated. A collective learning process has been established improving the policy resource base. For that reason this case can be assessed as a relatively success.
This outcome stands in contrast to the sectoral hypothesis given in this case. The implementation of this agreement took place in a complex network of actors with disparate interests. For that reason this sector must be characterised as being heterogeneous. Since this hypothesis does not account for the relative, other features must have driven it to success. One factor was probably the high competitiveness of the market concerned by the agreement (competition hypothesis!). Due to the international dependencies (import and export of consumer goods) the French industry was forced to sign its products because in Germany and in other countries similar efforts were made to finance the recycling and disposal of packages. In this context the French NA was driven by the developments in Germany and those on the level of EU legislation.

The British Energy Efficiency Case

The relatively low score in relation to the sectoral hypothesis for the British Energy Efficiency case reflects a high potential for free-riding within the sector (i.e. a score of 2 for III.3 compared with scores of 5 and 3 for III.1 and III.2 respectively). However, because the target improvement under the agreement requires only the implementation of cost effective measures (i.e. those with a commercial payback), the costs imposed on the sector are negligible – and hence free-riding is not an actual issue in this case. If however the agreement had imposed significant costs, then one might expect that this potential for free-riding would have had a negative impact on performance.

II.5.4. The competition hypothesis

We can see no clear pattern emerging from the quantitative evaluation. It is therefore difficult to decide which agreement supported this hypothesis and which one didn't. We will however look at some agreements were the closeness to the consumer market played a role.

The Belgian electricity case

It should be quite clear that, at the moment of signing the agreement, Electrabel and SPE together had a de facto monopoly on the Belgian electricity producing market. Moreover, demand for electricity is quite inelastic. Interviews with representatives of the industry make it quite clear that consumer pressure hardly played any role in negotiating and signing the agreement.

The Italian Agip case

The sector concerned in this case is close to the final market as it does not only deal with refining but also with the distribution of gasoline. Agip Petroli can, in fact, be seen to make use of this closeness to final markets through their choice to publicise their over-compliance (with respect to the objectives of the negotiated agreements): they differentiate their product by establishing a voluntary limit of a maximum content of benzene at less than 1% for the gasoline sold on the national market.
In concluding that the case sustains this hypothesis, it should be noted that the Unione Petrolifera maintains that the sector has not gained a more positive image with the public through fulfilling the agreement's commitments but rather has gained a more positive image in the eyes of the institutional actors. It would appear here that the consumers put pressure on the institutions to resolve the environmental problems, which then in turn put pressure on the industry.

The Dutch white and brown goods case

The logic of this hypothesis presupposes that consumers have relevant choices when an industry "misbehaves" in the eyes of the public. In this case – like in other Dutch target group approach cases – the scale of the negotiations is however national, including the importers. That means that consumers don't have meaningful choices when they consider the white and brown goods sector to behave in an irresponsible way. Though this sector is clearly very close to final markets, we conclude therefore that the hypothesis can not be applied in this case.

During the negotiations, the sector however argued that the price increase as a result of the disposal system would have a negative impact on their sales since consumers could go to neighbouring countries where there the prices of these goods do not include a fee for disposal. This means actually that the sector suggested another theorem: closeness to consumer markets forces a sector to be critical about costly environmental measures taken in one country because customers can start buying abroad.

The German Battery Case

In the German battery case the industry was close to consumer markets: The consumer pressure seemed to be high because of the awareness of the environmental problems related to the disposal of batteries. Although the competitive context should be favourable, this is not true in this case: the consumers' behaviour prevented a better performance and implementation of this agreement. Since the establishment of an efficient collection scheme for batteries failed the adequate preconditions for an efficient recycling were missing. Another factor for the relatively failure of this agreement is the structure of the retail sector which is responsible for the collection of batteries. The structure of this sector can be characterised as being very heterogeneous, ranging from international operating companies to little family owned retail shops. The heterogeneity of the sector set difficult obstacles for the branch to inform each enterprise efficiently about the correct collecting of batteries (only a specific type of batteries – the labelled ones - should be collected). Since this information campaign failed the efficient implementation of the collection scheme was made impossible. For that reason the sectoral heterogeneity outnumbered the competitive effects of this agreement.

The British Energy Efficiency Case

The British Energy Case was evaluated as being relatively successful despite the fact that it is not close to the final consumers. With the exception of the soap, perfumes and cosmetics sub-sector, a very high proportion (i.e. > 70%) of output goes to intermediate consumption. Consequently, consumer pressure is not very high, and other factors must exist which explain the relative success of the agreement

The main driving force behind the successful performance has been the creation and dissemination of information to SMEs concerning cost-efficient improvements in energy efficiency. This programme of consultancy visits was funded by the Government, and was embedded within existing support programmes (see instrumental hypothesis). The agreement also benefited from a supportive policy framework (see policy hypothesis).

The Dutch Electricity Case

This case is evaluated as a clear success. The reduction targets for SO_2 and NO_x have been achieved clearly by the power generation industry. Due to the fact that a strong competition in the electricity market of Netherlands does not exist the competition hypothesis does not support the outcome of the agreement. Until recently the electricity market was non-competitive (monopolistic structure) and in addition consumers electricity demand was rather inelastic. For that reason image did not play a role for the electricity producing sector. The link between selling directly to consumers and being dependent on the industry's image with these consumers is not obvious.

This fact leads to the question which other features of the agreement influenced the positive outcome. One reason seemed to be the clear and strong threat to revise the Decree Emission Requirements Combustion plants (BEES) resulting in stricter regulations concerning the emissions for SO_2 and NO_x. For NO_x it would have meant that every plant needed an expansive SCR installation. The threat to impose such cost-intensive regulation forced the Dutch power generation industry to make own more cost-effective investments on order to achieve reduction targets. As a large part of the reductions was realised by the closure of old coal-fired plants without abatement technology it remains unclear to what extent these reductions are due to the agreement. The agreement might have speeded up this process a little.

II.5.5. Conclusion

We can say that the results of the quantitative evaluation, which was in turn based on the scoring of the evaluation statements, provide a fairly good approximation of the reality. The three hypotheses that were generally not rejected (the policy, instrumental and sectoral hypothesis), were backed by the qualitative analysis of the agreements. However, consumer pressure seems to play a less important and sometimes ambiguous role. As the Dutch white and brown goods and the Belgian batteries agreement show, a distinction must be made between green pressure and economic pressure. When there is green pressure, companies may be more prone to conclude an agreement, but when there is economic pressure, the fear of losing customers can restrain companies from entering into an agreement. Often also the perceived 'willingness to pay' of the consumers can differ from the their actual 'willingness to pay'.

What was also made clear, is that none of the four studied socio-economic aspects (policy climate, alternative threat, sectoral structure and demand pressure) is sufficient as a guarantee for success. Conversely, a poor score on one aspect (e.g. a heterogeneous sector) is not sufficient to cause an agreement to fail. One must consider the 'combined' socio-economic context: the heterogeneity of the sector can be compensated by the existence of a severe legal instrument, which can make companies act as one over sub-sectoral boundaries. Sometimes there is no need for an alternative instrument, if the policy climate is optimal and if consumer pressure acts as a 'market threat'. The importance of this combined socio-economic context can be seen in our quantitative analysis as well as in our qualitative analysis.

Clearly, the socio-economic aspects are not the only determinants for success or non-success. We have noted above that there is a strong correlation between the specification of the agreement and its application and impact. The importance of the specification of the agreement can therefore not be underestimated.

III. General conclusions and policy recommendations

- In our view, the performance of a negotiated environmental agreement is a mixture of the degree of good application of the agreement, the degree of impact the agreement has on the environment and on the economic efficiency, and the degree of resource development that occurs while negotiating and implementing the agreement. Taking into account only the application of the agreement results in a very narrow definition of performance. Taking into account only the impact of the agreement is a better solution, though the individual impact of an agreement on the environment and on the economic efficiency is difficult to measure. We therefore take into account both the application and the impact, while not minimising the resource development.
- The specification of an agreement is a first precondition for a good performance of a negotiated agreement. This precondition is internal since it is created during the negotiations of each agreement. The degree of specification is positively correlated with the degree of application and with the degree of impact of an agreement, and hence with the average performance of an agreement.
- Sectors that are able to negotiate in a climate of trust and consensus seeking, built on a tradition in environmental policy, have a higher change to negotiate a more successful agreement.
- Also the instrumental hypothesis seems to be supported: of the studied agreements, there were no unsuccessful agreements where there was a strong stick behind the door. Alternatively, such a stick seemed not to be necessary in a few cases.
- Each agreement concluded in a rather homogeneous sector was relatively successful. None of the agreements studied concluded in a homogeneous sector were unsuccessful. On the other hand, there were a few agreements that were successful, although they were concluded within a heterogeneous sector.
- There is less evidence on the competition hypothesis, although it has to be said that there were no clearly unsuccessful agreements when there was a certain degree of demand pressure. Again, this feature alone is not crucial for the performance of negotiated agreements.

Attachment 2 to Appendix D

Voluntary Agreements

- **Alliant Energy**
- **EVTAC Mining**
- **Great River Energy**
- **Hibbing Taconite Company**
- **Ispat Inland Mining Company**
- **Koch Industries Inc.**
- **LTV Steel Mining Company**
- **Metropolitan Council Environmental Services**
- **Minnesota Power**
- **National Steel Pellet Company**
- **North Star Steel Minnesota**
- **Northern States Power**
- **Northshore Mining**
- **Otter Tail Power Company**
- **Western Lake Superior Sanitary District**

ALLIANT ENERGY.

MPCA, POLICY & PLANNING
APR 17 2000
OPERATIONS & PLANNING SECTION

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March 30, 2000

Mr. Tim Scherkenbach
Director, Policy & Planning Division
MPCA
520 Lafayette Road
St. Paul, MN 55155-4194

Re: Voluntary Mercury Reduction Program

Dear Mr. Scherkenbach:

On January 10, 2000, Alliant Energy notified MPCA of our intent to participate in Minnesota's voluntary mercury reduction program. Enclosed is our VOLUNTARY MERCURY REDUCTION AGREEMENT for the Fox Lake Power Station. The agreement outlines the specific plans, schedule, and recordkeeping we have or soon will be implementing to reduce mercury emissions and use from our facility in Minnesota.

If you have questions regarding the agreement, please contact Linda Lynch at (608) 252-0592 or me at (319) 398-4392.

Sincerely,

T M Bennington

Tim Bennington
Regional General Manager
Alliant Energy Corporation

Cc: John Wachtler - MPCA
Ken Kiss - Fox Lake Power Station

VOLUNTARY MERCURY REDUCTION AGREEMENT

INTENT

Alliant Energy supports the efforts of the State of Minnesota in the implementation of a voluntary program to reduce mercury use and emissions. It is Alliant Energy's intent to enter into a voluntary mercury reduction agreement with the Minnesota Pollution Control Agency (MPCA).

SPECIFIC PLANS AND OBJECTIVES

The releases of mercury from Alliant Energy's Fox Lake Power Station are well below the 50 pounds per year identified by the MPCA as sources targeted for the voluntary reduction program. As such, Alliant Energy is participating in the voluntary mercury reduction agreement as an interested party. Alliant Energy's specific plans for the voluntary agreement are as follows:

- One of the objectives of Alliant Energy's participation in the voluntary mercury reduction program is to reduce the amount of mercury used within the Fox Lake Power Station. As mercury-containing equipment and instrumentation requires repair or is taken out of service, Alliant Energy will evaluate non-mercury options. Non-mercury replacement options will be selected if they are technologically proven and economically feasible.
- A second objective is to reduce the mercury emissions associated with the generation of electricity based on 1990 levels. In 1990, mercury emissions from generation of electricity at the Fox Lake Power Station were 11.1 pounds. Due to the reduction in coal burned by the facility, the mercury emissions were reduced to 0.1 pounds in 1998, a reduction of 99.1%.
- The final objective is to educate employees on ways to incorporate mercury reduction into business operations and personal lives. Alliant Energy plans to provide informational materials to employees and have open discussions on the hazards associated with mercury use and the various opportunities to reduce releases of mercury into the environment.

SCHEDULE

- Alliant Energy has begun implementation of our voluntary mercury reduction program by switching from coal to natural gas as the main source of combustion fuel at the Fox Lake Power Station.
- Alliant Energy has inventoried the products at the Fox Lake Power Station that contain mercury. We are developing a procedure for evaluating equipment that is coming out of service or going for repair that will allow facility staff to determine the potential for mercury-containing items to be present. The procedure to evaluate equipment should be available by the June 30, 2000. If mercury-containing items are present, facility staff will evaluate non-mercury containing alternatives. Alliant Energy has already reduced the pounds of mercury in equipment from the 100 pounds in 1990 to approximately 54 pounds in 1998.

- Educational materials will be made available in the employee breakroom to identify the issues associated with mercury emissions and provide local options for recycling mercury. The educational materials will be made available by June 30, 2000.

PERFORMANCE MEASURES

- On an annual basis, Alliant Energy will provide a status report on the mercury reduction efforts for the Fox Lake Power Station.
- The status report will be submitted by January 31 of each year.
- The status report will outline any further reduction in mercury emissions and will provide a summary of the mercury-containing items that have been removed from service. The status report will be in letter format and will likely include the summary in tabular form.

EVTAC MINING

"People working together to secure the future"

March 30, 2000

Tim Scherkenbach
Director, Policy and Planning Division
Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155-4194

RE: Mercury Reductions Voluntary Agreement

Dear Mr. Scherkenbach:

Enclosed are two copies of the Mercury Reduction Voluntary Agreement for EVTAC Mining and the MPCA. The copies are signed by Chuck Williams for EVTAC Mining, please have Commissioner Studders sign for the MPCA, and return one copy for EVTAC files.

If you have questions regarding this agreement please phone me at 218/744-7849 or email me at banderson@evtac.com. Thank you and your staff for your help in this important environmental endeavor.

Sincerely,

Bradley E. Anderson

Bradley E. Anderson
Manager - Environmental Affairs

Encl.

C: H. W. Hilshorst
C. W. Williams

HgVolAgreementcover000330

EVTAC Mining
Voluntary Agreement with MPCA for Mercury Emissions Reduction
March 30, 2000

1. Statement to participate in the Voluntary Agreement Program.

EVTAC Mining continues to support mercury reduction efforts that will help reduce human health risk and improve the environment. This Voluntary Agreement contains three major efforts by EVTAC: 1. Mercury balance, 2. Mercury inventory, and 3. Community mercury reduction effort. The mercury balance will be used to determine possible methods of mercury reduction in the processing of iron ore. The mercury inventory and community mercury reduction efforts will lead to removal of mercury from waste streams that may contaminate the environment. The Community mercury reduction effort will be a cooperative effort with other stakeholders.

2. Summary of specific plans and objectives with estimate of reduction.

- EVTAC is planning to conduct a mercury balance of its process to determine the amount of mercury released to the environment and the amount retained in the material streams produced by the process. An environmental consulting company is being hired to develop and implement the mercury balance. EVTAC anticipates doing the sample collection and measurements, analytical testing, and reporting in 2000.

- EVTAC Mining is also planning to evaluate all mercury-containing process materials and equipment to determine a plan to reduce mercury emissions associated with these items. Among other actions this could include replacing mercury-type switches and other electrical devices and replacing mercury-containing materials with non-mercury-containing materials. This will be an ongoing effort with an inventory of mercury-containing material and equipment developed in 2000 and a plan for mercury reduction developed and implemented over the next five years.

  Along with the mercury inventory of present operations, EVTAC will examine available records to determine uses of mercury that have been eliminated since 1990.

  Purchasing practices will also be examined and measures taken to avoid unnecessary purchases of mercury or mercury-containing devices or products and to promote purchases of non-mercury substitutes.

- EVTAC Mining is planning to continue participation with other mining companies through the Iron Mining Association (IMA) in mercury emissions reductions. In addition to the IMA EVTAC is active with other stakeholders and with the MPCA. The exact mercury reduction programs are not yet established.

3. Implementation Schedule and reporting schedule.

Implementation of the Mercury Voluntary Agreement has started with planning in all phases of this Voluntary Agreement. EVTAC will report on the progress of the Voluntary Agreement in April for the past year. Plus when each major project is complete, a report will be issued on that specific project.

4. Summary of how to measure progress.

Progress will be measured by the amount of mercury that is not allowed into the environment on an annual basis. Since mercury is inherent in mineral handling, EVTAC believes that at the present production rate, mercury emissions from mining will remain relatively constant. EVTAC will follow new technology to collect mercury in the waste stream.

The most promising mercury reduction effort will be in the purposeful use category. EVTAC will find substitutes for mercury-containing devices and products. This will help reduce the accidental release of mercury to the environment. EVTAC is also committed to track mercury reduction technologies as they are developed and implement proven technology.

5. Commitment

EVTAC Mining is committed to reduce mercury contamination. EVTAC Mining is not agreeing to spend unlimited amounts of money to remove specified amounts of mercury from the environment. This Voluntary Agreement is a dynamic document that will be used to guide EVTAC toward mercury reductions. Each phase of the agreement may lead to increased knowledge and to other efforts, which may reduce mercury contamination.

Charles W. Williams
Vice President, Internal and External Affairs
EVTAC Mining

Karen Studders
Commissioner
Minnesota Pollution Control Agency

GREAT RIVER
ENERGY
17845 East Highway 10 • P.O. Box 800 • Elk River, Minnesota 55330-0800 • 763-441-3121 • Fax 763-241-2366

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January 30, 2001

Mr. Bob McCarron
Minnesota Pollution Control Agency
Major Facilities Planning
Policy and Planning Division
520 Lafayette Road North
St. Paul, MN 55155-4194

Re: Voluntary Mercury Reduction Agreement

Dear Mr. McCarron:

Great River Energy (GRE) is pleased to submit the enclosed Voluntary Mercury Reduction Agreement. GRE has participated in the Minnesota Pollution Control Agency's Mercury Contamination Reduction Initiative since its earliest inception and we are proud to be able to submit this agreement to formalize our continued involvement.

Mercury emissions from GRE's Minnesota operations are typically less than four pounds per year and, as such, GRE understands that its operations are not high on the agency's priorities. Nevertheless, GRE believes that the goal of reducing mercury releases to the environment is laudable and, furthermore, that mercury is a global issue – not just a Minnesota issue. Because of this global nature, GRE has included its largest operations located in North Dakota within its Voluntary Agreement.

GRE's strategies for reducing mercury releases include:

- Constructing low- or non-mercury emitting generating sources
- Supporting and participating in research to develop cost-effective mercury controls for coal-fired units
- Reducing the amount of mercury-containing products used in GRE's operations

GRE understands that you wish to make the Voluntary Agreements available for viewing and downloading from the MPCA's web page. A copy of GRE's Agreement will be e-mailed to you in Adobe portable document format.

If you have any questions regarding the enclosed Voluntary Agreement or our activities outlined in the Agreement, please contact Mark Strohfus in our Environmental Services Dept. at 763-241-2491 or mstrohfus@GREnergy.com.

Sincerely,

GREAT RIVER ENERGY

James Van Epps

James Van Epps
President and CEO

Enc. - Voluntary Mercury Reduction Agreement

c/enc: John Wachtler, MPCA

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GREAT RIVER ENERGY℠
A Touchstone Energy Cooperative

Voluntary Mercury Reduction Agreement

GREAT RIVER ENERGY
January 30, 2001

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1. Introduction

Great River Energy (GRE) has elected to participate in the Minnesota Pollution Control Agency's (MPCA's) Mercury Contamination Reduction Initiative. The Initiative includes a voluntary program whereby an industry that is a source of mercury releases develops a Voluntary Agreement between itself and the MPCA. These Voluntary Agreements describe the industry's plans for reducing emissions of mercury from its operations.

The MPCA's first priority for the program was to solicit Voluntary Agreements from those sources in the state with mercury emissions greater than 50 pounds per year. GRE's Minnesota sources emit less than four pounds of mercury per year. Nevertheless, GRE opted to participate in the program and went as far as including its out-of-state sources in the voluntary reduction agreement.

This document constitutes GRE's Voluntary Agreement, and it describes GRE's plans for reducing mercury releases to the environment. This is a working document that may undergo changes as new information is gathered and reviewed as part of GRE's reduction efforts. The plans and actions identified in this Agreement are non-binding.

GRE's strategies for reducing mercury releases include:

- Constructing low- or non-mercury emitting generating sources
- Supporting and participating in research to develop cost-effective mercury controls for coal-fired units
- Reducing the amount of mercury-containing products used in GRE's operations

GRE's priorities will be determined based on those strategies that are cost effective and offer the greatest and most probable mercury emission reductions.

2. Great River Energy's Operations and Policies

2.1. Operations

GRE is Minnesota's second largest electric utility in terms of generating capacity. It is a generation and transmission cooperative that serves 29 member distribution cooperatives. GRE's service area covers approximately 60 percent of the state, with its member cooperatives supplying energy to 1.5 million people.

GRE generates the majority of its electricity at three facilities: Coal Creek Station, Stanton Station, and Elk River Station. In addition to these three base-load facilities, GRE operates other peaking facilities located throughout Minnesota and has contractual rights for a portion of the output from Dairyland Power Cooperative's Genoa 3 plant. All of GRE's generating facilities are summarized in Table 1.

Table 1 – GRE's Current and Planned Generating Capacity

Facility Name	Location	Primary Fuel	Capacity (MW)
Coal Creek Station	Underwood, ND	Lignite	1081
Stanton Station	Stanton, ND	Lignite	186
Genoa 3	LaCrosse, WI	Sub Bituminous Coal	183 (1)
Elk River Station	Elk River, MN	Refuse-Derived Fuel	39
Lakefield Junction Station (2)	Trimont, MN	Natural Gas	486
Pleasant Valley Station (2)	Sargeant, MN	Natural Gas	434
St. Bonifacius	St. Bonifacius,MN	Distillate Fuel Oil	48
Rock Lake	Pine City, MN	Distillate Fuel Oil	21
Maple Lake	Maple Lake, MN	Distillate Fuel Oil	21
Cambridge	Cambridge, MN	Distillate Fuel Oil	21
Chandler Hills Wind Farm	Chandler, MN	Wind	6 (3)
		Total	2,526

MW = Megawatts
1. Capacity available to GRE.
2. Construction initiated in Spring 2000.
3. Existing capacity is 2 MW. An additional 2 - 4 MW of capacity is planned for Summer 2001.

2.2. Environmental Policy

GRE takes pride in conducting its business with the highest ethical standards and concern for the environment. Environmental considerations are part of everyday business at GRE as is reflected in its Environmental Policy (see below). Great River Energy is committed to conserving resources through environmental stewardship, pollution prevention, waste minimization, recycling and reuse. GRE believes that taking care of the environment makes good business sense. This Agreement has been developed consistent with GRE's formal Environmental Policy.

Great River Energy's
Environmental Policy

GRE believes that sound environmental policy contributes to its competitive strength and benefits its members and their customers by contributing to the overall wellbeing and economic health of the communities they serve. GRE shall:

A. Maintain a management system with defined objectives designed to minimize the environmental impacts of its business activities. These objectives will be periodically reviewed and updated by management.

B. Continuously improve its environmental management system through periodic audits, management review, and corrective action.

C. Conserve resources through environmental stewardship, pollution prevention, waste minimization, recycling, and reuse.

D. Comply with the spirit, intent, and letter of environmental laws, regulations, and other requirements to which GRE subscribes.

E. Support research and public policymaking.

F. Provide outreach to the community in which GRE's facilities are located and with which it has a direct relation through its operations, products, and services.

G. Communicate this policy to all of its employees.

H. Make this policy accessible to the public.

Approved and adopted by the board on January 12, 1999.
Arden Thompson, Chairman
Bill O'Brien, Secretary

As part of GRE's environmental commitment, it is proud to operate the first cooperative power plant in the United States that has been certified under ISO 14001: Coal Creek Station. ISO 14001 is the international standard of excellence for environmental management systems. GRE intends to proceed with developing and certifying environmental management systems for its other plants.

3. Past Reduction Efforts

Although this plan was written in 2000, GRE has for a number of years been working to reduce the use of mercury in its operations and studying how it can reduce mercury emissions. Since 1990, GRE has successfully taken more than 660 pounds of mercury out of its facilities. A total of 414 pounds were collected from flywheels alone. GRE will continue to identify where mercury is present in its facilities and, where appropriate and feasible, will remove the mercury. Plans for future reduction efforts are described in greater detail in later sections of this agreement.

GRE has also achieved some mercury emission reductions through the operation of conventional air pollution control equipment at Coal Creek Station. Testing conducted by the Energy and Environmental Research Center demonstrated that Coal Creek's flue gas desulfurization unit was scrubbing out better than 90 percent of the oxidized mercury species in the exhaust gases. Approximately 30 percent of the mercury in Coal Creek Station's exhaust gas is in the oxidized form.

4. Mercury Reduction Plan

Mercury is one of the most difficult issues facing the utility industry today because it is present in all of the conventional fuels - primarily coal - being used to provide customers with the electricity that they demand. Furthermore, despite industry and government efforts, no easy, cost-effective answers have been developed for significantly reducing or eliminating mercury emissions associated with the combustion of fossil fuels.

Still, several technologies are currently being studied. Sorbent technologies have proven to be the most successful at controlling elemental mercury emissions, which account for approximately 80 percent of GRE's total mercury emissions. However, no such control system has been installed and operated on a US coal-fired unit. Furthermore, cost projections for these technologies are extremely prohibitive. GRE remains optimistic, though, that cost-effective mercury reduction technologies for fossil-fuel-fired sources will be developed and, as such, a significant aspect of GRE's reduction program includes supporting the research and testing of mercury control technologies.

GRE's strategies for reducing mercury releases include:

- Constructing low- or non-mercury emitting generating sources
- Supporting and participating in research to develop cost-effective mercury controls for coal-fired units
- Reducing the amount of mercury-containing products used in GRE's operations

GRE's priorities will be determined based on those strategies that are cost effective and offer the greatest and most probable mercury emission reductions.

4.1. GRE's Generating Portfolio

GRE has begun to diversify its energy portfolio to include sources with lower or no mercury emissions. As evident previously in Table 1, this is especially true in recent years with the addition of wind energy and natural-gas-fired combustion turbines. Currently, approximately 90 percent of GRE's operating generating capacity is based on coal combustion. With the completion of the two combustion turbine stations, GRE's coal-based capacity will constitute 56 percent of the total capacity.

4.1.1. GRE's Wellspring™ Program

GRE, through its member cooperatives, was the first utility in the five-state region to offer its customers the choice to purchase some or all of their energy from wind through GRE's Wellspring™ Renewable Energy Program. Under this program, the co-op customer is able to purchase 100-kWh blocks of wind energy for a slightly added cost of $1.50 to $2 per month. The Wellspring™ Program is ultimately customer driven; customers must indicate the desire to purchase the wind energy before GRE contracts for the wind energy. GRE and its co-op members' role is to market the availability and environmental benefits to the customer.

Wind-generated energy is a relatively environmentally benign method for generating electricity, but it does have some disadvantages. Wind energy in recent years costs slightly more than coal-based energy. GRE's Wellspring program's minimal cost addition is due in part to large government subsidies. As the total available wind capacity increases, it is expected that unsubsidized costs are expected to become more competitive with coal-based energy and, indeed, GRE has recently seen a small decrease in wind energy costs. Wind energy is also not as reliable as coal-based energy since the wind cannot be turned on when more energy is needed. Nevertheless, GRE believes that offering wind energy is an important part of its generating portfolio and plans to expand its wind capacity.

Wind energy for the Wellspring™ Program is produced at the Chandler Hills Wind Farm located in southwestern Minnesota. GRE is currently contracted to purchase two-thirds of the energy generated by three wind turbines at the Chandler Hills Wind Farm. These three turbines have a combined capacity of two megawatts. GRE is now working on expanding its wind capacity. Plans are to contract for another two to four megawatts of capacity, with construction of the turbines in 2001.

A two-megawatt wind generator produces approximately 6,500 megawatt hours in a year. This electricity generally replaces energy produced at coal-fired, base-load units. Based on GRE's current best estimate of mercury emissions, two megawatts of wind capacity will reduce annual mercury emissions by about one-half pound.

4.1.2. Peaking Facilities

GRE will significantly expand its generating capacity with the installation of two natural gas-fired combustion turbine stations: the Lakefield Junction and Pleasant Valley Stations, which will operate as peaking plants. A total of six simple-cycle combustion turbines will be installed at Lakefield Junction and three simple-cycle combustion turbines will be installed at Pleasant Valley Station.

As peaking plants, these natural gas-fired units are expected to provide incremental energy needs when system demand is highest. Because peak energy on the open market can be extremely expensive, operating the units on natural gas can be cost competitive.

Energy produced from these units will likely replace energy that would normally be purchased on the open market. Because there is no reliable information on the mercury emissions associated with purchased energy, there is no reliable method to estimate emission reductions.

4.1.3. Refuse-Derived Fuel

Elk River Station produces electricity from processed municipal solid waste (refuse-derived fuel) generated in the Twin Cities Metropolitan Area. The station has a capacity to produce 39 MW and generates enough energy for approximately 4,000 households. The plant's mercury air emissions are less than four pounds per year based on annual stack emissions test results. In addition to having low mercury emissions, burning the solid waste has the added environmental benefit of reducing the volume of waste placed in landfills and avoiding the subsequent generation of landfill gas emissions.

Energy produced at Elk River Station is cost-competitive with coal-based energy. In a typical year, operation of Elk River Station avoids the emission of approximately 15 pounds of mercury from coal-fired plants.

4.1.4. Future Opportunities

GRE has continuously investigated the feasibility of other energy sources, and will continue to explore options for diversifying its energy portfolio with the inclusion of biomass, fuel cells, clean coal, and other technologies as they become available. It is impossible to predict which electricity generating technologies will be able to successfully compete with the low-cost and reliability of coal. However, GRE maintains an open mind with regard to alternate energy sources and will evaluate new sources and promote the development of promising technologies.

One biomass project GRE is involved in is the Northome Biomass Power Plant currently under development in Koochiching County, Minnesota. The plant is being designed to produce 15 MW from the combustion of wood residues. GRE has contracted to purchase the energy from the plant and will build and maintain the transmission facilities required for the plant.

Distributed generation is also gaining attention within the electric industry. GRE is participating in a distributed generation demonstration project by installing and operating a natural gas-fired microturbine at the Elk River Station. Right now, the most significant drawback of microturbines is high operating costs due to fuel costs and lower efficiencies. Despite these factors, there are limited applications where a microturbine can provide cost-effective energy. In addition, if the operating efficiency of the units can be improved and fuel costs can be decreased, the applicability of the technology will improve.

GRE has also recently begun to look at biofuels produced from waste restaurant oil for use in its fuel oil-fired peaking plants. Research data indicate that a 20:80 blend of biofuel with petroleum-based fuel oil can result in better fuel efficiency and lower air emissions. These claims have not been thoroughly investigated, and it is unknown if the fuel is usable in GRE generating systems. GRE is working with researchers at the University of Minnesota and trade associations to answer these questions.

4.2. Research

Coal-based energy provides the United States with approximately 60 percent of its electric energy needs. Replacement of the existing coal-based capacity with non-coal-based capacity cannot be accomplished cost effectively at this time. Construction of low- or non-mercury-emitting facilities will help to stem a potential increase in mercury emissions caused by an increase in the demand for electricity, but these sources cannot be expected to replace coal-based sources. Therefore, to decrease mercury emissions, rather than simply restrict the growth of mercury emissions, cost-effective technologies to reduce emissions from existing coal-fired units need to be identified. Currently, there is no cost-effective means for controlling mercury emissions from coal combustion. Research is the only way to develop newer and more cost-effective technologies.

GRE is optimistic that technologies can be developed to cost effectively control mercury emissions. GRE has been, and will continue to be, actively involved in research and development activities. Research work is costly, and while GRE has been successful in the past at acquiring sufficient co-funding for projects, it is not possible to predict the availability of such funding in the future. GRE will nevertheless continue to support and promote further research where GRE believes it benefits its company and the environment.

In the past, GRE has completed in-depth massbalance analyses at Stanton Station and Coal Creek Station to determine where the mercury naturally present in the coal ends up during the combustion process. All coal-fired utilities were required as part of an Environmental Protection Agency's information collection request (ICR) to provide information on the mercury content of their coal, and some utilities were required to test their plant's stack emissions. Stanton and Coal Creek were both subject to the stack-testing requirement. GRE did not just meet the testing requirements of the ICR though. GRE contracted with the University of North Dakota Energy and Environmental Research Center (EERC) to complete an in-depth massbalance to identify not only the amount of mercury emitted from its stacks but the amounts remaining in the ash and other waste streams. The North Dakota Industrial Commission (NDIC), Electric Power Research Institute (EPRI-an industry research organization), and the Department of Energy (DOE) provided co-funds for this study. This testing demonstrated that the scrubbers used to reduce sulfur dioxide emissions at the Coal Creek plant were capable of scrubbing better than 90 percent of oxidized mercury present in the exhaust gases. This work tells us that if the elemental mercury can be oxidized, the existing air pollution control equipment could effectively and significantly reduce mercury emissions.

Because of the massbalance work, GRE has also committed to being a host site for a long-term test of pilot scale oxidation catalysts under the DOE's mercury research initiative. A project proposal has been prepared and submitted, but the DOE will not award funds until later in 2001. GRE believes that oxidation technologies could be developed into a cost-effective way to control mercury emissions.

By the end of March 2001, GRE anticipates having completed a nearly $200,000 project at Coal Creek and Stanton stations to evaluate the most promising mercury control technologies currently being researched. Several different control technologies and operational modifications will be tested on a slipstream of exhaust gases at each plant to determine their efficiency at removing and/or oxidizing mercury. The project will also attempt to estimate costs associated with each of the control technologies and operational modifications. EPRI will manage the project and co-fund aspects of the study. The NDIC is also providing co-funds for this project.

GRE is also sponsoring a study by the University of North Dakota EERC to determine the fish consumption habits of the citizens of North Dakota and Minnesota. In EPA's 1998 utility air toxics report to Congress, EPA called for research to better understand fish consumption habits.

4.3. Minimization of Mercury-Containing Equipment and Devices

GRE has already removed more than 660 pounds of mercury from its plant operating systems. Plans are to continue to try and identify where mercury is present in its operations, prioritize those areas that pose the highest risk for a release to the environment, and determine if cost-effective alternatives are available. Where alternatives are available, the mercury-containing devices will be replaced. Where alternatives are not available, GRE will work to label the device as containing mercury to ensure proper handling and disposal of the device. GRE has already attempted to inventory the mercury-containing devices used in its operations. Based on the experience of others, it is believed that the level of effort needed for a comprehensive inventory is not warranted in relation to the risk posed by such components as mercury-wetted relays. Instead, GRE has conducted employee training to raise the level of awareness and to solicit the help of the plant operators and field technicians.

4.4. Demand Side Management

GRE's demand side management and conservation program helps reduce mercury emissions by reducing the energy demands of its customers. GRE is also implementing a fluorescent lamp recycling program to help ensure that the mercury contained in the lamps is properly treated and recycled.

GRE's conservation programs resulted in estimated energy reductions of approximately 9 million kilowatt-hours in 1999. Conservation programs that account for these energy savings include commercial and industrial energy efficiency grants, commercial and residential energy audits, and energy efficient lighting and air conditioner programs. These energy savings would equate to a reduction in mercury emissions of approximately one pound.

GRE's fluorescent lamp recycling program will be initiated in 2001. The program is a GRE-funded coupon program designed to encourage residential customers to recycle fluorescent bulbs safely and properly. Each year, participating distribution cooperatives mail a sheet of ten $.50-coupons to their residential customers. Customers redeem the coupon(s) when recycling fluorescent bulb(s) at participating area hardware stores. GRE has an agreement with Mercury Technologies of Pine City, MN to provide the recycling service. Mercury Technologies provides:

- Development of bulb recycling contracts with hardware stores throughout the GRE service area
- Storage containers for the recycled bulbs at the participating hardware stores
- Training of participating hardware store owners on the proper handling and storage of fluorescent bulbs requiring recycling
- Scheduled pick up of the bulbs requiring recycling
- Coupon account management by cooperative and reimbursement through GRE
- Safe and proper recycling of the bulbs at their facility in Pine City

The lamp recycling program reduces mercury releases in two ways. First, it avoids the release of the mercury contained in the lamps by ensuring proper waste handling. Second, it promotes the use of energy efficient fluorescent lamps. Based on GRE's best estimate of the number and types of lamps that will be turned in, approximately one pound of mercury emissions could be avoided. GRE is not able to estimate the energy efficiency savings that would result from the encouragement to use fluorescent lamps.

5. Agreement Progress Reports and Amendments

Progress reports on GRE's mercury reduction efforts will be submitted to the MPCA annually. The first report will be submitted by June 30, 2001. Subsequent reports will be filed every year by June 30.

GRE will review the agreement annually by June 30 of each year. If the plan is amended, a revised version of the plan will be submitted to the MPCA by July 31.

Hibbing Taconite Company
Cliffs Mining Company, Manager

December 19, 2000 **Certified Mail No. 70000520001709680706**

Mr. John Wachtler
Major Facilities - Policy and Planning Division
Minnesota Pollution Control Agency
520 Lafayette Rd. N.
St. Paul, MN 55155-4194

Re: Hibbing Taconite Company (HTC) Voluntary Mercury Reduction Agreement

Dear Mr. Wachtler:

Please find enclosed Hibbing Taconite's voluntary mercury reduction agreement. It is our understanding that the MPCA's review of this agreement will culminate with the MPCA issuing Hibbing Taconite a signed certificate of participation in this voluntary program.

Hibbing Taconite's voluntary reduction efforts are extensive, both multi-media focused, and internal/external focused. To summarize the program, Hibbing Taconite is researching the items we do not know how to control, reducing the items we do know how to control, and educating its employees and the greater community.

If you have any questions or comments, please call Scott Hautala at (218) 262-6856.

Sincerely,

John N. Tuomi
General Manager

Enclosure: Voluntary Mercury Reduction Agreement

C: NJM/SGR/SWH/JNB/DZS-CMSC/DBC-CCI

Hibbing Taconite Company

Voluntary Mercury Reduction Agreement

Date: 12/20/00

1. Introduction

Hibbing Taconite recognizes that the goal of industry participation with the Minnesota Pollution Control Agency (MPCA) in this mercury reduction agreement will reduce Minnesota mercury contamination. The Mercury Reduction Initiative's legislated goal is to reduce Minnesota mercury releases 60% by 2000 and 70% by 2005, using 1990 as a baseline. These are beneficial goals in the broader view of U.S. and worldwide mercury contamination. Hibbing Taconite will continue to conduct research to determine the feasible options that may allow it to reduce mercury releases from its facility.

As discussed in more detail in Section 3, the state's goal (using 1990 as a baseline) of mercury reduction presents Hibbing Taconite with a choice on where to focus its research efforts. Because Hibbing Taconite does not have baseline data from 1990, it could attempt to ascertain the mercury releases from this period, mercury releases that it believes are higher than 2000. However, Hibbing Taconite believes a more sound research approach is to focus on how to reduce its mercury emissions from the present value.

If a national/international program or agreement is signed after this State based agreement is implemented, it is Hibbing Taconite's need that its work be "credited" towards that broader goal. It must also be recognized that this document is dynamic and responsive. The agreement will be revised as either more is learned about mercury or adjustments are made to Hibbing Taconite's processes.

This voluntary mercury reduction plan is primarily based on the material presented in the taconite industry's options in the Mercury Advisory Council's Source Reduction Feasibility and Reduction Strategies Report (SRFRS). However, Hibbing Taconite's voluntary agreement only lists those options that are either chosen for reasons of feasibility or conducted to obtain more information. If Hibbing Taconite has made historical mercury reductions, these will be noted throughout each section.

Hibbing Taconite's voluntary mercury reduction agreement is organized as follows:

2. Hibbing Taconite Background

Hibbing Taconite Company, an unincorporated joint venture managed by Cliffs Mining Company, is located approximately 3 miles to the North of the City of Hibbing in St. Louis County. Hibbing Taconite commenced operations in 1976, with the major operating areas described below:

- Taconite ore mining (materials loaded and transported by haul trucks),
- Crushing (reducing the size of the blasted ore),
- Grinding (reducing the crushed rocks to a sand consistency),
- Concentrating (accomplished by magnetic separators, upgrading the 25% iron in the ore to 66% iron),
- Balling (the iron concentrate, with the addition of limestone and clay, is formed into 3/8 – 1/2 inch moist balls), and
- Pelletizing/Heat-hardening (allows for transfer by rail car and Great Lakes fleet without damage – the end result is a dry, round, solid, gray 3/8 – 1/2 inch ball).

Hibbing Taconite produces on average 8 million Dry Long Tons (DLT) of standard pellets per year. Since plant startup, Hibbing Taconite's annual pellet total has been as high as 8.6 million tons (1988) and a low of 4.1 million tons (1983). This annual production variation results from Hibbing Taconite's competition against a global market. On an annual basis, it is susceptible to global economic concerns and makes any prediction of future pellet production and mercury emissions extremely difficult.

Therefore, the primary means that Hibbing Taconite will use to track mercury emissions is a unit-basis factor (pounds Hg / million DLT pellets), as it is a better indicator if performance (mercury reduction) is improving than annual emissions (secondary means).

3. Taconite Ore Beneficiation

The process of upgrading the taconite ore is called beneficiation. Hibbing Taconite handles millions of tons of naturally occurring materials each year. Because these materials have trace mercury concentrations – similar to any common rock (ppb-part per billion), the cumulative effect is that there are measurable mercury releases from the pelletizing furnace. Through the process of heat hardening in the pellet furnace, the trace amounts of mercury (in the iron-bearing material, the clay, and the limestone) volatize from a solid to a gas. Hibbing Taconite uses a dry dust collector to remove coarse dust particles as a pretreatment before the furnace exhaust air goes through the wet (venturi-rod) scrubber to remove the finer dust particles, including some acid gas removal.

During 1996-1997, Hibbing Taconite participated in the research program with the Natural Resources Research Institute's (NRRI) Coleraine Minerals Research Laboratory (CMRL) to perform a mass balance of mercury from the pellet furnace. Based upon the analysis of the furnace inputs and outputs, NRRI calculated an estimated emission factor of **32 pounds Hg / million DLT pellets** at Hibbing Taconite.

In order to obtain a direct mercury emission factor, Hibbing Taconite performed a stack test during September 1998 with speciation. The Energy and Environmental Research Center (EERC), a leader in Midwest mercury testing, monitoring, and control development, performed the mercury emission stack test, the only stack test of its kind performed on a taconite pelletizing furnace to this date. The results of this study are that of the measured total **27.5 pounds Hg stack emission / million DLT pellets produced**, less than 0.05 pounds is particulate mercury, less than 1.9 pounds is oxidized mercury, and 25.5 pounds is elemental mercury. The study also demonstrated that 70-80 percent of the oxidized mercury was being collected in the wet scrubber, thus removing it from the furnace exhaust gas. The management of scrubber water will be discussed in the tailing basin section.

The opinion of the scientific community is that elemental mercury does not have a local or regional effect on mercury contamination, because of its long life in the atmosphere (greater than 1 year). Elemental mercury constitutes 93 percent of Hibbing Taconite's stack mercury content, thus indicating that its air releases are not affecting Minnesota mercury contamination. It has also been demonstrated that the existing pollution control devices do not remove the elemental mercury from the gas stream.

Historical Concentrator Improvements

The 1997 NRRI study also sampled the inputs (crushed crude ore) and outputs (concentrate and tailing) of the Concentrator during 1996 and 1997. The averages of these tests show that 81 percent of the mercury in the crude ore reports in the slurry to the tailing basin. Hibbing Taconite has invested in several projects in the concentrating process since 1989 that we believe may have reduced the amount of mercury in the concentrate.

This belief has basis in the 1997 NRRI study. In the study, another taconite mine had more mercury in its taconite ore but less mercury in its concentrate than Hibbing Taconite, thus resulting in lower mercury air releases. It is our opinion that the finer size material (grind) produced by its current Concentrator operations more closely resembles the other mine's process.

During the period 1989-2000, Hibbing Taconite invested in numerous upgrades in the Concentrator to produce historical concentrate levels. Throughout the 1990s, the silica particle grain and the iron particle grain are becoming similar in size as Hibbing Taconite continues to mine its ore reserves. This requires the ore to be ground to a finer consistency as discussed above.

The main difficulty in calculating the 1990-2000 reduction is that Hibbing Taconite does not have mass balance or stack test information from 1990 to serve as a baseline. That stated, it is difficult to "scientifically" demonstrate that the finer concentrate grind in 2000 contains less mercury than the coarser grind of 1990. However, the difference of the 1996 mass balance to the 1998 stack test provides evidence of a reduction of 4.5 pounds total Hg stack emission / million DLT pellets. As stated previously, NRRI's mass balance was performed during 1996-1997 and Hibbing Taconite does not have any other mass balance tests prior to this.

Voluntary mercury reduction action

1998 - Hibbing Taconite has conducted the only taconite industry speciated mercury stack test during 1998, which resulted in greater insight to the amount and form of the mercury being released.

2000-2001 – To ensure that the results of future mass balances can be confidently used, Hibbing Taconite will participate with other taconite facilities, the MN Department of Natural Resources, and the MN Natural Resources Research Institute to develop standards for mercury analysis of taconite materials, such as ore, pellets (unfired and fired), and tailing. Future mass balance studies can then use these reference standards to calibrate the laboratories results.

2001 - Hibbing Taconite will analyze the process materials sampled during the 1998 stack test to determine if the mass balance also demonstrates a decrease from 1996 to 1998.

2001-2005 - Conduct periodic samples of mercury concentrations in the pellet furnace input and outputs. The sampling will commence after the DNR Cooperative Environmental Research reference standard study has been completed. Results of the samples will be communicated in the annual report.

2001-2005 - Hibbing Taconite will participate in other taconite industry research. First, how have historical (and future) Concentrator investments affected the mercury concentrations in the concentrate? Second, what is the temperature dependence of mercury green pellet volatilization? Hibbing Taconite will evaluate each proposed project as research funds become available and cannot commit to specific projects beyond the current commitments.

2001-2005 - Hibbing Taconite will conduct an additional mercury stack test during the period to provide a direct measurement of mercury air emissions.

4. Tailing Basin

As discussed above, the majority of the mercury in the taconite ore is separated at the Concentrator, and reports as a solid particle (tailing) to the enclosed tailing basin. In addition, the pelletizing furnace scrubber water, which captures 70-80 percent of the oxidized mercury in the furnace exhaust, also reports to the tailing basin.

The tailing basin at Hibbing Taconite is a completely enclosed containment structure. The basin is divided by internal dams into smaller cells that allow the solids to separate from the water. A water pumphouse recycles over 120,000 gallons per minute for re-use in the process. The only discharge from the tailing basin is through engineered seeps that allow water to drain through the embankment to protect the exterior dam stability. Hibbing Taconite also has two siphon discharges that are used only for short durations to protect the exterior dam safety as required by MN Department of Natural Resources Rules. Hibbing Taconite samples all of the discharge points in accordance with the MPCA issued water discharge permit.

Research has also been conducted on the fate of the mercury in the tailing basin and the tailing basin water discharges at other taconite facilities using low-level detection mercury water samples in and around the tailing basin. These samples indicate that the mercury reporting to the tailing basin is not being released into the water outside of the tailing basin. In fact, the waters in these streams contain less mercury than nearby lakes and streams.

The next step is to perform testing inside the tailing basin to determine if the mercury in the water and tailing is being released (evading) as an air emission. Preliminary results indicate that the mercury in the tailing basin is not evading, and that amount deposited from the air is equal to the amount released from the land.

Voluntary mercury reduction action

Because other mines have already conducted low-level mercury water tests and have found the levels to not be of a concern, Hibbing Taconite will focus its limited research efforts elsewhere and not duplicate these tests at its facility.

2000 – Hibbing Taconite has partnered with other taconite facilities, the MN DNR, and the MPCA to sponsor the MPCA's screening study of the tailing basin flux. The MPCA will issue a preliminary and final report through the DNR.

2000-2005 – The implications that future process control methods (if feasible controls are discovered) have for the tailing basin mercury fate will play an integral role before, during, and after any such process control test is conducted.

5. Mercury Containing Products

Hibbing Taconite, a large industrial complex, has historically used many products that contain mercury. Such devices are thermometers; thermostats; pressure, tilt, and relay switches; batteries; and fluorescent and high intensity discharge (HID) lamps. Hibbing Taconite has previously used a chemical for iron determination (assay) that contained mercury (mercuric chloride). Through normal application, other materials (such as cleaners and dust control chemicals containing trace amounts of mercury) are placed on land and/or water. The MPCA also reviews these chemicals, and provides its comments and approvals for new product requests.

Historical Mercury Product Reductions

The use of mercuric chloride was phased out during 1995 through the action of Hibbing Taconite and the Cliffs Mining Services Company Research Lab to change the ASTM reference standard to a non-mercury method. The waste generated from the iron analysis resulted in the generation of twelve 55-gallon drums per year that contained approximately a total of **5 pounds of mercury** by weight. This material was shipped to a hazardous waste treatment facility.

Hibbing Taconite has also been recycling fluorescent and HID lamps since 1992. On average, Hibbing Taconite recycles 735 pounds (1700 4-foot lamps) of fluorescents and 440 pounds (500 lamps) of HID lamps per year. Assuming 45 mg per lamp during 1990, this equates to nearly **3 pounds of mercury per year**. In addition, improved handling practices have reduced breakage and potential releases.

Hibbing Taconite currently has approximately **45 pounds of mercury** collected during the last 9 years from replacing mercury-containing products. This material will be shipped out the first quarter 2001.

Voluntary mercury reduction action

2000-2001 – A mercury Purchasing Policy will be developed and implemented. This policy will inform HTC's suppliers of Hibbing Taconite's mercury reduction agreement, and require the supplier to identify their products as containing or not containing intentionally added mercury.

2000 – Hibbing Taconite will conduct an inventory of mercury containing products by site inspection, employee interviews, and review of engineering drawings.

2001 – A mercury product log will be developed to track the location of these devices and allow for proper waste management.

2001-2005 – HTC will develop a matrix to classify the risks of an environmental release, and proactively remove/replace those items identified as being a "high risk" for environmental release. Future mercury shipments will be documented to ensure HTC is keeping an accurate record of the efforts. Testing the low mercury containing (5 mg/bulb) fluorescent lamps is one part of this replacement practice.

6. Employee Outreach/Education

Hibbing Taconite recognizes that mercury education is the most important effort needed to change people's actions regarding mercury and mercury waste management. Because Hibbing Taconite was an initial member of the Minnesota Mercury Contamination Reduction Advisory Council, tremendous amounts of information have already been distributed at Hibbing Taconite and other taconite facilities through the presentations and materials handed out at the Mercury Advisory Council meetings.

Hibbing Taconite will make its employees aware of the importance of managing mercury products in the correct manner, and inform them of the potential health risks of mercury.

Voluntary mercury reduction action

1999-2005 – Hibbing Taconite will monitor progress and development of mercury control technology through continued involvement in state and federal workgroups.

2000-2005 – Hibbing Taconite started the operation (December 1, 2000) of an **onsite Mercury Recycling Center** for its **employees** to recycle their mercury containing products. The longevity of this recycling center is dependent upon the employees proper use of the Center. The items collected from this effort will be tracked separately from the rest of Hibbing Taconite's products to maintain a separate accounting of the items removed from the environment.

2000 – A mailing was sent to all employees on awareness of both mercury's background and of the Mercury Recycling Center's start of operations.

2001-2005 – Future employee educational materials will be distributed as needed, and mercury device (mercury for non-mercury thermometers) swaps may be evaluated and implemented.

7. Community Outreach/Education

As stated above, education is the key in order for Minnesota to make a difference in mercury contamination and mercury release reduction. Hibbing Taconite and the Iron Mining Association, have organized and held several meetings of groups interested in reducing mercury in the environment. Participants in this diverse group are the Western Lake Superior Sanitary District (WLSSD), St. Louis County and Lake County Solid Waste Departments, the Institute for a Sustainable Future, Minnesota Power, The Office of Environmental Assistance (OEA), and the taconite facilities.

The purpose of the meetings is to identify the existing solid waste collection programs specific to mercury, to identify the gaps in that collection effort, and to determine if taconite, and Hibbing Taconite in particular, could assist the County's efforts in any manner pertaining to collection and education.

Voluntary mercury reduction action

1999-2005 – Continue to discuss with the respective solid waste and interested parties how Hibbing Taconite can best add to their efforts without duplicating them.

1999-2005 – Continue to develop mercury awareness materials and provide information at industry trade group meetings. Inquire of local schools if they are interested in mercury awareness presentations. Partner with local schools on other environmental awareness issues (such as the GTE grant for the Hibbing High School).

2000-2005 – Continue to pursue mercury reduction efforts at healthcare and schools, possibly partnering with these facilities in the cost and/or knowledge required to replace the mercury containing devices.

8. Summary and Reporting

Hibbing Taconite's voluntary reduction efforts are extensive, both multi-media focused, and internal/external focused. To summarize the program, Hibbing Taconite is researching the items we do not know how to control, reducing the items we do know how to control, and educating its employees and the greater community. The research is focused on reducing mercury air releases from the present date, not the historical reduction from 1990 to 2000. A summary of the voluntary mercury reduction agreement action items is listed on page 8.

If either a voluntary mercury reduction agreement is issued on a national or international basis, or if the expanded programs should become a regulatory requirement, Hibbing Taconite's efforts during this state-specific program should be credited towards any future reduction requirements.

Annual reports will be submitted by March 31 documenting the mercury reduction activities and reduction amounts during the previous year. As of the date of this agreement, the format of the report has not been finalized, however, a proposed draft is provided on page 9.

Summary of Hibbing Taconite's Voluntary Mercury Reduction Agreement

Area	Year	Description	Outcome
Process – Pelletizing	1998	Ontario-Hydro mercury stack test	Obtain speciated Hg releases
Process – Mine wide	2000-01	Material reference standards	Will be used for more reliable future mass balance studies
Process – Pelletizing	2001	Pelletizing material mass balance	Will obtain results to verify if HTC reduced Hg releases 1996-1998
Process – Pelletizing	2001-05	Pelletizing material samples	Provide background on the iron ore concentrate variability and trending
Process – Mine Wide	2001-05	Industry-wide basic, applied research and technology investigations	Provide greater understanding of the feasibility of reducing mercury releases
Process – Pelletizing	2000-05	Pellet furnace mercury stack test	Provide another method to determine mercury air emissions
Process – Tailing Basin	2000	Tailing basin flux study	Provide details if mercury that enters the tailing basin will remain sequestered
Process – Tailing Basin	2000-05	Tailing basin mercury fate	If any process control strategy is implemented, the fate of mercury in the tailing basin will be accounted
Products	2000-01	Purchasing policy	Reduce the amount of new mercury products that HTC uses
Products	2000	Mercury product inventory	Allow an accurate accounting of devices in use
Products	2001	Mercury product log	Allows personnel to manage the devices properly
Products	2001-05	Mercury risk matrix	Allows for the removal of high risk items
Education	1999-2005	Mercury control scanning	Stay current on potential mercury control technology
Employees	2000-05	Mercury product recycling center	Reduces potential mercury release and contamination
Employees	2000-05	Mercury awareness mailings	Increases mercury awareness
Employees	2002-05	Mercury device swaps	Will be evaluated and implemented if reasonable
Community	1999-2005	State and county mercury waste meetings	Add to the mercury collection efforts and improve awareness
Community	1999-2005	Presentations	Increase mercury awareness in Minnesota
Community	2000-05	Healthcare/School mercury replacement programs	Reduce the amount of mercury in use in Minnesota

Hibbing Taconite Company Mercury Release Inventory

Rev 3 12/14/00

	Year	Taconite Process: Mercury Emission Factor (lbs. Hg / MM DLT)	Taconite Process: Pellet Production (MM DLT)	Taconite Process: Mercury Releases (pounds)	Iron Analysis Chemical: Mercury Equivalent Used (pounds)	Iron Analysis Chemical: Mercury Releases (pounds)	Iron Analysis Chemical: Mercury Release Reduction (pounds)	Mercury Products - Lamps: Lamps Removed from Service (pounds)	Mercury Products - Lamps: Lamps Recycled unbroken (pounds)	Mercury Products - Lamps: Mercury Releases (pounds)	Mercury Products - Lamps: Mercury Removed From Landfill (pounds)
	1990	32.2	8.15	262	5	0.5	0	1173	0	0.53	0.00
	1991	32.2	8.02	258	5	0.5	0	1173	0	0.53	0.00
	1992	32.2	7.80	251	5	0.5	0	1173	306	0.41	0.69
	1993	32.2	7.24	233	5	0.5	0	1266	1187	0.16	2.69
	1994	32.2	8.19	264	5	0.5	0	1177	1058	0.19	2.40
↑	1995	32.2	8.39	270	2.5	0.25	0.25	1508	1458	0.06	1.54
	1996	32.2	7.91	254	0	0	0.5	917	892	0.04	0.94
	1997	32.2	7.48	241	0	0	0.5	1974	1913	0.08	2.02
	1998	27.5	7.61	209	0	0	0.5	814	786	0.04	0.83
Actual	1999	27.5	6.64	182	0	0	0.5	939	914	0.04	0.97
Planned	2000	27.5	8.0	220	0	0	0.5	784	756	0.01	0.19
	2001	27.5	7.9	217	0	0	0.5			0.01	
	2002	27.5	7.9	217	0	0	0.5			0.01	
↓	2003	27.5	7.9	217	0	0	0.5			0.01	
	2004	27.5	7.9	217	0	0	0.5			0.01	
	2005	27.5	7.9	217	0	0	0.5			0.01	
	2000 mercury reduction			42			0.5			0.52	
	2005 mercury reduction			45			0.5			0.52	

	Year	Mercury Products – Devices: Devices Removed From Service (pounds)	Mercury Products – Devices: Devices Recycled (pounds)	Mercury Products – Devices: Mercury Releases (pounds)	Mercury Products – Devices: Mercury Removed from Landfill (pounds)	Mercury Products – Employees: Devices Removed From Service (pounds)	Mercury Products – Employees: Devices Recycled (pounds)	Mercury Products – Employees: Mercury Releases (pounds)	Mercury Products – Employees: Mercury Removed from Landfill (pounds)	Total Mercury Releases (pounds)	Total Mercury Releases Reduced (pounds)	Percent Mercury Releases Reduced (%)
	1990	ND	5	0.75	5	Unknown	0	Unknown	0	264.0	0	0
	1991	ND	5	0.75	5	Unknown	0	Unknown	0	259.7	4.4	2%
	1992	ND	5	0.75	5	Unknown	0	Unknown	0	252.6	11.4	4%
	1993	ND	5	0.75	5	Unknown	0	Unknown	0	234.4	29.6	11%
	1994	ND	5	0.75	5	Unknown	0	Unknown	0	265.0	-0.9	0%
↑	1995	ND	5	0.75	5	Unknown	0	Unknown	0	270.9	-6.8	-3%
	1996	ND	5	0.75	5	Unknown	0	Unknown	0	255.3	8.8	3%
	1997	ND	5	0.75	5	Unknown	0	Unknown	0	241.5	22.6	9%
	1998	ND	5	0.75	5	Unknown	0	Unknown	0	210.0	54.0	20%
Actual	1999	ND	5	0.75	5	Unknown	0	Unknown	0	183.3	80.8	31%
Planned	2000		5	0.75	5	Unknown		0	0	220.6	43.4	16%
	2001		5	0.75	5	Unknown		0	0	217.9	46.1	17%
	2002		5	0.75	5	Unknown		0	0	217.9	46.1	17%
↓	2003		5	0.75	5	Unknown		0	0	217.9	46.1	17%
	2004		5	0.75	5	Unknown		0	0	217.9	46.1	17%
	2005		5	0.75	5	Unknown		0	0	217.9	46.1	17%
	2000 mercury reduction			8.25				0			43.4	16%
	2005 mercury reduction			12				0			46.1	17%

Notes:

Taconite Process - MM = million, planned production for years 2001-2005 8.1 million WLT = 7.9 million DLT (2.5% water reduction)

Iron Assay Materials - 10% release factor because of the combination of incomplete product recovery & lost through the waste treatment facility process.

Iron Assay Waste Treatment – neutralization and metals recovery

Lamps - 4' bulbs 1990-1994 45 mg, 1995-1999 21 mg, 2000-05 5 mg; HID (mercury vapor & high pressure sodium) lamps 2x the mercury per period.

Lamps - breakage rate 1990-1994 10% fluorescent, 10% HID; 1995-2005 2% fluorescent, 5% HID – breakage 50% mercury available as a release.

Lamps - 2.5% mercury lost through recycling process; before recycling 15% lost through solid waste management (landfill)

Lamps - 1990-92 usage not recorded - the annual usage is the average usage from 1993-1999.

Mercury Devices - ND - Not documented, during the last 9 years, approximately 45 pounds of mercury has been removed from service ~ 5 lbs./year

Mercury Devices - 15% assumed to be released if not recycled.

Mercury Devices – Employees - Recycling Center started 12/1/2000

DRAFT
ISPAT INLAND MINING MERCURY VOLUNTARY REDUCTION AGREEMENT

Introduction

Ispat Inland Mining Company is located approximately 3 miles north of the City of Virginia. It is the smallest of the seven Minnesota taconite plants producing about 2.8 million long tons of fully fluxed pellets annually. The process utilizes conventional ore crushing, wet grinding, magnetic separation and flotation to liberate the magnetite. In addition, limestone/dolomite (flux) is crushed, wet ground and added to the iron concentrate slurry at a rate of about 12%. Pellet balling is done in balling discs and the green fluxed pellets are indurated in a Dravo Straight Traveling Grate Furnace. Pellets are shipped to Ispat Inland's Indiana Harbor Works where they are the main feed stock for Ispat Inland's # 7 Blast Furnace.

Proposed Voluntary Agreement Activities

Stack Emissions

The primary process fuel for the indurating process is natural gas, with #2 fuel oil as the back up fuel in the event of a natural gas curtailment. Natural gas emits the least amount of mercury of all the process fuels available.

Process gas emissions are cleaned by passing them through multiclones and then venturi rod wet scrubbers. (This technology is expected to be MACT for Taconite). Currently no technology exists to remove low levels of elemental mercury taconite process exhaust gas.

Ispat Inland Mining Company proposes to perform stack testing on its process stacks to quantify mercury emissions. Mercury emissions will be speciated and quantified. Pre and Post scrubber samples will be analyzed. Pellet green ball and fired pellets will also be tested for mercury as well as scrubber and tailings basin water. This testing is expected to be conducted by 2002.

Laboratory Mercury Emissions

Ispat Inland Mining Company is in the process of changing its method of doing iron assays. The new process will eliminate mercuric chloride from the test. The change should be completed by 2001.

Elements Related to Mercury Containing Products

Ispat Inland Mining Company began replacing mercury containing products with non-mercury or low mercury containing products back in the late 1980's. Ispat will continue with this practice which includes:

- Mercury containing products currently in use will be identified and inventoried by reviewing the MSDS files. Mercury containing products will be replaced with non-mercury containing products if available.
- Purchasing department will flag products or equipment containing mercury. Non-mercury containing products and equipment will be purchased if possible.
- Mercury containing equipment in use at the mine will be inventoried and labeled. When the equipment needs replacing, it will be replaced by non-mercury containing equipment if available.
- Mercury vapor lights will be replaced with low mercury high pressure sodium lights.
- All fluorescent bulbs will continue to be recycled.
- All thermometers and thermostats containing mercury will be replaced with non-mercury thermometers and thermostats.

These efforts should be completed by 2005. Reductions will be quantified and documented.

Mercury Reductions Since 1990

Purchase orders, recycling records, manifests will be researched for reductions since 1990. Reductions will be quantified and documented.

KOCH INDUSTRIES INC

DEB McGOVERN
MANAGER
REGULATORY AFFAIRS

April 19, 2000

Mr. John Wachtler, Coordinator
Voluntary Mercury Reduction Program
Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, MN 55155-4194

RE: KOCH PETROLEUM GROUP'S DRAFT MERCURY REDUCTION AGREEMENT (DATED APRIL 18, 2000)

Dear Mr. Wachtler:

For the Minnesota Pollution Control Agency's (MPCA's) review and consideration, enclosed please find Koch Petroleum Group's (KPG's) draft Voluntary Mercury Reduction Agreement. KPG requests that this agreement not be released to the public until the MPCA has issued a Certificate of Participation to KPG or at least not until the MPCA and KPG are satisfied with its contents.

If you should have any questions or wish to discuss this matter further, please contact me at 651/437-0642.

Sincerely,

Debra L. McGovern

Debra L. McGovern

Enclosure

cc: Lowell Miller Stolte, KPG
Mike Hansel, KII

P.O. Box 64596 • Saint Paul Minnesota 55164 • 651/437-0642 • FAX 651/437-0868

KOCH PETROLEUM GROUP'S PINE BEND REFINERY VOLUNATRY MERCURY REDUCTION COMMITMENT WITH THE MINNESOTA POLLUTION CONTROL AGENCY

APRIL 18, 2000

I. Introduction & Purpose

A. Koch Petroleum Group L.P. in Minnesota, hereinafter referred to as KPG-MN, is a duly owned subsidiary of Koch Industries, Inc.
B. KPG-MN owns and operates a petroleum refinery in Rosemount, Minnesota. That facility is the only KPG-MN asset covered by this voluntary Commitment document. No other KPG-MN or KII asset is the subject of this Commitment document.
C. KPG-MN supports the State of Minnesota's Voluntary Mercury Reduction Program as set forth in the MN Stat. 116.915.
D. KPG- MN understands that the Minnesota Pollution Control Agency, hereinafter referred to as the MPCA, has been designated as the lead state agency to implement Minnesota's Voluntary Mercury Reduction Program.
E. This Commitment represents the full extent of KPG-MN's participation in the MPCA's Voluntary Mercury Reduction Program. No other participation, expressed or implied, is covered by this Commitment document.
F. This Commitment has been developed to conform with the MPCA's Voluntary Mercury Reduction Agreement Guidelines (dated March, 2000).

II. Commitments—Plans and Objectives

A. KPG-MN will conduct a mercury mass balance of its Pine Bend refinery process to estimate the amount of mercury released into the environment and the amount contained in the products or material streams produced by the refining processes.
B. KPG-MN will engage a laboratory(s) using sampling and analytical method(s) which are consistent with MPCA guidance (see above) and which provide sufficiently low detection limits to provide meaningful information.
C. KPG-MN will characterize and, where possible, quantify the efforts undertaken at the refinery since 1990 to reduce mercury at the refinery and associated operations.
D. KPG-MN will inventory mercury containing materials and equipment currently used at the refinery and develop a plan to reduce or eliminate the use of those items where appropriate, cost-effective, and consistent with KPG-MN's health and safety policies.

III. Implementation & Reporting Schedules

A. The refinery mercury mass balance will be completed by October 31, 2000.
B. KPG-MN will document historical efforts (back to 1990 and before, if feasible) to eliminate or reduce mercury at the refinery. This information will be summarized and submitted to the MPCA in order to obtain early reduction credits which could

be authorized under subsequent state or federal regulatory programs. This effort will be completed by August 31, 2000.

C. KPG-MN will complete the inventory of mercury containing materials and equipment used currently at the refinery and develop a plan to reduce or eliminate the use of those items, where appropriate, cost-effective and consistent with KPB-MN's health and safety policies by December 31, 2000.

IV. Data Verification and Measurement Protocols

A. KPG-MN will submit sufficient information to the MPCA to verify that release estimates and reduction efforts are as accurate as possible, repeatable and reasonable. To that end, sampling and laboratory QA/QC information will also be included in the report.

B. KPG-MN will make every reasonable effort to comply with the MPCA's guidelines for Measurement Protocols and Data Reporting. Where deviations are necessary, these will be discussed with MPCA staff prior to undertaking the sampling and analysis.

V. Maintenance and Availability of Records

A. KPG-MN will retain all records pertinent to this voluntary Commitment throughout the duration of this Commitment.

B. These records will be available to MPCA for review and will be provided within a reasonable period of time after the request by the MPCA.

VI. Progress Reports to MPCA

A. KPG-MN will provide annual progress reports to the MPCA by July 1st of each year.

B. KPG-MN will submit an interim progress report to the MPCA by January 15, 2001. This progress report will address the status of Items A, B, and C under Part III of this Agreement.

VII. Primary Contacts

A. Debra L. McGovern, Regulatory Affairs Manager, is the primary contact for matters relating to the content of the Commitment. Lowell Miller Stolte is the alternate contact for matters relating to the content of this Commitment.

B. KPG-MN will notify the Agency in writing if the primary contact(s) for this Commitment change.

VIII. General Provisions

A. KPG-MN commits to implement the terms of this Commitment in good faith. If disputes arise, it is KPG-MN's expectation that both parties will attempt to resolve any disputes related to the terms of this Commitment or the MPCA's voluntary mercury reduction program through good faith negotiations.

B. KPG-MN expects that, given the voluntary nature of this Commitment, the MPCA will share any draft press releases so that KPG can review them for accuracy and completeness prior to issuance.

C. KPG-MN requests that the MPCA not release this Commitment to the public until a Certificate of Participation has been issued to KPG-MN by the MPCA.

D. KPG understands that the MPCA will issue KPG a Certificate of Participation after the Commitment has been deemed to meet the following criteria, as set forth in the Agency's March, 2000 Guidelines:

1) focuses on reducing mercury releases or related research;
2) outlines how KPG-MN's results will be tracked and measured; and
3) goes beyond existing regulatory requirements.

E. KPG-MN also understands that at the end of the MPCA's program--if KPG-MN meets or exceeds the plan's goals that KPG-MN will be issued another Certificate indicating KPG-MN's contribution to the program's success.

IX. Commitment Authorization

KPG-MN will implement the terms of this voluntary Commitment to the best of its ability and is duly authorized when signed and dated by the authorized officer designated below.

Koch Petroleum Group, L.P. in Minnesota

By: ______________________ Date: ______________________

Jeffrey C Wilkes

Title: Refinery Manager and Vice-President of Minnesota Operations

KOCH
INDUSTRIES INC

MPCA, POLICY & PLANNING
JUN 23 2000
MAJOR FACILITIES SECTION

DEB McGOVERN
MANAGER
REGULATORY AFFAIRS

June 21, 2000

Mr. John Wachtler, Coordinator
Voluntary Mercury Reduction Program
Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, MN 55155-4194

RE: KPG'S VOLUNTARY MERCURY REDUCTION AGREEMENT
SAMPLING & ANALYSIS PLAN FOR THE MERCURY MASS BALANCE

Dear Mr. Wachtler:

As we discussed at our May 11th meeting, enclosed for your review is the Sampling and Analysis Plan for the mercury mass balance which is being conducted in accordance with Koch Petroleum Group's Voluntary Mercury Reduction Agreement (dated April 18, 2000).

If you have any questions or comments, please feel free to contact me at 651/437-0642.

Sincerely,

Debra L. McGovern

Debra L. McGovern

Enclosure

cc: Jacque Derstein, KPG
Lowell Miller Stolte, KPG
Lori Stegink, Barr Engineering

P.O. Box 64596 ▪ Saint Paul, Minnesota 55164 ▪ 651/437-0642 ▪ FAX 651/437-0868

Sampling and Analysis Plan
Mercury Mass Balance
Koch Petroleum Group's Pine Bend Refinery

Prepared by Barr Engineering
June 16, 2000

This document presents a summary of the Sampling and Analysis Plan (SAP) for the mercury mass balance being conducted at Koch Petroleum Group (KPG) Pine Bend Refinery. The goal of the plan is to fill existing data gaps to facilitate estimating the facility's mercury mass balance with greater accuracy. Primary considerations for the SAP are obtaining high-quality data and consistency with previous sampling and laboratory analytical methods so that existing data for the refinery can be used to the maximum extent possible.

A literature review was conducted prior to the development of this sampling and analysis plan and served as one of the bases for its development. The literature was reviewed to identify streams in the refinery which may contain mercury and to identify sources of mercury data. In addition to the literature review, the inputs and outputs to the refining process were reviewed and diagramed. These streams were reviewed to identify those which could be major contributors in the mass balance calculations.

Streams to be Sampled

The inputs and outputs ("streams") to be sampled are shown in Table 1 along with the number of samples proposed for each stream. Sampling is planned for 29 streams altogether, covering a wide array of inputs, products and wastes. Streams that have not been sampled before are listed in Table 1 as "new samples," while those that were sampled as part of the sampling and analysis performed in 1998 by the Minnesota Pollution Control Agency and the Office of Environmental Assistance are listed as "confirmation samples".

The SAP is especially designed to obtain more data on crude oils received at the facility and streams that were not previously sampled by MPCA. Crude oil samples previously collected by the MPCA are not indicated in Table 1. Two composite samples will be collected of each of the crude oils on hand at the time of sampling. It is currently expected that four or five crude oils will be available at the time of sampling.

Table 1 lists other inputs to the refining process that will also be sampled and analyzed for mercury. These include gas-oil, natural gasoline, and sulfuric acid which are inputs to the refining process and are brought into the refinery from outside sources. A significant quantity of groundwater is also used in the refining process. Much of this in non-contact cooling water, but a significant amount is used in desalting of the crude. Mercury is not expected to be found in the groundwater, but because of the quantity used, it will be sampled to confirm this assumption.

Catalysts are used in several refining processes. Two major uses are in the desulfurization/hydrotreating and FCC units. It has been hypothesized that mercury may accumulate in these catalysts. If available, samples of spent catalyst will be collected and analyzed to evaluate this hypothesis. Samples of fresh catalyst will also be collected and analyzed to determine the mercury concentration (if any) in the fresh catalyst before it is used in the refining process.

Three products which were not sampled by the MPCA are included in this sampling plan. They are petroleum coke, asphalt cement, and sulfur. One data point from 1992 for petroleum coke indicates that mercury may be present. If mercury is present in petroleum coke it may also be present in asphalt cement since these are both heavy fractions resulting from the refining of crude oil. Sulfur was included because of the quantity produced and a tendency for mercury to associate with sulfur. Samples of fuel oil, gasoline and jet fuel will also be collected for conformation and comparison with the MPCA's previous sampling efforts.

Waste streams included in the sampling plan are the combined oily sludge, heat exchanger bundle sludge and spent sulfuric acid. The combined oily sludge was chosen because it is generated on a fairly regular basis and some of the literature reported a tendency for mercury to be found in oily sludges. Heat exchanger bundle sludge was selected because previous data indicated very high metal (especially iron) concentrations. One theory is that mercury may deposit on the inside of piping. Heat exchanger bundle sludge may give indications to whether or not this is occurring. Sulfuric acid was selected because of the quantity generated and the tendency for mercury to associate with sulfur.

Several of the waste streams are only generated during refinery turnarounds. A turnaround was completed in May, 2000. If these wastes are still on-site or there is sample remaining from waste characterization testing at the lab, samples will be collected and sent to Cebam for mercury analysis.

Sample Collection Methods

Sample collection, storage and transport methods will be selected to avoid sample contamination. Composite samples will be collected where feasible and appropriate. The following documents will be used as sources of sampling guidance: EPA SW-846 *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods;* EPA Method 1669 *Sampling Ambient Water for Trace Metals at EPA Water Quality Criteria Levels*, July 1996; and EPA Method 1631, Revision B, *Mercury in Water by Oxidation, Purge and Trap, and Cold Vapor Atomic Fluorescence Spectrometry*

Laboratory

Samples will be sent to the Cebam Analytical Inc. laboratory in Seattle, Washington, for analysis. Cebam was selected because the results of the MPCA/OEA oil refinery testing for mercury conducted in 1998 indicates that Cebam's thermal decomposition system for analysis of mercury in crude oil and related samples appears to be more conservative (i.e., higher concentrations). Cebam's results are believed to be higher because the thermal decomposition method used liberates more mercury from the sample than methods used by other laboratories.

Analytical Methods and Detection Limits

Cebam will use in-situ thermal decomposition to analyze samples of crude oil and similar matrices as well as for solid matrix samples. EPA Method 1631, Revision B, *Mercury in Water by Oxidation, Purge and Tràp, and Cold Vapor Atomic Fluorescence Spectrometry,* will be used as appropriate for other samples. The method detection limit for oil matrix samples is estimated to be 0.5 ng/g. The detection limit for solids is expected to be 0.5 ng/g or less. The detection limit for water and wastewater samples is estimated to be 0.2 ng/l.

Laboratory Quality Assurance

Cebam has a QC program it uses to ensure the reliability and validity of the analysis performed at the laboratory. All analytical procedures are documented in writing as Standard Operating Procedures (SOP) and each SOP includes a QC section, which addresses the minimum QC requirements for the procedure. The internal quality control include the following:

- Field blanks
- Method blanks
- Preparation blanks
- Instrument blanks
- Matrix spikes/matrix spike duplicates
- Field duplicates
- Laboratory duplicates
- Laboratory control standards

All laboratory glassware will be dedicated to low level mercury analysis, and not be used for any other type of analytical procedure. All sample preparation, handling and analysis will be preformed in clean areas to minimize laboratory contamination of samples.

All data obtained will be properly recorded. The data package will include a full deliverable package capable of allowing the recipient to reconstruct QC information and compare it to QC criteria. All samples analyzed and appearing in nonconformance with the QC criteria, will be reanalyzed by the laboratory, if sufficient volume is available.

Sufficient volumes/weights of samples will be collected to allow for reanalysis when necessary.

Schedule

Samples are expected to be collected during the first two weeks of July, 2000. Standard turn-around time on analytical results for mercury samples from Cebam is three weeks.

Table 1: Streams to be Analyzed and Number of Samples

POTENTIAL STREAMS	Confirmation Samples	New Samples
INPUTS		
Catalysts:		
Desulfurization/Hydrotreating		2
FCC (if available)		2
Crude oil tanks		10
Gas-oil for the FCC		2
Production water		1
Natural Gasoline		2
Sulfuric Acid		2
OUTPUTS		
Catalyst, spent:		
Desulfurization/Hydrotreating		7
FCC (if available)		2
FCC ESP Solid Waste		2
Fuel Oils (Residual):		
#1		2
#2 (low sulfur)	1	
#3 (light cycle)	1	
#4		2
#6 (commercial fuel oil?)	1	
Gasoline:		
Premium (unoxygenated)	1	
Regular (unoxygenated)	1	
Aviation gas (unleaded)	1	
Jet Fuel / Kerosene	1	
Asphalt (asphalt cement)		3
Pet coke – existing pile		2
Pet coke – new pile as it is produced		2
Sulfur		2
Waste:		
Combined oily sludge		2
Heat exchanger bundle sludge (if available)		2
Sulfuric acid, spent		2
Crude oil tank sludge		
Wastewater Discharge – plant influent		2
Wastewater Discharge – plant effluent	2	
Total Number of Samples	9	53
Duplicate Samples (minimum of 5, or 10% of total sample number)	1	6
TOTAL Estimated Number of samples	**10**	**59**

LTV Steel Mining Company
CLIFFS MINING COMPANY, MANAGER

April 3, 2000

Mr. John Wachtler
MPCA Mercury Reduction Coordinator
Major Facilities Section
Policy and Planning Division
520 Lafayette Road N.
St. Paul, MN 55155-4194

Dear Mr. Wachtler:

LTV Steel Mining Company (LTVSMC) is submitting the attached Draft Voluntary Mercury Reduction Agreement dated March 29, 2000 as stated in the letter of intent date December 15, 1999. Final Minnesota Pollution Control Agency (MPCA) Voluntary Mercury Reduction Agreement Guidelines of March 14, 2000 have been incorporated into the draft agreement.

Please contact me at (218) 225-4217 to arrange a time when we can meet to discuss and finalize the draft agreement.

Sincerely,

LTV STEEL MINING COMPANY

J. R. Scott
Area Manager
Technical Services

/rm(0400048.jrs – Mercury Reduction Agreement.doc)

cc: W West - LTV
D Skolasinski - CMSC
D Crouch - CCI
J Tuomi
D Koschak

<u>Decision to Participate</u>

LTV Steel Mining Company (LTVSMC) recognizes that it must do its part towards achievement of mercury reduction goals. Ore processed at the Hoyt Lakes Taconite Processing Plant contains trace amounts of mercury. Coal burned at the Taconite Harbor Power Plant contains trace amounts of mercury. Some products and devices used at LTVSMC contain mercury. LTVSMC has developed a voluntary reduction strategy to address mercury reduction within LTVSMC, where possible, combined with a focused outreach program to achieve reductions of releases to the environment.

This document is intended to be dynamic and responsive and will accordingly be revised as more is learned about mercury at LTVSMC or adjustments are made to processes or production rates at LTVSMC.

<u>Specific Plans and Objectives</u>

Mercury in the Ore

A Natural Resources Research Institute (NRRI) study (September 1997) included a material balance that indicates that the ore contains 8 to 15 ng Hg/g (i.e. 8 to 15 parts per billion). The study concludes that 90% of this remains with the tailings and does not dissolve in the water of the tailing basin. Based on this study, approximately 42 to 51 pounds of mercury per year is volatized in the pelletizing furnaces and released to the environment.

There is no known feasible technology that can reduce the amount of mercury reporting to the furnaces or the amount of mercury released from the furnace stacks.

LTVSMC operates twenty-three vertical shaft furnaces to produce taconite pellets. There are wet scrubbers on twelve furnaces and dry collectors on eleven. Based on testing at other facilities, there are indications that wet scrubbers remove more mercury from the air stream than dry collectors do. LTVSMC is committed to upgrading the eleven dry collectors to wet scrubbers.

<u>Voluntary Reduction Action:</u>

LTVSMC will perform stack testing on furnace emissions to verify mercury emissions from furnaces with wet and dry collectors.

LTVSMC will work with the MPCA to verify that mercury remains with the tailings and explore changes in tailings handling operating procedures that will maximize retention of mercury within the tailings.

LTVSMC will perform a mass balance to better understand the fate of mercury within the process and will explore process changes that result in more mercury reporting to tailings (based on verification that mercury reporting to tailings is retained by the tailings).

Specific Plans and Objectives (continued)

Mercury in Coal

LTVSMC routinely samples the amount of mercury in coal burned at the Taconite Harbor power plant and generates reports to the MPCA. Assuming all of this mercury is released via the boiler stacks, approximately 30 to 90 pounds of mercury per year is released to the environment.

There is no known feasible technology that can reduce the amount of mercury released from the boiler stacks.

Voluntary Reduction Action:

LTVSMC will perform stack testing on boiler emissions to verify mercury emissions.

LTVSMC will perform a mass balance (air emissions, fly ash, bottom ash and pyrites) to better understand the fate of mercury within the process.

Mercury in Products and Devices

LTVSMC has had a Mercury Elimination Program in place at the Taconite Harbor Power Plant since 1991. Switches, scales, manometers and flowmeters containing at total of 476 pounds of mercury have been replaced.

LTVSMC has been recycling fluorescent lamps and mercury-containing batteries since 1992.

At the Hoyt Lakes Taconite Processing Plant, free flowing mercury collected from devices (such as switches, scales, manometers and flowmeters) has resulted in removal from the waste stream of 964 pounds of mercury since 1990.

Voluntary Reduction Action:

LTVSMC will develop a more formal Mercury Elimination Program at the Hoyt Lakes Taconite Processing Plant. The program will include an inventory of mercury containing devices, a plan to phase out those devices where feasible and a methodology to avoid introduction of new mercury containing devices or products where mercury free alternatives exist.

Specific Plans and Objectives (continued)

Community Outreach

LTVSMC believes that significant amounts of mercury are released to the environment because the public is unaware of the mercury content of fluorescent lamps, batteries, thermostats, sump pump switches, etc.

Voluntary Reduction Action:

LTVSMC will participate in any joint effort which may be undertaken with other taconite processors and Minnesota Power to develop a Mercury Awareness Program targeted at Northeastern Minnesota and deliver it to the local community via brochures, newspaper advertising and radio advertising. Once the group finalizes the plan, LTVSMC will support a portion of this effort based on a funding strategy developed by the group.

LTVSMC will participate in any joint effort which may be undertaken with other taconite processors and Minnesota Power to develop a Community Mercury Recycling Program targeted at Northeastern Minnesota. Once the group finalizes a plan, LTVSMC will support a portion of this effort based on a funding strategy developed by the group.

Proposed Implementation and Reporting Schedule

Mercury in the Ore:

Stack testing to verify mercury emissions will be done on at least one furnace with a wet and one furnace with a dry collector in 2000. Test results will be submitted to the MPCA as soon as they are available. This effort will be in conjunction with a mass balance.

Measurement of mercury evasion from the tailings basin will be performed in 2000 assuming that the appropriate test equipment is available from the MPCA. Test results will be submitted to the MPCA as soon as they are available.

A mass balance will be performed in 2000. Test results will be submitted to the MPCA as soon as they are available. All or parts of this effort would be repeated if process changes were made that would impact the flow of mercury in LTVSMC's process.

<u>Proposed Implementation and Reporting Schedule (continued)</u>

<u>Mercury in Coal:</u>

Stack testing on boiler emissions to verify mercury emissions will be done on at least one boiler in 2000. Test results will be submitted to the MPCA as soon as they are available. This effort will be in conjunction with a mass balance.

A mass balance (air emissions, fly ash, bottom ash and pyrites) will be performed in 2000. Test results will be submitted to the MPCA as soon as they are available. All or parts of this effort would be repeated if process changes were made that would impact the flow of mercury in LTVSMC's process.

<u>Mercury in Products and Devices:</u>

An inventory of mercury devices installed at the Hoyt Lakes Taconite Processing Plant will be completed in 2000. The inventory will include an assessment of the risk of mercury release for each device. A report will be issued to the MPCA by the end of the first quarter of 2001.

A plan to eliminate mercury-containing devices, where practical substitutes exist, will be submitted by the end of the second quarter of 2001. The plan will be issued to the MPCA by July 31, 2001.

An inventory of mercury products used at the Hoyt Lakes Taconite Processing Plant will be completed in 2000. A report will be issued to the MPCA by the end of the first quarter of 2001.

A plan to reduce the use of (where practical substitutes exist) and/or improve the recycling of mercury containing products will be submitted by the end of the second quarter of 2001. The plan will be issued to the MPCA by July 31, 2001.

<u>Community Outreach:</u>

LTVSMC is prepared to participate with other taconite processing facilities and Minnesota Power in the development and delivery of a Mercury Awareness Program starting in 2000.

LTVSMC is prepared to participate with other taconite processing facilities and Minnesota Power in the development of a Community Mercury Recycling Program starting in 2000.

<u>Progress Measurement</u>

LTVSMC will update the attached LTVSMC Mercury Release Inventory in February of each year starting in January of 2001. The key reporting parameter for emissions from pelletizing furnaces and power plant boilers will be mercury emissions on a pound per ton or pound per MWH, produced respectively.

LTV Steel Mining Company Mercury Release Inventory

	Power Plant			Taconite Plant			Iron Analysis		Devices in Service			Lamp Recycling		Battery Recycling		Community Outreach		Total	Calculated
	Emissons lbs Hg	Production MWH	Emissons lbs Hg/MWH	Emissons lbs Hg	Production Long Tons	Emissons lbs Hg/MLT	Use lbs Hg	Calculated Release lbs Hg	Power Plant lbs Hg	Taconite Plant lbs Hg	Calculated Release lbs Hg	Number Recycled	Calculated Release lbs Hg	Number Recycled	Calculated Release lbs Hg	Pounds Collected	Calculated Release lbs Hg	Calculated Release lbs Hg	Release + Emissions lbs Hg
1990	0	0	0	50.6	7,718,295	6.56	2.1	0	527	x	131.75							131.8	182.4
1991	4.6	186,584	0.000025	44.8	6,827,870	6.56	2.1	0	497		124.25							124.3	173.6
1992	8.8	798,528	0.000011	42.7	6,515,658	6.56	1.1	0	397		99.25							99.3	150.8
1993	89.4	861,525	0.000104	48.7	7,418,478	6.56	0	0	247		61.75							61.8	199.8
1994	73.5	959,922	0.000077	49.1	7,485,723	6.56	0	0	142		35.50							35.5	158.1
1995	62.5	749,157	0.000083	48.9	7,453,412	6.56	0	0	142		35.50							35.5	146.9
1996	30.4	568,448	0.000053	47.0	7,171,271	6.56	0	0	112		28.00							28.0	105.4
1997	49.9	920,485	0.000054	48.9	7,457,816	6.56	0	0	82		20.50							20.5	119.3
1998	69.7	1,145,726	0.000061	45.0	6,865,337	6.56	0	0	51	x - 964	12.75							12.8	127.5
1999	56.4	1,023,845	0.000055	44.3	6,752,353	6.56	0	0											
2000							0	0											
2001							0	0											
2002							0	0											
2003							0	0											
2004							0	0											
2005							0	0											
2006							0	0											
2007							0	0											
2000 vs 1990																			
2007 vs 1990																			
Percent Mercury Assumed to be Released via Iron Analysis								0%											
Percent Mercury in Devices Assumed to be Released								25%											
Percent Mercury in Lamps Assumed to be Released								15%											
Percent Mercury in Batteries Assumed to be Released								5%											
Percent Mercury in Community Outreach Assumed to be Released								15%											

Notes:

1. Percentage assumed to be released to be finalized through discussion with MPCA
2. Mercury in devices at Taconite Plant to be determined via inventory.

Metropolitan Council Environmental Services
Voluntary Mercury Reduction Agreement
December 28, 2000

1.0 Introduction and Background

The Metropolitan Council ("Council") is a public corporation and political subdivision of the state of Minnesota organized under Minnesota Statutes, Chapter 473. The Council owns and operates the Metropolitan Disposal System ("MDS") in the Twin Cities Metropolitan Area. The MDS is comprised of nine wastewater treatment plants (WWTP) which treat approximately 300 million gallons of wastewater per day, has over 550 miles of interceptor sewer pipes and 239 lift and meter stations (as of 2000).

The Council has other responsibilities related to environmental quality in the Metropolitan Area, and is committed to the improvement of environmental quality in the Metropolitan Area.

Metropolitan Council Environmental Services (MCES), a division of the Council, supports the Minnesota Mercury Contamination Reduction Initiative and the Advisory Council recommendations that resulted from that effort. MCES and its predecessor agencies have maintained an active mercury reduction program. MCES is committed to further reducing mercury emissions and discharges to the environment. To that end, MCES has developed this Voluntary Mercury Reduction Agreement (VMRA). This VMRA summarizes our past actions and states our commitments under this agreement, according to topic area. These previous actions, current activities and future plans for reductions go well beyond any current regulatory requirements.

2.0 Control of Discharges to the MDS

2.1 Control of Industrial Sources

2.1.1 Previous Action. MCES has administered the delegated industrial pretreatment program for the metropolitan area since the early 1970's, including establishing limits, permitting, monitoring and inspection of dischargers to the Metropolitan Disposal System (MDS). We received delegation for the program from the MPCA in 1983. MCES has over 800 different companies on permit throughout the metropolitan area, with 300 of those being significant industrial users (categorical dischargers) (2000). In addition to permitting industrial dischargers, MCES has permitted all area hospitals since the early 1980's and requires each hospital to have a mercury reduction plan in place. Furthermore, pollution prevention and mercury reduction opportunities are regularly highlighted as part of the annual inspections of significant industrial users.

From 1990 through 1994 MCES conducted a collection system evaluation of the interceptors tributary to the Metropolitan Wastewater Treatment Plant (Metro Plant). The evaluation consisted of sampling major lines to try to find "hotspots" of mercury, PCBs and pesticides. With one exception, the results of this comprehensive 4-year effort did not identify any additional sources of mercury to be permitted and controlled or any historic loading or hotspot. However, it did lead us to identify the University of Minnesota Hospitals as a source that needed additional control. As a result, MCES placed additional conditions in that hospital's industrial discharge permit.

2.1.2 Current Activity. Every five years, as part of the pretreatment program, MCES reviews the discharge limitations, including mercury, that it places on the users of the MDS. Based on the results of the evaluation, the limits that dischargers to the MDS are required to meet may need to be changed. The last review occurred in 1996, and resulted in a lowering of the mercury limit for users from 100 micrograms per liter (μg/l) to 2 μg/l. MCES is currently conducting this evaluation as part of the pretreatment program requirements and is scheduled to complete the study by September 30, 2001.

2.1.3 VMRA Commitment: MCES will complete evaluation of its local limit for mercury by September 30, 2001.

2.2 Evaluation of Dental Discharges

2.2.1 Previous Action and Current Activity. MCES has conducted surveys of other sectors, including dental clinics, to assess their potential for discharge of mercury and other pollutants. Results from the dental clinic survey lead to the submission of a monograph published by the Water Environment Federation titled "Controlling Dental Facility Discharges in Wastewater – How to Develop and Administer a Source Control Program" (1999). That case study, presenting the survey information gathered in 1995-96, estimated mercury contributions to the collection system from dental clinics to represent 76-80 percent of the total mercury discharged. As a result, in January 1998, the MCES entered into a partnership with the Minnesota Dental Association (MDA) to further evaluate the contributions of mercury from the dental community and to test advanced amalgam removal equipment. MCES, in conjunction with MDA, has designed and implemented two extensive studies to achieve this objective.

2.2.2 Amalgam Removal Equipment Evaluation

The first study is designed to evaluate the removal efficiency and associated costs of a variety of amalgam removal equipment and to quantify clinic loadings. There is very little data available nationally regarding the efficiency of these units, nor is there a quantification of the amount of mercury that these types of units remove. The ultimate objective of the evaluation is to give the information to dentists so that they can make informed choices about the best removal equipment for their type of clinic setting.

MCES developed analytical methods for quantification of mercury in the removed amalgam. Two types of units were pilot tested in three clinics in 1999. The pilot testing allowed us to better understand the problems of installation of this type of equipment in dental offices and the procedures necessary for their proper operation. In-clinic testing of three additional types of amalgam filters and separators was completed in October 2000 at four other clinics. The data from the in-clinic testing, including removal efficiency and operating costs of the different units, will be evaluated, with project completion scheduled for approximately March 2001.

2.2.3. Community-wide Study

The second study is referred to as the "community-wide study." The purpose of the community-wide study is four-fold: 1) collect virtually all dental amalgam waste in the area tributary to the Cottage Grove and Hastings WWTPs, 2) to quantify the mercury removed by the equipment at the clinics, 3) to evaluate whether the mercury removed results in a measured reduction of mercury at the two WWTPs, and 4) to determine relative contributions of mercury from dental activities to WWTPs. All dental offices and clinics in the service areas have been identified and arrangements are being made to install equipment in all of them. We anticipate completing the clinic portion of this study by April 2001, with data analysis concluding by approximately June 2001.

2.2.4 VMRA Commitment. Complete the two studies in 2.2.2 and 2.2.3 and develop future programs related to control of mercury from the discharge of dental amalgam based on the results of these evaluations.

2.3 Evaluation of Domestic Sources of Mercury

2.3.1 Previous Action. MCES is a member of the Association of Metropolitan Sewerage Agencies (AMSA.) This national trade organization conducts much of its work through the use of committees, task forces and workgroups. Due to our concerns about mercury contributions to our facilities, MCES helped establish the AMSA Mercury Workgroup in July 1998. The initial task of the workgroup was to develop data and information about mercury discharges to publicly owned treatment works (POTWs) in order to develop effective control programs. Part of that work has resulted in the preparation of a report titled "Evaluation of Domestic Sources of Mercury for the AMSA Mercury Workgroup" (August 2000). The evaluation found significant contributions of mercury from domestic-only wastewater. In addition to quantifying the mercury concentrations in household products and estimating contributions to POTWs, the evaluation identifies that a significant portion (approximately 82%) of the total domestic mercury load is attributable to excreted dental amalgam mercury (due to in-place amalgam). MCES participated in providing data for this report by conducting monitoring of part of its collection system known to receive only domestic wastewater.

2.3.2 VMRA Commitment: MCES will continue to participate in the AMSA Mercury Work Group in order to share data and information nationally.

3.0 Policy-Related Actions

3.1 Mercury Reduction Strategy

3.1.1 Previous Action and Current Activity. The Council adopted a Mercury Reduction Strategy in April 1998. This strategy guides staff implementation activities and actions and is a demonstration of the Council's commitment to mercury reduction. In addition to the efforts that are conducted as part of controlling discharges to the MDS, the strategy is intended to be implemented through a variety of approaches such as education, pollution prevention, research, monitoring and technology-based controls. This strategy is intended to go beyond the substantial reductions already achieved through the control of industrial and other dischargers to the MDS and to go beyond the current regulatory requirements for owners and operators of WWTPs.

3.2 Minnesota Mercury Contamination Reduction Initiative

3.2.2 Previous Action and Current Activity. MCES actively participated in the Minnesota Mercury Contamination Reduction Initiative and Advisory Council. The Advisory Council evaluated mercury reduction options across all sectors. In addition, the report of the Advisory Council identified and recommended activities that the Minnesota Pollution Control Agency (MPCA) and the Minnesota Office of Environmental Assistance (MOEA) should conduct, including educational outreach activities and product bans.

3.2.3 VMRA Commitment: If the MPCA or MOEA develop a legislative program to seek bans of mercury containing products or conduct other such efforts to achieve product bans, the Council will discuss with MPCA or MOEA how best to support such efforts.

3.3 Mercury Dental Insurance Policy

3.3.1 Current Action. Given the estimated contribution of excreted dental amalgam mercury that was found in the AMSA Evaluation noted in item 2.3.1 above, the Council has taken action to change its dental insurance policies for its own employees to encourage the use of mercury-free posterior restorations (dental cavity fillings). Previous dental policies were negotiated to allow employees and dependents to select mercury-free composites, but would only cover up to the cost of a mercury amalgam filling. Since the mercury-free composite is significantly more expensive, there is a financial disincentive for employees and their dependents to select the mercury-free alternative.

3.3.2 VMRA Commitment: Effective with the new contract beginning January 1, 2001, the Council policy will remove this cost disincentive. The increased cost incurred by the Council is currently estimated to be approximately $8,000 per year for approximately 8000 employees and their dependents.

3.4 Grant Programs

3.4.1 Nonpoint Source Grant Program

3.4.1.1 Previous Action. By MPCA estimates, 1-2 percent of the mercury in surface waters statewide is from direct point source dischargers. The rest of the mercury comes from either direct atmospheric deposition to the surface water or from atmospheric deposition to land and subsequent runoff to the surface water. Results from a cooperative MPCA/MCES study indicates that as much as 90,000 grams per year makes its way into the Mississippi River from nonpoint source pollution (NPS) runoff and settles out in the sediment of Lake Pepin. That is one of the reasons MCES has committed $7.5 million over the five-year period to a grant program to reduce NPS runoff.

3.4.1.2 VMRA Commitment: Continue the NPS Grant Program through 2003.

3.4.2 Infiltration and Inflow Reduction Grant Program

3.4.2.1 Previous Action. Infiltration and Inflow (I/I) has been identified as another potential source of mercury in sanitary sewer collection systems, because of the mercury found to be present in groundwater (infiltration) and stormwater inflow. The MCES has had an ongoing program to remove I/I from our own collection system for many years. In addition, MCES initiated a grant program for local communities to address I/I beginning in 1993. Under four separate offerings, the MCES has offered financial assistance to communities to identify, locate and remove sources of I/I within local sanitary sewer collection systems. Each of the four financial assistance programs required a matching dollar share to come from the recipient community.

However, beginning with the 1996 offering, the program was expanded to offer matching dollar loans to communities to carry out capital improvements to physically remove targeted I/I from the system. Each loan had a provision in which, if the community could certify that the targeted I/I had not returned to the system, the annual repayment of the loan would be forgiven. The certification period for each loan project was 5 years in duration.

Overall, the MCES has expended a total of $1.375 million to-date to target I/I removal from local collection systems. The total amount of I/I removed from the system is approximately 800 million gallons per year. This figure does not include those projects that local communities initiated without aid of MCES financial assistance. It is unlikely that the Council would conduct another offering after the one in 2000, since most local needs have been met.

4.0 External Pollution Prevention

4.0.1 Previous Action and Current Activity. A key part of our pretreatment program includes periodically providing information to the regulated community regarding potential sources of mercury in their facilities and processes and encouraging mercury elimination to avoid discharge to the collection system. For example, we are aware that mercury can contaminate a variety of industrial chemicals such as acids and caustics and have communicated this and other information to industrial users**.**

In addition, staff write up case study information on "lessons learned", as sources of mercury are identified and dealt with. This is done to help internal staff and outside industries that are looking to find and reduce sources of mercury being discharged to the MDS.

MCES staff take every opportunity to communicate with our customers about various environmental issues and the impacts they may have on our facilities, operations and wastewater rates. We do this through a variety of communication methods including printed information to communities and industrial users, information posted on our website (www.metrocouncil.org), and when we make presentations or speeches to our customer communities, industry and other interest groups. These types of communications have the expressed purpose of educating people about potential mercury sources and reduction options.

MCES has participated in the preparation of mercury reduction materials by others. For example, MCES staff served on a 25-member advisory committee to assist the Western Lake Superior Sanitary District (WLSSD) in the development of the document titled "Blueprint for Mercury Elimination" (March 1997).

4.0.2 VMRA Commitment: Continue outreach programs.

5.0 Internal Pollution Prevention

5.1 Facility Inventory

5.1.1 Previous Action. MCES has inventoried the mercury containing devices at our facilities and has prioritized replacement with non-mercury containing items as appropriate. Removed mercury switches and other mercury-containing devices have been recycled. Some staff also conduct demolition activities at our facilities. These staff have been informed that all mercury-containing devices must be removed and recycled prior to demolition.

5.1.2 VMRA Commitment: MCES will record the type and number of devices removed from service.

5.2 Contract Specifications

5.2.1 Previous Action. MCES has experimented with contract language in capital projects that restricts the use of mercury-containing devices. For example, the South Washington County Wastewater Treatment Plant Request for Proposals (RFP) contained a prohibition on mercury containing devices except with MCES approval. Types of devices that would be allowed include fluorescent and ultraviolet lamps because they can be recycled.

5.2.2 VMRA Commitment: MCES will continue to consider ways to recover mercury in use as a part of demolition projects and/or reduce the use of mercury in new capital projects as appropriate on a case-by-case basis.

5.3 Product Substitution

5.3.1 Laboratory Thermometers

5.3.1.1 Previous Action. MCES has eliminated the use of mercury-containing thermometers in our laboratory and in the wastewater sample refrigerators at the WWTPs. In addition, where possible, we have eliminated or reduced the frequency of use of some analytical methods because they contain mercury. For example, we have requested the elimination of NPDES permit requirements to analyze effluent samples for total Kjeldahl nitrogen, since the reagent contains mercury.

5.3.2 Mercury Fever Thermometer Exchange

5.3.2.1 Previous Action. In September 2000, as part of Pollution Prevention Week, MCES conducted a pilot mercury fever thermometer exchange for approximately 120 employees in the Environmental Planning and Evaluation Department. For each mercury-containing thermometer that was brought in, employees were given a mercury-free digital thermometer at no cost to the employee. Each digital thermometer costs $3.29. During this pilot period, 66 mercury fever thermometers were collected for recycling.

5.3.2.2 VMRA Commitment: In 2000 and 2001, MCES will extend the exchange program to all MCES employees, as well as those in Regional Administration. This would expand the program to approximately 1235 more staff.

5.4 Research and Development (R & D)

5.4.1 Ultra-trace Mercury Analytical Capability

5.4.1.1 Previous Action. MCES has had extensive involvement in the development of ultra-trace mercury analytical capabilities beginning in 1991, and started up a clean R&D laboratory to perform work and conduct research projects beginning in 1993. Samples have been analyzed for others who have been interested in obtaining ultra-trace mercury analytical information. MCES performed all mercury sampling and analysis functions for Western Lake Superior Sanitary District's Mercury Zero Discharge Project, in addition to their effluent monitoring conducted in 1997 and 1998.

5.4.2 Metro Plant Mass Balance

5.4.2.1 Previous Action. In 1994, we performed a comprehensive mercury mass balance at Metropolitan Wastewater Treatment Plant, characterizing mercury in all major plant process streams. Results of this work were peer reviewed and published in *Water, Air and Soil Pollution*. To our knowledge, this is the first mass balance study voluntarily conducted at a municipal or industrial facility in Minnesota.

5.4.3 Water Quality Monitoring

5.4.3.1 Previous Action and Current Activity. Beginning in 1994, we initiated river water quality characterization. This work includes characterization of the mercury concentrations in the St. Croix, Minnesota and Mississippi Rivers and selected tributaries. The results from four different studies have been published in professional, peer-reviewed journals.

A mercury nonpoint source study of six streams in the Minnesota River basin has been conducted. In addition, MCES studied historical inputs of mercury and methyl mercury to 55 lakes in Minnesota (with MPCA and the Science Museum of Minnesota) and conducted two studies, in association with other agencies, that characterized mercury in snowmelt runoff from agricultural fields and mercury in snowmelt runoff in 12 rivers and streams.

In 1998, we received an Interagency Monitoring Grant, in association with the MPCA, to further evaluate mercury from nonpoint sources on the Minnesota River. The grant award of

$300,000 over 2 years has allowed us to establish six monitoring sites on rivers and streams in the Mankato area to characterize mercury and methyl mercury concentrations and loadings. This important work has helped us to establish a strong correlation between total suspended solids (TSS) from sediment, turbidity and mercury concentrations.

5.4.3.2 VMRA Commitment: We intend to continue this monitoring and research, contingent on continued grant funding, in order to better understand the implications for downstream water resources.

5.4.4 Aquatic Life Monitoring

5.4.4.1 Previous Action. The impact of mercury on aquatic life is important to us as well. In 1996 we completed a research study of mercury and methyl mercury uptake by zebra mussels in the Mississippi River, with the results published in a professional peer reviewed journal.

5.4.5 Drinking Water Testing

5.4.5.1 Previous Action. In 2000 we characterized mercury concentrations in drinking water of two metropolitan area cities and found mercury to be present in very low concentrations of 1 nanogram per liter or less in the 8 sites that were surveyed.

5.5 Production Laboratory with Low-level Mercury Analytical Capability

5.5.1 Previous Action. MCES investigation of a low-level analytical method for use in a production laboratory setting began in 1990. That investigation concluded in 1993, when it was determined that without a clean room in which to conduct the analyses, a production-oriented method was not possible at MCES' facilities. The R&D method noted in item 5.4.1 above can only process a very limited number of samples and is not practical to use on a permanent-ongoing basis for routine analytical work.

In May 2000, MCES completed construction of a new production-oriented laboratory facility that is designed with a clean room. The clean room was designed for low-level analytical methods to be conducted. It is anticipated that the laboratory will become certified by the Minnesota Department of Health (MDH) in the first quarter of 2001 to conduct low-level analysis for NPDES permits, making it one of a handful of laboratories nationwide that is certified by MDH to conduct such analysis.

5.5.2 VMRA Commitment: MCES intends to obtain MDH certification for low-level methods and offer this service to others beginning in summer 2001.

6.0 Technology-based Controls

6.1 Liquid Treatment

6.1.1 Previous Action. MCES has evaluated the cost and effectiveness of technology–based controls for mercury removal from municipal wastewater effluents at the Cottage Grove/South Washington County Wastewater Treatment Plant and as part of the

Rosemount Wastewater Treatment Plant Interim Improvements. The evaluation found that the analytical method for measuring low concentrations of mercury (in the single digit parts per trillion range) is so new that there is virtually no experience nationwide in assessing the effectiveness of these technologies in treating down to such levels. In addition, the evaluation found that it is not cost effective to provide technology –based controls for end of pipe removal of mercury from these types of effluents, particularly on a cost per pound removed basis. This result corresponds to findings by Western Lake Superior Sanitary District and MPCA.

6.2 Energy Efficiency

6.2.1 Previous Action. MCES is a MnGREAT! Award Recipient for 2000. The award recognizes the Metro Plant for innovations in energy recovery and wastewater handling technology. The Metro Plant has a nominal capacity of 250 million gallons per day. MCES converted the secondary wastewater treatment tanks' air-delivery system to fine-bubble diffusion, doubling the oxygen transfer rate and dramatically decreasing the power required for the air compressors. The plant recovers energy from the incineration of the solids removed from the wastewater and uses it to heat the plant, run pumps and fans, and treat the solids. Projected cost savings from these two innovations are nearly $3 million annually, and the combined annual energy savings are 25 percent since 1996. This can be converted to 8,130 tons of coal <u>not</u> being burned to generate electricity. The energy savings prevent 173 tons of nitrous oxides, 512 tons of sulfur oxides, 58,500 tons of carbon dioxide and 1.04 pounds of mercury in air emissions per year.

6.3 Air Emissions Control

6.3.1 Previous Action and Current Activity. The Metro Plant processes the solids removed from the treated wastewater through combustion in six multiple hearth incinerators. Each incinerator has an associated air pollution control ("APC") system which treats the exhaust gases from the combustion process. The existing APC systems are primarily composed of wet scrubber units. Because water from these scrubbers is recycled back into the plant, higher mercury concentrations are found in the solids than there would be without these recycle streams. When the solids are subsequently incinerated, this negates the incidental removal efficiency of the wet scrubber units.

The Council has initiated the Metro Solids Processing Improvements Project to replace the aging multiple hearth incinerators and APC systems with new combustion technology (fluidized bed incinerators) and accompanying APC systems. Procurement of these new systems began in early 2000. The Council awarded a contract for design and construction of the fluidized bed incinerators and accompanying APC systems at its December 13, 2000 meeting. Issuance of the notice to proceed is dependent on the issuance of the air emissions permit amendment. Operation of the new facilities is scheduled to begin in 2005.

Technology to achieve mercury removal from combustion exhaust gases at sewage sludge incineration ("SSI") facilities is still being researched and developed. There is no known SSI facility in North America that has an APC system specifically designed to achieve mercury removal. Technology used in other industries to remove mercury from exhaust gases has not yet been demonstrated as effective in SSI facilities.

6.3.2 VMRA Commitment: The Council will provide in the new APC systems the capability to treat exhaust gases with carbon which is expected to achieve a goal of reducing mercury in air emissions by approximately 70% from current emission estimates (1997). The cost for the carbon injection technology and the enhanced particulate removal technology, which are integral to enhanced mercury removal, is approximately $5.7 million. Once installed, MCES will operate the system.

6.3.3 VMRA Commitment: MCES will conduct quarterly stack testing of the new APC systems to determine the amount of mercury in the stack exhaust gases. This testing will be conducted for three years following the installation and operation of the new APC systems.

7.0 Mercury Reductions Achieved

The previous actions noted above and other efforts to control sources of mercury discharged to the MDS have resulted in a reduction of mercury concentrations in Metro Plant sewage sludge from approximately 3.0 milligrams per kilogram (mg/kg) in 1990 to 1.25 mg/kg in 1999. Where other data is available, similar reductions in mercury concentrations in sludges have been noted at our other facilities.

8.0 VMRA Administration

8.1 Primary Contact

All significant communications regarding the content of this VMRA shall be directed to: Rebecca J. Flood, Manager, Environmental Compliance Section, MCES

8.2 Annual Reporting

The Council will provide an annual report on the progress under the VMRA by March 1 of each year for the preceding calendar year.

**MINNESOTA POWER MERCURY VOLUNTARY AGREEMENT
SUBMITTED TO THE MPCA
JULY 6, 2000**

1.0 Introduction

Minnesota Power (MP) supports the Minnesota Mercury Contamination Reduction Initiative and the Advisory Council recommendations that culminated from that effort. For years, MP has had an active mercury reduction program. MP submits this Voluntary Agreement to the Minnesota Pollution Control Agency (MPCA) that outlines our commitment to explore additional opportunities to further reduce mercury. The programs and schedule outlined in this Voluntary Agreement will be modified as warranted, as new information becomes available. Based on successful completion of all Voluntary Agreement programs described herein, MP estimates a mercury emissions reduction of approximately 10 percent in year 2000 as compared to 1990 emission estimates. This reduction estimate may be high or low depending on unforeseen changes in operating scenarios and/or reduction accounting mechanisms for some of these programs.

2.0 MP Previous and Ongoing Activities Relevant to the Mercury Issue

MP has been and continues to be actively involved in trying to develop solutions to the mercury issue. Summarized below are some previous and ongoing mercury-related activities.

- MP volunteered - and was selected to participate in - the Electric Utility Study mandated by the Federal Clean Air Act of 1990. Boswell Unit 2 was chosen along with seven other units nationwide to participate in this comprehensive assessment of power plant emissions of air toxics, including mercury. Testing was completed in 1993, and the results provided to the MPCA.

- MP has voluntarily tested emissions and fuel from Boswell Units 3 and 4 in 1994 for air toxics, including mercury. The data have been provided to the MPCA.

- MP co-sponsored a major study by the University of North Dakota Energy and Environmental Research Center (EERC) in 1995 assessing the effectiveness of various mitigation techniques on the reduction of air toxics emissions due to coal combustion. The study indicated limited success in reducing mercury emissions from sub-bituminous coal, using various sorbents. Testing was conducted at the pilot scale level.

- MP has conducted water quality studies in our hydroelectric reservoirs as part of a process to relicense our St. Louis River Project. These studies included mercury analysis of game fish for the Minnesota Department of Health fish consumption advisory and mercury analysis in yearling perch, water and sediments. MP continues to conduct voluntary fish mercury analysis in conjunction with the Minnesota Department of Natural Resources. MP is actively involved in programs established to address St. Louis River water quality issues, including the Lake Superior Binational Program and the Total Maximum Daily Load (TMDL) development process.

- MP has in place a fluorescent bulb recycling program for our customers. Coupons are provided towards the cost of recycling to encourage customers to recycle their bulbs. Also, a network of hardware stores in our service territory has been established where coupons may be redeemed when used bulbs are brought in. MP routinely advertises the availability of the coupons and location of participating stores in our customer newsletter.

- MP has in place a mercury waste recycling program. All used MP batteries, fluorescent bulbs and other mercury-containing items are being recycled at licensed recycling facilities. MP has also implemented a purchase policy where items containing mercury can not be purchased if suitable substitutes exist.

3.0 Mercury Reductions That Have Occurred Since 1990 Due to MP Activities

Minnesota Power has implemented programs that have resulted in mercury release reductions, directly or indirectly. These programs are described below.

3.1 Mercury Emission Reductions Associated with Energy Use and Production

MP has undertaken several programs associated with energy use and production over the years that have the added benefit of reducing or offsetting mercury releases. Some of these programs are described below.

3.1.1 Demand Side Management, Conservation and Efficiency Improvements

MP initiated a Demand Side Management (DSM), Conservation Improvement Program in the early 1980's. Customer conservation improvement efforts include activities such as space heating, high efficiency lighting, process control, and energy auditing. The process efficiency improvement program is targeted to serve the needs of our industrial customers. MP has also implemented internal conservation measures to reduce our own electric usage.

The benefits of conservation improvements are included in the Minnesota Power load forecast, since it is anticipated that reducing customer electricity use will result in decreased electricity generation. Decreased generation due to implementation of the MP conservation improvement program, in turn, results in a reduction in mercury emissions.

The benefits of industrial process efficiency improvements are both direct and indirect. Direct reductions in emissions are achieved as a result of less customer energy use per unit of production. However, it is anticipated that reducing the unit cost of production for our industrial customers may also result in increased production. In this case, the customer would acquire additional market share, displacing less efficient suppliers. The indirect impact from efficiency improvement might be the reduced emissions from less efficient suppliers that lose market share.

3.1.2 Expanded Use of Renewable Biomass

MP operates the M. L. Hibbard/Duluth Steam District No. 2 steam plant for the City of Duluth. The facility provides process steam to a paper mill and a recycled fiber plant. Acceptable fuels at the facility include coal, natural gas and wood waste. The plant has sought to maximize use of renewable waste wood as a fuel since 1991, expending additional capital to increase the wood handling capability. Also, MP has actively sought out waste wood suppliers from throughout the region to provide fuel for the facility, including chipped railroad ties. Because of these efforts, coal usage has decreased annually since 1990, while total energy output has increased. These efforts have resulted in a reduction in mercury emissions by over four pounds per year since 1995 compared to 1990 levels.

3.1.3 Generation of Electricity at Hibbard

In addition to the mercury reductions identified previously, since 1996 Hibbard also generates electricity at those times that it makes economical sense. The high proportion of wood waste burned at the facility results in significantly lower mercury emissions from Hibbard generation compared to coal-fired only generation alternatives.

3.1.4 Expanded Generation from Existing Hydro Electric Resources

In 1991, Unit 1 at our Thomson Hydroelectric station was converted from 25 cycle to 60 cycle operation, which allowed an additional 5 MW of generation. At least a portion of the energy displaced by the additional generation would likely have come from mercury-emitting sources.

3.1.5 Heat Rate Improvements, Boswell Energy Center

A heat rate improvement team was formed in late 1993 at the Boswell Energy Center to identify and implement means by which the four Boswell units can generate more efficiently, serving to reduce emissions along with plant fuel usage and operating costs. Viable options identified were implemented in 1993, which improved the heat rate for the units. Improved heat rate results in more electricity generated per unit of coal, resulting in reduced emissions of mercury per unit of electricity generated.

3.1.6 Use of Lower Mercury Coal

MP has for many years used western, sub-bituminous Powder River Basin coal that, based on substantial coal mercury analysis data, is below the national average in mercury content. In addition, in 1996 MP began using a coal as a portion of its total coal supply that recent test data shows is significantly lower in mercury content than other coals that burned.

As a result, MP burns coal with an uncontrolled emission rate that is approximately half of the national average, based on the recently completed EPA Information Collection Request. In addition, MP achieves additional reduction in mercury emissions by existing pollution control equipment.

3.1.7 Mud Lake Substation – Reduced Transmission Losses

MP installed the Mud Lake 230/115 substation in September of 1996. This installation improved load flow in the regional transmission system, resulting in reduced energy losses. The reduced energy loss potentially offsets energy production from mercury emitting sources.

3.1.8 Summary of Mercury Emission Reductions Associated with Energy Use and Production

To summarize, based on the activities described above, MP has reduced or offset mercury emissions due to energy production annually since 1990. It is difficult to accurately calculate the amount of mercury reduced or offset. The amount depends, for example, on whether the generation that is offset would have come from mercury emitting sources, and what their emission rates are for mercury. Based on the simplifying assumption that the offset generation would have been from our own energy mix, mercury emission reductions due to the activities described previously would be as high as 50 pounds annually.

In addition to the activities described above, MP has recently announced two efforts that will likely offset coal-based generation in the future. One is our green power offering for our customers. Those that elect the green power option will be buying wind power generated electricity. The other effort is the planned construction of additional natural gas-fired generation capacity in Superior, Wisconsin.

4.0 Mercury Emission Reductions Associated with Product Use Changes and Waste Management Activities

MP has since before 1990 recycled mercury and mercury-containing devices and chemicals. During the period from 1990 to 1999, MP has sent to recyclers approximately 600 pounds of bulk mercury. MP has also recycled approximately 3000 pounds of materials, such as thermometers, switches, batteries, and chemicals, which contained mercury. In addition, MP recycles approximately 10,000 fluorescent bulbs each year.

5.0 Proposed Voluntary Agreement Activities

MP will focus on the following activities over the next year or so as part of the Voluntary Agreement to reduce or work towards reducing mercury releases. In addition, MP will continue to evaluate other options.

5.1 Efforts to Address Stack Mercury Emissions

Efforts that MP will undertake over the next year to address stack emissions of mercury are summarized below.

5.1.1 Increase Utilization of Lower Mercury Coal

MP has determined through routine coal mercury analyses that one of the coals we currently burn in our boilers is consistently lower in mercury than the other coals. We have increased the amount of coal that we purchase from that coal supplier by approximately two-and-a-half times beginning in the year 2000. Use of this coal has already affected mercury emission rates. Testing which has just been completed verifies that mercury emission rates from all units at our Boswell Energy Center are lower than measured in 1993 and 1994.

<u>Progress Measurement:</u> Emission factors developed during the recent testing at the Boswell Energy Center (see 5.1.4 below) are representative of the new coal mix. Progress towards reducing mercury is measured by the relationship between the lower emission rates associated with the current coal blend, compared to the emission rates measured in 1993 and 1994 under the old operating regime. However, actual annual emissions are also related to the amount of coal consumed during the year, so it is difficult to predict the actual reductions that will occur in 2000 compared to 1990 emissions. Year 2000 actual emissions will be calculated in early 2001 and compared to 1990 levels.

5.1.2 Routine Coal Mercury Monitoring

MP will continue to monitor coal mercury content on a routine basis to determine if there are any changes in coal mercury content over time from the various suppliers. This information will prove useful in developing accurate mercury inventory information, and aid in future decisions on coal procurement. The current schedule for mercury in coal analyses is to analyze 2 samples from each coal supplier on a quarterly basis. This sampling frequency may change based on the variability of the results.

<u>Progress Measurement:</u> Success of this program will be measured by successful completion of the analyses as described above. The results of the analyses may in the future be useful as one component of coal procurement decisions.

5.1.3 Control Technology Research

MP has in the past conducted control technology research as a funding member of the Air Toxics Control Target of the Electric Power Research Institute (EPRI). As described previously, MP also co-funded a study by the EERC on mercury mitigation technology. In the year 2000, MP has significantly increased our commitment to this type of research. MP continues to fund the Air Toxics Control and Air Toxics Health Risk targets of EPRI.

In addition, MP will conduct control technology studies specifically on some of our own units. Minnesota Power will work with EPRI to assess mercury emissions from our Boswell facility and conduct control technology experiments. The study will look at various control options using a slipstream of flue gas. The effort will focus on Boswell Units 3 and 4, the two largest units. This study is to be conducted in 2000, with results expected in early 2001. A study design document will be submitted to the MPCA upon completion, which will provide more detail on the study, including QA/QC.

<u>Progress Measurement:</u> Success of this program will be measured by successful completion of the study as described above. The results of the study may in the future be used to drive future control technology research activities.

5.1.4 Characterize Mercury Emissions from Coal Combustion

MP volunteered to be a host site for a study assessing the fate of mercury in Lake Superior. The study did not receive full funding, however, portions of the study were conducted in 2000 and included characterizing the flue gas mercury speciation and the capture efficiency of existing control devices. The study was conducted on Boswell units 2, 3 and 4 in May. The results from the testing indicate that mercury emission rates are lower for all units tested than they were in 1993/1994. The final report has been submitted to the MPCA, and includes a detailed discussion on QA/QC.

<u>Progress Measurement:</u> Success of this program is measured by successful completion of the study as described above. The results of the study will be useful in refining the emission inventory. The results are also relevant to assessing control technology options, due to the inclusion of speciated mercury analyses.

5.2 Program Elements Related to Mercury in Products

Efforts that MP will undertake over the next year to address mercury in products are summarized below.

5.2.1 Product Use Inventory Update

In 1994, MP conducted an inventory of products that we use which contain mercury. Beginning in the latter half of 2000, MP will update that inventory starting with our two largest facilities, Boswell Energy Center and Laskin Energy Center. The inventory will be updated by a walk-through of the facility to identify items that contain mercury.

Information gathered through the inventory will be useful in developing an effective program for further phase-out of mercury-containing products. Mercury-containing products will be categorized based on the relative potential that mercury releases will occur from those products. A decision on whether to phase out a specific item and the timing of phase-out will be based on several criteria, such as the potential for actual release, the availability of reasonable mercury-free alternatives, and the cost.

Progress Measurement: Success of this program will be measured by successful completion of the product inventory as described above. The results of the inventory will be useful in developing a phase-out program of products that have a higher potential of mercury release. The inventory may also be useful for revising the MPCA mercury emission inventory for products.

5.2.2 Label Mercury-Containing Devices

One of the strategies included in the Advisory Council recommendations is to label mercury-containing devices currently in use. MP will label devices that contain mercury where feasible, to promote proper handling and disposal. The labeling will occur at the same time that the inventory is being developed. In addition to the labeling, employee awareness training will include training on the purpose of the labels, and how items that are removed are to be recycled.

Progress Measurement: Success of this program will be measured by successful completion of the product labeling as described above, as well as employee training (also see 5.2.3).

5.2.3 Update MP Purchase Policy for Mercury Products

As previously described, MP has a purchase policy where items containing mercury can not be purchased if suitable substitutes exist. Since the policy was put in place, purchasing practices at MP have been modified. In order to ensure that the policy is still effective, it will be reviewed and modified. Training will be conducted for employees on the revised purchase policy.

Progress Measurement: Successful review and modification of the purchase policy and development of a training module will measure success of this program for employees. Training will be conducted as part of the routine employee environmental training.

5.2.4 Evaluate the Purchase of Low Mercury Fluorescent Bulbs

MP will evaluate implementing a purchase policy that states that only low mercury fluorescent bulbs may be purchased. MP already purchases low mercury fluorescent bulbs at some locations within the company. Preliminary results indicate that the low mercury bulbs may have a shorter life span. An assessment will be conducted to determine if this is true. Based on the results of this analysis, a decision will be made on whether to initiate a company-wide policy to purchase only low mercury fluorescent bulbs, or to discontinue purchase of the low mercury bulbs.

Progress Measurement: Success of this program will be measured by completion of a review of the life span of low mercury fluorescent bulbs, and implementation of a company-wide fluorescent bulb purchase policy.

5.2.5 Support Customer Mercury Waste Management

MP will hold meeting(s) with relevant entities in portions of our service territory to determine whether there are gaps in the infrastructure for mercury-containing product waste management. MP will then evaluate the cost effectiveness of filling those gaps. At a minimum, MP will use the communication devices available to us (e.g., billing stuffers) to inform the public on the proper use and management of mercury-containing products. MP is currently working with the taconite companies on a joint effort in this area.

Progress Measurement: Success of this program will be measured by successful completion of a review of the needs within portions of our service territory. Based on this initial review, a plan may be developed to fill some of those needs. Also, based on the success of this program it may be expanded to other areas within our service territory.

5.2.6 Employee Mercury Thermometer Exchange

MP is evaluating a thermometer exchange program for our employees, where mercury-free thermometers are provided free of charge to those employees that bring in their mercury thermometers.

Progress Measurement: If the program moves forward, success will be measured by counting the number of thermometers exchanged and multiplying by the amount of mercury in the thermometers that is successfully recycled.

5.3 Supporting Relevant Research and Inventory Activities

Summarized below are activities that MP has committed to that will not directly result in mercury reductions. However, these activities will enhance the understanding of human health risks associated with mercury in Minnesota.

5.3.1 Co-Sponsor Fish Consumption Study

MP will support research activities relevant to the state mercury issue by co-sponsoring a fish consumption survey to be conducted by the EERC.

5.3.2 Fish Tissue Monitoring

As previously noted, MP has voluntarily conducted fish tissue monitoring over the past several years on the headwater reservoirs of the St. Louis River watershed. MP will continue to conduct the monitoring and provide the data to the Minnesota Department of Natural Resources.

6.0 Timeline for Implementation of Voluntary Agreement Components

The timeline for implementation of the Voluntary Agreement components described above is summarized in Table I. This timeline only goes out to the first quarter of 2001. During 2000, the overall program may undergo revisions based on what we learn. A formal review of the various program components will be conducted in early 2001. Based on that review, the Voluntary Agreement may be revised. Those programs that have not proven to be effective will be modified or discontinued. New program ideas will be evaluated and, if they make sense, they will be considered for addition to the program. Once this program review and modification is complete, a revised Voluntary Agreement will be submitted to the MPCA, with an implementation schedule for 2001 and beyond. At the same time, MP will submit a progress report to the MPCA that summarizes the findings to date, including estimates of mercury reductions achieved, if applicable to the specific program component. It is anticipated that the progress report would be submitted by April 1, 2001.

Table I. Timeline for Mercury Voluntary Agreement Implementation, Year 2000

Program ID	1st Qtr 2000	2nd Qtr 2000	3rd Qtr 2000	4th Qtr 2000	1st Qtr 2001
Increase utilization of lower mercury coal	*	*	*	*	*
Routine coal mercury monitoring	*	*	*	*	*
Control technology research [1]			*		
Characterize mercury emissions from coal		*			
Product use inventory update[2]				*	
Label mercury-containing devices [2]				*	
Update MP purchase policy for mercury products				*	
Evaluate purchase low mercury fluorescent bulbs				*	
Support customer mercury waste management [3]				*	
Employee mercury thermometer exchange				*	
Co-sponsor fish consumption study					*
Fish tissue monitoring			*		
Evaluate, revise Voluntary Agreement					*

[1] testing to be completed, final report expected early 2001
[2] Boswell and Laskin Energy Centers only, other MP facility inventories and labeling in 2001
[3] program development finalized, implement in 2001

National Steel Pellet Company

PO Box 217
Keewatin MN 55753-0217
(218) 778-8700 Phone
(218) 778-6112 Fax

August 1, 2000

Bob McCarron
Minnesota Pollution Control Agency
520 Lafayette Road N
St. Paul, MN 55155-4194

Dear Mr. McCarron,

Please find enclosed National Steel Pellet Company's (NSPC) revised Voluntary Mercury Reduction Agreement. NSPC has revised the agreement to include more specific details of our program as per your request in a memo dated June 30, 2000. The agreement will be updated as necessary.

If you have any questions or comments, feel free to call me at (218) 778-8672.

Sincerely,

LaTisha R. Gietzen

LaTisha R. Gietzen
Environmental Manager

c: John Wachtler

National Steel Pellet Company
Draft Voluntary Mercury Reduction Agreement

1.0 Introduction

National Steel Pellet Company (NSPC) supports the Minnesota Mercury Contamination Reduction Initiative and with this report, will submit our plans and goals of mercury reduction to the Minnesota Pollution Control Agency (MPCA). As new information becomes available, this document and its contents will be modified to fit changing circumstances, if needed. Upon successful completion of this agreement, NSPC hopes to decrease our mercury uses by a considerable amount. Precise reduction amounts are not available at this time, but will be estimated/calculated in the near future. Further study is needed to achieve accurate values. At this time, a major facility inventory is in progress to determine the amount of mercury onsite and how it is used. After this study, NSPC will be in a better position to estimate/calculate reduction amounts.

1.1 Facility Description

National Steel Pellet Company is a taconite mining and processing facility located on the Mesabi Iron Range one mile north of Keewatin, Minnesota. NSPC is a wholly owned subsidiary of National Steel Corporation of Mishawaka, Indiana. Creating iron ore pellets from low-grade taconite requires a lengthy process of mining, crushing, separating, concentrating, and pelletizing. Once the pellets are formed, they are shipped to our customers in Illinois and Michigan.

2.0 Previous and Ongoing Mercury Reduction Activities of NSPC

NSPC continues to actively investigate mercury reduction opportunities. Listed below are previous activities that were conducted to provide information on mercury levels.

- A mercury mass balance was conducted at NSPC during August of 1999.

- NSPC has a mercury waste-recycling program currently in place. Mercury containing batteries, switches, lab wastes, fluorescent bulbs, and other mercury-containing devices are being recycled at a licensed recycling facility.

- NSPC in 1999 made changes in the chemical lab procedures and no longer uses mercuric acid for any lab assay work.

3.0 Mercury Emission Reductions from Product Use Changes

- NSPC has, and will continue, to take an active roll in recycling mercury. During the period from 1994 to 1999 NSPC has sent to recyclers approximately 9,877 pounds of mercury containing lamps. In addition during 1999, NSPC set up a recycling program and sent for recycling approximately 4.25 pounds of mercury containing devices such as thermometers, switches, and batteries.

- NSPC has in 2000 removed mercury from two (out of service) Merrick scales on site. The mercury removed from the two scales and a scale maintenance kit resulted in approximately 50 pounds of bulk mercury removed. NSPC plans to replace the remaining two Merrick scales with non-mercury containing Ramsey scales.

4.0 Proposed Voluntary Agreement Activities

NSPC will work on the following activities as part of the voluntary mercury reduction agreement. In addition NSPC will also continue to evaluate other options.

4.1 Product Related Activities

- Conduct an inventory of mercury containing products. NSPC will use this information in developing a program to phase out or replace mercury-containing products. Once the inventory is complete the products will be categorized by their associated risk, which will take into account the likelihood of a mercury release from such products. A determination will then be made on whether to phase out a specific item. The specific timing for phasing out a particular device will be based on the availability of mercury free alternatives, the risk of release and the cost.

  Progress Indicators: Success of this portion of the program will be identified by the completion of the product inventory.

- NSPC will label mercury-containing devices, where feasible. NSPC will develop a process for labeling devices that contain mercury; this will promote proper handling and disposal of the devices.

  Progress Indicators: Success of this portion of the program will be identified by the completion of the labeling of the mercury containing products.

- NSPC will communicate with employees the proper use and management of mercury containing products. This will be accomplished through annual environmental awareness training. NSPC will also provide mercury containing product information, to its (approximately) 550 employees, on facilities that manage mercury wastes. NSPC will do this by providing dates, times and locations for existing programs to its employees.

- NSPC, along with the Iron Mining Associations (IMA), is currently evaluating several potential community mercury programs. The IMA has been having meetings with Western Lake Superior Sanitary District (WLSSD) and the local counties to identify additional needs or gaps in the existing community programs. The group is also examining the needs that schools, hospitals, and nursing homes may have in dealing with mercury issues. Once the analysis is complete and a decision is made, NSPC will update this agreement.

4.2 Research Related Activities

The following are three research projects that NSPC is co-sponsoring along with the Department of Natural Resources, Hibbing Taconite Company, US Steel Mintac, Eveleth Taconite, Ispat Inland Taconite and North Shore Taconite.

4.2.1 Preparation of Certified Mercury Standards from Taconite

The result of this project will be the preparation of three taconite standards certified for total mercury. The accuracy of mercury balances performed at Minnesota taconite facilities is dependent on the accuracy of mercury analysis obtained from contract analytical laboratories. There currently are no Minnesota taconite ores that are certified for total mercury.

4.2.2. Mercury Removal from Induration Off Gas by Wet Scrubbers

The amount of mercury removed by the wet scrubbers will be quantified. An investigation will be performed to determine if mercury-removal efficiency is related to scrubber water chemistry and or the dust chemistry.

4.2.3. Mercury Volatilization Associated with Taconite Tailings

The estimation of mercury volatilization to the atmosphere from taconite tailings, tailings ponds, coarse and fine tailings, and tailings that have been amended to promote plant growth. The quantification will be at a screening level, rather than a determination of exact rates.

5.0 Schedule of Voluntary Agreement Development and Implementation

Throughout the life of this agreement the program will very likely undergo changes. NSPC plans on submitting progress reports annually to report on agreement activities and any modifications to the agreement. NSPC will conduct an annual review and produce a report to be submitted to the MPCA on or about April 30. The following is an approximate timeline for the implementation of the above agreement program components.

Program Component	Implementation Date
Mercury Removal From Scales	December 31, 2001
Inventory Mercury Containing Devices	September 30, 2000
Identify Risk of Devices	December 31, 2000
Device Phase Out Determinations	June 30, 2001
Label Mercury Containing Devices	August 30, 2001
Employee Training (Annual)	November 30, 2000
Research Activities	December 31, 2001
Progress Report	April 30, 2001

JSS/John Wachtler

Tim

MPCA, POLICY & PLANNING
-2 1999
OPERATIONS & PLANNING SECTI

North Star Steel Minnesota

P.O. BOX 64189, 1678 RED ROCK ROAD SAINT PAUL, MINNESOTA 55164

July 29, 1999

To David Thornton
Majors Section, P+

Mr. Tim Scherkenbach
Division Manager
Policy and Planning Division
Minnesota Pollution Control Agency
20 Lafayette Rd. N
St. Paul, MN 55155-4194

Re: Voluntary Mercury Reduction Agreement Program

Dear Mr. Scherkenbach,

North Star Steel supports voluntary environmental programs that feature flexible means of achieving environmental goals. Accordingly, we have chosen to take part in your voluntary reduction agreement program. We are aware of your minimum participation standards and we are beginning to prepare our proposal. We anticipate utilizing a mercury mass balance to identify opportunities for mercury reductions. To expedite our work we would appreciate the opportunity to review other proposals for similar ideas. Please contact Judd Ebersviller, our Regional Environmental Manager (651-731-5697), at your earliest convenience to set up a meeting with you or your staff in order that we can get our proposal completed as soon as possible.

Sincerely,

Bob Jakse

Bob Jakse
Vice President and General Manager

PHONE 731-5600, AREA CODE 612

North Star Steel Minnesota

P.O. BOX 64189, 1678 RED ROCK ROAD SAINT PAUL, MINNESOTA 55164

August 26, 1999

Mr. Tim Scherkenbach
Division Manager
Policy and Planning Division
Minnesota Pollution Control Agency
20 Lafayette Rd. N
St. Paul, MN 55155-4194

Re: Voluntary Mercury Reduction Agreement Program

Dear Mr. Scherkenbach,

Enclosed is our proposal to prepare a mercury mass balance for our facility using a two-phase approach. We will need prompt review of portions of the plan since we have scheduled stacktesting for the week of October 4. We estimate being able to provide a summary of our phase 1 efforts by the end of November. The schedule and nature of subsequent work will depend on the outcome of the phase 1 work.

Sincerely,

Judd Ebersviller

Judd Ebersviller
Regional Environmental Manager

cc: John Wachtler

PHONE 731-5600, AREA CODE 612

North Star Steel Minnesota
Facility Mercury Mass Balance
Work Plan

1 Introduction

This work plan is the first step in North Star Steel's (NSS) participation in the Minnesota Mercury Reduction Initiative (MMRI). NSS committed to participating in the voluntary reduction agreement program in July 1999 (Attachment 1). In a letter to Judd Ebersviller (Attachment 2), Tad Schindler (MPCA) recommended that NSS complete a comprehensive mass balance of mercury entering and leaving the North Star Steel site and listed data appropriate for the mass balance (see Data Collection section). NSS proposes a tiered approach to developing a mercury mass balance for the St. Paul facility as part its participation in the MMRI. The work plan is being submitted to the MPCA to clarify, and to agree upon, this tiered approach.

The overall objective of the mercury mass balance study is to develop a clear understanding of the potential major inputs and outputs of mercury at the NSS St. Paul facility. For the mercury reduction initiative, it will also be useful to understand the primary sources and sinks of mercury and mercury-containing equipment within the facility. The mercury mass balance will be developed with these objectives in mind.

2 Methodology

2.1 Mass Balance Model Approach

NSS plans to prepare the mercury mass balance as a spreadsheet-flow diagram that will clearly show the interconnections among the inputs and outputs of mercury at the facility. An MS Excel97 spreadsheet will include the flow diagram of the NSS operations, along with material flows, mercury concentrations, and mercury mass loads. A tiered approach is proposed, involving two phases:

- In Phase I of the mercury mass balance preparation, the mass balance will be created as a spreadsheet model based on a flow diagram of the facility operations and existing mercury data. NSS has collected mercury samples from North Star Lake and ground water, and will be collecting stack test data on mercury emissions in October that can be used in the model development. Additional published data will be used as appropriate.

- In Phase II, NSS will evaluate what additional mercury data collection is necessary to provide additional information about potential opportunities for mercury reduction. Before proceeding with Phase II, NSS will discuss the data needs with MPCA staff.

2.2 Data Collection

In the letter from Tad Schindler to Judd Ebersviller (June 1, 1999), the following data was listed relevant to better understanding of the movement of mercury at the site:

a) Mercury quantities in raw materials brought into NSS each year
b) Mercury removed from raw materials prior to recycling each year
c) Mercury emissions (concentration and lb/year) from shredder (measured by stack test)
d) Mercury concentrations and quantities per year in shredder byproducts (fluff and nonferrous metals) (measured, if possible)
e) Mercury emissions (concentration and lb/year) from electric arc furnace (measured by stack test)
f) Mercury concentrations and quantities in furnace products and byproducts (measurements; may be near zero)
g) Mercury concentrations and quantities in flue dust produced per year (measurement)
h) Mercury concentrations in ground water and quantity of ground water discharged to North Star Lake (measurement)
i) Mercury concentrations in storm water and the quantity of storm water discharged to North Star Lake (measurements).

In Phase I, known mercury quantities in raw materials, emission, ground water, and storm water will be included in the spreadsheet-flow diagram to help assess the above-referenced elements.

2.3 Data Sources

Primary data will be the inputs that are collected by NSS. These data include surface and ground water analyses. Secondary data will be literature values from either scientific journals, government publications, vendors or other unpublished data that we can support.

2.4 Data Quality

Available mercury concentration data in secondary sources will be evaluated for its quality by determining the methods of sampling and analysis used to acquire the data. Only data obtained in the last 15 years will be considered for the mass balance. Prior to 1985, there was a poor understanding of the need for clean techniques for low level metals analysis. The method detection limits will be considered and analyses that have high MDLs compared to present low-level methods, will not be used in the mass balance. The number of samples also will be considered, although single values will be used, if necessary, as long as the quality of the data is acceptable.

2.5 Data Gaps

Where data gaps exist in the mass balance, they will be noted for consideration in Phase II of the mercury mass balance.

2.6 Testing Protocol

When mercury sampling and analysis is needed, NSS will rely on laboratories that use the most up-to-date analytical methods, such as cold-vapor atomic fluorescence, Method 1631 (for water), and Method 29 (for air). Samples will be collected using appropriate clean techniques.

2.7 Data Analysis

The anticipated data analysis involves the scrutiny of data quality and the calculations of mass loads. No statistical analyses are warranted at this time; however, NSS will consider the uncertainty of various data and data sources, and if necessary, present ranges of values where there is a high level of uncertainty in the concentration or mass.

3 Mass Balance Components

As noted above, the MPCA has recommended data appropriate for determining the inputs and outputs of mercury to the NSS facility. NSS has identified the following list of site-specific components that will be considered in the development of the mass balance:

- Acids/bases
- Additives/Alloys (FeMn, FeSi, FeCr, Pet Coke, Coal, Vanadium, Nickel, Lime, Electrodes, Foamy slag)
- Ambient Air
- Appliance switches
- Argon
- Automobiles
- EAF Baghouse Emissions
- Blowdown/cooling tower
- City water
- Contact Cooling Water
- Corrosion Chemicals
- Finished Steel (billets)
- Flue dust
- Frag
- Fuel Oil
- Hydrogen Peroxide
- Knockout box material
- Lubricant Oils/grease

- Mill Scale
- Natural gas
- Non-ferrous stream of shredder
- Oxygen
- Shredder Emissions
- Shredder fluff
- Slag
- Storm Water
- Sump water (blowdown 1-2 x per year)
- Water Source
- Water Treatment Chemicals

4 Deliverables

The mass balance will be presented in a report that describes the data sources, data evaluation, and assumptions that were used to derive the mass balance. The spreadsheet-flow diagram will be footnoted with the computations and assumptions used in the calculations. An electronic version of the spreadsheet-flow diagram will be provided along with the report.

5 Schedule

NSS expects to complete the first draft of the Phase I mercury mass balance by December, 1999. The draft will be submitted to the MPCA for comments. The final draft is expected to be completed 60 days after all comments have been received from the MPCA. The schedule for Phase II will depend on the amount of data that must be collected, but it is anticipated that the completed mercury mass balance will be submitted by February 2000. The proposed schedule for Phase II will be included in the final draft of the Phase I report.

Northern States Power Company

Patti Leaf
414 Nicollet Mall
Mpls, MN 55401

612.330.7630

May 17, 2000

Mr. Tim Scherkenbach
Minnesota Pollution Control Agency
520 Lafayette Road
St Paul, MN 55155

Dear Mr. Scherkenbach,

Northern States Power is pleased to submit its Voluntary Mercury Reduction Plan to the Minnesota Pollution Control Agency. Please contact me at 612.330.7630 with any questions you may have.

Sincerely,

Patricia B Leaf

Patricia B. Leaf
Sr Environmental Analyst

cc: John Wachtler, MPCA

Northern States Power's
Voluntary Mercury Reduction Plan

May 8, 2000

What NSP Intends to Do

1. Product Inventory and Phase Out

NSP is in the process of updating the Generating Plant, Service Center and Building mercury product surveys conducted in 1998 and obtaining mercury inventories for the Minnesota generating plants and other sites which did not previously complete a survey. NSP's goal is to ensure that all inventories accurately list all devices on site, which contain mercury, with accurate estimates of the amount of mercury per device.

As part of the 2000 inventories, NSP will also classify each type of mercury containing device according to the risk of environmental release by assigning one of three risk levels. The risk level will be determined by field personnel who are familiar with the equipment and are defined as follows:

- High Risk – Mercury containing device, which is moved frequently and may release Hg if dropped or bumped.
- Medium Risk – Mercury containing device, which is moved infrequently but may release Hg if dropped or bumped.
- Low Risk – Mercury containing device which is stationary and will not release Hg under any foreseeable circumstance.

In addition, the cost to remove mercury containing devices and replace with non-mercury containing equipment is being estimated. This includes determining the cost differential if any plus associated labor costs. Other issues, such as availability and reliability of non-mercury devices, are being taken into consideration. NSP will share the completed product inventory information with the Minnesota Pollution Control Agency. NSP will use the inventory information obtained on risk level and the cost to replace mercury containing devices to develop a mercury phase-out plan, which will emphasize replacement of high risk equipment as a priority.

During 2000, NSP will begin labeling the mercury containing devices that were identified in the inventories with small mercury labels. This will raise awareness that mercury is present in devices helping to ensure that the equipment is handled appropriately and disposed of properly.

NSP generating plants, service centers and office buildings have been phasing out products that contain mercury for many years. NSP's Facilities Department has been installing non-mercury thermostats in NSP offices and service centers since May 1996. NSP generating plants have removed devices that contain high levels of mercury, including flow and level meters that contained up to 14 pounds of mercury per meter. The NSP High Bridge Plant pursued the removal of mercury containing equipment in the 1980's, with the quantity shipped for recycling in 1990 and prior totaling 5,700 pounds. Both the Allen S. King Plant and the Riverside Plant have made the decision to purchase only non-mercury equipment for their sites. Riverside made this decision five years ago and the Allen S. King Plant, as part of its mercury reduction efforts, shipped 183 pounds between 1991 and 1997. All removed mercury containing devices were shipped to the NSP Chestnut Hazardous Waste Storage Facility where they were placed in bulk containers and shipped off-site for recycling of the mercury. The amount of mercury shipped from NSP sites and recycled from 1990 and before, and from 1991 through 1997, is contained in Appendix A along with fluorescent and HID lamp recycling data for 1995 through 1999 and NSP's mercury containing device inventory data from 1998 and 1999.

2. Emissions Sampling
NSP intends to conduct mercury emissions sampling on most, if not all, of its Minnesota coal-fired boilers in 2000 and 2001. It is anticipated that sampling for speciated mercury at the inlet and outlet will be conducted with the Ontario Hydro method. This information will be used to assess earlier results of tests conducted in the early 90's and for estimating NSP's Hg emissions as well as to help guide research efforts.

3. Electric Power Research Institute Funding
NSP will continue its support of the Electric Power Research Institute's (EPRI) programs aimed at understanding mercury in the environment and control of mercury from coal-fired boilers in the year 2000. EPRI is an electric utility research organization funded by electric utilities. EPRI has an extensive research program and has been a leader in the development of potential mercury control technologies for many years.

4. Energy and Environmental Research Center Funding
NSP will continue its support of the Energy and Environmental Research Center's (EERC) Center for Air Toxic Metals (CATM) program for the year 2000. The CATM was established in 1992 at the EERC at the University of North Dakota. CATM is a partnership among government, industry, and academia that conducts research on the behavior of air toxic metals to develop methods for prevention and control of air toxic metal emissions from the combustion of fossil fuels. Ongoing research at CATM focuses on understanding mercury transformation mechanisms of air toxic metals to determine the effectiveness of control devices and to identify new control technologies, and to inform the public of research findings. NSP has been a member of CATM since its inception, with continuing contributions of $25,000 per year. CATM has an annual operating budget of more than $1,400,000 per year, so NSP's contribution is highly leveraged for state-of-the-art air toxic metals research. NSP intends to continue its membership in this organization as a mean to advance the scientific understanding of mercury releases from coal-fired facilities and their potential control.

5. Ash Study
NSP will participate in a collaborative project with EPRI entitled "Potential for the Release of Contaminants to the Environment from Field-Scale Use of Cementitious Fly Ash for Soil Stabilization." This is directly related to measuring the level of Hg in runoff and percolation.

6. Control Technology Research

NSP intends to partner with the EPRI to research mercury control technologies on one or two NSP boilers. This research is expected to be conducted in the 2000/2001 time frame.

7. Sherco Units 1 and 2 Study

NSP intends to conduct mercury sampling on Sherco units 1 and 2 in 2001, to determine if increasing the SO_2 removal rate has any impact on the removal of mercury across the wet scrubbers. This will not be done if one of the boilers chosen in item 6 is Sherco units 1 or 2 or if it is determined to be unlikely to provide additional reduction of mercury.

8. Coal Sampling and Analysis

NSP will continue to collect and analyze coal samples for mercury on a monthly basis in 2000.

9. Repowering

NSP has committed to "repower" Black Dog units 1 and 2 with natural gas combined – cycle technology with a maximum capacity of 275 mW's. The repowered units are expected to be in operation in mid-2002. Relying on new natural gas generation for this additional capacity should offset mercury emissions within the region. These units have the potential to offset 35 pounds mercury annually assuming they offset generation from the NSP system.

10. Conversion to Natural Gas Studies

NSP has committed to evaluate the feasibility of converting High Bridge units 3 and 4 and Riverside units 7 and 8 to natural gas. These studies will be conducted no later than July 1, 2001.

11. Fluorescent Lamps

NSP is currently determining the feasibility of reducing the amount of mercury purchased in lamps by changing to low mercury fluorescent lamps. The issue being researched is whether the service life of low mercury lamps is comparable to regular fluorescent lamps. If the change-out frequency is significantly higher, there may be more risk of environmental release with low mercury lamps since they would be handled much more frequently and there would be, therefore, an increased potential for breakage. All fluorescent lamps are currently being recycled and breakage represents the main route of potential environmental release from this product.

12. General Employee Hazardous Waste Training

NSP conducts General Employee Hazardous Waste Training on an annual basis for all employees who receive employee Right-to-Know training. More than 1,500 employees receive this training annually. During this training in 2000, employees are being informed about NSP's voluntary mercury reduction efforts, the health and environmental hazards of mercury and how they can help prevent mercury from entering the environment. This training emphasizes that each and every employee can play an important role by using careful work practices, properly disposing of mercury containing devices and immediately reporting all mercury spills.

13. Thermostat Pilot
In summer 2000, NSP's Electric Marketing will run a test pilot to research a load management program to evaluate the functionality of remotely controlled setback thermostats. If the research pilot proves successful, NSP may evaluate the feasibility of replacing existing residential thermostats with the new thermostats. If the program is implemented, it will promote proper disposal of household waste containing mercury and may decrease energy consumption.

14. Fluorescent Light Bulb Rebates
Since 1995, NSP has provided a program to assist small business and residential customers with fluorescent lamp recycling. NSP pays for mercury recovery costs at county collection centers located in NSP's service territory. As well, coupons are issued annually in the newspaper, which allow customers to recycle up to 10 bulbs at participating hardware stores for fifty cents off the price charged by the store.

NSP will increase its commitment to these programs by increasing the amount spent on recycling efforts by $60,000 in 2000 to support program awareness. Coupons will be issued bi-annually and advertising campaigns may be used to increase customer awareness of the program. NSP will contact those counties, in NSP's service territory, that are not currently participating in the program to reassess their program participation.

Since 1995, the recycling program has recycled more than 560,000 lamps, recovering approximately 30 pounds of mercury.

15. Information Dissemination
NSP will develop various mechanisms to help inform our customers about mercury and what they can do. Selected NSP customer communications vehicles will focus on mercury and identify mercury containing products typically in use in a residential home along with detailing alternatives and proper disposal techniques. NSP will also incorporate information about mercury on its website.

16. *Hg Sniffing dog*
NSP hopes to partner with the MPCA to fund the purchase of a dog specially trained to detect mercury. The dog will be used to detect mercury mainly in sink traps at industrial and institutional sites. A dog employed in Sweden and brought to 20 university locations has located 10 tons of mercury in sinks, cupboards and unused instruments.

17. *NSP-Gas: Evaluation of Town Border Stations*
NSP Gas, in conjunction with Northern Natural Gas and Viking Gas, will investigate the use of equipment that may have contained mercury at its Town Border Stations.

What NSP Has Done

1. Inventories

1998 Release Inventory

A multi-media inventory of mercury releases for 1998 is contained in Appendix B.

1998 Product Inventory Data

On March 2, 1998, NSP provided a mercury inventory of products, mercury waste shipments and fluorescent / HID lamp recycling information to Mr. Ed Swain at the Minnesota Pollution Control Agency. The inventory included information on the number of mercury containing devices found at eight NSP generating plants and NSP service centers and office buildings. This also included data on the amount of mercury per device and the total quantity of mercury at each of the generating sites and at the NSP service centers and offices buildings as a group. However, because some of the devices were in operation and / or difficult to access, this information represented estimates in both the number of devices and the amount of mercury per device. Mercury waste shipment information was also provided for these same facilities for both 1990 and before, and 1991 to 1997. Fluorescent / HID lamp recycling information was provided for all NSP facilities which shipped lamps in 1995 through 1999. This data has been included in this document as Appendix A. Also included in Appendix A is mercury waste shipment information for 1998 and 1999.

2. Coal Consumption

NSP uses low sulfur coals from Montana and Wyoming which have relatively low mercury concentrations, 0.05 ppm Hg, dry basis (weighted average for the 1999 NSP system) compared to other U.S. coals. In fact, the coals NSP consumes are among the lowest 23% of all coal mercury contents listed in the EPA 's national database for the 1999 Mercury Information Collection Request based on data through third quarter, 1999. NSP's annual coal consumption is about 12 million tons (9 million tons, dry basis), corresponding to about 935 lb/year mercury If NSP were to use "average" (median) U.S. coal, the amount of mercury would be over 70 percent higher. Because NSP's coal mercury contents are already so low, it does not appear that any significant opportunity exists to further reduce mercury by coal switching.

3. NSP Gas

NSP Gas has taken a proactive approach towards mercury and actively removed mercury containing equipment from use because of the risks to human health and the environment. Knowing that equipment used in the metering of gas has the possibility of containing mercury, NSP has done a preliminary investigation of its gas operations to determine what types of equipment have contained mercury in the past and whether any equipment is currently in use that could contain mercury. Several of these devices and results of preliminary investigations are discussed below.

Regulators

NSP's preliminary investigation of the use of regulators in its system has determined that there are no regulators that contain mercury in use at this time. It is estimated that internal weight-style regulators, those that can contain mercury, were removed from the system and replaced with non-mercury alternatives in the 1960's and 1970's. These regulators were confined to district regulator stations and town border stations and were only used in above ground applications, not in vault applications due to the possibility of mercury mixing with water. Information from our preliminary investigation indicates that mercury containing regulators were not used in residential or small commercial settings.

Manometers

Manometers are used extensively in the gas industry to test pressure and, until the early 1990's, the traditional mercury containing "U" shaped tube was used by NSP Gas. In 1990 and 1991 the decision was made to replace these devices with non-mercury spring gauge manometers. Extensive research was conducted to identify reliable alternatives for both low pressure and high pressure manometers and establish transportation and calibration methods which would assure the accuracy of these instruments. By 1996, the conversion was nearly complete and all of the removed mercury containing devices had been carefully shipped to the NSP Chestnut Hazardous Waste Storage Facility where they were placed in bulk containers and shipped off-site to a mercury recycling facility.

Orifice Meters

Preliminary investigations of the use of orifice meters in the NSP system has identified that, at one time, orifice meters containing mercury had been used. Orifice meters determine and use the difference in mercury levels across the orifice plate to calculate gas consumption. NSP's investigation thus far indicates that there are no orifice meters containing mercury still in use in the NSP Gas system.

Customer-Owned Residential Devices

K&B Service provides service to NSP's customers who subscribe to NSP's Advantage Service Program. They remove from service approximately 5-10 mercury containing thermostats per week. JR Recycling disposes of the mercury waste for K&B Service.

K&B also provides service to NSP customers for flame sensors and regulators (flow controllers). These devices, encountered by K&B, generally do not contain mercury.

Current Practices

1. Procurement Review

In 1995, NSP established a Hazardous Materials Procurement Control Program, which requires that NSP's Safety and Environmental Departments evaluate products prior to purchase. As part of this program, a list of "Targeted Ingredients" was developed. These are ingredients that have been targeted for elimination from company use because of health or environmental concerns. Mercury is a targeted ingredient. Products containing targeted ingredients will be disapproved for purchase or allowed to be purchased on a restricted base only if a less hazardous alternative is not available. Product evaluations are done using the manufacturer's Material Safety Data Sheet (MSDS) so, if a product contains less than 1.0% mercury it may not be identified and eliminated through this process. NSP's new Chemical Management Program, which is described below, will be designed to remove these contaminants from the products we purchase and use.

Chemical Management

In 1999, the Chemical Management Team obtained approval from NSP officers to move forward with a Chemical Management program. Implementation of the program will begin in 2000. This program will standardize the chemical products being used at NSP, providing greater control and tracking. As part of this program, NSP will evaluate products as indicated above. As well, NSP will be going one step further and asking suppliers and manufacturers to provide NSP with information on products which contain mercury at levels which are below the MSDS reportable threshold of 1%.

Sodium Hydroxide (Caustic) and Sulfuric Acid

One example of where NSP has already reduced environmental mercury by reducing the amount of mercury inadvertently purchased as a contaminant, is through its bulk chemicals contract. NSP uses large volumes of sodium hydroxide and sulfuric acid to process the water, used to create steam in our generating facilities. By adding contract language which limits the amount of mercury allowed in sodium hydroxide to 5 ppb and the amount allowed in sulfuric acid to 100 ppb, mercury releases to the environment have been reduced.

2. Demand Side Management/ Conservation Improvement Program

Since 1985, NSP's Conservation Improvement Program (CIP) has saved 11,500 GWh's of energy at a cost of $294 million. These efforts have avoided emission releases of approximately 380 pounds of mercury.

NSP has filed its 2000 CIP plan with the Minnesota Department of Commerce outlining measures that will save more than 191,000 MWh's of energy with a budget of $33 million. The plan has been filed but has not been officially approved. If fully implemented the plan could avoid an approximate additional 6 pounds of mercury from being released.

3. *Advantage Service*

NSP Gas offers a service program that provides maintenance and equipment to the consumer. NSP Gas Advantage Service deals primarily with water heaters, furnaces, air conditioners, and humidifiers. Advantage service repairs and/or replaces this equipment when needed; much of the equipment does not contain mercury, but those that do, are disposed of using a recycling company.

NSP Wisconsin

Northern States Power Company-Wisconsin (NSPW) has implemented efforts similar to those of NSP-Minnesota to reduce the amount of mercury it uses in its operations or that is released to the environment. These efforts fall into two broad categories: removal and replacement of mercury containing equipment and air emission reductions. Both are summarized below.

1. Removal and Replacement of Mercury Containing Equipment
Since 1996 over 700 pounds of Hg have been removed from NSPW generating plants. Equipment containing mercury has been replaced with non-mercury containing devices. NSPW is currently updating its inventory of mercury containing equipment at its generating plants and service centers. Voluntary phase-out of mercury containing equipment will continue consistent with the overall NSP system Voluntary Mercury Reduction Plan.

2. Mercury Emission Reductions
NSPW's solid fuel fired generating plants rely primarily on the use of alternate fuels, principally biomass (e.g. wood waste and shredded railroad ties), as their dominant fuel source. Wood waste and shredded railroad ties contain very low amounts of mercury. Though coal is used only at NSPW's Bay Front plant, the amounts consumed are small in comparison to alternate fuels and the coal that is burned (low sulfur coal from Wyoming) has relatively low concentrations of mercury. Use of alternate fuels at French Island and Bay Front has resulted in a sustained 30% reduction in mercury emissions. The recent conversion of Bay Front boilers 1 and 2 to supplemental natural gas firing will further reduce mercury emissions further.

3. Additional Actions
In addition to the efforts described above, NSPW also financially supports research on the environmental impacts of mercury deposition in Wisconsin. These efforts were initially focused on quantifying the impact of atmospheric constituents, including mercury, on Wisconsin's lake resources. Over the last several years these studies have been re-directed towards assessing the ecological risk of mercury exposure on the Common Loon. This species is particularly susceptible to impacts from mercury uptake in the environment. This cutting edge research has been jointly funded by the Wisconsin Department of Natural Resources, the Electric Power Research Institute and the Wisconsin Utilities Association, including NSPW.

In the future, NSPW plans to adopt those elements of the NSP Voluntary Mercury Reduction Plan that are cost effective and logistically possible in Wisconsin. These elements include, but are not limited to:

1) Review and evaluation of mercury speciation stack test results conducted at Bay Front in cooperation with the Wisconsin Department of Natural Resources and Frontier

GeoScience in October 1995 as well as additional speciation testing conducted by Mastardi Platt under the direction of EPA in 1999

2) Supporting research on reliable, cost-effective mercury emission control technology

3) Use of company approved procurement and chemical management procedures to minimize or eliminate use of mercury in products used by NSPW

4) Fuel switching when cost effective, and

5) Implementation of customer outreach programs to enhance recycling of mercury, potentially including thermostat replacement and fluorescent light bulb rebate initiatives.

NSPW also participates in the Wisconsin Department of Natural Resources sponsored mercury stakeholder group. NSPW supports the creation of a Wisconsin Mercury Advisory Council charged with developing a comprehensive strategy to achieve realistic mercury reduction goals through voluntary efforts. Subgroups within this Council would represent the general public, the paper industry, health care, dental, electrical manufacturing, chemical manufacturing, transportation, government, utilities, environmental groups and other stakeholders. Effective use of this Council could result in recommendations for voluntary actions which, when implemented, would substantially reduce the amount of mercury in the environment.

NRG

In October 1999, NRG began participating in a pilot program initiated by the Minnesota Pollution Control Agency (MPCA) and the Office of Environmental Assistance (OEA) to heighten consumer awareness of mercury in the household waste stream. The program allows consumers to take their mercury thermometers to County Household Hazardous Waste Facilities (HHWF) across the state and exchange them for digital electronic models. NRG is promoting the program and supplying 1,500 thermometers to HHWF's in the 11 counties serve by NRG Resource Recovery. NRG will evaluate the success of the program over the next several months.

NRG's participation in the thermometer exchange is an initial effort in a broader campaign to heighten consumer awareness of all hazardous wastes that may become part of the waste stream. The program, which uses the slogan "Every Waste Has Its Place", will continue public education efforts designed to reduce the amount of mercury and other hazardous materials in the municipal solid waste received by its resource recovery facilities. Key to this initiative will be continued collaboration with the county HHWF's, the MPCA and the OEA.

1995	Avg lamp- 25 mg Hg. 99% recovery		
		Lamp	Recovered
	No. lamps	lbs Hg	lbs Hg
A.S.King	750	0.04125	0.0408375
Black Dog	691	0.038005	0.037625
Brooklyn SC	137	0.007535	0.0074597
Chestnut	2117	0.116435	0.1152707
EauClaire	1621	0.089155	0.0882635
Edina SC	81	0.004455	0.0044105
Fargo SC	122	0.00671	0.0066429
Faribault SC		0	0
General Office	5263	0.289465	0.2865704
High Bridge	160	0.0088	0.008712
Inver Hills	52	0.00286	0.0028314
Mankato SC	17	0.000935	0.0009257
Minot SC	74	0.00407	0.0040293
Monticello	795	0.043725	0.0432878
PI	3850	0.21175	0.2096325
Red Wing SC	60	0.0033	0.003267
Red Wing	64	0.00352	0.0034848
Ren Square	351	0.019305	0.019112
Riverside	464	0.02552	0.0252648
Sherco	3805	0.209275	0.2071823
Shorewood SC	171	0.009405	0.009311
Sioux Falls SC	95	0.005225	0.0051728
Special Cons	225	0.012375	0.0122513
St. Cloud SC	286	0.01573	0.0155727
St. Paul SC	1509	0.082995	0.0821651
Substations	2553	0.140415	0.1390109
Wescott	14	0.00077	0.0007623
Winona SC	373	0.020515	0.0203099
TOTAL	25700	1.4135	1.399365
MN Total	23415	**1.287825**	**1.2749468**

1996		Lamp	Recovered
	No. Lamps	lbs Hg	lbs Hg
A.S.King	874	0.04807	0.0475893
Black Dog	471	0.025905	0.02564595
Blue Lake	28	0.00154	0.0015246
Brainerd SC	1559	0.085745	0.08488755
Brooklyn SC	295	0.016225	0.01606275
Chestnut	3013	0.165715	0.16405785
EauClaire	3499	0.192445	0.19052055
Edina SC	250	0.01375	0.0136125
Fargo SC	620	0.0341	0.033759
Faribault SC	639	0.035145	0.03479355
General Office	4110	0.22605	0.2237895
Grand Forks SC	696	0.03828	0.0378972
High Bridge	313	0.017215	0.01704285
Inver Hills	32	0.00176	0.0017424
Mankato SC	275	0.015125	0.01497375
Maple Grove	788	0.04334	0.0429066
Minot SC	127	0.006985	0.00691515
Montevideo SC	34	0.00187	0.0018513
Monticello	2361	0.129855	0.12855645
Newport SC	660	0.0363	0.035937
Pathfinder	90	0.00495	0.0049005
PI	3885	0.213675	0.21153825
Red Wing SC	0	0	0
Red Wing	0	0	0
Ren Square	420	0.0231	0.022869
Riverside	1542	0.08481	0.0839619
Sherco	5618	0.30899	0.3059001
Shorewood SC	426	0.02343	0.0231957
Sioux Falls SC	259	0.014245	0.01410255
Special Const.	8	0.00044	0.0004356
St. Cloud SC	355	0.019525	0.01932975
St. Paul SC	2789	0.153395	0.15186105
Substations	34	0.00187	0.0018513
Wescott	123	0.006765	0.00669735
White Bear Lake	210	0.01155	0.0114345
Wilmarth	228	0.01254	0.0124146
Winona SC	0	0	0
Total	36631	2.014705	1.99455795
MN Total	31340	**1.7237**	**1.706463**

1997		Lamp	Recovered
	No. lamps	lbs Hg	lbs Hg
A.S.King	1170	0.06435	0.0637065
Black Dog	625	0.034375	0.0340313
Blue Lake	0	0	0
Brainerd SC	360	0.0198	0.019602
Brooklyn SC	0	0	0
Chestnut	911	0.050105	0.049604
EauClaire	2454	0.13497	0.1336203
Edina SC	374	0.02057	0.0203643
Fargo SC	0	0	0
Faribault SC	339	0.018645	0.0184586
General Office	4106	0.22583	0.2235717
Grand Forks SC	291	0.016005	0.015845
High Bridge	225	0.012375	0.0122513
Inver Hills	68	0.00374	0.0037026
Mankato SC	220	0.0121	0.011979
Maple Grove	257	0.014135	0.0139937
Minot SC	30	0.00165	0.0016335
Montevideo SC	220	0.0121	0.011979
Monticello	1639	0.090145	0.0892436
Newport SC	144	0.00792	0.0078408
Pathfinder	0	0	0
PI	3348	0.18414	0.1822986
Red Wing SC	230	0.01265	0.0125235
Red Wing	0	0	0
Ren Square	503	0.027665	0.0273884
Riverside	625	0.034375	0.0340313
Sherco	4402	0.24211	0.2396889
Shorewood SC	0	0	0
Sioux Falls SC	388	0.02134	0.0211266
Special Const.	0	0	0
St. Cloud SC	277	0.015235	0.0150827
St. Paul SC	744	0.04092	0.0405108
Substations	25	0.001375	0.0013613
Wescott	135	0.007425	0.0073508
White Bear Lake	0	0	0
Wilmarth	200	0.011	0.01089
Winona SC	402	0.02211	0.0218889
otal	24712	1.35916	1.3455684
IN Total	21147	**1.163085**	**1.1514542**

Appendix A

1990 & BEFORE			1991 - 1997		
FACILITY	**WASTE**	**LBS SHIPPED**	**FACILITY**	**WASTE**	**LBS SHIPPED**
Black Dog			**Black Dog**	Flow Indicators	140
				Liquid Mercury	56
Allen S. King	Switches	20	**Allen S. King**	Liquid Mercury	112
	Mercury Contam Solids	15		Mercury Contam Solid	40
				Switches	6
				Batteries	25
Monticello			**Monticello**	Liquid Mercury	20
				Batteries	5
High Bridge	I&C Controls	4500	**High Bridge**	Mercury Batteries	135
	Liquid Mercury	800		Mercury Solids/Wastes	345
	Mercury Solids/Wastes	400			
Riverside	Meters/devices	285	**Riverside**	Liquid Mercury	232
				Meters/Switches	246
Srvc Cntrs/			**Srvc Cntrs/**	Liquid Mercury	62
Office Bldgs			**Office Bldgs**	Switches/solids	274
Prairie Island			**Prairie Island**	Mercury Compounds	4
				Batteries	500
Sherco	Coal Feeder/Shaker	2309	**Sherco**	Switches/devices	20
	Switches/devices	7			
	Mercury Solids	40			
Red Wing			**Red Wing**	Switches/solids	97
NSP TOTAL		8376	NSP TOTAL		2319

Appendix A

199[illegible] Mercury Inventory

FACILITY	INSTRUMENT TYPE	NO. ON SITE	LBS. OF HG/INSTRMNT	TOTAL HG (POUNDS)
Black Dog	BFP Flow Meter	3	14	42
	DEA Level	2	13	26
	Gas Flow Meter	2	13	26
	Steam Flow Meter	1	10	10
	Mill Level	2	4	8
	Exhaust Trip	4	4	16
	Condenser Vacuum	2	1	2
	Barometer	1	1	1
	Compensated Air Flow	**2**	**0.5**	**1**
	Uncompensated Air Flow	2	0.5	1
	Mercoid/Magnatrol Switches	75	0.31	23.25
			Black Dog Total =	**156.25**
Allen S. King	Magnetrol Level Switches	70	0.31	21.7
	Barometer	1	7.1	7.1
	Transmitter	1	3.6	3.6
	Thermometers	5	0.02	0.1
	Thermostats	5	0.16	0.8
			Allen S. King Total =	**33.3**
Monticello	Manometer	3	5	15
	Barometer	1	5	5
	Thermometer	16	0.12	1.92
	Turbine Bearing Thermometer	8	0.25	2
	Mercury Switches	96	0.25	24
	Mercury Level Assemblies	80	0.25	20
	Wetted Contact Relay	50	1	50
	Small Relay Boards	60	0.02	1.2
	Misc. Thermometers	16	0.12	1.92
	Vial of Mercury	1	1	1
			Monticello Total =	**122.04**
High Bridge	Mercury Switches	53	0.015	0.795
	Mercoid Controls	5	0.0125	0.0625
	Barometer	1	1	1
	Vial of Mercury	15	6	90
			High Bridge Total =	**91.8575**
Riverside	Mercoid Devices	17	0.07	1.19
	Thermometers	15	0.01	0.15
	Mercoid Devices	53	0.06	3.18
	Mercury Relay	1	0.4	0.4
			Riverside Total =	**4.92**
Srvc Cntrs/				
Office Bldgs	Thermostats	30	0.015	0.45
	Control Switches	4	0.03	0.12
			SCs and Bldgs Total =	0.57

Appendix A

1998 Mercury Inventory

FACILITY	INSTRUMENT TYPE	NO. ON SITE	LBS. OF HG/INSTRMNT	TOTAL HG (POUNDS)
Sherco	Potted Mercury Relays	3218	0.007	22.526
	Potted Mercury Relays	5566	0.0132	73.4712
	Mercoid Press/Temp Switches	362	0.037	13.394
	Magnetrol Level Switches	344	0.074	25.456
	Meriam Pressure Guage/Barom	16	3	48
	Sprinkler System Check Valves	24	0.147	3.528
	TD Relays	14	0.099	1.386
	Durakool Relays	142	0.33	46.86
	Misc Thermometers	75	0.007	0.525
	Merc items in stock			7.82
			Sherco Total =	**242.9662**
Minn Valley	Bailey Flow/Level Meters	9	14	126
	Mercoid Pressure Switches	30	0.08	2.4
	Manometers	3	1.6	4.8
	Manometers	1	3	3
	Vial of Mercury	1	5	5
			Minn Valley Total =	**141.2**
Blue Lake	Switches	169	0.25	42.25
	Thermometers	18	0.007	0.126
	Barometer	1	3	3
			Blue Lake Total =	**45.376**

1998 NSP Mercury Totals Received and Processed by the HWSF

	# of >4' lamps	pounds Hg	# of < or = 4' lamps	pounds Hg	# of HID	pounds Hg	# of U-shaped	pounds Hg	# of Compact	pounds Hg	lbs of Broken	Mercury, Metallic, lbs	Mercury Solids, lbs	Button Batteries, lbs
MN Facilities														
Black Dog	320	0.0176	442	0.024	201	0.01		0		0.000			23	
Chestnut Area	21	0.001155	204	0.011	10,257	0.56		0		0.000				
Chestnut S.C.	210	0 01155	2553	0.140	6,953	0.38		0		0.000				1
Edina S.C.		0		0.000	603	0.03		0		0.000				
Elk River RDF		0	30	0.002		0		0		0.000	53			
Faribault S.C.		0		0.000	494	0.03		0		0.000				
General Office		0	1,733	0.095		0	16	0	55	0.003				
High Bridge		0	608	0.033	29	0	18	0	4	0.000			92	
Inver Hills		0	50	0.003	27	0		0		0.000		5		
King		0	840	0.046		0		0		0.000				
Mankato		0	76	0.004	1,644	0.09		0		0.000				
Maple Grove	51	0.002805	356	0.020	2,513	0.14		0	87	0.005				
Montevideo S.C.		0	80	0.004	161	0.01		0		0.000				
Monticello NGP	14	0.00077	1,770	0.097	33	0	14	0		0.000				
Newport Area		0	8	0.000		0		0		0.000				
Newport S.C.	65	0.003575	135	0.007	3,721	0.2		0		0.000				
Newport RDF	30	0.00165	123	0.007	23	0		0		0.000				
Prairie Island		0	3,994	0.220	53	0	120	0.01	11	0.001	114	10	22	
Red Wing S.C.	15	0.000825	60	0.003		0		0		0.000				
Rice Street S.C.	185	0.010175	1,372	0.075	2,167	0.12	35	0		0.000	4		17	
Riverside		0	540	0.030	78	0		0		0.000				
Sherco	205	0 011275	4,712	0.259	811	0.04	58	0		0.000	311			
Shorewood		0		0.000	2,161	0.12		0		0.000				
St Cloud S.C.		0	234	0.013	1,260	0.07		0		0.000				
Viking Gas	18	0.00099	132	0.007	55	0		0		0.000				
White Bear S.C.	'12	0.00066	38	0.002	234	0.01		0		0.000				
Winona S.C.		0		0.000	906	0.05		0		0.000				
Totals	**1146**	**0.06303**	**20090**	**1.105**	**34384**	**1.89**	**261**	**0.01**	**157**	**0.00864**	**482**	**15**	**154**	**1**
ND Facilities														
Fargo S.C.	60	0.0033	141	0.0078	2,172	0.12								
Grand Forks S.C.		0		0		0								1
Minot S.C.		0	54	0.003	240	0.01								
Totals	**60**	**0.0033**	**195**	**0.0107**	**2412**	**0.13**	**0**				**0**	**0**	**0**	**1**
SD Facilities														
Sioux Falls S.C.			112	0.0062	178	0.01								
Totals	**0**		**112**	**0.0062**	**178**	**0.01**	**0**		**0**		**0**	**0**	**0**	**0**
WI Facilities (all)	41	0.002255	2,152	0.1184	4,830	0.27	22	0						
Totals	**41**	**0.002255**	**2152**	**0.1184**	**4830**	**0.27**	**22**		**0**		**0**	**0**	**0**	**0**
NSP Overall Totals	**1247**	**0.069**	**22549**	**1.2402**	**41804**	**2.3**	**283**	**0.01**	**157**	**0.00864**	**482**	**15**	**154**	**2**

based on conservative lamp average of 25 mg Per Brian Golob

Appendix A

1999 Mercury Totals
Processed
by the HWSF

State	Facility	Waste Type	Quantity	known lbs Hg
Minnesota				
	Allen S. King Generating Plant			
		# of Fluorescent, <4ft	1360	0.0748
		# of High Intensity Discharge	100	0.0055
	Black Dog Generating Plant			
		# of Fluorescent, <4ft	625	0.034375
		# of Fluorescent, >4ft	40	0.0022
		Mercury Contaminated Solids, lbs	163	
		Mercury Filled Equipment, lbs	166	
		Mercury, Metallic, lbs	48	48
	Brainerd Gas			
		# of Fluorescent, <4ft	750	0.04125
		# of Fluorescent, >4ft	620	0.0341
	Centre Pointe			
		Broken, lbs of lamps	46	
		# of Fluorescent, <4ft	122	0.00671
	Chestnut Area			
		# of Fluorescent, <4ft	194	0.01067
		# of Fluorescent, >4ft	22	0.00121
		# of High Intensity Discharge	7461	0.410355
	Chestnut Service Center			
		# of Fluorescent, <4ft	1422	0.07821
		# of Fluorescent, >4ft	280	0.0154
		# of High Intensity Discharge	7200	0.396
		Mercury, Metallic, lbs	1	1
	Edina Service Center			
		# of Fluorescent, <4ft	237	0.013035
		# of Fluorescent, >4ft	75	0.004125
		# of High Intensity Discharge	2562	0.14091
	Faribault Service Center			
		# of Fluorescent, <4ft	210	0.01155
		# of Fluorescent, >4ft	150	0.00825
		# of High Intensity Discharge	1650	0.09075
	General Office Building			
		# of Compact Fluorescent	170	0.00935
		# of Fluorescent, <4ft	5940	0.3267
		# of Fluorescent, >4ft	57	0.003135
		# of U-Shaped	27	0.001485
	Grand Forks Area			
		# of High Intensity Discharge	504	0.02772
	High Bridge Generating Plant			
		# of Fluorescent, <4ft	442	0.02431

Appendix A

1999 Mercury Totals Processed by the HWSF

State	Facility	Waste Type	Quantity	known lbs Hg
		# of High Intensity Discharge	48	0.00264
		Mercury Contaminated Solids, lbs	23	
		Mercury, Metallic, lbs	10	10
	Inver Hills Generating Plant			
		# of Fluorescent, <4ft	149	0.008195
	Mankato Service Center			
		# of Fluorescent, <4ft	223	0.012265
		# of Fluorescent, >4ft	26	0.00143
		# of High Intensity Discharge	1291	0.071005
	Maple Grove Area			
		# of High Intensity Discharge	330	0.01815
	Maple Grove Materials Complex			
		Broken, lbs of lamps	31	
		# of Compact Fluorescent	5	0.000275
		# of Fluorescent, <4ft	362	0.01991
		# of Fluorescent, >4ft	168	0.00924
		# of High Intensity Discharge	3115	0.171325
	Montevideo Service Center			
		# of Fluorescent, >4ft	62	0.00341
		# of High Intensity Discharge	963	0.052965
	Monticello Generating Plant			
		# of Compact Fluorescent	112	0.00616
		# of Fluorescent, <4ft	1953	0.107415
		# of Fluorescent, >4ft	105	0.005775
		# of U-Shaped	35	0.001925
	Newport Service Center			
		# of Fluorescent, <4ft	210	0.01155
		# of Fluorescent, >4ft	65	0.003575
		# of High Intensity Discharge	3090	0.16995
	Prairie Island Nuclear Generating Plant			
		Broken, lbs of lamps	68	
		# of Compact Fluorescent	41	0.002255
		# of Fluorescent, <4ft	4226	0.23243
		# of High Intensity Discharge	177	0.009735
		# of U-Shaped	138	0.00759
	Red Wing Service Center			
		# of Fluorescent, <4ft	25	0.001375
		# of Fluorescent, >4ft	70	0.00385
		# of High Intensity Discharge	492	0.02706
	Renaissance Square			
		# of Fluorescent, <4ft	1379	0.075845
	Rice Street Service Center			

Appendix A

1999 Mercury Totals
Processed
by the HWSF

State	Facility	Waste Type	Quantity	known lbs Hg
		# of Fluorescent, <4ft	2214	0.12177
		# of Fluorescent, >4ft	168	0.00924
		# of High Intensity Discharge	200	0.011
		# of U-Shaped	67	0.003685
	Riverside Generating Plant			
		# of Fluorescent, <4ft	1090	0.05995
		# of High Intensity Discharge	150	0.00825
	Sherburne County Generating Plant			
		Broken, lbs of lamps	117	
		# of Fluorescent, <4ft	6660	0.3663
		# of Fluorescent, >4ft	630	0.03465
		# of High Intensity Discharge	970	0.05335
		# of U-Shaped	81	0.004455
	Shorewood Service Center			
		# of Compact Fluorescent	11	0.000605
		# of Fluorescent, <4ft	360	0.0198
		# of Fluorescent, >4ft	75	0.004125
		# of High Intensity Discharge	726	0.03993
		# of U-Shaped	12	0.00066
	St. Cloud Service Center			
		# of Fluorescent, <4ft	110	0.00605
		# of Fluorescent, >4ft	64	0.00352
		# of High Intensity Discharge	2030	0.11165
	Viking Gas - Cushing			
		# of Fluorescent, <4ft	22	0.00121
	Viking Gas - Milaca			
		# of Fluorescent, <4ft	20	0.0011
	White Bear Lake Service Center			
		# of Fluorescent, <4ft	259	0.014245
		# of Fluorescent, >4ft	28	0.00154
		# of High Intensity Discharge	1995	0.109725
	Wilmarth Generating Plant			
		# of Fluorescent, <4ft	36	0.00198
		# of Fluorescent, >4ft	77	0.004235
	Winona Service Center			
		# of Fluorescent, <4ft	274	0.01507
		# of High Intensity Discharge	933	0.051315
North Dakota				
	Fargo Service Center			
		# of High Intensity Discharge	2064	0.11352
	Grand Forks Service Center			
		# of Fluorescent, <4ft	420	0.0231

Appendix A

1999 Mercury Totals Processed by the HWSF

State	Facility	Waste Type	Quantity	known lbs Hg
		# of Fluorescent, >4ft	30	0.00165
		# of High Intensity Discharge	496	0.02728
		Mercury, Metallic, lbs	20	20
	Minot Service Center			
		# of Fluorescent, <4ft	30	0.00165
		# of High Intensity Discharge	994	0.05467
South Dakota				
	Angus Anson/Pathfinder Generating Plant			
		# of Fluorescent, <4ft	30	0.00165
	Sioux Falls Service Center			
		# of Fluorescent, <4ft	187	0.010285
		# of High Intensity Discharge	865	0.047575
Wisconsin				
	Abbotsford District Office			
		# of High Intensity Discharge	668	0.03674
	Amery Service Center			
		# of Fluorescent, <4ft	137	0.007535
		# of High Intensity Discharge	364	0.02002
	Ashland District Office			
		# of High Intensity Discharge	570	0.03135
	Bayfront Steam Plant			
		# of Fluorescent, <4ft	70	0.00385
		Mercury Filled Equipment, lbs	150	
	Blair District Office			
		# of High Intensity Discharge	105	0.005775
	Chippewa Falls Hydro Plant			
		# of High Intensity Discharge	231	0.012705
	Chippewa Falls Service Center			
		# of Fluorescent, <4ft	66	0.00363
		# of High Intensity Discharge	135	0.007425
	Durand Service Center			
		# of High Intensity Discharge	360	0.0198
	Eau Claire Black Avenue			
		# of Fluorescent, <4ft	144	0.00792
		# of Fluorescent, >4ft	33	0.001815
	Eau Claire Melby Center			
		# of Fluorescent, >4ft	45	0.002475
	Eau Claire Railroad Building			
		# of Fluorescent, <4ft	416	0.02288
	Eau Claire Service Center			
		# of High Intensity Discharge	1671	0.091905

Appendix A

1999 Mercury Totals Processed by the HWSF

State	Facility	Waste Type	Quantity	known lbs Hg
	Eau Claire Skypark Building	# of High Intensity Discharge		
		# of Fluorescent, <4ft	1928	0.10604
		# of Fluorescent, >4ft	174	0.00957
		# of High Intensity Discharge	4	0.00022
	Hayward Service Center			
		# of Fluorescent, <4ft	28	0.00154
		# of High Intensity Discharge	101	0.005555
	Hudson Service Center			
		# of High Intensity Discharge	477	0.026235
		# of U-Shaped	2	0.00011
	LaCrosse Service Center			
		# of High Intensity Discharge	1488	0.08184
	Menomonie Service Center			
		# of Fluorescent, <4ft	16	0.00088
		# of High Intensity Discharge	1236	0.06798
	Sparta District Office			
		# of Fluorescent, <4ft	32	0.00176
		# of High Intensity Discharge	502	0.02761
	Total Quantified Hg			**83.75536**

Average lamp content 25 mg per Brian Golob

Appendix B

NSP' s 1998 Multi-Media Mercury Inventory

A S King			Best Estimate	Alternate Estimate
	Quantity	Hg Concentration	lbs Hg/yr	lbs Hg/yr
Coal	1,437,831 tons	.038ppm, dry[a]	109[a]	
Air		1.827 e-6 #/MBtu[c]	33.8 [b]	48.5[c]
Ash Landfilled	40,680 tons	0.75 ppm[d]	76[d]	
Ash/slag Utilized	37,055 tons	0.03 ppm[d]	3[d]	
Total Inputs			109	
Total Releases			112.8	127.5
Leachate	645,640 gallons	0.0008 ppm[d]	0.004[d]	
Ash Discharge Water		< 0.0001 ppm[j]	0	

Black Dog			Best Estimate	Alternate Estimate
	Quantity	Hg Concentration	lbs Hg/yr	lbs Hg/yr
Coal		0.032 ppm, dry[a]		
unit 1	1,779 tons		0.11[a]	
unit 2	6,568 tons		0.42[a]	
unit 3	311,304 tons		19.9[a]	
unit 4	613,703 tons		39.3[a]	
Air				
unit 1		3.097 e-6 #/MBtu[c]	0.025 [b]	0.75[c]
unit 2		2.6 e-6 #/Mbtu[c]	0.33 [b]	0.39[c]
unit 3		3.097 e-6 #/MBtu[c]	4.6 [b]	17.4[c]
unit 4		3.097 e-6 #/MBtu[c]	9.0 [b]	32.9[c]
Ash Landfilled	12,304 tons	fly ash: 0.10 ppm[d]	7 [d]	
Ash Utilized	24,295 tons	bottom ash: 0.3 ppm[d]	34[d]	
Total Inputs			59.73	
Total Releases			54.96	92.44
Leachate				
Ash Discharge Water		< 0.0001 ppm[j]	0	

High Bridge			Best Estimate	Alternate Estimate
	Quantity	Hg Concentration	lbs Hg/yr	lbs Hg/yr
Coal		.036 ppm, dry[a]		
unit 3/4	169,514 tons		12.2[a]	
unit 5	342,083 tons		24.6[a]	
unit 6	589,570 tons		42.4[a]	
Air				
unit 3/4		3.923 e-6 #/MBtu[c]	11.9[c]	12.2 [b]
unit 5		3.923 e-6 #/MBtu[c]	23.8[c]	24.6 [b]
unit 6		3.923 e-6 #/MBtu[c]	40.8[c]	42.4 [b]
Ash Landfilled	10,475 tons	fly ash: 0.09 ppm[d]	2[d]	
Ash Utilized	29,764 tons	bottom ash: 0.03 ppm[d]	19[d]	
Total Inputs			79.2	
Total Releases			97.5	100.2
Leachate		N/A		
Ash Discharge Water	32,231,803 gallons[k]	0.0004 ppm[l]	0.1	

Mn Valley			Best Estimate	Alternate Estimate
	Quantity	Hg Concentration	lbs Hg/yr	lbs Hg/yr
Coal	3,657	0.116 ppm, dry[a]	0.8[a]	
Air		3.923 e-6 #/Mbtu[f]	0.8 [i]	0.32[f]
Leachate				
Ash Discharge Water		< 0.0002 ppm[j]	0	

Red Wing			Best Estimate	Alternate Estimate
	Quantity	Hg Concentration	lbs Hg/yr	lbs Hg/yr
Inlet	206,723 tons	0.44 ppm[g]	181.9[g]	
Air		0.021 #/hr[c]	325.9[c]	
Ash Landfilled	57,315 tons	2.53 ppm[d]	235[d]	
Ash Utilized				
Total Inputs			181.9	
Total Releases			560.9	
Leachate	1,644,000 gallons	0.0005 ppm[d]	0.007[d]	
Ash Discharge Water		N/A		

Riverside			Best Estimate	Alternate Estimate
	Quantity	Hg Concentration	lbs Hg/yr	lbs Hg/yr
Coal				
unit 6/7	646,968 tons	0.041 ppm, dry[a]	53[a]	
unit 8	844,527 tons	0.043 ppm, dry[a]	72.6[a]	
Air				
unit 6/7		4.867e-6 #/MBtu[c]	55.0[c]	53 [b]
unit 8		3.087e-6 #/MBtu[c]	47.9[c]	72.6 [b]
Ash Landfilled				
unit 6/7	8,402 tons	bottom ash: 0.03 ppm[d] fly ash: 0.22 ppm[d]		
unit 8	18,428 tons	bottom ash: 0.03 ppm[d] fly ash: 0.74 ppm[d]		
Ash Utilized				
unit 6/7	17,417 tons	bottom ash: 0.03 ppm[d] fly ash: 0.22 ppm[d]		
unit 8	20,157 tons	bottom ash: 0.03 ppm[d] fly ash: 0.74 ppm[d]		
Ash Landfilled or Utilized			10[d]	
Total Inputs			125.6	
Total Releases			112.9	135.6
Leachate		N/A		
Ash Discharge Water		< 0.0005 ppm[j]	0	

Sherco			Best Estimate	Alternate Estimate
	Quantity	Hg Concentration	lbs Hg/yr	lbs Hg/yr
Coal				
unit 1	2,290,633	0.035 ppm, dry[a]	160.3[a]	
unit 2	2,696,518	0.035 ppm, dry[a]	188.75[a]	
unit 3-NSP	2,120,396	0.038 ppm, dry[a]	161.15[a]	
unit 3-SMMPA	1,383,778	0.038 ppm, dry[a]	105.17[a]	
Lime S3 Blr Hrs	8,181.46 hours	.00056 #/hour [h]	4.6[h]	
Air				
unit 1		3.923e-6 #/MBtu[c]	157.2[c]	64.1 [b]
unit 2		3.923e-6 #/MBtu[c]	185.3[c]	75.5 [b]
unit 3-NSP		5.107e-6 #/MBtu[c]	191.1[c]	88.6 [b]
unit 3-SMMPA		5.107e-6 #/MBtu[c]	123.7 [c]	57.8 [b]
Ash Landfilled				
unit 1 and 2	389,876 tons	bottom ash: 0.03 ppm[d] fly ash: 0.08 ppm[d]	112[d]	
unit 3	312,902 tons	bottom ash: 0.02 ppm[d] fly ash: 0.07 ppm[d]	42[d]	
Ash Utilized				
unit 1 and 2	0			
unit 3	12,504 tons	bottom ash: 0.02 ppm[d] fly ash: 0.07 ppm[d]	2[d]	
Total Inputs			619.97	
Total Releases			813.3	442.0
Leachate		N/A		
Cooling Tower Blowdown Water	849,400,000 gallons	0.0004 mg/l[e]	2.84	

Wilmarth			Best Estimate	Alternate Estimate
	Quantity	Hg Concentration	lbs Hg/yr	lbs Hg/yr
Inlet	204,103 tons	0.40 ppm[g]	163[g]	
Air		.000015 #/MBtu[c]	36[c]	
Ash Landfilled				
Ash Utilized	59,934 tons	3.81 ppm[d]	339[d]	
Total Inputs				
Total Releases				
Leachate	1,762,710 gallons	0.0009 ppm[d]	0.12[d]	
Ash Discharge Water		N/A		

a) ICR Fuel Analysis, 1999
b) based on a) and removal rates as determined by stack tests
c) Stack Test Emission Rate
d) based on ash or leachate analysis
e) based on an average of three samples
f) Based on High Bridge Stack Test Emission Rate
g) Fuel Analysis, 1998
h) Lime analysis
i) based on a) and f)
j) based on priority pollutant monitoring
k) Process water directed to sanitary sewer in 1998 under MCES permit #0576
l) Based on an average of MCES permit monitoring results 1Q ‘98- 3Q ’99.

N/A- Not Applicable

NORTHSHORE MINING

Northshore Mining Company
A Subsidiary of Cliffs Minnesota Minerals Company

28 March 2000

Mr. John Wachtler
Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, MN 55155-4194

Subject: Voluntary Mercury Reduction Agreement for Northshore Mining Mining Company

Dear Mr. Wachtler:

Northshore Mining is pleased to submit the enclosed Draft Voluntary Mercury Reduction Agreement. Most of the efforts listed are already in progress. Community education and outreach efforts will be expanded this summer.

I regret that I will be unable to attend the April meeting when these plans will be presented. I hope the meeting goes well and produces confidence that Minnesota will be able to reach its reduction goals through plans such as these. Please feel free to contact me if you have any comments or questions.

Sincerely,

NR Smith

Nancy R. Smith
Environmental Engineer

10 Outer Drive · Silver Bay, MN 55614-1499 · 218-226-4125 · Fax 218-226-6096

Northshore Mining Company
A Subsidiary of Cliffs Minnesota Minerals Company

Robert C. Berglund
Vice President/General Manager

Voluntary Agreement for Mercury Reduction Efforts **8/3/2000**
Northshore Mining Company **Approved**

Introduction

Northshore Mining Company has an active mercury reduction program that began under its previous ownership, Cyprus Northshore Mining, and that has improved since then. Northshore Mining supports the goals of the Minnesota Mercury Reduction Initiative and hereby submits its voluntary mercury reduction agreement, which is a formalization of completed work as well as works in progress.

Elements of Northshore Mining's Voluntary Reduction Agreement

Research

Northshore funded an extensive mercury mass balance study which analyzed all raw materials, plant water flows, plant water discharges, coal ash and stack discharges for trace levels of mercury. As a result of this mass balance, it was determined that the maximum potential mercury emissions to the air due to production of taconite pellets and power generation (combined) is 9.5 lbs/year, or 10.6 lbs/year at maximum production under a proposed Direct Reduced Iron project. Further information about specific releases and collection efficiencies is available in the full report. Most of the potential mercury emissions from this plant are contained in the Milepost 7 Tailings Basin. Water discharges from the basin have mercury levels lower than those of the receiving stream, and information to date indicates that the mercury levels are below the stringent levels required under the Great Lakes Initiative.

Community Education and Outreach

Northshore is working with Lake County to publicize current collection programs available as well as to make them more effective. At present this approach involves two strategies: increasing publicity regarding devices and products which might contain mercury and their proper handling as wastes; and making it easy for local citizens to dispose of those materials correctly. An estimated 400 fluorescent lamps are collected for recycling every year in Silver Bay and the surrounding communities. Although there is no information available concerning the exact number of bulbs which fail every year, the number seems low and a casual inspection of unauthorized dumping areas shows that at least some bulbs are not being recycled. Northshore proposes to accept, for free, fluorescent lamps from citizens and send them out for recycling. In order to help local businesses, Northshore proposes to assist their recycling efforts by providing a collection and storage area for waste lamps. Each business will pay the cost of recycling but not of storage or shipping.

Northshore also proposes to work with Lake County in a publicity campaign to promote awareness of mercury around the home and in appliances which might be scrapped. The publicity campaign and collection efforts will target not only mercury-containing devices such as thermometers and tilt switches, but also chemicals such as old medicines and fungicides. If assistance is needed farther north, the efforts can be extended into Cook County.

Accounting for the actual reduction in mercury releases to the environment for the above two steps will be difficult because there is no real information on current releases due to improper disposal. However, records will be kept of the materials collected and shipped for recycling, and the approximate amount of mercury collected as a result. It should be noted that community collection and education efforts are expected to evolve and improve with time and experience, but may be dropped if they prove ineffective.

Process Changes

Northshore Mining changed its laboratory method of assaying ore and pellets for iron in 1994 from a method which used mercuric oxide and which generated 15 – 20 pounds of mercury compound wastes per year, to one which does not use mercury. This has eliminated the cycling of 15 – 20 pounds of mercury compounds per year through the warehouse and laboratory, and eliminated a possible contamination source.

Instrumentation Changes

Since 1990 Northshore has collected and shipped out for recycling over 900 pounds of elemental mercury used to run instruments such as manometers. Some of that mercury was in use in instruments which have been replaced. Some of that mercury was stocked to replace mercury lost to spillage or equipment breakage. By removing 900 pounds of mercury from service and committing to using alternate instrumentation wherever possible, Northshore has eliminated the possibility of releasing that mercury to the environment.

Northshore personnel are now alert to the possibility of mercury devices in active equipment, and Northshore has a policy of removing mercury switches, relays and other closed devices and sending them for recycling as the equipment can be replaced. Roughly 5 pounds of such devices are removed from service and recycled every year. Assuming that one-half the mass of the devices is due to mercury, that translates to 2.5 pounds mercury removed safely from the plant every year. The practice of searching for mercury devices in equipment before scrapping it began in 1992. Consequently a small but unquantifiable amount of mercury was released to the environment before then. An example of such savings and releases comes from the belt scales of Northshore's Concentrator. The Concentrator has 22 sections, of which roughly half are active. In February 2000 an Instrument Shop technician realized that the old conveyor belt scales, which are no longer used, contained mercury switches. The technician collected 81 mercury switches from the belt scales still on the property. Each switch ampoule weighs 11.6 grams. Although it contains glass, wiring and a plug, a significant amount of mass of the assembly is the mercury contained within. A conservative assumption would be that half the mass of the ampoule is due to mercury. Therefore, the collection project removed at least 470 grams (1 pound) of mercury and prevented its release to the atmosphere. Unfortunately, half the scales had been shipped out for scrap in the early 1990's, before plant personnel had begun collecting mercury switches. Roughly a pound of elemental mercury must have been released to the air when those scales were scrapped.

Northshore Mining began collecting fluorescent lamps in 1992 for recycling; prior to that time lamps were routinely thrown in the trash as they were throughout the state. Based on records of lamp shipments to recycling facilities, an estimated 0.3 lbs/year of mercury was released to the environment each year prior to the beginning of recycling efforts. That amount of mercury is now prevented each year from being released to the environment, due to recycling efforts.

Relamping and Energy Savings

Northshore Mining is currently replacing 230 mercury vapor lamps at its mine in Babbitt with high-pressure sodium lamps and the appropriate fixtures. Depending on wattage, the lamps contain $^{1}/_{7}$ to ¼ the amount of mercury of the mercury vapor lamps they are replacing, and represent 28.7 grams (0.06 pounds) less mercury cycling through the plant. In addition, they are more efficient. Minnesota Power, which provides power to the Babbitt operations, estimates energy savings from this relamping operation of 907,000 kwH/year, with a mercury reduction due to power generation of 0.05 lb/year.

Accounting Methods

The mercury collection methods that are viable for Northshore Mining will not lend themselves easily to the percentage reduction method of accounting desired for the statewide mercury emissions inventory, because in most cases the previous emissions will be impossible to estimate accurately. However, Northshore Mining is a small mercury source, with emissions well under the 50 lbs/year limit established for the first round of voluntary reduction agreements to be solicited. It would take Northshore over 90 years of running at maximum production to emit the amount of mercury from its stacks that it has already removed from circulation and eventual release at the plant. Northshore has also already contributed significantly to the body of knowledge regarding mercury release and fate from its facility. Northshore agrees to report, on an annual basis, the amount of mercury collected and recycled in the form of lamps and devices collected both at the plant and from the surrounding communities.

Sincerely,

Robert C. Berglund
General Manager

215 South Cascade Street
PO Box 496
Fergus Falls, Minnesota 56538-0496
218 739-8200
www.otpco.com (web site)

June 28, 2000

OTTER TAIL
Power Company

Mr. Timothy K. Scherkenbach
Division Director
Minnesota Pollution Control Agency
Policy & Planning Division
520 Lafayette Road North
St. Paul, MN 55155-4194

Dear Mr. Scherkenbach:

Subject: OTTER TAIL POWER COMPANY
VOLUNTARY MERCURY REDUCTION INITIATIVE

Enclosed is Otter Tail Power Company's proposed Voluntary Mercury Reduction Initiative. In addition to the items presented in the Voluntary Mercury Reduction Initiative, Otter Tail Power Company has participated in a number of historical mercury reduction activities.

- In 1989, 280 pounds of bulk mercury was collected and shipped to Mercury Refining of Albany, NY. In 1999, 60 additional pounds were collected and shipped to the same company.
- In 1994, Otter Tail Power Company became a member and financial contributor to the University of North Dakota Energy and Environment Research Center's Center for Air Toxic Metals. A number of research projects involved mercury and mercury emissions. 1999 research activities included:
  - Fundamental Mechanisms of Mercury Species Formation in Coal Combusiton Flue Gas.
  - Round Robin Study to Validate Mercury and Chlorine Analysis.
  - Development of Mercury Control Technologies.
  - Mercury and VOC Control using Fiber-Based Bioreactors.
  - Economic Evaluation of Mercury Control Options.

- In 1988, Hoot Lake Plant in Fergus Falls, Minnesota switched from a lignite coal to a subbituminous coal as the primary fuel. The mercury content of the subbituminous coal is about two-thirds the mercury content of lignite (0.07 ppm verses 0.12 ppm). In addition to a lower mercury concentration, the subbituminous coal has a higher Btu heating value and therefore we burned less subbituminous coal to produce each kWh of electrical energy.

The remainder of 2000 will involve investigating the feasibility of the programs listed in the plan and the possible funding requirements for budgeting purposes. The plan will be evaluated and updated on a yearly basis. We feel it is too early to detail how our results will be tracked. This will be part of the investigation to take place during the remainder of the year.

We would appreciate your thoughts regarding our plans and look forward to working with you. If you have any questions, please call me at (218) 739-8407 or email at tgraumann@otpco.com.

Sincerely,

Terry Graumann, Manager
Environmental Services

Enclosure

Otter Tail Power Company
Minnesota Voluntary Mercury Reduction Initiative
June 19, 2000

Proposed Voluntary Mercury Reduction Activities

Although Otter Tail Power Company released less than 50 pounds of mercury during 1999, we still wish to be proactive in the reduction of mercury emissions in Minnesota. Otter Tail Power Company will voluntarily agree to focus on the following mercury reduction activities during the following year:

<u>In-House Activities</u>

1. Investigate all systems within Otter Tail Power Company that contain or may release mercury and determine reduction activities if feasible. This would include mercury in switches, thermostats, thermometers, manometers, and fluorescent bulbs. If feasible, label devices containing mercury.

2. Train Otter Tail Power Company employees that work in areas where mercury containing equipment is located, to handle releases of mercury in the most environmentally sound manner.

1. Participate in selected studies, which includes:
   ◆Financially co-sponsoring the University of North Dakota Energy & Environment Research Center's (EERC) Fish Consumption Study.
   ◆Continued membership and financial contributor of the University of North Dakota EERC Center for Air Toxic Metals.

4. Conduct routine coal testing to determine mercury content.

5. Evaluate on an on-going basis if additional lower mercury coals are suitable for use at Hoot Lake Plant.

6. A Company goal has been to phase out mercury containing switches in Otter Tail Power Company communications equipment and SCADA and microwave site mercury relays by 2004. Other areas of the company will be evaluated for future phase out of mercury containing devices.

Otter Tail Power Company
Minnesota Voluntary Mercury Reduction Initiative
May 7, 2001

<u>Outside of Company Activities</u>

1. Through bill stuffers or other methods, educate customers on the proper use and disposal of mercury. This may include such items as the location of local collection sites for fluorescent bulbs, what to do if a mercury thermometer breaks at home, or other safety information on the dangers of mercury. Encourage the use of non-mercury containing devices.

2. Work with schools and medical care facilities in our service territory to help them participate in mercury reduction activities and provide a resource for information on the proper cleanup and disposal of mercury spills as necessary. This would include such items as collection and exchange of mercury thermometers or other equipment where replacements are available.

3. Work with heating and cooling contractors in our service territory to let them know about programs such as Honeywell's thermostat recycling program or county household hazardous collection sites for mercury containing devices.

4. Work with industrial customers to encourage replacement of mercury containing equipment, if replacements are available. As necessary, provide a resource for clean up information in the event of a mercury release.

5. When offering customer fluorescent bulb promotions, provide information on used bulb disposal.

6. Investigate a possible contribution to a MPCA website regarding the status the Minnesota Voluntary Mercury Reduction Initiative.

WLSSD

Clear Answers for Clean Water™

February 9, 2001

Ms. Elizabeth Shevi
Director, Policy & Planning Division
Minnesota Pollution Control Agency
520 Layfayette Road North
St. Paul, MN 55155-4194

RE: Voluntary Mercury Reduction Agreement

Dear Ms. Shevi:

The Western Lake Superior Sanitary District (WLSSD) is in strong support of the Voluntary Mercury Reduction Project. The WLSSD was an active member of the Minnesota Pollution Control Agency's (MPCA's) Mercury Contamination Reduction Initiative and agrees with the consensus decision that a voluntary approach is preferable to a broad regulatory approach at this time. WLSSD has complied with mercury emission limits for both its sludge/solid waste incinerator and its wastewater discharges for a number of years. WLSSD has and will continue to minimize releases to the environment from these sources.

Since we do not create the waste we receive, we choose to work with our customers in order to meet common environmental goals. We have found success in helping customers to identify sources of mercury they release to our facilities so they may be eliminated at the source. WLSSD has been a national leader in education of the public, business, and industrial customers on mercury pollution prevention. We believe source reduction is the most promising option for reducing mercury emissions from waste management facilities.

Presently, the WLSSD is a small discharger of mercury. Many of the sources of mercury to our plant are also small dischargers. The steps taken by many small dischargers can and do add up to significant reductions. Small sources may have low-cost preventive options available to them that some larger dischargers do not have.

WLSSD's mercury reduction effort will be two-fold. First, we will be shutting down our incinerator, which is a source of mercury emitted to the air. It also is a small source of

Western Lake Superior Sanitary District
2626 Courtland Street • Duluth, MN 55806-1894 • 218/722-3336 • FAX 218/727-7471

mercury to the water, since mercury is released to the wastewater treatment plant from the emissions control equipment. Instead of incinerating the wastewater sludge, we will be producing and land applying biosolids for beneficial use. WLSSD will assist MPCA researchers that are attempting to quantify mercury emissions at land application sites and evaluate options to reduce this potential re-emission source.

True mercury reductions in the waste management industry will come through source reduction and pollution prevention programs. We will continue to work with the public, business, and industrial customers to reduce use and therefore reduce disposal of products that contain mercury. We will continue pilot-test activities intended to reduce use of mercury containing items by residential, commercial, and industrial customers.

The healthcare sector will continue to be a focus of our waste reduction and waste management efforts. WLSSD has worked with hospital to find alternatives to laboratory test procedures and equipment that have historically used mercury, such as thermometers and blood pressure devices. Proper management of amalgam waste from dental practices is another activity that will continue to contribute to mercury reductions. We will continue to search for and eliminate mercury discharged to us from any source.

The table below shows our actual mercury emissions from all sources for 1990, 1998 and 1999, along with future estimates. The 2001 and 2008 estimates are based on known factors, such as the shut down of our incinerator and the continuation of current reduction trends.

Mercury Emissions from WLSSD Facilities

Type of Emission	**1990**	**1998**	**2000**	**2001**	**2008**
	lbs/yr	lbs/yr	lbs/yr	lbs/yr	lbs/yr
Incinerator Stack (AIR)	47	10	11	5	0
Wastewater Effluent (WATER)	42.4	2.0	1.0	0.8	0.5
Incinerator ash (Landfill)	1.3	52.5	5	2	0
Biosolids (Land Application)	0	5.9	5	10	11
Subtotal	**90.7**	**70.4**	**23.4**	**17.8**	**11.5**
Solid waste Estimate (Landfill)	118	55.2	100	95	80
Total	**208.7**	**125.6**	**123.4**	**112.8**	**91.5**

We propose to report this information to the reduction initiative on an annual basis. The report will consist of a summary of mercury concentrations and loadings in the incoming waste streams, as well as concentrations and loadings of mercury released to the various media. The report will be submitted in February of each year.

If you have any further questions about our commitment to reduce mercury emissions, please feel free to call Tim Tuominen of my staff at (218) 722-3336 extension 324.

Sincerely,

Kurt N.W. Soderberg
Executive Director

CC: John Wachtler

Attachment 3 to Appendix D

Progress Reports

- **Taconite Industry**
- **Alliant Energy**
- **Koch Industries Inc.**
- **Metropolitan Council Environmental Services**
- **Minnesota Power**
- **North Star Steel**
- **Otter Tail Power Company**
- **Minnesota Mercury Initiative**

Taconite Industry Voluntary Mercury Reduction Progress Report

Submitted To The MPCA

Pursuant To Individual Mine Voluntary Mercury Reduction Agreements

April 30, 2001

Background

Mercury is a naturally occurring element and, in conformance with the natural laws of physics, it can neither be created nor destroyed. In this regard, mercury is distinctly different from organic chemicals such as PCBs, certain solvents, pesticides, herbicides, and other compounds that can be broken down. When it is collected with the intent of removing it from further use, it can only be stored in some form of repository. Currently, no permitted waste mercury repositories exist in the United States. Under these circumstances, all mercury shipped from a source for "disposal" is sent to mercury recyclers, and eventually it is returned to use in some form of mercury containing device or product.

Minnesota's 1999 Mercury Reduction legislation sets a statewide goal of reducing the release of mercury into the air and water of the state by 60 percent from 1990 levels by the end of 2000 and by 70 percent from 1990 levels by the end of 2005. To assist the state in achieving the goal, the Minnesota Pollution Control Agency (MPCA) invited mercury sources that emit more than 50 pounds of mercury per year to enter into Voluntary Mercury Reduction Agreements.

The Iron Mining Association of Minnesota (IMA) member taconite mining companies accepted the MPCA's invitation, and each mine entered into a Voluntary Mercury Reduction Agreement with the Agency. This list of taconite mining companies includes EVTAC Mining, Hibbing Taconite Company, Ispat-Inland Mining Company, LTV Steel Mining Company, National Steel Pellet Company, and Northshore Mining Company. It should be noted that not all of the mining companies release more than 50 pounds of mercury per year. Nevertheless, all of the companies chose to participate in the voluntary reduction program.

The mercury legislation requires the MPCA to submit mercury reduction progress reports to the legislature on October 15, 2001, and October 15, 2005. To assist the MPCA in preparing its 2001 report, the Taconite Industry submits this report on its mercury reduction efforts. Due to the similarity in approaches to mercury reductions among the mines, the industry chose to submit a single report. The specific mercury reduction programs at each mine are included in subsections of the report.

Mercury Association With Taconite Mining

Taconite, a form of iron ore, is mined and processed in a number of steps. In very brief summary, the ore is mined by conventional open pit methods, reduced in size by passing through a series of crushers and grinding mills until it is the consistency of fine sand, and the iron is then concentrated. The concentrate is mixed with fluxes and binding agents and formed into onefourth to one-half inch spheres called green balls. The green balls are heated to approximately 2400° F in indurating furnaces to form oxidized, hardened pellets. The furnaces are typically natural gas fired although some alternative fuels are used such as wood and coal. The pellets are subsequently shipped to steel mills where they are melted and chemically reduced in blast furnaces to make iron and steel. During the concentrating step the non-iron bearing ground rock, referred to as tailings, is separated from the iron bearing concentrate and is stored in large basins.

The release of mercury from taconite ore processing became known only recently. The MPCA contracted with the Coleraine Minerals Research Laboratory (CMRL) of the University of Minnesota to investigate the atmospheric mercury emissions that occur during the processing of taconite ore into pellets. The study was conducted during 1996-97 and a final report was published during September 1997. CMRL's work consisted of mass balance studies of ore, concentrate, and fired pellet streams at four of the seven Minnesota taconite mines. Since that time all of the mines have conducted various levels of mercury stack testing, and in some cases mass balances, to further define mercury emissions.

Mercury is ubiquitous in the earth's crust and trace amounts (a few parts per billion) are present in the taconite ores found on the Mesabi Iron Range. The taconite mines have different production rates and produce between 3 million and 8 million dry long tons of pellets per year. (A long ton is equal to 2240 pounds.) The CMRL study found that 60% to 93% of the mercury present in the ore is rejected with the non-iron bearing rock and reports to the tailings basins where it remains sequestered as discussed later in this report. The remaining 7% to 40% of the mercury remains with the iron ore concentrate that is formed into green balls.

In the process of heating the green balls in the indurating furnaces, the trace amount of mercury contained in each green ball is volatilized and emitted from the furnaces. Because of the large quantity of ore processed and the additional emissions from coal fired power plants at some ore processing facilities, individual facilities emit roughly between 10 and 225 pounds of mercury per year. This variation is due primarily to production rate and the specific mercury content of the ore being mined. Emission factors have been determined from recent mercury stack tests at the mines. Mercury emission calculations yield a three-year (1999-2001-projected) average annual emission rate of 677 pounds per year for the taconite processing plants. (This does not include mercury emissions from associated power plants). This is in contrast to the MPCA 1999 mercury emission inventory, which lists 787 pounds of mercury (excluding mercury emissions from associated power plants) emitted from the taconite industry for 1990 and 828 pounds emitted for 1995, 2000, and 2005.

Mercury stack testing at one mine has demonstrated that approximately 96% of the volatilized mercury is elemental mercury, and approximately 4% is oxidized mercury. The elemental mercury passes through the particulate emission control equipment and is emitted to the atmosphere. Unfortunately, technically and economically viable emission control equipment currently does not exist for capture of elemental mercury emissions.

Of the 4% oxidized mercury, approximately 70% is captured by the particulate emission control equipment. This mercury eventually reports to the tailings basins along with the non-iron bearing rock that carries, as noted above, 60% to 93% of the mercury contained in the raw ore.

Mass balance studies and a recent tailings mercury volatilization study conducted by the MPCA strongly indicate the mercury remains with the tailings and very little is released to the air or to the water. Analysis of tailings basin effluent at one mine found mercury to be present at 1 ng/l (part per trillion) while the receiving stream mercury concentration was 4 ng/l. Due to the associated chemistry, the mercury is sequestered in the tailings.

Overview Of Mercury Release Reduction Efforts

As previously stated, the primary sources of mercury releases are from the indurating furnaces in the taconite pellet plants, and technically and economically viable emission control equipment is not available to capture the mercury. However, the industry is hopeful that once mercury removal technology is developed for coal fired electric power plants it can be adapted for use on the taconite indurating furnaces.

Because of the recent nature of the information on mercury associated with taconite ore and the lack of technology to capture mercury from taconite processing plant emissions, the mines have chosen to focus their voluntary mercury reduction efforts in the following general areas:

- Conduct further mercury research.
- Inventory mercury used in various pieces of equipment and monitoring devices at the mines.
- Collect and dispose of mercury from devices removed from service.
- Partner with other groups to promote mercury awareness, collection, and recycling.

As part of the mercury research effort, all of the Minnesota taconite mines have jointly partnered with the Minnesota Department of Natural Resources (DNR) and the MPCA by providing matching funds to conduct three mercury research projects. Following is a brief description of each of the projects:

- **Mercury Volatilization From Taconite Tailings**

  During the summer of 2000, Dr. Ed Swain of the MPCA, used a mercury flux meter to measure the amount of mercury volatilizing from taconite mine tailings basins. Dr. Swain indicated he would be summarizing the results of this study in a written report during 2001. While he is still working on the report, Dr. Swain reported verbally that the mercury concentrations in the air above the tailings were among the lowest he had measured from various sources in the state. This supports the conclusion of the CMRL study that mercury reporting to the tailings basins binds with the tailings particles and very little of the mercury is subsequently released.

- **Preparation Of A Certified Mercury Standard For Taconite**

  The concentrations of mercury now of concern are so low that new sampling and analytical techniques had to be developed. Trace-level mercury analyses in solids have additional complications due to interference from other elements typically present. The resulting variability and uncertainty in laboratory analyses of bulk samples has made accurate mass balances difficult and very expensive. Analytic standards must be established that help assure repeatability of analytical results and that provide a basis for comparison between laboratories, as well as over time.

  To accomplish this the Coleraine Minerals Research Laboratory will collect bulk samples of taconite ore, concentrate, and pellets from one or more mines and submit representative sub-samples to several commercial laboratories for mercury analysis. The laboratory results will then be used to establish certified mercury concentration values for the samples. Certified samples will then be available to the taconite mines from CMRL. Taconite facilities will be able to submit the certified samples along with samples from mass balance studies or other testing programs to establish a higher level of confidence the laboratory results. This work is in progress.

- **Determination Of Stages In The Induration Process Where Mercury Volatilization Occurs**

  CMRL will collect samples and conduct tests to determine where in the induration process mercury is volatilized and whether it changes oxidation state at some point in the process. If volatilization of oxidized mercury occurs in a specific process area with its own stack, it may be possible to focus mercury removal efforts on that stack. Also if oxidized mercury can be captured before it is converted to elemental mercury, overall mercury removal could be increased.

An IMA Ad Hoc Mercury Reduction Task Force met with St. Louis County and Lake County waste management officials to determine if the taconite mines can assist the counties in their efforts to collect mercury devices and wastes. The Minnesota Office of Environmental Assistance and the Western Lake Superior Sanitary District also participated in these meetings. The Task Force learned early on that any of its efforts to provide mercury collection and disposal services for the public in the two counties would only duplicate and interfere with the programs the counties already have in place. As an alternative, a tentative plan has been developed to assist the counties in notifying the public of their annual mercury clean sweeps programs for collection of household mercury wastes and mercury containing devices.

Details of mercury research conducted by individual mines, a mine's efforts to inventory mercury containing devices, and any associated mercury collection and disposal are discussed in the individual mine sections of this report, which follow.

EVTAC Mining

Voluntary Mercury Reduction Progress Report

April 30, 2001

This is the first annual report concerning the voluntary mercury reduction agreement between EVTAC Mining and the Minnesota Pollution Control Agency. A major fire in October 2000 interrupted normal operations of the facility and necessitated the diversion of efforts to the environmental issues associated with the rebuilding of the facility. Because the mercury reduction program was delayed due to the fire, EVTAC has had the opportunity to rethink the program to assure that the action to be taken in 2001 and beyond will be more beneficial to the goal of mercury reductions. The following items summarize EVTAC's 2000 mercury reduction activities:

Mercury Balance

EVTAC Mining planned to conduct a comprehensive mercury balance of its beneficiation process from the fine crushing, concentrating and pellet production. Since the facility was not operating in a normal manner following the fire, the mercury mass balance was postponed until 2001. A mass balance of the pelletizing process was previously conducted in 1997 as part of the Coleraine Minerals Research Laboratory study. Subsequent economic events and re-evaluation of the mercury testing already completed have led to re-planning of the mercury balance. EVTAC is presently using a consultant to evaluate gaps in the data already in hand and will plan appropriate data gathering measures to fill the gaps.

Mercury-Containing Process Materials and Equipment

Since the mid-1990's EVTAC has recycled all its mercury-containing fluorescent lamps and high intensity lamps.

Several mercury-containing batteries have been turned into EVTAC personnel. These will be appropriately recycled or disposed.

Prior to 1995, EVTAC Mining changed its iron ore assay method to eliminate the use of mercury chemicals in the analysis.

EVTAC has not yet organized a program to identify and inventory mercury-containing equipment such as thermostats and switches. This task has been discussed with consultants and will be completed in 2001. Included in this program will be a system to avoid most purchases of mercury-containing equipment. Also included in the system will be a method to quantify reduction efforts. One new issue included in the fire-related rebuilding effort was to specify non-mercury-containing equipment for the rebuild project.

Iron Mining Association Efforts

EVTAC is continuing to support mercury research sponsored by the Minnesota Department of Natural Resources.

Hibbing Taconite Company

Voluntary Mercury Reduction Progress Report

April 30, 2001

Hibbing Taconite Company, an unincorporated joint venture managed by Cliffs Mining Company, is located approximately 3 miles to the North of the City of Hibbing in St. Louis County. Hibbing Taconite produces on average 8 million Dry Long Tons (DLT) of standard pellets per year. Since plant startup annual pellet production has ranged from a high of 8.6 million tons (1988) and a low of 4.1 million tons (1983). This annual production variation results from Hibbing Taconite's competition against a global market.

Mercury Stack Testing

During 1996-1997, Hibbing Taconite participated in the research program with the Natural Resources Research Institute's Coleraine Minerals Research Laboratory (CMRL) to perform a mass balance of mercury from the pellet furnace. Based upon the analysis of the furnace inputs and outputs, CMRL calculated an estimated emission factor of **32 pounds Hg / million DLT pellets** at Hibbing Taconite. In order to obtain a direct mercury emission factor, Hibbing Taconite performed a stack test during September 1998 with mercury speciation. The Energy and Environmental Research Center, a leader in Midwest mercury testing, monitoring, and control development, performed the mercury emission stack test, the only stack test of its kind performed on a taconite pelletizing furnace up to that date. The results of this study are that of the measured total **27.5 pounds Hg stack emission / million DLT pellets produced,** less than 0.05 pounds is particulate mercury, less than 2.0 pounds is oxidized mercury, and 25.5 pounds is elemental mercury. The study also demonstrated that 70-80 percent of the oxidized mercury was being collected in the wet scrubber, thus removing it from the furnace exhaust gas.

Mercury Reduction Through Historical Concentrator Improvements

The 1997 CMRL study also sampled the inputs (crushed crude ore) and outputs (concentrate and tailing) of the Concentrator during 1996 and 1997. The averages of these tests show that 81 percent of the mercury in the crude ore reports in the slurry to the tailing basin. Hibbing Taconite has invested in several projects in the concentrating process since 1989 that it believes may have reduced the amount of mercury in the concentrate.

This belief has basis in the 1997 CMRL study. In the study, another taconite mine had more mercury in its taconite ore but less mercury in its concentrate than Hibbing Taconite, thus resulting in lower mercury air releases. It is HTC's opinion that the finer size material (grind) produced by its current Concentrator operations more closely resembles the other mine's process.

During the period 1989-2000, Hibbing Taconite invested in numerous upgrades in the Concentrator to produce historical concentrate levels. Throughout the 1990s, the silica particle grain and the iron particle grain are becoming similar in size as Hibbing Taconite continues to mine its ore reserves. This requires the ore to be ground to a finer consistency as discussed above.

The main difficulty in calculating the 1990-2000 reduction is that Hibbing Taconite does not have mass balance or stack test information from 1990 to serve as a baseline. That stated, it is difficult to "scientifically" demonstrate that the finer concentrate grind in 2000 contains less mercury than the coarser grind of 1990. However, the difference of the 1996 mass balance to the 1998 stack test provides evidence of a reduction of 4.5 pounds total Hg stack emission / million DLT pellets. As stated previously, CMRL's mass balance was performed during 1996-1997 and Hibbing Taconite does not have any other mass balance tests prior to this.

Reduction Of Mercury Containing Products

Hibbing Taconite, a large industrial complex, has historically used many products that contain mercury. Such devices are thermometers; thermostats; pressure, tilt, and relay switches; batteries; and fluorescent and high intensity discharge (HID) lamps.

The use of mercuric chloride was phased out during 1995 through the action of Hibbing Taconite and the Cliffs Mining Services Company Research Lab to change the ASTM reference standard for iron analysis to a non-mercury method. The waste generated from the iron analysis resulted in the generation of twelve 55-gallon drums per year that contained approximately a total of **5 pounds of mercury** by weight. This material was shipped to a mercury recycler.

Hibbing Taconite has also been recycling fluorescent and HID lamps since 1992. On average, Hibbing Taconite recycles 735 pounds (1700 4-foot lamps) of fluorescent lamps and 440 pounds (500 lamps) of HID lamps per year. Assuming 45 mg per lamp during 1990, this equates to nearly **3 pounds of mercury per year**. In addition, improved handling practices have reduced breakage and potential releases. Hibbing Taconite currently has approximately **45 pounds of mercury** that it collected during the last 9 years from replacing mercury-containing products. This material will be shipped to a recycler during 2001.

During 2000 Hibbing Taconite conducted an inventory of mercury containing products by site inspection, employee interviews, and review of engineering drawings. Work was also initiated on a corresponding mercury product log for use by mine personnel to ensure the proper management of the mercury containing products. Work was also initiated on a Mercury Purchasing Policy that will inform HTC's product suppliers of Hibbing Taconite's mercury reduction agreement, and require the supplier to identify its products as containing or not containing intentionally added mercury.

Employee Outreach And Education

Hibbing Taconite recognizes that mercury education is the most important effort needed to change people's actions regarding mercury and mercury waste management. Because Hibbing Taconite was an initial member of the Minnesota Mercury Contamination Reduction Advisory Council, tremendous amounts of information have already been distributed at Hibbing Taconite and other taconite facilities through the presentations and materials handed out at the Mercury Advisory Council meetings.

During 2000 Hibbing Taconite commenced operation (December 1, 2000) of an **onsite Mercury Recycling Center** for its **employees** to recycle their mercury containing products. The items collected from this effort will be tracked separately from the rest of Hibbing Taconite's mercury waste products to maintain a separate accounting of the items removed from the environment. A mailing was sent to all employees informing them of the Mercury Recycling Center's start of operations, the potential health risks of mercury, and the importance of properly managing mercury from an environmental perspective. During December 2000, 44 four-foot long fluorescent lamps, two thermostats, and one thermometer were recycled by Hibbing Taconite employees. This prevented 2.1 ounces of mercury from potentially entering landfills.

From 1998 through 2000, HTC expended nearly $70,000 and 1,000 man-hours on testing, inspecting and developing waste management procedures, and reviewing and researching mercury literature and potential mercury reduction opportunities.

Ispat-Inland Mining Company

Voluntary Mercury Reduction Progress Report

April 30, 2001

Mercury Light Fixture Replacement

Ispat-Inland began a campaign of mercury vapor light fixture replacement with high pressure sodium light fixtures in 1990. Currently over 75% of our mercury vapor fixtures have been replaced. Following is a summary of the mercury fixtures replaced:

	Number	Hg/bulb
4 foot Fluorescent Bulbs -	10,400	22.8 Mg/bulb
8 foot Fluorescent Bulbs -	1050	30 Mg/Bulb
1000W Merc. Vapor -	4500	185.33 Mg/Bulb

Broken Merc. Vapor - 800 Lbs. of bulbs

Mercury Process Changes

Ispat-Inland will have completed a changeover of its iron assay procedure from one that used mercuric chloride to a non-mercury procedure by the end of 2001.

Mercury Device Inventory

Ispat-Inland is conducting an inventory of mercury containing devices and expects to complete an associated mercury device labeling program by the end of 2001. This effort will help ensure that the devices will be managed properly when they are eventually taken out of service.

Mercury Stack Testing

Ispat-Inland performed stack testing for mercury on its four process stacks during 2000. Using the mercury emission factors derived from the tests and the 1997 CMRL study, Ispat-Inland's annual mercury emissions, based on a three-year average (1990, 2000, and 2001 projected) are estimated at 44 pounds per year. As part of the state's mercury release reduction efforts, the MPCA invited mercury emission sources that emit more than 50 pounds per year of mercury to participate in the Voluntary Mercury Reduction Program. Ispat-Inland Mining Company chose to participate in the program even though its annual emissions are less than 50 pounds per year.

LTV Steel Mining Company

Voluntary Mercury Reduction Progress Report

April 30, 2001

LTVSMC consists of a taconite ore mining and processing facility in Hoyt Lakes, Minnesota and a coal fired power plant at Taconite Harbor on the shore of Lake Superior. LTVSMC terminated production operations during early January 2001. For this reason the Company does not plan to complete Voluntary Mercury Reduction Actions associated with the taconite processing plant. However, because of the likelihood of the power plant being operated, LTVSMC plans to complete Voluntary Mercury Reduction Actions associated with the power plant where practical.

Specific Plans and Objectives

(The status of actions is shown in italics.)

Mercury in the Ore

Voluntary Reduction Action:

LTVSMC will perform stack testing on furnace emissions to verify mercury emissions from furnaces with wet and dry collectors. *Some testing done, records will be retained.*

LTVSMC will work with the MPCA to verify that mercury remains with the tailings and explore changes in tailings handling operating procedures that will maximize retention of mercury within the tailings. *Cancelled.*

LTVSMC will perform a mass balance to better understand the fate of mercury within the process and will explore process changes that result in more mercury reporting to tailings (based on verification that mercury reporting to tailings is retained by the tailings). *Cancelled.*

Mercury in Coal at the Power Plant

Voluntary Reduction Action:

LTVSMC will perform stack testing on boiler emissions to verify mercury emissions. *Testing done; results to be analyzed.*

LTVSMC will perform a mass balance (air emissions, fly ash, bottom ash and pyrites) to better understand the fate of mercury within the process. *Testing done; results to be analyzed.*

Mercury in Products and Devices

Voluntary Reduction Action:

LTVSMC will develop a more formal Mercury Elimination Program at the Hoyt Lakes Taconite Processing Plant. The program will include an inventory of mercury containing devices, a plan to phase out those devices where feasible and a methodology to avoid introduction of new mercury containing devices or products where mercury free alternatives exist. *LTVSMC removed mercury-containing devices from the Taconite Processing Plant as part of shutdown procedures. The mercury has not yet been disposed so the amount is not known.*

Community Outreach

Voluntary Reduction Action:

LTVSMC will participate in any joint effort which may be undertaken with other taconite processors and Minnesota Power to develop a Mercury Awareness Program targeted at Northeastern Minnesota and deliver it to the local community via brochures, newspaper advertising and radio advertising. Once the group finalizes the plan, LTVSMC will support a portion of this effort based on a funding strategy developed by the group. *LTVSMC will consider participation as appropriate to its circumstance.*

LTVSMC will participate in any joint effort which may be undertaken with other taconite processors and Minnesota Power to develop a Community Mercury Recycling Program targeted at Northeastern Minnesota. Once the group finalizes a plan, LTVSMC will support a portion of this effort based on a funding strategy developed by the group. *LTVSMC will consider participation as appropriate to its circumstance.*

National Steel Pellet Company

Voluntary Mercury Reduction Progress Report

April 30, 2001

Background

NSPC, a wholly owned subsidy of National Steel Corporation, is a taconite ore processing plant located approximately 2 miles north of Keewatin, MN. Original construction of the facility occurred during 1965-1967. The original plant consisted of two (2) surface combustion rotary hearth systems. This system was replaced with an Allis Chalmers 15-ft. grate-kiln system in 1969 (Phase I). In 1976 the plant expanded by adding a larger Allis Chalmers 18-ft. grate-kiln system (Phase II). In 1980, Phase I was idled, and it has not been operated since.

Five main steps accomplish the process of increasing the ore percentage (ore beneficiation):

- Mining (drilling, blasting, loading, hauling) – removes the ore from the rock body.
- Crushing (in-pit crushers, primary mills, secondary mills) – reduces the size of the ore to a face powder consistency and aids in removing contaminants such as silica and rock.
- Concentrating (magnetic cobbers, disc filters) – separates the ore by magnetic extraction and dewaters to approximately 10% moisture.
- Balling (balling drums) – combines the ore with limestone and bentonite to produce ½" to ¾" "green" balls.
- Induration (grate-kiln, cooler) – heat hardens the "green" ball to 2400 °F to optimize the oxidation process producing taconite pellets.

Average annual production of iron ore pellets is 5.4 million long tons per year. The pellets are transferred by rail to a customer in Granite City, IL and by ship to Ecourse, MI. NSPC employs approximately 520 people.

Mercury Inventory

NSPC employed a summer intern in 2000 to prepare an inventory of mercury containing products on the property. This information was used in developing a program to phase out or replace mercury-containing products. The products were categorized by their associated risk and a determination was made on the timing of the product phase out.

The inventory included 110.2 pounds of liquid mercury and mercury-containing products. The majority of the liquid mercury identified was contained in "dash pots". The dash-pots are cylindrical containers that sit inside the scale housing, and the mercury is open to the atmosphere. These devices are used in Merrick scales to dampen the effects of vibration common to industrial equipment. The dash-pots were removed from two scales that had been decommissioned. The liquid mercury was removed from two Merrick scale maintenance kits and mercury manometers. Overall, 68.5 pounds of liquid mercury was removed from the property in 2000.

The mercury remaining onsite is contained in two Merrick scales utilized in the in-pit crushers and the vast number of mercoid switches and thermostats used on the property. The crusher scales will be removed to eliminate any potential for a release of mercury.

NSPC is continuing to recycle fluorescent bulbs with a local recycler. The recycling program was initiated in 1987 with an average of 1850 pounds of bulbs recycled each year. Mercoid switches and thermostats are also recycled. An average of 2 mercoid switches per year are replaced with new mercoid switches. At the present time, there is no non-mercury alternative available. Thermostats are replaced on an as-needed basis. After completion of the crusher scale changes, the only remaining mercury will be contained in thermostats, mercury vapor lamps, and mercoid switches. This will be approximately 15 pounds of mercury products and devices.

Table 1: Mercury Quantification

	Production (MM LT)	Emission Factor(lb/MM LT)	Emissions (lbs/yr)	Mercury Devices/ Products (lbs)	Total Mercury Onsite (lbs)	% Reduction from 1990 levels
1990	4.81	33.00	158.73	110.00	268.73	0.00%
2000	5.47	20.00	109.40	41.50	150.90	43.85%
2005	5.75	20.00	115.00	15.00	130.00	51.62%

The emission factor for 1990 was obtained from the Coleraine Minerals Research Laboratory 1997 report. Testing completed in 1999 provided the updated value of 20.00 lb/MM LT. Historical improvements to the concentrator operations have enabled NSPC to reduce its mercury emissions. One such improvement is the finer grinding of the ore, which reduces the amount of silica and mercury continuing to the induration process. The 1999 mass balance showed that 80.4% of the mercury in the ore went to the tailings basin. Chart 1 is a graphical representation of the actual and planned reductions NSPC has seen.

Employee Training

Employees were briefed on the contents of NSPC's Voluntary Mercury Reduction Agreement during Annual Environmental training. The importance of employee involvement was communicated. A scale in an outlying area was discovered from information provided by an employee. NSPC realizes that the employees are in these areas and use the equipment everyday. Employees will continue to be informed on mercury issues through the weekly communication newsletter and annual training.

Mercury Mass Balance

NSPC contracted with Barr Engineering and the University of Minnesota – Coleraine Minerals Research Laboratory to conduct mercury stack testing and complete a mercury mass balance. The mass balance identified and measured the pathways in which mercury enters and leaves the plant. This information will be used by NSPC to evaluate economical alternatives to further reduce the mercury emitted to the atmosphere.

2001 Activities

NSPC will continue to work with the other taconite facilities on mercury research in the year 2001. This research may provide an economic, viable solution to effectively reduce the amount of mercury released to the environment. Additional activities for the year 2001 include labeling of all identified mercury-containing devices to ensure proper maintenance and disposal, a determination on the feasibility of phasing out existing mercury containing products with non-mercury containing products, and the replacement of the two remaining Merrick scales with non-mercury containing Ramsey scales.

NSPC is committed to making the smallest impact on the environment possible while providing a strong economic base for Northern Minnesota. The Voluntary Mercury Reduction Agreement is one way of reaching the goals necessary to ensure the same natural wonders are here for generations to come.

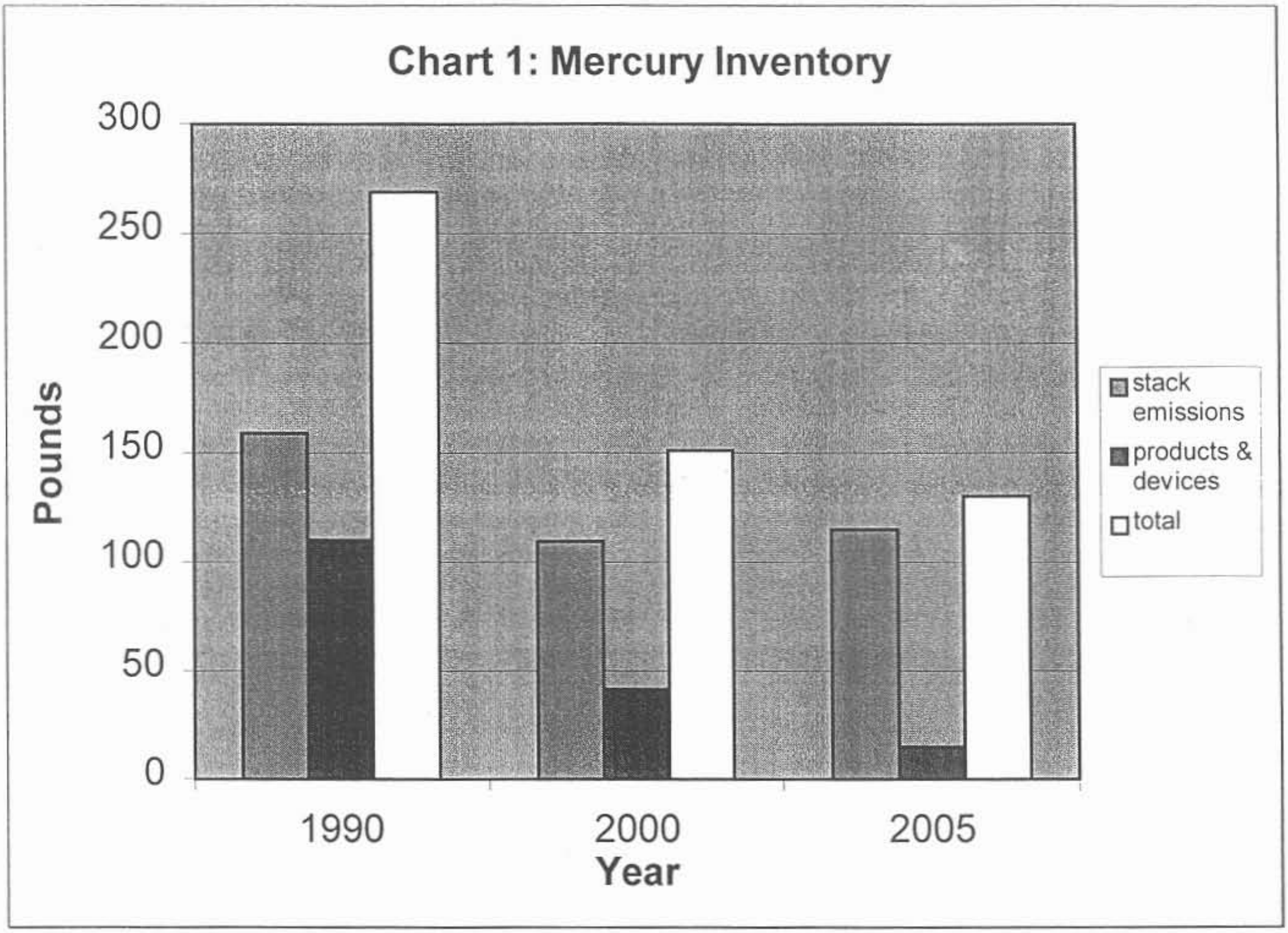

Chart 1: Mercury Inventory
300
250
200
150
100
50
0
Pounds
1990
2000
2005
Year
stack emissions
products & devices
total

Northshore Mining Company

Voluntary Mercury Reduction Progress Report

April 30, 2001

The Northshore Mining Company operates an open pit taconite mine near Babbitt, Minnesota and an ore processing facility and coal fired power plant in Silver Bay, Minnesota.

Mercury Reduction Process Changes

The iron assay method used in the company's quality control lab was changed in 1994, from a method using mercury compounds to a mercury-free assay method. The result was the elimination of a waste stream that generated some 15-20 pounds of mercury compounds every year, as well as the elimination of the raw mercury compounds brought onto the property for purposes of the lab assay. In 1996 a clean sweep was made of all laboratories, eliminating all known lab reagents containing mercury compounds on the premises. A total of 96 pounds of assorted mercury compounds were sent out for recycling at that time.

Mercury Collection and Recycling

In the early 1990's the company (then Cyprus Northshore Mining) began collecting mercury devices, replacing them where practical, and reducing the amount of free mercury in flasks available for replacement in instruments. A total of 630 pounds of elemental mercury was shipped out for recycling in 1990.

In 2000, the company identified and removed 94 mercury capsules from idled equipment. The switches were weighed, and an estimate was made as to the percentage of total weight that was mercury. Based on this estimate, 677.9g (1.5 lbs) elemental mercury was removed for recycling. Some similar equipment was scrapped in the early 1990's without first removing the mercury capsules, simply because they were overlooked during the general mercury collection under way at that time. That mercury was probably emitted to the atmosphere in the subsequent scrap meltdown. Therefore, the 1.5 lbs collected during 2000 would probably have gone to the atmosphere if it had not been collected.

An additional 2.5 lbs of assorted mercury capsules from other switches and thermostats were collected and sent out for recycling as well, bringing the total amount of elemental mercury collected from sealed containers and recycled in 2000 to 4 lbs. It is difficult to determine the fate of these capsules had they not been collected for recycling; chances are some of them would have gone to landfills and some would have gone to incinerators.

In 2000 the company recycled 5354 – 4 foot lamps, 2055 – 8 foot lamps, and 339 assorted high intensity lamps ranging from mercury vapor lamps to compact fluorescent bulbs. Based on mercury content data from Recyclights, and assuming these lamps are relatively new with the lower mercury content, the estimated amount of mercury collected from these 7748 lamps is 0.22 lbs. (Fluorescent lamps produced during the early 1990s had a greater mercury content than those currently produced. Therefore, if any of the lamps recycled during 2000 were older lamps, the amount of mercury recycled would be greater than that indicated above. The fate of that mercury, had it not been recycled, is still subject to debate as to whether it would all evaporate or stay in a landfill.

Talks are proceeding with the Lake County solid waste officer to establish or assist a community collection program. The talks have been slow because of a personnel change at the county solid waste office, associated redefinition of existing programs, and uncertainty as to the most effective means of improving current collection programs rather than duplicating or interfering with them. Meanwhile, employees have been bringing in household bulbs and thermostats for recycling. That material is a small fraction of the 0.22 lbs from lamps and 4 lbs from capsules listed above.

Mercury Reduction Through Re-lamping

The re-lamping project at Babbitt is about 75% complete. The old mercury vapor lamps and lamp fixtures are being replaced with low-pressure sodium lamps, at a substantial energy savings and with an appreciable reduction in mercury cycling through the plant within the lamps. There are three ways the re-lamping project reduces mercury emissions:

- When the project is complete, the estimated amount of mercury present in lamps in use at any given time will decrease by an estimated 28.7 g. That means that, for every total lamp replacement, 28.7g less mercury will need to be recycled.

- In addition, the new lamps have a considerably longer life span: 4 to 7 times the life span of the old mercury vapor lamps, depending on the replacement bulb type. During a full replacement lamp life cycle, therefore, the reduction in mercury cycling through the plant will range from 115 to 200 grams.

- There is a direct energy savings due to reduction in electricity use. A total of 151 lamps have been reduced from 1000W to 400W; another 81 lamps have been reduced from 400W to 250W. The reduction in power use will correspond to a reduction in mercury emitted during power generation. Minnesota Power estimates the reduction at 0.05 lb mercury per year which would otherwise have been emitted to the atmosphere during power generation.

Mercury Research

An extensive and careful mercury mass balance for Northshore Mining was completed and accepted by the MCPA in 1999. The mercury investigation combined low-level stack tests, water analyses, feedstock and waste analyses. A number of findings from that study have been and are continuing to be used to suggest further research regarding the sequestering of mercury at certain points in the production stream for Northshore as well as other taconite plants.

Northshore Mining hosted Dr. Ed Swain of the MPCA for measurements of mercury emissions from Northshore's tailings basin, as part of a screening research project funded in part by the taconite companies. Dr. Swain has verbally reported that mercury emissions were very low from the tailings basins he measured, thus confirming Northshore's earlier research, but Dr. Swain has not yet published his findings.

Facility Information

According to the above-mentioned mercury mass balance, the mercury emissions to the atmosphere from the entire facility operating at maximum pellet and power production would be 9.5 lbs/year. Since the plant did not operate at full capacity in 2000, the mercury emissions for 2000 would have been somewhat less.

John Wac.

To: David Thornton
Major & P+PD

ALLIANT

Interstate Power Company - Fox Lake Station
844 125th St.
PO Box 367
Sherburn, MN 56171-0367
Phone (507) 764-7541
Fax (507) 764-7641

RECEIVED

JAN [illegible] 2001

MPCA, [illegible]

January 18, 2001

Mr. Tim Scherkenbach
Director, Policy & Planning Division
Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155-4194

Re: 2000 Annual Progress Report - Voluntary Mercury Reduction Program

Alliant Energy is submitting the annual progress report for the Fox Lake Station. If you have any questions please feel free to give me a call.

Sincerely,

Kenneth J. Kiss

Kenneth J. Kiss
Assoc. Business Manager – Fox Lake Plant

2000 ANNUAL PROGRESS REPORT
VOLUNTARY MERCURY REDUCTION AGREEMENT
ALLIANT ENERGY'S FOX LAKE STATION

INTENT

Alliant Energy supports the efforts of the State of Minnesota in the implementation of a voluntary program to reduce mercury use and emissions. It is Alliant Energy's intent to participate in a voluntary mercury reduction agreement with the Minnesota Pollution Control Agency (MPCA).

SPECIFIC PLANS AND OBJECTIVES

Mercury From Fuel Combustion

One objective is to reduce the mercury emissions associated with the generation of electricity in Minnesota. In 1990, mercury emissions from the generation of electricity at the Fox Lake Power Station were 11.1 pounds. Due to the reduction in coal burned by the facility, the mercury emissions were reduced to 0.15 pounds in 2000, a reduction of 98%.

Year	Mercury Emissions (Lbs)
1990	11.1
1995	2.4
1998	0.1
1999	0.2
2000	0.15

Mercury-Containing Equipment

Another objective of Alliant Energy's voluntary mercury reduction program is to reduce the amount of mercury used within the Fox Lake Power Station. As mercury-containing equipment and instrumentation requires repair or is taken out of service, Alliant Energy evaluates non-mercury options. Non-mercury replacement options are selected if they are technologically proven and economically feasible.

Year	Mercury Contained in Plant Equipment (Lbs)
1990	124.5
2000	65.5

Employee Education

The final objective is to educate employees on ways to incorporate mercury reduction into business operations and personal lives. Alliant Energy provided informational materials to employees on the hazards associated with mercury use, on the environmental effects of mercury, and the various opportunities to reduce releases of mercury into the environment.

MPCA Mercury Emissions Inventory
Alliant Energy - Fox Lake Power Station

Year: **2000**

Combustion Source	Fuel Type	Hg Emissions (Lbs)
Boiler #1	Nat. Gas	0.0001
	#6 Oil	0.0239
	Total	**0.024**
Boiler #2	Nat. Gas	0.0000
	#6 Oil	0.1031
	Total	**0.103**
Boiler #3	Nat. Gas	0.0005
	#6 Oil	0.0120
	Bit. Coal	0.0000
	Total	**0.012**
C.T. #4	#2 Oil	**0.006**
Htg. Boiler	Nat. Gas	0.0000
		-
		0.000
Plant Total		**0.145**

Heat Input E12 Btu	Hg Factor (Lb/E12 Btu)	Fuel Burned	Units	Heat Content	Units
0.07745	0.0008	77.452	MMCF	1000	Btu/CF
0.00143	16.7	9634	Gal	148,343	Btu/gal
0.03451	0.0008	34.514	MMCF	1000	Btu/CF
0.00617	16.7	41604	Gal	148,343	Btu/gal
0.64853	0.0008	648.526	MMCF	1000	Btu/CF
0.00072	16.7	4,836	Gal	148,343	Btu/gal
0.00000	6.4	-	Tons	10,993	Btu/Lb
0.01215	0.46	87,019	Gal	139,650	Btu/Gal
0.01292	0.0008	12.917	MMCF	1000	Btu/CF
0.00000	0.46	0	Gal	139,650	Btu/Gal

Year: **1990**

Combustion Source	Fuel Type	Hg Emissions (Lbs)
Boiler #1	Nat. Gas	0.00002
	#6 Oil	0
	Total	**0.000**
Boiler #2	Nat. Gas	0.00002
	#6 Oil	0
	Total	**0.000**
Boiler #3	Nat. Gas	0.0006
	#6 Oil	0.1565
	Bit. Coal	10.9028
	Total	**11.060**
C.T. #4	#2 Oil	**0.001**
Htg. Boiler	Nat. Gas	-
Plant Total		**11.061**

Heat Input E12 Btu	Hg Factor (Lb/E12 Btu)	Fuel Burned	Units	Heat Content	Units
0.02067	0.0008	20.665	MMCF	1000	Btu/CF
	16.7	0			
0.01997	0.0008	19.972	MMCF	1000	Btu/CF
	16.7	0			
0.75511	0.0008	755.11	MMCF	1000	Btu/CF
0.00937	16.7	62,385	Gal	150,172	Btu/Gal
1.7036	6.4	76,297	Tons	11,164	Btu/Lb
0.00232	0.46	16,840	Gal	138,000	Btu/Gal
0	0.0008	0	MMCF	0	Btu/CF

Fuel use info from plant statistics as submitted for MPCA annual emissions inventory.
HG emissions factors from 12/8/97 letter from E. Swain, citing EPRI report "Mercury in the Environment - A Research Update", 1996
#6 Fuel Oil Hg factor from EPA-Fire database for emission factors.

KOCH
INDUSTRIES INC

NOV 8 2000

[illegible] SECTION

DEB McGOVERN
MANAGER
REGULATORY AFFAIRS

November 27, 2000

Mr. Bob McCarron
Policy & Planning Division
Minnesota Pollution Control Agency
520 Lafayette Road North
St. Paul, MN 55155-4194

RE: MASS BALANCE SUBMITTAL UNDER KOCH'S VOLUNTARY MERCURY REDUCTION AGREEMENT

Dear Mr. McCarron:

Enclosed is a copy of Koch's Pine Bend Refinery's mercury mass balance evaluation (dated November, 2000) which was conducted by Barr Engineering. We would like to meet with Minnesota Pollution Control Agency staff in December to discuss the results and conclusions from this mass balance evaluation.

If you should have any questions or comments regarding this submittal, please contact me at 651/437-0642.

Sincerely,

Debra L. McGovern

Debra L. McGovern

Enclosure

cc: Ed Swain, MPCA (w/enclosure)
John Wachtler, MPCA
Lowell Miller Stolte, KPG
Lori Stegink, Barr Engineering

Pine Bend Refinery Mercury Mass Balance Evaluation

Prepared for
Koch Petroleum Group, L.P.
Pine Bend, Minnesota

November 2000

BARR

4700 West 77th Street
Minneapolis, MN 55435
Phone: (952) 832-2600
Fax: (952) 832-2601

Executive Summary

In 1999, the Minnesota legislature passed a mercury reduction law (Minnesota Statutes § 116.915) which set a statewide goal of reducing mercury releases to the air and water. The law requires the Minnesota Pollution Control Agency (MPCA) to establish a voluntary mercury reduction program for industry. One of the first steps in determining if mercury can be reduced at a specific facility is an evaluation and quantification of mercury inputs and outputs through a mass balance approach.

Koch Petroleum Group L.P. (KPG) submitted a Voluntary Mercury Reduction Agreement to the MPCA (see Appendix A). The voluntary agreement commits Koch to the following three steps:

- Conduct a mercury (Hg) mass balance assessment of KPG's Pine Bend refinery located in Rosemount, MN for current operations and retroactively to 1990.
- Characterize and quantify, if possible, efforts undertaken since 1990 to reduce mercury use and emissions at the Pine Bend refinery.
- Inventory mercury containing materials and equipment currently used at the refinery and develop a plan to reduce or eliminate the use of mercury.

This report is a summary of the first element. Other elements will be reported separately.

<u>Summary and Conclusions</u>

- **<u>2000 Mass Balance and Current Releases of Mercury</u>**
    - Hg in blended crude oil processed at the Pine Bend refinery ranges in concentration from 1.1 to 5.4 ppb (June 2000 data). Samples were collected in duplicate from each of seven storage tanks. A total of 27 individual crudes made up the blended crude sampled from the seven tanks. In comparison, Hg in unblended crude oil sampled in 1998 by the Minnesota Office of Environmental Assistance (MOEA)/MPCA from the Pine Bend refinery showed Hg concentrations ranging from 3.7 to 13.5 ppb (MOEA, 1999; Cebam data). Samples were collected in duplicate in 1998 from three unblended individual crudes (MOEA, 1999).
    - About 80 pounds per year of mercury currently enter the refinery; 97% from crude oil.

- Approximately one-third of the incoming mercury is accounted for in the outputs of the mass balance.

- Approximately 20% percent of the incoming mercury is found in products – mostly in sulfur and petroleum coke.

- Little mercury is present in transportation fuels (gasoline, jet fuel, diesel fuel) produced by KPG-MN; thus, mobile sources using KPG-MN fuels would not be expected to be a large source of mercury to the environment.

- Water releases of mercury are less than 0.1 pounds per year; less than 1/10th of 1% of incoming mercury is released to the Mississippi River.

- Waste releases of mercury are less than 1.5 pounds per year; less than 2% of incoming mercury is released as waste.

- Using available data, refinery air emissions are estimated to be less than 10 pounds per year. If all unaccounted mercury is assumed to be air releases, air releases of mercury could be as much as 60 pounds per year.

- The measured mercury concentration with the most uncertainty is for the sulfur product. A relatively small difference in the concentration of mercury in the sulfur product could account for much of the unaccounted for mercury due to the relatively large output of the sulfur product from the refinery. The sulfur product is a difficult matrix to analyze and Cebam is continuing its own efforts to provide an alternative determination of mercury in the sulfur product by the Radiochemical Neutron Activation Analysis (RNAA) method. Additional mercury concentration data from the RNAA method may result in changes to the mass balance calculations.

- An additional source of uncertainty is the Hg concentration of gases produced during the refining process (butane, propane, fuel gas).

- **Mercury Reduction Since 1990**

  - Although incoming mercury to the refinery has increased by about 30% from 1990 to 2000 (from 62.1 to 80.5 pounds/year), releases to the environment have increased by only 25% (assuming all unaccounted mercury is released to the environment).

- Koch has reduced it's total releases of mercury per barrel of crude oil processed by 3% since 1990 (assuming all unaccounted mercury is released to the environment). If one excludes the unaccounted mercury from this calculation, Koch has reduced its total releases of mercury per barrel of crude oil processed by 50% since 1990. The reduction in release of mercury is due to recycling waste materials back into the process that were formerly landfarmed back into the refining process and installation of the powdered activated carbon (PAC) system on the wastewater treatment plant to remove material from the water prior to effluent discharge to the Mississippi River.

- Water releases have decreased by nearly 88% (from 0.8 to less than 0.1 pounds per year) since 1990 due to installation of the PAC system; waste releases have decreased by approximately 80% (from 6.9 to 1.4 pounds per year) since 1990 due to discontinuing landfarming and recycling waste material back into the refining process.

- Air emissions have increased by approximately 40% (from 44 to 63 pounds per year, assuming all unaccounted for mercury is an air emission) since 1990, similar to the increase in the crude processing rate. If one excludes the unaccounted mercury from this calculation, Koch's air emissions have increased only slightly (approximately one pound) since 1990.

Mass Balance and Refining Process Discussion

Most of the incoming mercury appears in the sulfur and fuel gas. The partial pressure of elemental or simple organic forms of mercury (e.g. methyl mercury) is sufficient at the temperatures in the crude distillation columns, and in fractionation downstream of cracking operations (delayed coking of asphalt and fluid catalytic cracking of gasoil) to move the entire incoming mass of mercury overhead to the gas plants. Some of this mercury might complex with the hydrogen sulfide and other simple forms of reduced sulfur in fuel gas and be removed when the fuel gas is scrubbed with a liquid amine solution. If mercury does not react in the gas stream, there is sufficient amine circulation to remove the mercury seen in elemental sulfur to the sulfur recovery units, (assuming the solubility of mercury in amine is as low as 1 part per billion).

The sulfur and mercury containing amine is re-generated, and the liberated hydrogen sulfide (and associated mercury vapor) are routed to the sulfur recovery unit, where hydrogen sulfide is converted to elemental sulfur. This reaction occurs at high temperature, in a reducing atmosphere. Mercury, with its high affinity for sulfur, may react with the sulfur and become complexed with the elemental sulfur. The fact that a significant amount of the incoming mercury is present in the sulfur product supports this theory.

Mercury not removed by amine scrubbing would remain in the fuel gas and be combusted in refinery heaters and boilers.

Some mercury is present as stable salts (e.g. HgCl). Even though asphalt is coked at high temperatures and in a reducing atmosphere, the mercury would be expected to remain as salts. Thus, it is not surprising that some of the mercury winds up in the petroleum coke. It is somewhat surprising, however, that there is not more mercury in the asphalt, given mercury levels in the petroleum coke.

Other liquid products (LPG [Liquid Petroleum Gas; butane and propane], gasoline, jet and diesel fuel) are processed at much higher temperatures. Mercury would be driven off of these products to the fuel gas, and thus it is not surprising that the liquid products have low concentrations of mercury. Although it is noted that the premium grade fuels showed order-of-magnitude higher levels of mercury than the regular fuels. The additional octane in premium fuels originates from alkylate that is produced using a sulfuric acid alkylation process. The entrained sulfuric acid and increased solubility of mercury in the alkylate would likely explain the higher mercury levels in the premium fuels.

3.0 Mercury Mass Balance

Details of the mass balances for 2000 and 1990 are provided in Figures 1 and 2, respectively. The 2000 mass balance is constructed using quantity data from 1999 and sampling and analysis data from June 2000 and is presented first because it is believed the 2000 mass balance has the better data regarding quantities and Hg concentration data.

The 1990 balance was developed from the 2000 balance. Relationships between the quantity of crude oil and quantity of products in the 2000 balance were used in the 1990 balance to derive estimates of quantities and subsequently the mass of Hg. Some of the data from the 2000 balance was used directly in the 1990 balance and is identified in the footnotes. Table 7 provides a summary of the mass balances and identifies a number of similarities and differences which are discussed further below.

Table 7. Summary Table of Mercury Inputs and Outputs for the 2000 and 1990 Mass Balances.

2000 SUMMARY: INPUT/OUTPUT	Lbs Hg	Total (lbs)	% of Input	% of Output	Environ. Release* (lbs)
Input:		80.6			
Crude oil	77.8		97%		
Other	2.7		3%		
Output:		26.4	33%		
Products (byproducts)	15.8		20%	60%	
Solid Waste	1.4		2%	5%	1.4
Water	0.1		0%	0%	0.1
Air	9.2		11%	35%	9.2
Unaccounted (Inputs – Outputs)		54.0	67%		
Hg Release Sum (lbs)					10.7
Potential Hg Release (lbs) per MMBbls**					0.12
1990 SUMMARY: INPUT/OUTPUT	**Lbs Hg**	**Total (lbs)**	**% of Input**	**% of Output**	**Environ. Release* (lbs)**
Input		62.1			
Crude oil	60.2		97%		
Other	1.9		3%		
Output:		25.8	42%		
Products (byproducts)	10.1		16%	39%	
Solid Waste	6.9		11%	27%	6.9
Water	0.8		1%	3%	0.8
Air	8.0		13%	31%	8.0
Unaccounted (Inputs – Outputs)		36.3	58%		
Hg Release Sum (lbs)					15.7
Potential Hg Release (lbs) per MMBbls**					0.23

* Environmental Release: Includes Hg in solid waste, water, and air emissions. Unaccounted Hg is not included as an environmental release. Products are used by other entities and are not considered a release to the environment by either the Pine Bend refinery or KPG-MN.

** Potential Mercury release in pounds per million barrels (MMBbls) of crude oil processed = Env. Release / crude oil input MMBbls

Figure 1
Koch Petroleum Group - Pine Bend Refinery
Mercury Mass Balance - 2000*

PROCESS INPUTS	REFINERY PROCESS	PROCESS OUTPUTS

PROCESS INPUTS

COMPOUND	Throughput Mass	Units	Pounds	[Hg] ppb	Hg Mass lb/year
Crude Oil Tanks				1.15 - 5.2	
Crude Oil [1]	8.873E+07	barrels	2.83E+10	2.75	77.89
Crude Oil Tank Sludge [1b]	3.150E+02	tons	630,000	5.25	0.003
Natural Gasoline & Gasoil [2]	8.375E+05	barrels	2.17E+08	.0.4-1.7	0.370
Butane and Natural Gas [3]	8.213E+06	MMBtu		5.10E-07	2.09
Catalysts [4]			4.95E+06	0.4 - 1.1	0.005
Sulfuric Acid [5]					0.205
Caustic soda [6]			8.34E+06	<1	0.004
Ground Water [7]					
Prod. Well 3 (Jordan Aquifer)	1.37	BG	1.14E+10	0.00022	0.003
Prod. Well 5 (Hinkley Aquifer)	1	BG	8.34E+09	0.00207	0.017
Corrosion Inhibitors/Additives [8]					
Activated Carbon [9]					
Nitrogen (from air) [10]					
TOTAL Hg INPUT					80.6

INPUT/OUTPUT SUMMARY	Lbs Hg	Total	% of Input	% of Output	Environ. Release
Input:		80.6			
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Other	2.7		3%		
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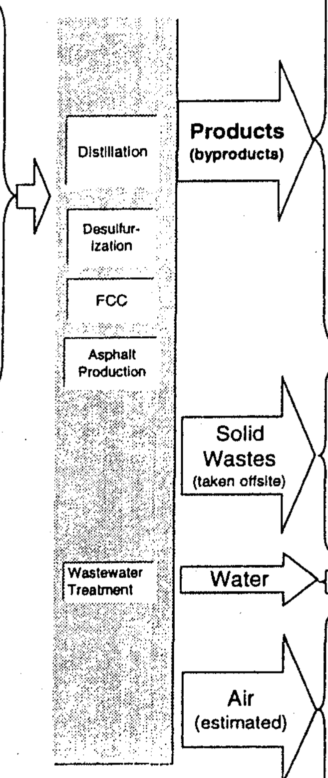
Solid Waste	1.4		2%	5%	1.4
Water	0.1		0%	0%	0.1
Air	9.2		11%	35%	9.2
Unaccounted (Inputs - Outputs)		54.1	67%		
Hg release sum (lbs)					10.7
Hg release, lb/MMBbls)					0.12

*Based on 1999 throughputs; 2000 Hg concentration data (Cebam Analytical)
Mercury (Hg) concentrations in ppb (ng/g for solids; ng/mL for liquids)

Footnotes contain confidential business information and are available for MPCA review upon request to KPG.

REFINERY PROCESS



PROCESS OUTPUTS

COMPOUND	Throughput Mass	units	Pounds	[Hg] ppb	Hg Mass lb/year
Products (byproducts)					
Carbon dioxide [11]				NA	
Butane and Propane [12] [Hg conc: lb/MMBtu]				5.10E-07	2.210
Gasoline [13]				<0.1 - 1.7	1.018
Other (non-ethanol)					
Ethanol Blends					
Aviation Gas 80 (no lead)					
Premium 91 **					
Regular 87					
Fuel Oil [14]				<0.1 - 0.7	0.673
No. 1 Jet Fuel/Kerosene					
No. 2 Low Sulfur					
No. 4 Light Cycle					
No. 6 Comm. Fuel Oil **					
Residual Products					
VGO					
Asphalt [15]				<0.1	0.080
Pet Coke [16]				0.6 - 0.9	1.826
Sulfur [17]				10. - 20.	9.961
Solid Wastes (taken offsite)					
Sulfuric Acid [18]					0.348
Sludge [19]					
Combined Oily Sludge			2,308,111	99 - 397	0.916
Heat Exchanger Bundle Sludge			55,981	143.65	0.008
Spent Catalyst [20]				0.5 - 360.9	0.016
Guardbed catalysts **					
Spent Hydrotreater					
Spent Platformer					
Miscellaneous [21]			2.66E+07	0.9 - 7.4	0.138
Water					
Wastewater Discharge [22]	1.3	BG	1.08E+10	0.005	0.053
Air (estimated)					
Natural Gas Combustion [23] [Hg conc: lb/MMBtu]	730,584	MMBtu		2.55E-07	0.186
Fuel Oil (residual) Combustion [24] [Hg conc: lb/MMBtu]	1,079,232	MMBtu		9.10E-07	0.982
Fuel Gas Combustion [25] [Hg conc: lb/MMBtu]	27,164,760	MMBtu		2.55E-07	6.927
Other Est. Emissions [26]				0.4 - 2.75	1.105
Coke Burn at the FCC					
Decoking					
FCC Gasoil Processing Particle Emissions					
Fugitive Pet Coke Loading Emissions					
Wastewater Treatment Plant Thermal Oxidizer					
Flares (intermittent)					
TOTAL OUTPUTS					26.4

** Highest Hg concentration in that group
(e.g. Premium 91 has highest Hg concentration among gasoline blends)

4.0 Summary and Conclusions

KPG-MN has conducted a mass balance evaluation for the Pine Bend refinery as part of the MPCA's Voluntary Mercury Reduction Program. Additional efforts may be warranted after reviewing this and other information further. The results of this evaluation show the following:

- <u>2000 Mass Balance and Current Releases of Mercury</u>

  - Hg in blended crude oil processed at the Pine Bend refinery ranges in concentration from 1.1 to 5.4 ppb (June 2000 data). Samples were collected in duplicate from each of seven storage tanks. A total of 27 individual crudes made up the blended crude sampled from the seven tanks. In comparison, Hg in unblended crude oil sampled in 1998 by the Minnesota Office of Environmental Assistance (MOEA)/MPCA from the Pine Bend refinery showed Hg concentrations ranging from 3.7 to 13.5 ppb (MOEA, 1999; Cebam data). Samples were collected in duplicate in 1998 from three unblended crudes (MOEA, 1999).

  - About 80 pounds per year of mercury currently enter the refinery; 97% from crude oil.

  - Approximately one-third of the incoming mercury is accounted for in the outputs of the mass balance.

  - Approximately 20% percent of the incoming mercury is found in products – mostly in sulfur and petroleum coke.

  - Little mercury is present in transportation fuels (gasoline, jet fuel, diesel fuel) produced by KPG-MN; thus, mobile sources using KPG-MN fuels would not be expected to be a large source of mercury to the environment.

  - Water releases of mercury are less than 0.1 pounds per year; less than 1/10th of 1% of incoming mercury is released to the Mississippi River.

  - Waste releases of mercury are less than 1.5 pounds per year; less than 2% of incoming mercury is released as waste.

  - Using available data, refinery air emissions are estimated to be less than 10 pounds per year. If all unaccounted mercury is assumed to be air releases, air releases of mercury could be as much as 60 pounds per year.

Figure 2
Koch Petroleum Group - Pine Bend Refinery
Mercury Mass Balance - 1990*

PROCESS INPUTS

COMPOUND	Throughput Mass	Units	Pounds	[Hg] ppb	Hg Mass lb/year
Crude Oil[1]	6.861E+07	barrels	2.19E+10	2.75	60.227
Crude Oil Tank Sludge[1b]	1.000E+00	tons	2,000	5.25	0.000
Natural Gasoline & Gasoil[2]	8.339E+05	barrels	2.16E+08	0.4 -1.7	0.367
Butane & Natural Gas[3]	2.638E+06	MMBtu		2.55E-07	0.673
Catalysts[4]			4.15E+06	0.4 - 1.1	0.005
Sulfuric Acid[5]					0.158
Caustic soda[6]			8.34E+06	<1	0.004
Ground Water[7]					
Prod. Well 3 (Jordan Aquifer)	1.12	BG	9.34E+09	0.00022	0.002
Prod. Well 5 (Hinkley Aquifer)	1.49	BG	1.24E+10	0.00207	0.026
Corrosion Inhibitors/Additives[8]					
Activated Carbon[9]					
Nitrogen (from air)[10]					
Sulfur[11]					0.658
TOTAL Hg INPUT					62.1

REFINERY PROCESS

- Distillation
- Desulfurization
- FCC
- Asphalt Production
- Wastewater Treatment

PROCESS OUTPUTS

	COMPOUND	Throughput Mass	units	Pounds	[Hg] ppb	Hg Mass lb/year
Products (byproducts)	Carbon dioxide[12]					
	Butane and Propane[13] [Hg conc: lb/MMBtu]				2.55E-07	0.165
	Catalyst, FCC (spent)[14]				3.7	0.009
	Gasoline[15]				<0.1 - 1.7	0.720
	Aviation Gas 80 (no lead)					
	Premium 91 (no lead) **					
	Regular 87 (no lead)					
	Reg.+Ethanol+MidGrade					
	Fuel Oil[16]				<0.1 - 0.7	0.026
	No. 1 Jet Fuel/Kerosene					
	No. 2 Low Sulfur					
	No. 4 Light Cycle					
	No. 6 Comm. Fuel Oil **					
	Asphalt[17]				<0.1	0.047
	Pet Coke[18]				0.9	1.766
	Sulfur[19]				10 - 20	7.349
Solid Waste	Sulfuric Acid[20]					0.268
	Sulfuric Acid (weak)[21]					0.003
	Sludge[22]					
	Combined Oily Sludge (DAF Float)			1.59E+07	397	6.315
	Heat Exchanger Bundle Sludge			70,000	143.65	0.010
	Spent Catalyst[23]			-	0	0.000
	Miscellaneous Solid Wastes[24]					
	FCC ESP Solid Waste				1.2	0.000
	Pet Coke with Dirt				0.9	0.000
	Hydrocarbon Contaminated Soil/Sludge (landfarmed)[25]			779,328	7.4	0.006
	Other Waste Shipped Off-site[26]			7,100	<0.1	0.000
	Asphalt (in containers, spills)			81,240	20.4	0.002
	Sulfur spill			1,000		
	Leaded tank bottoms			25,856		
	Nickel filter sludge			11,009	2.75	0.000
	Oil spill cleanup			3,753	2.75	0.000
	Used Oil					
	Other Landfarmed Waste[27]			1,244,000	213.3	0.265
Water	Wastewater Discharge[28]	1	BG	8.34E+09	0.1	0.834
Air (estimated)	Natural Gas Combustion[29] [Hg conc: lb/MMBtu]	2,637,910	MMBtu		2.55E-07	0.673
	Fuel Oil Combustion[30] [Hg conc: lb/MMBtu]	2,280,650	MMBtu		9.10E-07	2.075
	Fuel (Process) Gas Combustion[31] [Hg conc: lb/MMBtu]	16,578,912	MMBtu		2.55E-07	4.228
	Coke Burn at the FCC[32] [Hg conc: lb/MMBtu]			3.79E+08	2.75E-09	1.041
	Other Estimated Emissions[33]				0.9 - 2.75	0.000
	Decoking					
	FCC Gasoil Processing Particle Emissions					
	Fugitive Pet Coke Loading Emissions					
	Wastewater Treatment Plant Thermal Oxidizer					
	Flares (intermittent)					
	TOTAL OUTPUTS					25.8

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(e.g. Premium 91 has highest Hg concentration among gasoline blends)

INPUT/OUTPUT SUMMARY	Lbs Hg	Total	% of Input	% of Output	Environ. Release
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Air	8.0		13%	31%	8.0
Unaccounted (Inputs - Outputs)		36.3	58%		
Hg release sum (lbs)					15.7
Hg release, lb/MMBbls					0.23

*Based on 1999 throughputs; 2000 Hg concentration data (Cebam Analytical)
Mercury (Hg) concentrations in ppb (ng/g for solids; ng/mL for liquids)

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- The measured mercury concentration with the most uncertainty is for the sulfur product. A relatively small difference in the concentration of mercury in the sulfur product could account for much of the unaccounted for mercury due to the relatively large output of the sulfur product from the refinery. The sulfur product is a difficult matrix to analyze and Cebam is continuing its own efforts to provide an alternative determination of mercury in the sulfur product by the Radiochemical Neutron Activation Analysis (RNAA) method. Additional mercury concentration data from the RNAA method may result in changes to the mass balance calculations.

- An additional source of uncertainty is the Hg concentration of gases produced during the refining process (butane, propane, fuel gas).

- **Mercury Reduction Since 1990**

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Metropolitan Council Environmental Services
Voluntary Mercury Reduction Agreement

2000 ANNUAL REPORT
March 1, 2001

1.0 Introduction and Background

The Metropolitan Council Environmental Services (MCES), a division of the Metropolitan Council, submitted a Voluntary Mercury Reduction Agreement (VMRA) to the Minnesota Pollution Control Agency on December 28, 2000. The VMRA summarizes the past actions and outlines the commitments under this agreement, according to topic area. This annual report describes the activities and accomplishments that occurred during the year 2000. These activities and accomplishments are arranged using the same major headings found in the VMRA.

2.0 Control of Discharges to the MDS

- In 1998, MCES lowered its Local Limit from 100 µg/l to 2 µg/l. During 2000, MCES continued to administer this limit for industries discharging to MCES. If mercury was found at significant levels in wastewater from industries, MCES worked with the industries to identify sources and requested that they minimize their mercury loadings. MCES wrote "case studies" describing the situation so that other staff could learn about sources of mercury and ways to minimize the discharge of mercury. Five such case studies were prepared in 2000. If an industry's discharge levels were above the local limit, MCES issued a Notice of Violation (NOV), which required more formal investigation and reduction efforts by the industry. Two such NOVs were issued in 2000.

- A Dental Amalgam Removal Equipment Evaluation continued through 2000. See Attachment No. 1 to this Annual Report showing the monitoring of advanced amalgam removal equipment at local dental clinics. The attachment shows both the monitoring done in 1999 and in 2000. Data tabulation began in 2000 and is being completed as of the writing of this Annual Report.

- Method development to improve the reproducibility and recovery of sludge mercury analytical methods was completed in 2000 by MCES Laboratory Services staff. This effort was undertaken to improve data reliability. As a result of this method development, sample preparation procedures and analytical digestion procedures were modified.

- The Community-wide Dental Amalgam Removal Study, a cooperative study with the Minnesota Dental Association and the Cottage Grove and Hastings area dentists continued during 2000. For approximately a 3-month period, amalgam removal equipment was installed in all Hastings dental offices. This equipment was subsequently removed and will be installed in the Cottage Grove dental offices during 2001. Daily sludge samples are being collected at the Cottage Grove and Hastings Wastewater Treatment Plants and monitored for mercury concentrations. The sludge mercury concentrations will be evaluated during the course of this study in order to determine if additional removal equipment results in a decrease of mercury at the treatment plants.

3.0 Policy-Related Actions

- MCES continued to participate in the Minnesota Mercury Contamination Reduction Initiative and Advisory Council.

- MCES is supporting the 2001 legislative program of the Minnesota Office of Environmental Assistance (MOEA) that seeks to phase out the use of mercury fever thermometers.

- The Metropolitan Council has taken action to change its dental insurance policies for its own employees to encourage the use of mercury-free posterior restorations (dental cavity fillings). Previous dental policies were negotiated to allow employees and dependents to select mercury-free composites, but would only cover up to the cost of a mercury amalgam filling. In 2000, the Council negotiated a new contract with its dental provider that removes the financial disincentive for employees and their dependents to select the mercury-free alternative. The additional coverage for approximately 8,000 employees and their dependents costs approximately $8,000 per year.

- In 2000, MCES awarded $1.7 million of the $7.5 million in grant monies available (over a five-year period - 1999-2004) to reduce non-point source (NPS) runoff. Since mercury strongly associates with soil particles, reductions in NPS runoff will lead to reductions in mercury in runoff to surface waters.

- In 2000, MCES completed its $1.375 million targeted grant program for Infiltration and Inflow (I/I) removal from local collection systems. Since mercury can be found in I/I, its removal will lead to a decrease in mercury to wastewater treatment plants.

4.0 External Pollution Prevention

- MCES worked with staff at the University of Minnesota (Environmental Health and Safety) to determine how to treat the wastewater discharged from the 370 operatories (chairs) used within the University Dental School. A new "air/water separator" tank was installed in 2000 that was designed with help from MCES. This tank includes new plumbing and electronic control features to accommodate installation of advanced filtration equipment. The filtration equipment is scheduled for installation in the second quarter of 2001.

- MCES has been an active participant in the Mercury Work Group of the Association of Metropolitan Sewerage Agencies (AMSA), a trade group of major publicly owned treatment works (POTW). This group has been active in persuading the U.S. Environmental Protection Agency (EPA) to resume validation testing of EPA's mercury Method 245.7 and conducting follow-up sampling of EPA's 1994 study of Great Lakes POTWs. The AMSA work group has prepared a Domestic Waste Characterization Study that has been presented to EPA. MCES contributed to the study by characterizing mercury in domestic-only wastewater and in report preparation.

- In 2000, MCES set up a partnership with Park Nicollet Health Services (then called HealthSystem Minnesota) and the Minnesota Technical Assistance Program. PNHS operates Methodist Hospital and other medical clinics. As one example of this partnership, MCES is providing services for analysis of various hospital reagents and chemicals to determine mercury concentrations in frequently used materials, and PNHS will provide staff support and access to their facility. This work will complement PNHS' use of a MnTAP intern in 2000 to identify uses of mercury and alternative products.

- MCES has been an active participant in MOEA's Healthcare Industry Environmental Management Advisory Group, by attending meetings and making contributions to the group in 2000. MCES also spoke to the Twin Cities Healthcare Engineers' Association to inform them of our concerns regarding minimizing mercury discharges to the sanitary sewer.

- As part of a cooperative project, MCES contributed staff time in 2000 to help write a protocol to test advanced amalgam removal equipment in dental clinics. This protocol is being put together by NSF International for EPA as part of the "Environmental Technology Verification Program" or "ETV".

5.0 Internal Pollution Prevention

- In 2000, MCES reviewed its previously prepared inventory of mercury containing devices and has prioritized replacement with non-mercury containing items as appropriate. A total of ten pounds of liquid mercury, 4,229 mercury containing fluorescent light tubes, and twenty pounds of mercury-containing switches and other mercury-containing devices have been recycled.

- MCES staff that conduct demolition have been informed that all mercury-containing devices must be removed and recycled prior to demolition.

- A warning poster was designed by MCES to alert operations and maintenance personnel of buildings and areas that contain mercury-containing devices. The poster describes devices that contain mercury and the procedures to follow if the device needs to be repaired, removed or a spill occurs. This poster has been placed throughout MCES facilities at appropriate locations.

- MCES experimented with contract language in capital projects that restricts the use of mercury-containing devices. For example, the South Washington

County Wastewater Treatment Plant Request for Proposals (RFP) contained a prohibition on mercury-containing devices except for those with MCES approval. Types of devices that would be allowed include fluorescent and ultraviolet lamps because they can be recycled.

- MCES has eliminated the use of mercury-containing thermometers in the laboratory and in the wastewater sample refrigerators at the WWTPs. In addition, where possible, MCES has eliminated or reduced the frequency of use of some analytical methods because they contain mercury. For example, MCES has requested the elimination of NPDES permit requirements to analyze effluent samples for total Kjeldahl nitrogen, since the reagent contains mercury.

- In 2000, MCES conducted several mercury fever thermometer exchanges for its employees. For each mercury-containing thermometer that was brought in, employees were given a mercury-free digital thermometer at no cost to the employee. Each digital thermometer costs $3.29. Approximately 288 mercury fever thermometers were collected for recycling through this program.

- MCES has continued its research and development activities utilizing a previously developed research analytical method to determine mercury ultra-trace concentrations on 40 sediment samples for the Lake St. Croix Sediments Study, in partnership with the Science Museum of Minnesota. This study is funded through a Metropolitan Council MetroEnvironment Partnership grant.

- Also during 2000, the MCES utilized its ultra-trace research analytical method to continue to determine mercury concentrations from nonpoint sources on the Minnesota River. A total of 240 water samples were analyzed for total mercury and 140 water samples were analyzed for methyl mercury.

- During 2000 MCES characterized mercury concentrations in drinking water of two metropolitan area cities and found mercury to be present in very low concentrations of 1 nanogram per liter or less in the eight sites that were surveyed.

- In May 2000, MCES completed construction of a new production-oriented laboratory facility that is designed with a clean room. The clean room is designed for low-level analytical methods to be conducted.

- An automated mercury analyzer was upgraded to include the gold amalgam trap necessary to perform low-level mercury analyses with EPA Method 1631. Method development work continued throughout 2000 in order to obtain the required minimum detection level (MDL) for subsequent certification by the Minnesota Department of Health.

- Procedures have been developed and implemented to use EPA Method 1669, for collection of low-level mercury samples at the Cottage Grove Wastewater Treatment Plant.

6.0 Technology-based Controls – Liquid Treatment Processes

- MCES evaluated the cost and effectiveness of technology–based controls for mercury removal from municipal wastewater effluents at the Cottage Grove/South Washington County Wastewater Treatment Plant (1999) and as part of the Rosemount Wastewater Treatment Plant Interim Improvements Project (2000). These evaluations found that it is not cost effective to provide technology–based controls for end of pipe removal of mercury from these types of effluents, particularly on a cost per pound removed basis.

- MCES is a MnGREAT! Award Recipient for 2000. The award recognizes the Metro Plant for innovations in energy recovery and wastewater handling technology. The energy savings prevent 173 tons of nitrous oxides, 512 tons of sulfur oxides, 58,500 tons of carbon dioxide and 1.04 pounds of mercury in air emissions per year.

Technology-based Controls – Air Emissions Processes

- The Council has initiated the Metro Solids Processing Improvements Project to replace the aging multiple hearth incinerators and air pollution control (APC) systems at the Metro Plant with new combustion technology (fluidized bed incinerators) and accompanying APC systems. The Council will provide in the new APC systems the capability to treat exhaust gases with carbon which is expected to achieve a goal of reducing mercury in air emissions by approximately 70% from current emission estimates (1997). Procurement of these new systems began in early 2000. The design build selection process began with the prequalification of five potential design build contractors. A total of two proposals were submitted to MCES in July 2000. Following review of the proposals and negotiations with each of the respective contractors, a Notice of Award was issued to VonRoll, Inc. in December 2000 for the design and construction of the fluidized bed incinerators and accompanying APC systems. Issuance of the notice to proceed is dependent on the issuance of the air emissions permit amendment. Operation of the new facilities is scheduled to begin in 2005.

- The cost for the carbon injection technology and the enhanced particulate removal technology, which is integral to enhanced mercury removal, is approximately $5.7 million.

7.0 Mercury Reductions Achieved

- Previous actions taken to control sources of mercury discharged to the collection system have resulted in a reduction of mercury concentrations in Metro Plant sewage sludge from approximately 3.0 milligrams per kilogram (mg/kg) in 1990 to 1.25 mg/kg in 2000.

8.0 VMRA Administration

- MCES agreed to provide an annual report of the progress made under the VMRA by March 1 of each year for the preceding calendar year. This report fulfills that commitment.

ATTACHMENT NO. 1

Overview of MCES 1999-2000 Monitoring of Dental Clinics
Minneapolis – St. Paul Minnesota Metropolitan Area

Baseline Monitoring:		Number of Weeks
Dr. K:	August 16, 1999 – September 8, 2000	4
B.D. Clinic:	August 20, 1999 – September 13, 1999	3
Dr. L:	November 12, 1999 – January 6, 2000	8
Dr. Mc:	July 5, 2000 – August 23, 2000	7
Dr. Mdj:	July 12, 2000 – August 16, 2000	5
Asdex Filters (by Avprox, Inc.):		
Dr. K:	July 22, 1999 – August 13, 1999	3
B.D. Clinic:	August 3, 1999 – August 20, 1999	3
Dr. L:	September 7, 1999 – October 1, 1999	4
"Fraker Tank" (The Amalgam Collector, by R&D Services, Inc.)		
Dr. K:	September 8, 1999 – September 29, 1999 (1st tank)	3
Dr. K:	September 29, 1999 – November 4, 1999 (2nd tank)	5
B.D. Clinic:	September 13, 1999 – October 1, 1999 (1st tank)	3
B.D. Clinic:	October 11, 1999 – November 8, 1999 (2nd tank)	4
Dr. L:	October 4, 1999 – November 12, 1999 (1st tank)	6
Durr Centrifuge:		
Dr. Tyr:	June 21, 2000 – August 9, 2000	7
Dr. Mc:	August 23, 2000 – September 27, 2000	5
Rebec Settling/Filtration System:		
Dr. Tm:	August 7, 2000 – September 28, 2000	8
Dr. Mdj:	August 16, 2000 - September 20, 2000	5
Metasys ECO II Settling System:		
Dr. Mdj:	September 20, 2000 – October 25, 2000	5

The study of the above systems is being done under a partnership with the Minnesota Dental Association. A review panel has been established to review the testing protocol and the draft report, when it is completed.

The dates above are the dates that the equipment was in place at the clinics. Wastewater samples were collected for the vast majority of these time periods. Most, but not all, of the solids collected within the amalgam removal systems were analyzed.

minnesota power / 30 west superior street / duluth, minnesota 55802-2093 / 218-722-5642 / www.mnpower.com

August 15, 2001

Mr. John Wachtler
Minnesota Pollution Control Agency
520 Lafayette Road
St. Paul, MN 55155

RE: Minnesota Power Mercury Voluntary Agreement Progress Report

Dear John,

Enclosed is a report summarizing the progress Minnesota Power (MP) has achieved in implementing our Mercury Voluntary Agreement ("Agreement") with the MPCA. As you know, MP submitted the Agreement to the MPCA on July 6, 2000. The enclosed report briefly summarizes the activities implemented to date, and activities that are planned for the future.

Please let me know if you would like any further details on the activities summarized, or have any other questions or comments related to our Agreement. I can be reached at 218-722-5642, extension 3423.

Sincerely,

Tim Hagley

Tim Hagley

MINNESOTA POWER PROGRESS REPORT ON OUR MERCURY VOLUNTARY AGREEMENT SUBMITTED TO THE MPCA AUGUST 15, 2001

SECTION 1. INTRODUCTION

Minnesota Power (MP) supports the Minnesota Mercury Contamination Reduction Initiative, and the Advisory Council recommendations that culminated from that effort. One recommendation of the Advisory Council was for mercury sources to enter into voluntary agreements with the MPCA that detail action items to reduce or work towards reducing mercury releases. MP submitted a Mercury Voluntary Agreement to the Minnesota Pollution Control Agency (MPCA) on July 6, 2000, that described our commitment to explore additional opportunities to further reduce mercury. MP submits this progress report to outline the activities that have been implemented to date, and any additional activities that are planned for the future or are being evaluated at this time.

For many years, MP has had a mercury reduction program. MP has been and continues to be actively involved in trying to develop solutions to the mercury issue. Past activities include such things as voluntary emissions testing and environmental monitoring, co-sponsoring mercury control technology studies, and various mercury product and waste management programs for MP and our customers. These activities are summarized in more detail in the Mercury Voluntary Agreement document referenced above.

SECTION 2. EFFORTS TO ADDRESS STACK MERCURY EMISSIONS

Efforts that MP has undertaken over the past year to address stack emissions of mercury are summarized below. These efforts focused on achieving feasible short-term mercury emission reductions, characterization of our mercury releases and related inputs and outputs, and focused control technology research aimed at finding solutions for longer-term, more significant emission reductions. As a result of these activities, we have reduced mercury emissions between 1990 and 2000 at our coal fired facilities in Minnesota by approximately seventeen percent, while the amount of electricity generated at these same facilities increased over the same time period.

Increase Utilization of Lower Mercury Coal

MP has determined through routine coal mercury analyses that one of the coals we currently burn in our boilers is consistently lower in mercury than the other coals. We have increased the amount of coal that we purchase from that coal supplier by approximately two-and-a-half times beginning in the year 2000.

Use of this coal has already affected mercury emission rates. Emission factors developed during the stack testing conducted in year 2000 at the Boswell Energy Center are representative of the new coal mix. Progress towards reducing mercury is measured by the relationship between the lower emission rates associated with the current coal blend, compared to the emission rates measured in 1993 and 1994 under the old operating regime. However, actual annual emissions are also related to the amount of coal consumed during the year.

MP recently submitted to the MPCA year 2000 estimated emissions of mercury (Letters addressed to Dr. Edward Swain, dated April 13 and April 17, 2001, revised in a letter dated August 13). MP has three coal-fired generating stations which we own or operate, all located in Minnesota: Boswell Energy Center (Boswell) located in Cohasset, Laskin Energy Center (Laskin) located in Aurora, and Hibbard Energy Center (Hibbard) located in Duluth. The Hibbard facility, fueled principally with waste wood, operates primarily to provide steam to a paper mill. Mercury emissions for the year 2000, as summarized in the above-referenced letters to the MPCA, totaled approximately 286 pounds for the three facilities. Estimated mercury emissions from these three facilities totaled 343 pounds in year 1990. This represents a reduction in mercury emissions from year 1990 to year 2000 of approximately 57 pounds, or 17 percent. This was accomplished while at the same time there was a slight increase in overall electricity production from these facilities. This reduction in mercury emissions is believed to be attributable primarily to the change in fuel blend.

Future Planned Activities: MP intends to continue burning the lower mercury coal in amounts comparable to the year 2000. MP will also continue to consider mercury along with other environmental and operational factors when making coal supply decisions in the future.

Control Technology Research

Boswell Control Technology Study

MP conducted control technology studies specifically on some of our own units in 2000. Minnesota Power worked with EPRI to assess mercury emissions from our Boswell facility and conduct control technology experiments. The objectives of the study were to evaluate flue gas mercury concentration, mercury speciation, and removal effectiveness for the existing air pollution control equipment at Boswell, assess potential options to further reduce stack mercury emissions to different levels, and project feasibility and cost impacts.

The study looked at various mercury control options using a slipstream of flue gas. The effort focused on Boswell Units 3 and 4, the two largest units in our system in Minnesota. This study was conducted in 2000, with a final report issued in June 2001. Preliminary results were presented to the MPCA in early June.

Response to DOE's Mercury Control Technology Solicitation

In March 2000, DOE issued a financial assistance solicitation, "Testing And Evaluation Of Promising Mercury Control Technologies For Coal Based Power Systems". MP teamed up with WEPCO, EPRI, URS Corporation, Apogee Scientific, the Illinois State Geological Survey, the University of Illinois at Urbana-Champaign, Corning Incorporated, Meserole Consulting, and Pall Corporation to submit a proposal to DOE in response to their solicitation under Topic 4 of the solicitation ("Testing Novel and Less

Mature Control Technologies on Actual Flue Gas at the Pilot-Scale"). The objective of this project was to evaluate the ability of fixed sorbents to remove mercury. MP volunteered our Boswell facility as a host site for evaluating the effectiveness of these novel technologies for facilities that burn sub-bituminous coal. MP also offered some funds and in-kind services for this project. Unfortunately, this project was not chosen for funding by the DOE.

Evaluation of Other Novel Mercury Control Technologies
Minnesota Power has actively pursued other potentially promising mercury control technologies over the last year. These are novel concepts that are at the experimental stage, and therefore are proprietary. Because of this, detailed descriptions are not possible.

One project looked at a specific approach to remove mercury from the coal prior to injecting it into the furnace. The added benefit of this process, if it works, is to keep the mercury-laden material separate from the ash, making disposal easier. Pilot test screening of the sub-bituminous coals that MP utilizes showed that the separation process was not very effective at removing mercury. The process shows more promise with bituminous coals. Based on the results of the pilot test, the cost of this technology would be somewhat comparable to EPA's estimates of removal costs (1997 EPA Mercury Report to Congress). However, due to the relatively low removal effectiveness, MP made the decision to not pursue this control option further at this time.

Two other potential mercury control technologies are still being evaluated. One is looking at possible co-benefits for mercury removal by a multi-pollutant control technology. The other project is looking at mercury control through oxidation using a proprietary material, and subsequent capture by the scrubber. These programs are still in the developmental stages.

Research Support
MP has in the past supported control technology research as a funding member of the Air Toxics Control Target of the Electric Power Research Institute (EPRI). As described in our voluntary agreement with the MPCA, MP also co-funded a study by the Energy And Environmental Research Center (EERC) on mercury mitigation technology. In the year 2000, MP has significantly increased our commitment to this type of research. MP continues to fund the Air Toxics Control and Air Toxics Health Risk targets of EPRI. MP has also increased our funding to EPRI for air toxics related activities by almost double, signing up for the Plant Multimedia Toxics Characterization (PISCES) target beginning in calendar year 2001.

Future Planned Activities: MP intends to continue mercury control research targeted specifically towards our facilities. MP is currently evaluating a proposal to conduct full scale testing of one or more promising control technologies at one of the units at our Laskin facility in 2002. Laskin offers a smaller unit which makes full scale experiments more manageable. Due to the fact that we have three units that are essentially identical (units 1 and 2 at Laskin, and the much larger unit 3 at Boswell), full scale testing at Laskin also has wider applicability for our system.

As described above, MP will also continue to explore those control technologies that still show some promise, and seek out other potentially viable control options for evaluation for our systems. At the same time, MP intends to continue funding EPRI targets which are geared towards addressing the mercury issue.

Characterize Mercury Emissions from Coal Combustion
MP volunteered to be a host site for a study assessing the fate of mercury in Lake Superior. The study did not receive full funding, however, portions of the study were conducted and included characterizing the flue gas mercury speciation and the capture efficiency of existing control devices. The study was conducted on Boswell units 2, 3 and 4 in March 2000. The results from the testing indicate that mercury emission rates are lower for all units tested than they were in 1993/1994, and that mercury emissions are primarily in the elemental form. The final report has been submitted to the MPCA, and includes a detailed discussion on QA/QC. The results of the study are useful in refining the emission inventory. The results are also relevant to assessing control technology options, due to the inclusion of speciated mercury analyses.

Future Planned Activities: No further stack testing is planned at this time. However, gathering emissions information will be an important component of any evaluation of control technologies specific to our facilities.

Routine Coal Mercury Monitoring
MP will continue to monitor coal mercury content on a routine basis to determine if there are any changes in coal mercury content over time from the various suppliers. This information will prove useful in developing accurate mercury inventory information, and aid in future decisions on coal procurement. Two samples from each coal supplier have been collected and analyzed on a quarterly basis beginning in March 2000. The analysis shows the same relative mercury concentrations of the various coals we burn as we saw in the Information Collection Request (ICR) data.

Future Planned Activities: Coal sampling on a quarterly basis is planned to continue at this time.

SECTION 3 EFFORTS TO ADDRESS MERCURY IN PRODUCTS

Efforts that MP has undertaken in the year 2000 to address mercury in products are summarized below.

Product Use Inventory Update
In 1994, MP conducted an inventory of products that we use which contain mercury. In the year 2000, MP conducted a product inventory at our two largest facilities, Boswell Energy Center and Laskin Energy Center. The inventory was updated by a walk-through of the facility to identify items that contain mercury.

Future Planned Activities: Information gathered through the inventory will be useful in developing an effective program for further phase-out of mercury-containing products. Mercury-containing products will be categorized based on the relative potential that mercury releases will occur from those products. A decision on whether to phase out a specific item and the timing of phase-out will be based on several criteria, such as the potential for actual release, the availability of reasonable mercury-free alternatives, and the cost. Dependent on the success of this program, other MP facilities may be inventoried as well.

Label Mercury-Containing Devices

One of the strategies included in the Advisory Council recommendations is to label mercury-containing devices currently in use. The purpose of labeling is to inform employees when they are working with mercury containing equipment, and to ensure proper handling and disposal. MP labeled devices that contain mercury at Laskin and Boswell as part of the inventory process described above. In addition to the labeling, employee environmental awareness training includes training on the purpose of the labels, and how items that are removed are to be recycled.

Update MP Purchase Policy for Mercury Products

MP has had a purchase policy in place for several years where items containing mercury can not be purchased if suitable substitutes exist. Since the policy was put in place, purchasing practices at MP have been modified somewhat. In order to ensure that the policy is still effective, a description of the policy and what it means for employees was included in the routine employee environmental awareness training.

Future Planned Activities: MP will continue to include a training module on proper purchase, use and disposal of mercury containing devices for our employees.

Evaluate the Purchase of Low Mercury Fluorescent Bulbs

MP originally intended to evaluate implementing a purchase policy that states that only low mercury fluorescent bulbs may be purchased. MP already purchases low mercury fluorescent bulbs at some locations within the company. However, preliminary results indicate that the low mercury bulbs may have a shorter life span. An assessment was to be conducted to determine if this is true. However, due to a change in the process for changing out bulbs, this assessment became impractical.

Future Planned Activities: No further internal evaluation is planned at this time.

Support Customer Mercury Waste Management

MP held meetings with relevant entities in portions of our service territory to determine whether there are gaps in the infrastructure for mercury-containing product waste management. It was determined that the most important role that MP could play would be to use the communication devices available to us (e.g., billing stuffers) to inform the public on the proper use and management of mercury-containing products. MP included in our April/May 2000 edition of the customer newsletter information on how and when to recycle mercury-containing devices. Also included was information on the Minnesota Department of Health Fish Consumption Advisory Booklet.

Future Planned Activities: MP will continue to evaluate opportunities to support our customers in mercury reduction activities.

Employee Mercury Thermometer Exchange

MP conducted a thermometer exchange program for our employees in the fall of 2000, where digital thermometers were provided free of charge to those employees that brought in their mercury fever thermometers. A total of 168 thermometers were collected and sent to a recycling facility. In addition to collecting the thermometers, information was provided to employees on identifying mercury-containing products in the home, the proper disposal of those products, and alternatives to mercury containing products.

Future Planned Activities: No further activity is planned at this time.

SECTION 4. RELATED RESEARCH AND INVENTORY ACTIVITIES

Summarized below are activities that MP has participated in that will not directly result in mercury reductions. However, these activities will enhance the understanding of human health risks associated with mercury in Minnesota.

Co-Sponsor Fish Consumption Study

MP supported research activities relevant to the state mercury issue by co-sponsoring a fish consumption survey conducted by the EERC. The study has been completed, and the report is being finalized.

Future Planned Activities: No future activities are planned at this time.

Fish Tissue Monitoring

MP has voluntarily conducted fish tissue monitoring for mercury over the past several years on the headwater reservoirs of the St. Louis River watershed. In 2000, MP conducted mercury analysis of fish tissue from Rice Lake reservoir and provided the data to the Minnesota Department of Natural Resources (DNR). A total of 30 northern pike and 31 walleye were analyzed.

Future Planned Activities: In 2001 Whiteface reservoir was sampled by the DNR. MP has just received 26 walleye and 22 northern pike tissue samples which we will have analyzed for mercury.

July 11, 2001

NORTH STAR STEEL VOLUNTARY MERCURY REDUCTION INITIATIVE PROGRESS REPORT

1.0 INTRODUCTION

This report summarizes the actions North Star Steel has taken to reduce mercury emissions and reviews related issues. North Star Steel (NSS) is a steel mini-mill. The steel we recycle makes up 95 to 97 percent of our finished steel product. Steel recovered from "end-of-life" vehicles makes up approximately one-third of our raw materials. We receive all our end-of-life vehicles from third party companies who prepare the vehicles for recycling. There is an existing Minnesota law requiring that our suppliers make their "best efforts" to remove mercury switches from end-of-life vehicles before they reach our facility.

Since 1990 NSS has accomplished reductions in the emissions of particulate metals including mercury. Excluding the use of fabric filters to remove metals in particulate form, there is no steel mill in the world that currently has pollution control equipment specifically designed to remove gaseous mercury from its air emissions.

NSS's voluntary mercury reduction initiative agreement focuses on gaseous mercury. It was the first agreement submitted to the state and was done prior to finalization of the program guidelines. Our main goal is source reduction. Prior to our recent efforts under the mercury reduction initiative we had performed no quantification or speciation of gaseous mercury emissions from our facility. The initial goal of our reduction initiative was strictly to quantify gaseous mercury emissions and their sources. These efforts included the proposal to develop a facility mercury mass balance by sampling all raw materials, products and emissions from our facility for mercury.

2.0 INITIATIVES

Following is a short summary of the mercury reduction initiatives undertaken by NSS. Resulting reductions are discussed in Section 3. Related costs are provided where possible. Please note that all costs exclude staff time.

2.1 Mercury Lamp Recycling

Mercury lamp recycling began in 1993. All spent mercury containing lamps in the facility are collected and recycled. Our recycling fees are approximately $1,500 per year.

2.2 Plant Improvements:

A new baghouse was constructed in 1992 at a cost approximately $10 million dollars. Emissions from the melt shop building were eliminated by constructing a sealed building to contain our new processing equipment in 1993-1994 as part of a $40 million dollar plant renovation. We also installed a wet scrubber at our metal shredder in 1997 at a cost of approximately $1 million dollars.

2.3 Mercury Switch Collection Program

NSS established its mercury switch collection program in 1997 and expanded it in 2000. We have now committed thousands of dollars each year to offering free disposal and a bounty of $40/lbs for mercury switch pellets our suppliers remove from their vehicles and deliver to North Star Steel. Mercury switch removal is viable. We have several suppliers who inspect every vehicle and perform removal.

2.4 Mass Balance Study 2000.
In December 1999 NSS submitted a mass balance to the MPCA. It was a $30,000 effort and was the first such mercury project for a steel minimill in this country. This work clearly indicates that source reduction of mercury in scrap is the primary technique to reduce emissions. Difficulties were encountered in sampling and in developing a laboratory procedure that accurately measured mercury on scrap metal. This is obviously a critical factor in our efforts to achieve effective source reduction. There are problems in obtaining representative samples from scrap steel that ranges in size and shape from bridge support beams to heavily contorted shredded fragments of automotive metal. Since there are no reliable/accepted analytical methodologies to measure mercury, a methodology was developed. We were not able to overcome the difficulties in obtaining representative samples.

Initial measurements indicate that approximately 60 percent of the mercury entering our steel mill is captured and that mercury occurs in coatings on scrap steel. The mercury actually in the steel itself occurs at levels below the MPCA background value of 0.01 ppm and only accounts for less than ten pounds a year entering our process. Since approximately two-thirds of our scrap material comes pre-processed from large scrap brokers throughout the midwest, NSS only has a limited influence on the third of its scrap that is obtained directly from local suppliers and processed on site.

2.5 Inventory and Replacement of Mercury Containing Devices in the NSS Facility.
We have committed resources to identifying mercury-containing equipment in our mill and to identifying it for proper disposal. To date the quantity of mercury identified in plant equipment is estimated to be approximately five pounds.

3.0 EVALUATION OF REDUCTIONS

Quantification of 1990 baseline process emissions is necessary to evaluate overall reductions. This work is still in progress. Since 1990, significant upgrades have been made to our process equipment and to the melt shop building. Mercury data for these conditions do not exist. We have just completed an engineering study to help quantify baseline emissions. Calendar year 2000 reductions due to implemented activities are summarized in the attached Table 1 and discussed in the following text.

3.1 Mercury Lamp Recycling
NSS recycles approximately 1200 mercury lamps/year. This amounts to approximately one pound of mercury since recycling began in 1993.

3.2 Melt Shop Improvements
The sealing of the melt shop roof is estimated to have reduced fugitive mercury air emissions by approximately two pounds per year. Reductions in energy use due to the installation of a more energy efficient furnace are approximately 25 million kwh/year. This reduces potential mercury emissions at power plants by an unquantified amount.

We are still working to quantify the reductions in mercury emissions from shredder operation due to air pollution equipment installation.

3.3 Mercury Switch Collection Program

A total of 160.85 lbs of mercury switches have been collected since the program began in 1997 (30 to 56 lbs/yr of switch pellets) or approximately 46 pounds of pure mercury. The corresponding reduction in mercury emissions to air averages 5 lbs/yr and ranges from 4 to 7 lbs/yr. (The balance of the mercury eleminated by recycling of the mercury switches would be accounted for by reductions in mercury releases in our other waste streams.) During calendar year 2000 we estimate we received the mercury pellets from approximately 20,000 automobiles based on MPCA data. The institution of the mercury bounty has increased the amount of mercury switch pellets we recycle by up to 200%. However, we are currently only getting participation from less than ten percent of our suppliers. None of our auto crushers have participated yet.

3.4 Mass Balance

Our mass balance work has shown that the mercury enters our system on the scrap metal. Our analytical work has shown that our other raw materials are insignificant sources of mercury in our process. This work has served to focus our source reduction efforts on eliminating mercury switches from the end-of-life vehicles we shred for scrap. We continue to search for ways of quantifying mercury in other types of scrap steel.

4.0 FUTURE ACTIVITIES

There are several mercury reduction alternatives that have promise for future results. These actions include the following:

- Investigate the potential for mercury reductions in scrap steel other than our automobile frag;

- Document the usage of mercury switches in appliances and automobiles already manufactured and work with auto and appliance manufacturers to eliminate use of mercury; (We understand that Daimler-Chrysler has stopped use and that Ford and GM will stop by model year 2002. Therefore we should now begin seeing reductions in the mercury that arrives at our plant. However, since the average age of a car we shred is approximately10 years, it will be many years before the amount of mercury in the automobile frag we process here at NSS is substantially reduced from this action. At this time we do not have a list of specific automobiles or appliances which contain mercury switches to assist suppliers in their removal; and

- Evaluate the effectiveness of an expanded/enhanced automobile and appliance mercury switch collection program to reduce the occurrence of mercury in processed frag and work with NSS suppliers, including custom crushers, to get more of them to participate.

TABLE 1 SUMMARY OF NSS REDUCTIONS IN EMISSIONS OF MERCURY TO AIR	
Initiative	**Reduction (lbs/yr)**
Mercury Lamp Recycling	0.1
Plant Improvements (1)	2
Mercury Switch Collection Program	7
TOTAL	**9.1**
(1) Not including reductions at electric utility generating plant.	

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TO David Thornton
P+P Div

January 23, 2001

OTTER TAIL
Power Company

Mr. Timothy K. Scherkenbach
Division Director
Minnesota Pollution Control Agency
Policy & Planning Division
520 Lafayette Road North
St. Paul, MN 55155-4194

SUBJECT: OTTER TAIL POWER COMPANY
VOLUNTARY MERCURY REDUCTION INITIATIVE
2000 STATUS REPORT

Attached is a copy of the status of Otter Tail Power Company's voluntary mercury reduction plan. The plan was originally submitted to the Agency on June 28, 2000 and therefore this is a half-year report.

A major accomplishment was Otter Tail Power Company's involvement with the City of Fergus Falls and Otter Tail County to introduce and have passed a local ordinance prohibiting the sale of mercury fever and basal thermometers in the City of Fergus Falls. See the attached update for plans to be implemented in 2001.

If you have any questions I can be contacted at (218) 739-8407 or tgraumann@otpco.com. If I am not available, please contact Beverly Rund at (218) 739-8249 or brund@otpco.com.

Sincerely,

Terry Graumann, Manager
Environmental Services

Enclosure

Otter Tail Power Company
Voluntary Mercury Reduction Initiative
Progress Report
2000

The following is a status report of the activities conducted during 2000 as part of Otter Tail Power Company's voluntary mercury reduction. The voluntary plan was submitted to the Minnesota Pollution Control Agency on June 28, 2000.

2000 Status Report

1. Otter Tail Power Company has joined with the local City of Fergus Falls and Otter Tail County to reduce the amount of mercury disposed of in the local solid waste stream. Currently solid waste from the city and several surrounding counties is burned at the Fergus Falls waste to energy incinerator. By removing the products containing mercury from the waste stream, there should be a significant decrease in mercury emissions from the incinerator. Together we have put together a mercury reduction plan for the city, that will also affect the surrounding area, and the city is awaiting approval of the plan by the MPCA.
   A. The first step in the plan was to introduce a ban on the sale of mercury fever thermometers in the City of Fergus Falls. The concept was introduced to the City Council of Fergus Falls on November 6th and was well received. The ordinance passed and was effective December 30, 2000. We are hopeful that this will also spur mercury fever thermometer bans at the county level and possibly in surrounding counties. It is our understanding that the city of Duluth was the first Minnesota city to have such a ban.
   B. The second step has been to develop and distribute a survey to the businesses in Fergus Falls that may deal with mercury and not know of options for disposal. There were seven different surveys developed. They are as follows:
      1. Contractors: Heating and Cooling, Electrical, Plumbing; Appliance Dealers & Repair, Industrial, Manufacturing, Electrical Utilities, Dairy Service Contractors.
      2. Dental Clinics & Dental Labs.
      3. Daycares: Daycares & Day Care Centers
      4. Department Stores; Pharmacies; Health Care Supply Retailers; Jewelers
      5. Service Garages: Auto, boat, small engine, salvage yards.
      6. Health Care Facilities: Hospitals, Clinics, Nursing Homes, Assisted Living Centers, Group Homes & Home Health Care, Optometrists, Podiatrists, Chiropractors.
      7. Schools

      Marie Tysdal of Otter Tail County and Bev Rund of Otter Tail Power Company developed the survey. Otter Tail Power Company printed the survey and the city provided postage for mailing. The City of Fergus Falls assigned an employee to make contact with all the 340 some businesses if they did not return their survey to City Hall by December 12th. There was a 51% response rate on the survey.

The county will enter all the results into a database for further analyses. This was truly a group effort.

C. Otter Tail County has conducted some mercury thermometer exchange programs. They conducted one locally in Fergus Falls in October and collected 373 thermometers, which resulted in the recycling of 11.4 pounds of mercury thermometers and a few switches. Once the mercury thermometer sale ban is in effect, exchange programs should be even more effective. According to EPA mercury fever thermometers are the largest single source of mercury discarded annually in municipal solid waste, estimated at 17 tons of mercury per year.

2. Otter Tail Power Company has test burned a lower mercury coal at the Hoot Lake Plant in Fergus Falls, Minnesota. In addition to economic considerations, the coal also increased NO_x emissions over the annual limit and was therefore undesirable. As other fuels are test burned, we will evaluate their mercury content in addition to other parameters.

3. In addition to test burning low mercury coals, Hoot Lake Plant is also evaluating all equipment at the plant that contains mercury. Where feasible, mercury containing switches, thermometers and manometers are being replaced with non-mercury containing products. At this time, there has not been a problem with breakage and mercury releases as a result of the use of these products.

Plans for 2001

1. The ban on the sale of mercury thermometers in the City of Fergus Falls, which took effect on December 30, 2000, will now drive plans to do more mercury thermometer exchanges in the City of Fergus Falls and surrounding area. The City of Fergus Falls, Otter Tail County and Otter Tail Power Company will contribute to a fund to purchase non-mercury thermometers for the exchanges. Otter Tail Power Company's contribution will be $2,000. Fergus Falls will join Duluth, MN and seven other communities, counties and states as one of the seven cities and one county to pass such an ordinance.

- The next step would be to approach Otter Tail County to pass a like ordinance sometime in January. Discussions with the county solid waste staff have indicated that it may be wise to attach it to the other solid waste ordinances.
- If Otter Tail County does pass a ban on mercury thermometer sales, our next step would be to approach surrounding counties and encourage them to pass similar ordinances.
- If ordinances to ban move to other counties, we have to look at more funding for thermometer exchanges.

2. Currently Hoot Lake Plant, Fergus Falls is replacing mercury-containing equipment when necessary and if feasible. Not all applications can use non-mercury products. In the case of a spill, mercury spill kits will be purchased for the plant during 2001.

3. Education on the proper handling and disposal of mercury wastes is also part of the Mercury reduction plan. During February 2001, Marie Tysdal of Otter Tail County and Bev Rund of Otter Tail Power Company will attend electrical contractor training and discuss disposal options to 100 contractors. We are hopeful there will be other training opportunities in the future.

If you have any questions, please contact me at 218.739.8249 or brund@otpco.com.

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MINNESOTA MERCURY INITIATIVE
VOLUNTARY AGREEMENT PROGRESS REPORT

SEPTEMBER 14, 2001

ACTIVITIES & PROGRESS TO DATE

1. PRODUCT INVENTORY AND PHASE OUT

Xcel Energy has completed mercury product surveys for its Minnesota Generating Plant, Service Center and Building sites. This process included risk classification, labeling and estimation of removal cost. Equipment classified as high risk is replaced as a priority.

In 2000 our focus was on development of a mercury inventory and disposal database to contain, summarize and report Xcel Energy North (NSP) mercury products inventory and disposal data. In 2000 this database was developed and all past inventory and disposal data was entered. We are still putting the finishing touches on this database and our goal in 2001 is to verify the data, obtain updated inventories and input this new data into the database for reporting in 2002.

Highlights observed included:

- ✓ Removal of 56 pounds of mercury from the Black Dog plant. This was accomplished as part of the Black Dog repowering project and resulted from the removal of old plant equipment. (Emission reductions expected from the Black Dog repowering are expected to result in 35 pounds of mercury annually.)
- ✓ In early 2001, as part of our on-going efforts to remove all mercury remaining in our gas service shops the Faribault Service Center removed and properly disposed of 25 to 30 pounds of mercury. In years past these shops used mercury containing manometers, which were refilled with bulk mercury, but have now changed to mechanical measuring devices.

All mercury and mercury containing devices removed in 2000 were shipped to the NSP Chestnut Hazardous Waste Storage Facility where they were placed in bulk containers and shipped off-site for recycling of the mercury.

In 2000 we continued to recycle all lamps which contain mercury. Activities in Minnesota, Wisconsin, North Dakota and South Dakota resulted in the recycling of 45,013 fluorescent lamps and 43,753 high intensity discharge lamps.

2. EMISSIONS SAMPLING

Xcel Energy has completed mercury emissions sampling on its Allen S. King and Sherco generating facilities. The sampling at King reconfirmed previous test results. These results indicate that the high carbon content in the King ash allows for the removal of about 70% of the mercury present in the coal by existing pollution control equipment. Results at Sherco have confirmed the majority of the mercury in the flue gas exists in the elemental state. As a result, the existing pollution control equipment is minimally effective in mercury removal.

3. FUEL SAMPLING

Xcel Energy has completed its third year of mercury testing in fuel samples. Daily fuel samples were taken from each of the coal and RDF fired electric generating plants. The daily fuel samples were then made into quarterly composites and analyzed for mercury. The mercury data was utilized in mass balance formulas to calculate total release information for the annual Toxic Release Inventory.

4. EPRI AIR TOXICS HEALTH AND RISK ASSESSMENT FUNDING

Xcel Energy continued its support of the Electric Power Research Institute's (EPRI) Air Toxics Health and Risk Assessment programs (see attached) focused on understanding mercury in the environment and control of mercury from coal fired boilers. EPRI's program provides a nationally unique approach for addressing remaining key scientific uncertainties concerning the exposure, environmental fate, and potential health effects of hazardous pollutants. Research is tightly coordinated with work performed under several EPRI programs involving fuels, plant operations, water quality and environmental control. Products included improved methods for estimating air toxics exposures, as well as better techniques and data for estimating health risks. Field methods for more accurately measuring concentrations and emissions in background environments are developed and tested for wider use by the research community in determining source contributions.

5. *EERC CENTER FOR AIR TOXICS METALS FUNDING*

Xcel Energy continued its support of the Energy and Environmental Research Center's Center (EERC) for Air Toxic Metals (CATM) research on the behavior of air toxic metals to develop methods for prevention and control of air toxic metal emissions from the combustion of fossil fuels.

6. *EPRI ASH STUDY*

Xcel Energy participated in a collaborative project with EPRI entitled "*Potential for the Release of Contaminants to the Environment from Field-Scale Use of Cementitious Fly Ash for Soil Stabilization.* This research directly related to measuring the level of Hg in runoff and percolation. Publication of this research is expected by the end of August 2001.

7. *EPRI CONTROL TECHNOLOGY RESEARCH*

Xcel Energy is partnering with EPRI to determine the amount of mercury emissions from its power plants, the options for reducing mercury emissions and their cost effectiveness, and the potential impact on power plant operation and other air pollutant emissions. The objective of the current project is to evaluate flue gas mercury concentration, speciation, and removal effectiveness of the existing air pollution control equipment at selected Xcel Energy power plants, assess potential options to further reduce stack mercury emissions to different levels, and project feasibility and cost impacts.

EPRI worked with Xcel Energy to review available fuel and emissions data to determine the extent of mercury removal across the existing air pollution control devices for key units within Xcel Energy and determined which units could provide the greatest potential for further mercury reduction. Options to further reduce mercury emissions were studied and prioritized in terms of potential cost effectiveness. Sherco Units 2 and 3 were selected as the two sites where tests would be conducted. The mercury concentration and speciation at selected locations along the flue gas path were measured with EPRI's semi-continuous mercury analyzers to compare and confirm historical data.

8. *EPRI SHERCO STUDY*

Because of Sherco's size and the degree of difficulty presented by it in terms of control technology design, EPRI's control technology research efforts were then focused on upon it. EPRI's mini catalyst test system and multi-Pollutant Control Test (PcCT) system was used to conduct field testing of promising control options. Utilizing a slipstream of flue gas from the boiler/plant duct via existing ports, the mini catalyst test system was used to determine the effectiveness of novel mercury oxidation catalysts and the extent of mercury speciation changes across the catalyst. In some tests, the outlet gas from the oxidation catalyst was bubbled through impinger bottles containing scrubber solution to determine the effectiveness and stability of mercury captured in solution.

Sorption tubes were used to characterize sorbent effectiveness in different flue gases. The sorbent characteristics enabled a projection of how different sorbents would behave for the Xcel Energy power plants and a selection of the most promising ones for injection testing. For injection testing, the PoCT system was configured as a baghouse and electrostatic precipitator. Fly ash and different novel sorbents were prepared in the laboratory and reinjected at different temperatures and residence times. Gold plated sorbent tubes were tested by insertion into the flue gas duct.

The most promising mercury control options to investigate for Sherco are summarized in Table 1. Sorbent injection is selected as the most promising mercury removal technology for units equipped with ESP and baghouses with activated carbon from Norit (Norit FGD carbon) being the current standard used by EPRI to compare with other potential sorbants. Alternatively, potentially lower cost sorbents include fly ash, carbon from fly ash (LOI), biomass, and tires.

For units with wet scrubbers EPRI has been developing specific mercury oxidation catalysts and some of these, along with a commercially available vanadia-titania catalyst are selected for testing.

Finally, a novel mercury removal concept using goal coated metal sorbent tubes or plates is tested (U.S. patent 5,948,143). The tubes can be inserted anywhere along the duct (preferably just before the stack) where mercury is adsorbed by the gold. The tubes can be regenerated in situ to recover the mercury. No chemicals are needed and only a concentrated mercury waste is generated. However, the approach is still in the proof-of-concept stage and significant scale-up work needs to be conducted to show feasibility.

Table 1. Post-combustion mercury reduction options for evaluation at Xcel

	Mercury Reduction Options				
	Reduce Temperature:	Add Sorbents:	Improve Contact time:	Change mercury species:	Advanced Options:
Emissions Control	-Air pre-heater -Water	-Fly ash -LOI Carbon -Modify scrubber chemistry -Others	-Use fine particles –COHPAC -Wet ESP -Increase L/G	-Catalyst –Corona -Chemical	-Regenerable adsorbers –Chemistry
Baghouse	X	-FGD carbon -Fly ash/LOI -Novel sorbents	-Reduce particle size by grinding		
- Wet FGD – Venturi Scrubber - Wet ESP	X			-SCR -Novel catalyst	-Gold tubes
Cold Side ESP	X	-FGD carbon -Fly ash/LOI -Novel sorbents			-Gold Tubes

Other utilities participating in the Initiative are conducting similar testing activities. Xcel Energy is currently reviewing external research activities and evaluating its mercury reduction research options for future testing.

9. *REPOWERING*

Xcel Energy has committed to "repower" Black Dog units 1 and 2 with natural gas combined-cycle technology with a maximum capacity of 275MW's. The repowered units are expected to be in operation in mid-2002 and have the potential to eliminate 35 pounds mercury annually. (Assuming these units offset generation from the Xcel Energy system.)

10. *CONVERSION TO NATURAL GAS STUDIES*

Xcel Energy has evaluated the feasibility of converting High Bridge units 3 and 4 and Riverside units 7 and 8 to natural gas. Our analysis suggests that significant increases in power supply costs would result from gas conversion alternatives at Riverside. High Bridge 3 and 4 currently supply steam to Rock Tenn Paper mill in St. Paul and do not produce electricity. The feasibility work presented in the attached reports suggest power supply costs would increase slightly with those options that include cogeneration, however, significant steam supply cost increases may result.

11. Fluorescent Lamps

Xcel Energy is determining the feasibility of reducing the amount of mercury purchased in lamps by changing to low mercury fluorescent lamps. The issue being researched is whether the service life of low mercury lamps is comparable to regular fluorescent lamps—increasing the potential for breakage and subsequent environmental release. All florescent lamps are currently being recycled and breakage represents the main route of potential environmental release from this product. In 2000, Xcel Energy recycled 45,013 fluorescent lamps and 43,753 high intensity lamps in Minnesota, Wisconsin, North Dakota and South Dakota.

12. General Employee Hazardous Waste Training

Xcel Energy conducts General Employee Hazardous Waste Training on an annual basis for all employees who receive employee Right-to-Know training. More than 1,500 Minnesota employees receive this training annually. In 2000, employees were informed about Xcel Energy's voluntary mercury reduction efforts, the health and environmental hazards of mercury and how they can help prevent mercury from entering the environment. This training emphasized that each and every employee can play an important role by using careful work practices, properly disposing of mercury containing devices and immediately reporting all mercury spills.

In June 2001, Xcel Energy became aware of customer-owned gas equipment that contained mercury. This piece of equipment is believed to have some regulating and/or pressure relief capabilities. This item was located during a recent system upgrade on customer-owned piping, downstream of the residential meter. The device was removed from service, decontaminated and will be used in future annual training.

13. Thermostat Pilot

Xcel Energy's electric marketing planned to evaluate a test pilot to research a load management program to evaluate the functionality of remotely controlled setback thermostats. The pilot was postponed because of delays in thermostat supply. As a result, Xcel Energy will conduct the thermostat pilot in 2001-2002.

14. Fluorescent Light Bulb Rebates

Xcel Energy increased the amount spent on its program to assist small business and residential customers with fluorescent lamp recycling by $60,000 in 2000 to support program awareness. Coupons were issued bi-annually and advertising campaigns used to increase customer awareness. Since 1995 the recycling program has recycled more than 560,000 lamps, recovering approximately 30 pounds of mercury.

15. Information Dissemination

Selected Xcel Energy customer communications vehicles focused on mercury and identified mercury containing products typically used in a residential home along with detailing alternatives and proper disposal techniques. Xcel Energy has also incorporated information about mercury on its website.

16. Hg Sniffing Dog

Xcel Energy is currently partnering with the MPCA to fund a dog specially trained to detect mercury. The dog will be used to detect mercury mainly in sink traps at industrial and institutional sites. A dog similarly employed in Sweden has located 10 tons of mercury in sinks, cupboards and unused instruments.

17. Evaluaton of Town Border Stations

Xcel Energy has contacted Northern Natural Gas (NNG) and Viking Gas concerning equipment at the town border stations. Equipment in these stations is either owned by the transmission company (NNG or Viking) or Xcel Energy. These stations have been investigated and it is believed that all the equipment owned by Xcel Energy in these stations does not contain mercury.

18. Xcel Energy Advantage Service Program

Xcel Energy contractors remove from service and recycle approximately 5-10 mercury containing thermostats from Xcel Energy's Advantage Service customers per week.

Timely, Objective Information for Science-Based Policy Making and Effective Risk Management

The air toxics health and risk program continues to deliver scientifically credible information for assessing the health and exposure issues associated with energy operations nationally. The work under way addresses the issues involved in the decision in late 2000 by the U.S. Environmental Protection Agency (EPA) to regulate the emissions of hazardous air pollutants (HAPs) from electric power generating units and the resulting program of intensive data gathering and interpretation by public and private agencies. The potential risks that might result from multimedia exposure to air toxics emissions, from power plants and from other sources, are evaluated by applying a consistent framework. By reducing the uncertainties associated with exposure and risk estimates, the program's products provide critical information for sound air toxics policy making and risk management, helping decrease reliance on overly conservative assumptions.

EPA's Mercury Research Strategy states that the agency intends to rely on EPRI research for information on mercury emissions and processes. The air toxics health and risk program is the primary vehicle for assessing the health and environmental questions related to this issue. The role of EPRI research remains that of providing unbiased technical information on mercury and other multimedia toxics in the natural and human environment. It is critical that the EPRI program continues on its present course, focusing on mercury and other toxics of key interest, such as arsenic, dioxins, chromium, lead, and organic pollutants.

EPRI's program provides a nationally unique approach for addressing remaining key scientific uncertainties concerning the exposure, environmental fate, and potential health effects of hazardous pollutants. Research is tightly coordinated with work performed under several EPRI programs involving fuels, plant operations, water quality, and environmental control. Products include improved methods for estimating air toxics sources and exposures, as well as better techniques and data for estimating health risks.

EPRI findings on mercury and other chemicals are extended and refined as new data emerge, particularly on background emissions and on human health effects. These research findings serve to constrain estimates of mercury source terms from anthropogenic emissions when compared to modeled and observed deposition patterns; the result is, over time, a reduction in the uncertainty associated with mercury source-receptor relationships.

All results are incorporated in a risk assessment/management framework and, in recognition of their time-critical nature, are efficiently communicated to program participants, regulators, and other stakeholders in a policy-relevant context. In addition to informing regulatory debates, the program's products help participating organizations assess multimedia risks and develop cost-effective management strategies for individual and grouped facilities. For example, estimates of mercury control costs that might be incurred by the electric power industry have ranged from $1.5 billion per year (EPA, 2000) to $6 billion per year (Edison Electric Institute [EEI], 1997). EPRI research has focused on evaluating whether such potential steps would in fact result in measurable lowering of mercury in food fish within a reasonable time frame, or whether trends in utilities and other source categories indicate significant changes in mercury emissions.

EPRI works closely with EPA and other regulatory agencies in this program by providing data and information directly and through the peer-reviewed literature. Participants benefit from their ability to provide guidance to the research program, to remain current on the issues and science through access to EPRI staff and contractors, and to work collaboratively among themselves and with other stakeholders through EPRI's leverage and credibility.

Target 42 – Air Toxics Health and Risk Assessment Projects Summary (Subject to the availability of funds)

1. **Mercury and Multimedia Substances Exposure and Risk (SP3395), 2002-2003**
   Emerging survey data will be combined with regional modeling results to derive more-robust characterizations of mercury exposure via fish consumption in the United States. Use of the exposure data and models will be applied to potential alternative scenarios to assess a spectrum of changes in deposition, exposure, and fish levels of mercury in U.S. waterways.

2. **Health Effects of Mercury Exposure (SP0357), 2002-2004**
   Results from this focused mercury health effects research serve to reduce reliance on unconstrained "uncertainty factors" that often introduce unnecessary conservatism into health risk estimates.

3. **Mercury Cycling and Fate: Atmospheric and Aquatic Systems (SP3396), 2002-2003**
   Key information is required to improve assessments of mercury emissions from background sources—both natural and altered landscapes—and the cycling and chemistry of atmospheric and aquatic mercury. New data on mercury chemistry in near-plume environments and in the free atmosphere are being integrated into the atmospheric models used, to improve simulations of transport and deposition. While these studies are in themselves critical, integration of receptor-region deposition and its time and spatial patterns will be used for model comparison and validation.

4. **Health Effects of Exposure to Arsenic, Nickel, and Other Air Toxics (100031), 2002-2004**
   Health effects information on arsenic, nickel, and other trace emissions is provided to the research and regulatory community to inform and refine the health risk assessment process.

5. **Comprehensive Risk Assessment Framework for Toxics (CRAFT) (SP0358), 2003**
   The CRAFT framework incorporates both exposure and health risk modules to allow either screening or detailed inhalation risk assessments, depending on requirements for specificity, source inclusion, and spatial scale. CRAFT is capable of simulating a range of health effect dose-response curves with the emergence of new data.

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Attachment 4 to Appendix D

Further Reading
on Voluntary Agreements

Further Reading on Voluntary Agreements

A network has formed to study different aspects of voluntary measures designed to improve environmental quality. The network consists of European government agencies and universities. One Internet Website (*www.cerna.ensmp.fr/prog/menu_ht.html*) provides links to workgroups that have evaluated voluntary systems in many countries. Workgroups of particular interest are:

- CAVA Concerted Action on Voluntary Approaches
- NEAPOL Voluntary Agreements Policy Lessons to be Learned
- VAIE Voluntary Agreement Implementation and Efficiency

Studies reviewed for this report are:

Blackman, Allen and James Boyd	"Tailored Regulation: Will Voluntary Site-Specific Environmental Performance Standards Improve Welfare?" Resources for the Future Working Paper 00-03-REV, July 2000.
Brau, Rinaldo and Carlo Carraro	"Voluntary Approaches: Market Structure and Competion," CAVA working paper 99/08/1.
Cabugueira, Manuel F. M.	"The Voluntary Agreements as an Environmental Policy Instrument - Evaluation Criteria," CAVA working paper 99/10/12.
Chidiak, Martina, Matthieu Glachant, and Lars Gårn Hansen	"Theoretical Perspectives on the Efficiency of Voluntary Approaches to Promote Energy Efficiency," VAIE Project — Task a Final Report, CERNA, Centre d'économie industrielle, Ecole Nationale Supérieure des Mines de Paris, June 1999
Cohen, Mark A.	"Monitoring and Enforcement of Environmental Policy" Owen Graduate School of Management, Vanderbilt University, August 1998.
Convery, Frank and Francois Lévêque	"Applying Voluntary Approaches – Some Insights from Research," in CAVA Concerted Action on Voluntary Approaches," International Policy Workshop on the Use of Voluntary Approaches Feb. 1, 2001, Brussels, Chapter 6.
De Clercq, M. *et. al.*	"A Comparative Study of Environmental Negotiated Agreements," paper presented at the NEAPOL closing conference, Nov. 30-Dec. 1, 2000.
Delmas, Magali A. and Ann K. Terlaak	"Voluntary Agreements for the Environment: Innovation and Transaction Costs," CAVA working paper 00/02/13, February 2000.
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European Environment Agency	"Environmental Agreements: Environmental Effectiveness," Environmental Issues Series No. 3, Vol. 1.
Foulon, Jérôme, Paul Lanoie, and Benoît Laplante	"Incentives for Pollution Control Regulation and (?) or (?) Information," The World Bank, Development Research Group, October 1999.
Glasbergen, Pieter	"Voluntary Environmental Agreements as Institutional Change," CAVA working paper 00/02/2, February 2000.
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Krarup, Signe	"The Efficiency of Voluntary Approaches — A CAVA Literature Survey," CAVA working paper 99/08/2.
Krarup, Signe	"Can Voluntary Approaches be Environmentally Effective and Economically Efficient?" in CAVA International Policy Workshop on the Use of Voluntary Approaches, Feb. 1, 2001, Brussels, Chapter 5.
Krarup, Signe and Stephan Ramesohl	"Voluntary Agreements in Energy Policy – Implementation and Efficiency," Final Report from the project Voluntary Agreements – Implementation and Efficiency (VAIE), January 2000.
Lyon, Thomas P. and John W. Maxwell	"Voluntary Pollution Reduction: Transaction Costs and Free-Rider Effects," CAVA working paper 99/10/9.
Lyon, Thomas P. and John W. Maxwell	"Corporate Environmental Strategies as Tools to Influence Regulation," paper distributed in advance of publication in *Business Strategy and the Environment*, October 1998.
Maxwell, John W. and Thomas P. Lyon	"What Causes US Voluntary Environmental Agreements?" CAVA working paper 99/10/2.
Moffet, John and François Bregha	"The Implications of Voluntary Codes of Conduct for Competition and Competitiveness," CAVA working paper 99/10/10.

Newman, John	"Electricity Sector: Utility Voluntary Agreements to Reduce Greenhouse Gas Emissions," Working Paper 17, Annex I Expert Group on the UN FCCC, November 1997.
Organization for Economic Cooperation and Development (OECD)	"The Use of Voluntary Agreements in the United States: An Initial Survey," Environmental Policy Committee, December 1998.
Organization for Economic Cooperation and Development (OECD)	"Voluntary Approaches for Environmental Protection in the European Union," Environmental Policy Committee, December 1998.
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Paton, Bruce	"Resources as Capital: Insights and Efficiency Gains from Voluntary Environmental Policies," CAVA working paper 99/10/7, October 1999.
Ramesohl, Stephan and Kora Kristof	"The 'Declaration of German Industry on Global Warming Prevention': A Model for Effective and Self-Improving Climate Policy Processes?" CAVA working paper 98/11/6.
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