

## Assessing Stricter Mercury Controls in Michigan

by Diane S. Katz and Jon M. Heuss

### Executive Summary

On April 17, 2006, Michigan Gov. Jennifer Granholm directed the Department of Environmental Quality to draft a rule under the state's Clean Air Act to reduce mercury emissions from coal-fired power plants by 90 percent. The governor ordered the reductions to occur in two phases. The first phase is supposed to entail the reduction schedule established by the U.S. Environmental Protection Agency last year. The second phase is supposed to exceed the federal requirements by reducing emissions 90 percent by the year 2015.

The governor's mercury directive carries huge economic consequences for energy suppliers, industry and consumers. Calculating both the benefits and the costs requires careful examination of the sources of mercury in Michigan, the scientific facts about the risks of mercury exposure, and the likely impact of reductions on future mercury levels in the state. We examine these issues in this report to assist lawmakers, the media and the public in determining whether the governor's mercury reduction mandate constitutes sound policy.

Based on our analysis, we conclude that Gov. Granholm's mercury directive will impose significant costs on the Michigan economy without materially benefiting public health or the environment. The state would do better to defer control requirements that exceed the federal standards, and cooperate with neighboring states and the EPA to better define the risks associated with mercury exposures as well as to refine our understanding of the interplay between mercury emissions, depositions and bioaccumulation.

### About the Author

*Diane S. Katz is director of science, environment and technology policy with the Mackinac Center for Public Policy. Jon M. Heuss is principal scientist for Air Improvement Resource Inc., an environmental consulting firm based in Novi, Mich.*

### Types of Mercury

Mercury (Hg) is a naturally occurring element in the Earth's crust, and is present in trace quantities in coal and other geologic materials. Mercury undergoes a variety of chemical and physical changes as it cycles through the environment, but the same amount of mercury has existed on Earth since its formation.

Most mercury is released into the atmosphere from surface and undersea volcanic eruptions, as well as from deep-sea vents, hot springs, ocean evaporation and the erosion of soil and rock. According to researchers with the Smithsonian Institution, more than 5,000 surface and underwater volcanoes erupt 50 to 60 times a month. Consequently, volcanic "degassing" is considered to be the single largest source of atmospheric mercury.<sup>1</sup> This fact has important implications for determining how best to address mercury exposure in Michigan.

Mercury is the only pure metal liquid at room temperature. The most recognizable form is the heavy silver liquid that beads at the slightest touch. This "elemental" form of mercury vaporizes quickly and, therefore, is the most common form of mercury in the atmosphere. Because gaseous elemental mercury can persist for weeks or months, it may be transported on wind currents across long distances. This fact also must be considered in crafting an effective mercury-control regimen.

The mercury found in soil and water is typically the product of a process called "oxidation." That is to say, when elemental mercury encounters oxidants such as ozone, bromine and chlorine in the atmosphere, it loses electrons, becomes more water soluble, and is carried to Earth by rain and snow. This process is termed "wet deposition."

Mercury enters the food chain primarily through fish and other seafood. As explained above, oxidized mercury is deposited into lakes and oceans through precipitation. Some of this oxidized mercury is absorbed into sediment on the

---

lake or ocean floor. A portion of the oxidized mercury is ingested by bacteria in the water, some of which, in turn, generate methane. This type of bacteria “methylates” the mercury, producing methylmercury, which is considered to be the most toxic form of mercury. Methylmercury accumulates in the tissue of fish from feeding on the higher end of the food chain. High doses of methylmercury over extended periods of time can be highly toxic.

## **Sources of Mercury Emissions**

The industrial use of mercury in the United States has been dramatically reduced in recent years, with releases decreasing more than 75 percent between 1980 and 1997.<sup>2</sup> Mercury deposition has likewise decreased substantially.<sup>3</sup> This has been achieved through a combination of phasing out some uses, improved control technologies and product recycling. For example, the mining of mercury in the United States ended in 1991, thereby eliminating emissions from the milling and roasting of ores. The use of mercury in fungicides and biocides has also been reduced, and the removal of mercury from paints in 1990 and 1991 cut mercury emissions by approximately 140 tons per year.<sup>4</sup>

The mercury emissions that remain today largely come from combustion, in which mercury is a trace element of the fuel or feedstock such as coal. These sources are undergoing control. Federal emissions regulations governing municipal, medical and hazardous waste incineration were issued in the 1990s.

The amount of mercury currently released worldwide each year is estimated to be between 4,000 tons and 7,000 tons. Total emissions are produced in roughly equal measure by “natural” sources such as volcanic eruptions; human activity such as industrial processes; and the re-release of mercury from past deposits.

In the United States, the volume of mercury releases that are related to human activity (anthropogenic) was estimated by the EPA to be 115 tons in 2001. Current anthropogenic releases in Michigan are estimated to be 2.3 tons per year.

As noted earlier, not all releases of mercury result in depositions on land and water near the source of emissions. But a precise measurement of actual deposits from local releases is virtually impossible because of the complex chemical and physical interactions that affect deposition patterns. Consequently, scientists rely on models of the atmosphere to estimate the amount of deposition that results from various releases. Unfortunately, it is difficult at present to test the accuracy of these models because

there are very few monitors that measure actual “wet” depositions (precipitation), and no monitoring of “dry” depositions (when gases or particles stick to surfaces).

There is wide agreement, however, that Michigan sources contribute only a small percentage of the mercury deposited in the state. The firm Atmospheric and Environmental Research Inc. conducted a modeling study in 2004 to determine the sources of mercury depositions in Michigan. Based on measurements of deposits at the Sleeping Bear Dunes National Lakeshore, the AER researchers determined that 30 percent of the mercury deposited there originated from anthropogenic sources throughout North America.<sup>5</sup> Emissions from Asia as well as natural sources contributed about 25 percent each, while the balance originated in Europe, Africa, and South and Central America. The myriad sources of mercury depositions must be taken into account when crafting regulatory controls.

Michigan power plants contribute only a fraction of the mercury deposited in the state. In recent years, coal-fired power plants in Michigan have released an estimated 1.25 tons to 1.55 tons of mercury annually.<sup>6</sup> But only about 2 percent of the four tons of mercury deposited annually in Michigan is the result of emissions from in-state utilities.

The AER researchers also calculated that Michigan utilities only contribute between 0.5 percent and 3 percent of the mercury deposits over the entire Great Lakes. A large portion of the in-state utility releases are gaseous elemental mercury that is transported downwind.

## **Assessing the Risks of Mercury Exposure**

During the Clinton Administration, the EPA conducted research on the risks of mercury exposure and concluded that there are no health risks from mercury in the air in the vicinity of coal-fired power plants, or from ingesting crops grown in the vicinity of power plants.

The primary health concern with mercury releases is human consumption of methylmercury. Consuming large quantities of seafood with extremely high levels of methylmercury over an extended period of time may lead to neurological damage. Children and fetuses are believed to be the most sensitive to the potentially toxic effects of methylmercury. However, the extent of harm from current levels of mercury in fish and other seafood is a matter of considerable debate.

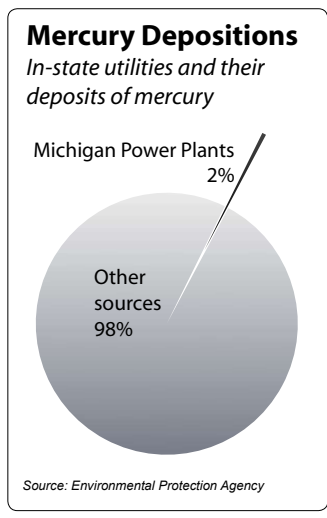
Various national and international groups have developed estimates for what constitutes a “safe” level of mercury consumption. Most safety thresholds are based on studies of populations that were accidentally exposed to very high

levels of methylmercury, or studies of island populations for whom seafood is a dietary mainstay. The levels declared to be safe all contain a considerable margin of safety — that is, the safety standard is set far below the levels at which health effects result.

The EPA's standard for chronic exposure is 0.1 microgram of methylmercury per kilogram of body weight per day. The U.S. Agency for Toxic Substances and Disease Registry has a minimum risk level of 0.3 microgram of methylmercury per kilogram of body weight per day. The World Health Organization has a "permissible tolerable weekly intake" recommendation of 3.3 micrograms per kilogram of body weight (which translates into a daily rate of 0.47 microgram per kilogram of body weight per day). Thus, there is a considerable range in the government's safety levels, with the EPA's being the most stringent.

State and federal regulators consider safety levels — as well as surveys of actual mercury levels in fish — when deciding whether to issue public advisories that recommend limits on fish consumption. Michigan has had a statewide fish consumption advisory for inland lakes since 1988. The advisory warns against eating more than one meal a week of rock bass, perch or crappie over nine inches in length, or any size largemouth bass, smallmouth bass, walleye, northern pike or muskie from inland lakes. Women of childbearing age and children under age 15 are advised not to eat more than one meal of these fish per month.

The EPA, in setting federal mercury standards, analyzed various studies that tested for effects on children who had been chronically exposed to mercury while in vitro by mothers who consumed large quantities of seafood. In each of the three studies analyzed by the EPA, a battery of neurological tests was administered. Two of the three studies found subtle effects on some neurological functions. The results of these studies were used by the EPA to establish the federal safety threshold of mercury exposure — a threshold level at least 10 times more stringent than the level at which the subtle health effects were observed. This standard is expressed as the amount of daily exposure to mercury that is unlikely to produce deleterious effects in the course of a lifetime.



Michigan's utility companies are responsible for 2 percent of the four tons of mercury deposited annually in the state.

For the federal mercury rule, the EPA considered IQ to be a surrogate for the neurological effects of mercury exposure since deficits in IQ can be monetized. None of the studies found statistically significant effects on IQ from methylmercury exposure. Subsequently, the EPA commissioned a further analysis that combined the results of all three studies as one. The combined analysis showed a small effect on IQ.

The EPA does not claim that methylmercury degrades IQ. Instead, agency policy holds that children who are exposed to methylmercury in vitro may be at increased risk for poor performance on tests that measure attention, verbal memory and visual-spatial abilities.

### Effects of More Stringent Mercury Controls

The precise effect of emissions controls on the production of methylmercury is unknown. There is no model, at present, to imitate the complex chemical and physical processes that contribute to the formation of methylmercury and its uptake in the food chain. But enough is known to establish that conditions in the Great Lakes are not particularly conducive to methylmercury formation and bioaccumulation, and conditions vary from lake to lake. Tributaries and surrounding wetlands may support methylation.<sup>7</sup>

In developing the federal mercury regulations, the EPA used a model (Mercury Maps)<sup>8</sup> that assumed the reduction in mercury levels in fish would be proportionate to the reduction in mercury deposition in the watershed.<sup>9</sup> Given the minimal impact of Michigan utility emissions on mercury depositions in Michigan and the Great Lakes, more stringent controls would only minimally reduce the amount of methylmercury in fish over the span of several decades.

Contrary to the conclusions of the EPA, independent researchers have determined that coal-fired power plants do not represent a major source of mercury depositions.<sup>10</sup> For example, the density of coal-fired power plants is highest in the Ohio Valley and Appalachia. But while the deposition of mercury from power plants is highest within and downwind of this region, the levels of mercury in fish are among the lowest nationwide.

The EPA has evaluated the potential health effects of more stringent reductions in mercury emissions.<sup>11</sup> The agency concluded that the average IQ impairment due to all power plant emissions of mercury in the United States for children exposed in vitro to a mother's consumption of freshwater fish (caught recreationally) was inconsequential

---

— a mere 0.009 of an IQ point. Likewise, the average IQ impairment to 25,000 Michigan children born to mothers who consumed freshwater fish was 0.008 of an IQ point. The agency also evaluated the effects of mercury exposure from consumption of commercial freshwater fish, estuarine fish and marine fish, and concluded the risk of IQ impairment to be even less.

Overall, the health benefit of more stringent mercury controls was extremely small in all the cases evaluated by the EPA. When these results are monetized, which is necessary to measure regulatory efficacy, the benefits of stricter mercury controls were in the range of a few million dollars per year. The cost of stricter controls, however, was estimated by the EPA to be on the order of several billion dollars annually.

Despite this unbalanced cost-benefit ratio, the EPA still has required a 70 percent reduction in mercury emissions by coal-fed power plants.

This does not mean that reducing mercury emissions won't reduce mercury levels in fish. But it does mean that the amount of deposited mercury that ends up in fish varies substantially across the country, depending on a variety of factors such as storage and release from aquatic sediments, as well as differences in the acidity and oxygenation of lakes.

## **Examining the Case for Stricter Controls**

The federal regulations governing emissions issued last year were the first mercury-specific controls required for permanently installed coal-fired power plants. However, the controls required for other pollutants — particulate matter, sulfur dioxide and nitrogen oxides — already remove about 40 percent, on average, of the mercury emitted by power plants.

Michigan is among 16 states and several activist groups that have filed suit in federal court seeking to force the Bush Administration to issue stricter regulatory controls on mercury emissions. According to Steve Chester, director of the Michigan Department of Environmental Quality, “The message being sent to the Environmental Protection Agency is that their proposal does too little, too late.”<sup>12</sup>

Opponents are particularly critical of the cap-and-trade system, whereby a utility must either reduce mercury

emissions to meet the control standard or purchase additional allowances from utilities that have exceeded their required reductions. However, as a candidate in 2002, Gov. Granholm endorsed a cap-and-trade program such as that adopted by the Bush Administration. As stated in her platform, the governor called for implementing “an approach, such as a cap and trading policy, that sets firm limits and timetables, while giving utilities the ability to incorporate pollution control into long-term investments and to capitalize on market incentives to reduce emissions cost effectively.”<sup>13</sup>

Many of the commonly heard claims about mercury risks that underlie calls for stricter controls lack scientific validity. Four of these claims are examined below.

*Claim:* Many women of child-bearing age and young children are exposed to unsafe levels of mercury.

*Fact:* The most recent study by the U.S. Centers for Disease Control found that women of child-bearing age had mercury levels below the threshold associated with any adverse health effects.<sup>14</sup> Moreover, the CDC found that mercury levels in human blood actually declined between 1999 and 2002. Only 6 percent of women of child-bearing age registered mercury concentrations that even fell within a factor of 10 of the level associated with health effects.

The CDC report also confirmed previous findings that no children have mercury levels that are even close to the level where health effects have been detected, and are not at risk from consuming seafood.

*Claim:* The effects of mercury on child development are “devastating.”

*Fact:* According to the EPA, the vast majority of children are totally unaffected by mercury, and the effects — even for the highest exposed individuals — are subtle. Only in accidental exposures where populations have been exposed to massive levels of methylmercury, have serious health effects been observed. It would be grossly misleading to infer that the effects observed from extremely high doses also occur at low exposures.

*Claim:* The best way to reduce mercury exposure is to eliminate mercury from the emissions of coal-fired power plants.

*Fact:* As numerous analyses have shown, the mercury deposited in Michigan comes from both natural sources and anthropogenic sources around the world. Coal-fired power plants in the United States produce only about

**The myriad sources of mercury depositions must be taken into account when crafting regulatory controls.**

---

1 percent of global mercury emissions. According to the EPA, the emissions from power plants account for only about 10 percent of mercury depositions in the United States. Consequently, the elimination of mercury from power plant emissions will have a negligible effect on human health.

*Claim:* New federal regulations to control mercury emissions are insufficient to protect public health and the environment.

*Fact:* Under the federal “cap-and-trade” program, the EPA will allocate to each participating state an emissions allowance. States, in turn, will allocate emissions allowances to each coal-fired power plant. U.S. coal-fired power plants currently emit an estimated 48 tons of mercury annually. The federal program is designed to reduce these emissions in two phases. The first phase will cap mercury emissions at 38 tons nationwide in 2010. The second phase will cap emissions at 15 tons nationwide by 2018, which constitutes a reduction of nearly 70 percent from 1999 levels.

A utility must either reduce mercury emissions to meet its allowance or purchase additional allowances from utilities that have exceeded their required reductions. Based on industry economics, larger utilities are likely to have the access to capital necessary to undertake major emissions reductions and thus sell credits to smaller utilities. The flexibility of allowance trading creates financial incentives for utilities to look for new and low-cost ways to reduce emissions and to improve the effectiveness of pollution control equipment. In addition, the financial penalties for noncompliance are significant.

The phased approach also allows utilities to take advantage of emissions controls that must be installed by 2010 to reduce sulfur and nitrogen oxides. While these controls will reduce total mercury only modestly, they will substantially reduce the inorganic form of mercury that is of greatest concern for local deposition.

## **A Critique of the Governor’s Rule Proposal**

As a candidate for governor, Jennifer Granholm promised to eliminate mercury emissions from coal-fired power plants. Toward that end, she requested in 2003 the formation of the Michigan Mercury Electric Utility Work Group, which was charged with developing recommendations for an emissions reduction strategy for coal-fired electric generating units. While consensus on a reduction strategy was sought, the group did not reach agreement on reductions in excess of federal requirements.

The governor’s directive, as noted earlier, requires mercury emissions to be reduced in two phases. The first phase will entail adopting the reduction schedule established by the EPA last year. The second phase is supposed to exceed the federal requirements by reducing emissions 90 percent by the year 2015.

In addition, the directive provides for technical and cost-based exceptions to the reduction deadline. For example, a utility would be given additional time to comply if emissions-control technology is installed but testing fails to demonstrate compliance. Additional time also would be provided if a power plant demonstrates that the incremental cost of surpassing the federal requirements exceeds a fixed percentage of the utility’s revenue (the cost threshold is to be determined during the rule-making process).

There are a number of problems with the governor’s proposal. As detailed elsewhere in this report, even complete elimination of mercury emissions in Michigan would not materially affect public health or mercury concentrations in fish. The reduction target of 90 percent is arbitrary; it is not based on exposure risk, the availability of control technology or the cost-effectiveness of emissions reductions.

The deadline of 2015 also is problematic. According to the EPA, the most advanced technology for mercury capture — activated carbon injection — is not available on a commercial basis.<sup>15</sup> In addition, there are no long-term data on the performance of this technology, nor has it been tested on the variety of the power plant systems now in operation. As noted by Gov. Granholm’s workgroup, there exist myriad factors that may mitigate the effectiveness of emissions controls, including:

- The types of coal burned.
- The design of the boiler and combustion system.
- The extremely low level of mercury in flue gas (on the order of several parts per billion)
- The chemical form of the mercury.
- The properties of the fly ash.
- The type of pollution control equipment already installed.

There also are issues related to disposal of the material used to absorb the trapped mercury, as well as byproducts such as fly ash. Although much progress has been made toward developing mercury-specific control technology, much more work remains to be done before commercially viable technologies will be available for use in all types of power plants.

---

That there apparently will be exceptions in the regulatory timeline may seem reasonable.<sup>16</sup> But it makes little sense to require technology that is expected to fail. Nor is it rational to base a regulatory deadline on an arbitrarily fixed marginal cost. Regulation can only be justified by comparing costs with benefits — a test that the Granholm plan fails.

## Conclusion

The release of mercury is a global issue. While the extent of risk from mercury exposure is a matter of debate, it is prudent to refine the measurements of emissions sources and improve society's understanding of the effects of mercury on human health and the environment.

The United States is the first country to regulate mercury emissions from coal-fired power plants. To the extent that mercury controls are deemed necessary, the federal cap-and-trade program is more economically efficient than the conventional command-and-control regime. Emissions trading at least provides incentives for developing new, cost-effective controls.

Gov. Granholm's mercury directive will prove to be significantly more costly than the federal program, and not materially more beneficial. Michigan would do better to defer control requirements that exceed the federal standards. This would provide time for development of more effective control technologies under the cap-and-trade program.

In the meantime, Michigan should cooperate with neighboring states and the EPA to better define the risks associated with mercury exposures as well as to refine our understanding of the interplay between mercury emissions, depositions and bioaccumulation.

## Endnotes

- <sup>1</sup> [http://www.realmercuryfacts.org/about\\_mercury/index.html](http://www.realmercuryfacts.org/about_mercury/index.html)
- <sup>2</sup> Mercury in the Environment: the Problems, the Risks, and the Consequences, The Annapolis Center for Science-Based Public Policy, Annapolis Maryland, May 2003, Figure 1, from U. S. Geological Survey Circular 1197.
- <sup>3</sup> Mercury in the Environment: the Problems, the Risks, and the Consequences, The Annapolis Center for Science-Based Public Policy, Annapolis Maryland, May 2003, page 2.
- <sup>4</sup> U.S. Environmental Protection Agency, Mercury Study: Report to Congress, EPA-452/R-97-003, December 1997, Volume II, pages 3-9.
- <sup>5</sup> C. Seigneur, et al., Global Source Attribution for Mercury Deposition in the United States, *Environ. Sci. Technol.*, 38, pages 555-569 (2004).

- <sup>6</sup> Michigan Mercury Electric Utility Workgroup Final Report on Mercury Emissions from Coal-fired Power Plants, June 20, 2005.
- <sup>7</sup> *Ibid.*, page 56.
- <sup>8</sup> U.S. Environmental Protection Agency, Mercury Maps: A Quantitative Spatial Link Between Air Deposition and Fish Tissue — Peer Reviewed Final Report, EPA 823/R-01-009, September 2001.
- <sup>9</sup> *Ibid.*
- <sup>10</sup> F. Lipfert et al., Methylmercury, Fish Consumption, and the Precautionary Principle, *J. Air & Waste Manage. Assoc.*, 55, pages 388-398 (2005).
- <sup>11</sup> U.S. Environmental Protection Agency, Regulatory Impact Analysis for the Clean Air Mercury Rule, EPA-452/R-05-003, March 2005.
- <sup>12</sup> "State proposes mercury rule stricter than EPA's," *Booth Newspapers*, April 18, 2006.
- <sup>13</sup> Michigan Mercury Electric Utility Workgroup Report, June 2005.
- <sup>14</sup> Centers for Disease Control, Second National Report on Human Exposure to Environmental Chemicals, January 2003.
- <sup>15</sup> U.S. Environmental Protection Agency, Control of Mercury Emissions from Coal-Fired Electric Utility Boilers: An Update, February 2005.
- <sup>16</sup> A utility would be given additional time to comply if its emissions control technology is installed but testing fails to demonstrate compliance. Additional time would also be provided if a power plant demonstrates that the incremental cost of surpassing the federal requirements exceeds a fixed percentage of the utility's revenue.

## **Additional Research**

### *Articles and Viewpoint Commentaries*

---

#### **Little Consensus on Mercury Recommendations**

↳ [www.mackinac.org/7356](http://www.mackinac.org/7356)

#### **Federal Regulations of Mercury Emissions Appear Adequate**

▣ V2005-32    ↳ [www.mackinac.org/V2005-32](http://www.mackinac.org/V2005-32)

#### **Regulations Run Amok in Michigan: Part Two**

↳ [www.mackinac.org/7784](http://www.mackinac.org/7784)

#### **Eagle Sightings Signal Improved Michigan Water Quality**

▣ V2003-15    ↳ [www.mackinac.org/V2003-15](http://www.mackinac.org/V2003-15)

#### **Testimony of Diane Katz Before the U.S. Senate Committee on Environment and Public Works**

↳ [www.mackinac.org/7651](http://www.mackinac.org/7651)

### *Michigan Legislation Analysis*

---

MichiganVotes.org, a free public service of the Mackinac Center for Public Policy, is a continuously updated web database of objective, concise, plain-English descriptions of every bill and amendment in the Michigan Legislature. Complete voting records of every legislator, for every bill and amendment, are instantly accessible. Users may search the database by bill number, legislator, keyword, or nearly 100 policy areas.

↳ [www.michiganvotes.org](http://www.michiganvotes.org).

These and other publications are available at no charge via the Internet at **www.mackinac.org**. For telephone orders, please call the Mackinac Center at 989-631-0900. You may also order print copies via the internet. The Center accepts Visa, MasterCard, and Discover/NOVUS for your convenience.

### ***Board of Directors***

D. Joseph Olson, Chairman  
*Senior Vice President and General Counsel, Amerisure Companies*

Lawrence W. Reed, President  
*Mackinac Center for Public Policy*

Joseph J. Fitzsimmons  
*Retired President, University Microfilms*

Hon. Paul V. Gadola  
*U.S. District Court Judge*

Richard G. Haworth  
*Chairman of the Board, Haworth, Inc.*

Phil F. Jenkins  
*CEO, Sweepster Inc.*

Mara M. Letica  
*Executive Vice President, General Counsel and Secretary, Letica Corp.*

Edward C. Levy Jr.  
*President, Edu. C. Levy Co.*

Rodney M. Lockwood Jr.  
*President, Lockwood Construction Company, Inc.*

Joseph P. Maguire  
*President, Wolverine Development Corporation*

Richard D. McLellan  
*Attorney, Dykema Gossett*

James M. Rodney  
*Chairman of the Board, Detroit Forming Inc.*

Linda K. Rodney  
*Attorney at Law, Law Offices of Linda K. Rodney, P.C.*

### ***Board of Scholars***

Dr. Donald Alexander  
*Western Michigan University*

Dr. William Allen  
*Michigan State University*

Dr. Thomas Bertonneau  
*Writer and Independent Scholar*

Dr. Brad Birzer  
*Hillsdale College*

Dr. Peter Boettke  
*George Mason University*

Dr. Theodore Bolema  
*Law Offices of Theodore Bolema*

Dr. Stephen Colarelli  
*Central Michigan University*

Andrew Coulson  
*Cato Institute*

Robert Crowner  
*Eastern Michigan University (ret.)*

Dr. Richard Cutler  
*University of Michigan (ret.)*

Robert Daddow  
*Oakland County Department of Information Technology*

Dr. Richard Ebeling  
*Foundation of Economic Education*

Dr. Jefferson Edgens  
*Morehead State University*

Dr. David Felbeck  
*University of Michigan (ret.)*

Dr. Burton Folsom  
*Hillsdale College*

Dr. Wayland Gardner  
*Western Michigan University (ret.)*

John Grether  
*Northwood University*

Dr. Michael Heberling  
*Baker College*

Dr. Ormand Hook  
*Mecosta-Osceola Intermediate School District*

Robert Hunter  
*Mackinac Center for Public Policy*

Prof. Harry Hutchison  
*Wayne State University*

Dr. David Janda  
*Institute for Preventative Sports Medicine*

Annette Kirk  
*Russell Kirk Center for Cultural Renewal*

David Littmann  
*Mackinac Center for Public Policy*

Dr. Dale Matcheck  
*Northwood University*

Dr. Paul McCracken  
*University of Michigan (ret.)*

Charles Meiser  
*Lake Superior State University (ret.)*

Glenn Moots  
*Northwood University*

Dr. Robert Murphy  
*Hillsdale College*

Dr. George Nastas III  
*Marketing Consultants*

Dr. John Pafford  
*Northwood University*

Dr. Mark Perry  
*University of Michigan - Flint*

Dr. Leonard Plachta  
*Central Michigan University (ret.)*

Gregory Rehmke  
*Economic Thinking/ E Pluribus Unum Films*

Dr. Steve Safranek  
*Ave Maria School of Law*

Dr. Howard Schwartz  
*Oakland University*

James Sheehan  
*Deutsche Bank Securities*

Rev. Robert Sirico  
*Acton Institute for the Study of Religion and Liberty*

Dr. Bradley Smith  
*Capital University Law School*

Dr. John Taylor  
*Grand Valley State University*

Dr. Richard K. Vedder  
*Ohio University*

Prof. Harry Verysen Jr.  
*Walsh College*

John Walter, Jr.  
*Dow Corning Corporation (ret.)*

Dr. William Wilson  
*Economic Consultant*

Dr. Martin Wing  
*Kettering University*

Dr. Gary Wolfram  
*Hillsdale College*

### ***Guarantee of Quality Scholarship***

The Mackinac Center for Public Policy is committed to delivering the highest quality and most reliable research on Michigan issues. The Center guarantees that all original factual data are true and correct and that information attributed to other sources is accurately represented.

The Center encourages rigorous critique of its research. If the accuracy of any material fact or reference to an independent source is questioned and brought to the Center's attention with supporting evidence, the Center will respond in writing. If an error exists, it will be noted in an errata sheet that will accompany all subsequent distribution of the publication, which constitutes the complete and final remedy under this guarantee.

© 2006 by the Mackinac Center for Public Policy. All rights reserved.

140 West Main Street • P.O. Box 568 • Midland, Michigan 48640 • 989-631-0900 • Fax: 989-631-0964

www.mackinac.org • info@mackinac.org

Permission to reprint in whole or in part is hereby granted, provided that the Mackinac Center for Public Policy is properly cited.

ISBN: 1-890624-48-9

S2006-04