

INTRODUCTION TO THE WHITE PAPER ENTITLED: Methylmercury Contamination and its Global Health Implications

The White Paper you are about to read has been written by Ted Kuepper, Executive Director of Global Water * and Mati Waiya, Executive Director of the Wishtoyo Foundation ** and Ventura Coastkeeper® ***. We have written this paper because we feel it is important for everyone to understand the critical issues affecting us all in terms of mercury pollution.

The purpose of the White Paper is to discuss the fact that industrial emissions of mercury into the atmosphere have contaminated the fish in many of the freshwater sources within the United States and other industrialized countries, as well as the world's oceans. The current level of contamination is thought to already be sufficient to cause irreparable neurological damage to hundreds of thousands of newborn babies born in the US annually and around the world.

The White Paper documents three primary aspects of mercury contamination: 1) the reasons why there is such confusion and a lack of information concerning the amount of mercury found in fish and shellfish sold commercially in the United States, 2) the myriad of health effects caused by ingesting mercury-contaminated fish, and 3) the fact that currently there exists cost-effective technologies to remove mercury emissions from the major source of mercury discharge in the world - coal-fired power plants

We believe mercury contamination of the world's oceans is the most blatant disregard for human health of any industrial pollutant for three reasons: 1) there is proof of its neurological damage to children, 2) its unique ability to bioaccumulate/biomagnify in a significant portion of the world's food stocks, fish, and 3) the fact that mercury contamination can be controlled with such low-tech technologies as carbon injection and fabric filters when installed on coal-fired power plants.

With the wide variety and quantities of chemicals used throughout the developed world and the lack of controls placed upon many liquid discharges and exhaust emissions of industry, it is not at all surprising that eventually something released into the environment would cause an observable health problem within the human population. It is also logical that the segment of the population that is physiologically most sensitive would be the one showing symptoms of that pollutant. The poisoning of the human race has been ongoing at an ever-increasing rate since World War II and is now apparently beginning to reveal itself as neurological problems in children born to mothers who eat fish and shellfish. For this reason, mercury contamination has become the first global pollutant emergency requiring a swift and focused approach to correct.

We believe that once the truth about methylmercury is better understood in terms of its damaging health effects, it may be a defining moment for the US and, hopefully, the world. Leaving it up to government agencies that are influenced by political and economic persuasions has allowed an entire industry, the coal-fired power industry, to pollute our wonderful country to the point that we no longer can eat many of our native fish without wondering if we may be poisoning ourselves. What's worse is that hundreds of thousands of newborn babies born in the US every year are being encumbered with the potential for neurological damage that may cause many to have learning disabilities for the rest of their lives.

* Global Water is an international non-profit humanitarian organization focused on creating safe water supplies for rural populations of developing countries (www.globalwater.org).

** Wishtoyo Foundation is a non-profit native-American organization focused on preserving the cultural heritage of the Chumash people through educational programs for schools and at public events. Wishtoyo is also working to strengthen legislation that protects culturally significant historical sites for the benefit of all Californians. (www.wishtoyo.org)

*** Ventura Coastkeeper® (VCK), a project of Wishtoyo, is a member of the International Waterkeeper Alliance®, founded and directed by Robert Kennedy Jr. (www.waterkeeper.org). VCK has an ongoing program to monitor Ventura County watersheds and agricultural runoff and works to ensure enforcement of the Clean Water Act laws.

Methylmercury Contamination and its Global Health Implications

Written by

Ted Kuepper, REM
Executive Director
Global Water
Project Management Office
3600 S. Harbor Blvd. #514
Oxnard, CA 93035
Phone: 805.985.3057
Email: info@globalwater.org

Mati Waiya
Executive Director
Wishtoyo Foundation/VenturaCoastkeeper®
3600 S. Harbor Blvd., Suite 222
Oxnard, CA 93035
Phone: 805.382.4540
Email: matiwaiya@wishtoyo.org

June 19, 2004

Methylmercury Contamination and its Global Health Implications

Executive Summary

This White Paper discusses the fact that industrial emissions of mercury into the atmosphere have contaminated native fish stocks in many of the freshwater sources within the United States and other industrialized countries, as well as the world's oceans. The current level of contamination is thought to already be sufficient to cause irreparable neurological damage to hundreds of thousands of newborn babies born in the US annually and around the world.

The White Paper documents three primary aspects of mercury contamination: 1) the reasons why there is such confusion and a lack of information concerning the amount of mercury found in fish and shellfish sold commercially in the United States, 2) the myriad of health effects caused by ingesting mercury-contaminated fish, and 3) the fact that currently there exists cost-effective technologies to remove mercury emissions from the major source of mercury discharge in the world - coal-fired power plants.

In addition, the White Paper discusses why mercury contamination is such a significant problem and the governmental response to reducing mercury contamination in the US. Recommendations are identified that have the potential to eliminate mercury contamination from US sources.

Why is Mercury Contamination a Significant Problem?

The 650,000 inhabitants of the Arctic regions of Greenland and northern Canada are people who live according to centuries old customs of living off the ocean's bounty of fish and mammals. As we now know, they have become the industrialized world's involuntary subjects in a human experiment where industrial chemicals and agritoxins are concentrated in the human body without limit (Agritoxin is a word coined by the Wishtoyo Foundation and refers to *toxic agricultural pesticides*). In 1987, medical researchers in Canada were testing breast milk of mothers and this evaluation included several mothers living in the Arctic region. At first, the researchers thought their test samples had somehow become tainted since they did not believe people who live so far away from the industrialized world could have such high concentrations of toxic chemicals in their bodies.

Unfortunately, we have since come to understand that the myriad of chemicals that find their way into the world's oceans go into a vast and complicated web of nature we call the food chain. Starting in algae and bacteria and through direct transfer into the gills of small fish, dissolved man-made chemicals and natural substances concentrated by industrialized processes start accumulating in the bodies of larger fish as they feed on smaller ones. Practically every living thing on earth that eats fish or shellfish has elevated levels of chemicals and metals in their bodies associated with the industrialized world. Indigenous Arctic people eat both fish and fish-eating mammals and consequently the breast milk of mothers in this region has been categorized as hazardous waste (REF 1). Tests have shown that babies from this region routinely suffer greater rates of infections because their immune systems appear to be impaired

and as the children continue to grow their brain development is altered, reducing their intelligence and memory proficiency.

The substance responsible for these health-related problems has been found to be mercury, one of the hazardous materials concentrating in the bodies of these people. We have since learned that mercury is primarily introduced into the atmosphere by man-made causes, principally coal-fired power plants. We have also learned that such emissions are controllable with relatively modest efforts using conventional technologies. Knowing these facts begs to ask the question – why is this contamination being allowed to continue; that is the question this White Paper investigates and attempts to answer.

Mercury has been characterized as the most toxic aquatic pollutant in the world (REF 2). Bacteria and algae in freshwater and seawater convert mercury's inorganic form into organic methylmercury, which is highly toxic to the brain, permanently destroying neurons, key cells that transmit and process signals in the brain and other parts of the nervous system (REF 3). The result can be neurological toxicity, causing brain damage, as well as damage to several organs of the body, including the kidneys and liver.

Accidental high-dose mercury poisoning episodes in Japan and Iraq in the 1950's and 1970's, respectively, have provided much of the information that the health community today possesses about the health effects caused by exposure to methylmercury. In 1956, Japanese citizens living near Minamata Bay suffered serious neurotoxic effects by eating fish from the bay that had accumulated high levels of methylmercury as a result of mercury discharges by a nearby chemical manufacturer. In the 1970's, over 6,000 citizens of Iraq became ill after eating bread that was prepared from wheat grown from seeds treated with a methylmercury-based fungicide. In the Iraq incident, symptoms, in many cases, did not begin to show for a month or more as people continued to eat the tainted bread. Methylmercury continued to buildup in their bodies until a critical concentration was achieved that initiated the start of symptoms. During the intake period many victims ingested what would ultimately become a lethal dose without any effects whatsoever, not even stomach irritation. Once symptoms started, they went through an observable progression. The effects in adults started with numbness of fingers and toes and quickly progressed to headache, memory loss, hearing loss, visual and speech disorders, lack of coordination, paralysis, coma, and in some cases, death. The exact number of deaths associated with this event is unknown because it occurred in a largely rural area of Iraq, but it is believed over 400 people died (REF 4).

These two tragedies enabled researchers to not only identify the severe neurological damage that occurred to adults as a result of high-dose ingestion of methylmercury, but also a wide variety of severe symptoms in newborn children who were exposed in utero. Children exposed to high concentrations of methylmercury in utero suffered various adverse effects, including: mental retardation, cerebral palsy, deafness, blindness and dysarthria (a speech disorder that is due to a weakness or lack of coordination of the speech muscles).

Thankfully, poisoning episodes like those in Japan and Iraq have been rare. However, chronic low-dose prenatal mercury exposure from maternal consumption of contaminated fish has been associated with more subtle, but still damaging end points of neurotoxicity in children. Those end points are described in more detail in the "Health Effects" section of this report but, in general, include poor neurobehavioral performance on tests of attention, fine motor function, language, visual-spatial abilities (e.g. drawing), and verbal memory. These symptoms observed in children correlate well with animal studies, in particular, those involving non-human primates that indicate the developing nervous system is a sensitive target organ for low-dose mercury

exposure. In addition to causing damage to cognitive, motor, and sensory functions, animal studies have shown evidence that mercury contamination targets the immune and reproductive systems (REF 5).

Minute quantities of mercury are sufficient to pollute entire ecosystems. For example, an often quoted statistic is the fact that 1/70th of a teaspoon of mercury can contaminate a 20 acre lake to the point that fish are unsafe to eat (REF 6). The majority of freshwater fish advisories issued throughout the US every year that warn fisherman to restrict their consumption of particular fish species are the result of high mercury levels.

The general population is exposed to various forms of mercury through inhalation, consumption of contaminated food or water, and exposure to substances containing mercury, such as some pesticides, with the most prominent route of exposure being the consumption of contaminated fish. Outside of occupational settings, methylmercury is the most toxic form of mercury to which humans are regularly exposed for two reasons: (1) because of its natural tendency to be deposited in freshwater and seawater bodies of the world, and (2) because of its natural ability to bioaccumulate (and biomagnify) in fish and shellfish. The ability for a toxic substance, such as mercury, to concentrate so dramatically in living things that are eaten by humans allows the potential for mercury poisoning to occur much more readily than poisoning from other pollutants and thus sets mercury contamination apart from most other forms of pollution. The significance of biomagnification is demonstrated by the fact that methylmercury concentration in a large fish are orders of magnitude greater than in smaller fish and may be as much as one million times greater than its surrounding water.

As mentioned, mercury contamination now resides in the bodies of virtually every living thing on Earth that eats fish or shellfish. The ramifications of this level of toxicity in the world's human population with a substance proven to cause damage to the human body at low-levels is unprecedented. One of the reasons for this high level of contamination is the fact that, unlike organic contaminants, such as polychlorinated biphenyls (PCB's), herbicides, insecticides and dioxins that concentrate in skin and fatty tissues of the body, mercury distributes itself uniformly throughout all fish tissues, thus making it impossible to remove mercury contaminated body parts before consumption (REF 7).

The fact that such a large segment of the world's food supply is already contaminated with mercury means a significant portion of the world's human population will continue ingesting mercury, which may lead to neurological damage in children for many years in the future. This is a startling situation that is currently on a path to worsen if something is not done about it now and on a global scale.

How Mercury Enters the Atmosphere

Although humans and wildlife come in contact with mercury through a variety of sources (including some natural sources, such as volcanic eruptions), the overwhelming majority of mercury contamination today is from human activities; in fact, it is estimated 80% of the mercury in the earth's atmosphere is due to human activities (REF 8). In the US, power generation from coal-fired plants accounts for 60% of the total power generated in the country. Because all coal contains mercury, the largest quantity of mercury emissions in the US comes from coal-fired power plants, as shown in Table 1. Therefore, in order to make a significant impact in reducing the bulk quantity of mercury exposure in the US, the emissions from coal-fired power plants must be reduced.

Table 1 1999 National Emissions Inventory for Mercury by Source Type

Source Category	1999 Estimated Emissions (tons/year)	Percent of Total U.S. Inventory (%)
Utility Boilers	48.7	41.6
Coal	47.8	40.8
Oil	0.5	0.4
Natural gas	0.44	0.4
Municipal waste combustors	5.1	4.3
Commercial/Industrial boilers	9.73	8.3
Medical waste incinerators	2.84	2.4
Hazardous waste combustors	2.94	2.5
Residential boilers	1.23	1.1
Coal	0.08	0.1
Oil	1.15	1
Wood-fired boilers	0.69	0.6
Crematories	0.13	0.1
Chlorine manufacturing	6.53	5.6
Portland cement	2.36	2
Pulp and paper	1.69	1.4
All Other	35.36	30
TOTAL	117.3	100

Source: Mercury Emissions from Coal-Fired Power Plants - The Case for Regulatory Action. Northeast States for Coordinated Air Use Management (NESCAUM). October 2003. (p.2-2).

Mercury enters the atmosphere as a vapor that escapes with smoke stack flue gases when coal is burned in power generating plants. Mercury is emitted in three chemical states: in the elemental form, as oxidized mercury, and absorbed to particulates. Each power plant has a different speciation profile, with the difference related to the type of coal burned, the presence of an oxidizing chemical in a flue gas, and the plant's pollution control devices that may be in use.

Each of the mercury species has a different fate in the atmosphere. Elemental mercury vapor can be transported over very long distances, even globally, with air masses. The atmospheric residence time of elemental mercury is in the range of months to approximately one year. Therefore, emissions of mercury on any continent of the world can contribute to deposition on all other continents. One note of interest is the fact that mercury is the only known metal to vaporize at normal "room temperatures." When heated, mercury readily vaporizes at a very accelerated rate. Particle-bound mercury has a much shorter atmospheric lifetime than elemental mercury vapor and deposit by wet or dry deposition within roughly a few days, or within 500 miles of the source. It should be noted that mercury can convert from one species to another during atmospheric transport, especially due to rain and snow, which has a significant effect on transport distances.

How Mercury is Deposited into Water Bodies

Gaseous elemental mercury in the atmosphere falls naturally onto land as it mixes with air-borne particulates or is washed by rain and snow from the air. A portion of it enters the aquatic

systems directly and the remaining becomes bound to the soil until rain and irrigation waters wash it into adjacent water bodies. After mercury is deposited from the atmosphere, its greatest adverse impact occurs in the aquatic ecosystem. In a series of chemical reactions, mercury is converted by bacteria and algae in water and in sediments to methylmercury, an organic form that is especially toxic to humans and wildlife. This process is often referred to as the methylation of inorganic mercury.

Fish absorb methylmercury in two ways, directly from water as it passes over their gills, and as they feed on algae and other organisms. As larger fish eat smaller ones, methylmercury concentrations increase in bigger fish, a process known as bioaccumulation. Consequently, large predator fish will have significantly higher concentrations of methylmercury from eating contaminated prey as each higher level of the food chain consumes ever-increasing quantities. Humans, birds and other wildlife that eat fish are exposed to methylmercury in this way. In particular, swordfish, shark, tilefish (from the Gulf of Mexico), king mackerel and many freshwater species are routinely found to be high in methylmercury concentrations. Many other ocean fish species have lower, but significantly elevated concentrations of methylmercury. In particular, white albacore tuna have elevated concentrations of mercury and since it is often consumed by children in relatively large quantities, it too deserves a special caution. Unfortunately, these fish species represent a large portion of the world's food supply received from the ocean.

A Truly Global Problem

There is no question that industrial power plant emissions of mercury emanating from the developed world have resulted in global mercury pollution. The US Environmental Protection Agency (EPA) has estimated that roughly 66% of all of the mercury deposited in the US comes from US sources, while the remaining 34% comes from sources outside the country. No area in the world is immune from the potential effects of mercury contamination due to airborne emissions.

The geographical areas in the US that have the highest modeled mercury deposition are: southern Great Lakes and Ohio Valley, and the Northeast, including southern New England and scattered areas in the South. These areas coincide with either locations near, or areas downwind of coal-fired power plants.

Coal-fired power plants are used all over the world with significant concentrations in the developed world in Europe, the United Kingdom, South Africa, India, Japan and many parts of Asia, in addition to the United States. Today, however, much of the developing world is trying to "catch-up" with the developed world's standard of living and coal-fired power plants play an integral part of that new development. Projections for power plant construction in China alone add fuel to the concern for global dimensions of power plant emission's health and environmental issues. In concert with that concern, satellites have recently tracked China's dust storms and documented the deposition of particulates by this transport system to the Pacific Northwest of the North American Continent (REF 9).

Health Effects

Mercury is an extremely dangerous substance for two primary reasons: first, because of its inherent toxicity and ability to cause brain and other organ damage in low concentrations, and second, because of its ability to bioaccumulate in organisms that are in the bottom of one of the main segments of the world's food chain – fish and shellfish. Mercury is one of the few metals

that is known to biomagnify in aquatic food webs due to its easily assimilated organic form that has an inherent tendency to bioaccumulate in fish and shellfish (REF 10). When fish and shellfish are eaten, humans and predator wildlife receive the highest doses of mercury of any organism on Earth.

Although understanding exactly how methylmercury reacts in the body is beyond the scope of this White Paper, it is instructive to document the highlights of its capability to move throughout the body so readily. On a cellular level, methylmercury combines with the amino acid *cysteine* to form a complex that has a structure very similar to the large essential amino acid, *methionine*. It is readily transported throughout the body on amino acid carriers and can therefore penetrate all mammalian cells. When contaminated fish are eaten, a very high percentage of the methylmercury in fish tissue (on the order of 95%) is absorbed into the bloodstream through human intestines. In addition, methylmercury easily crosses the placental barrier in pregnant woman, as well as the blood-brain barrier allowing it to enter the interstitial tissue of the brain in both mother and developing fetus. Here, it affects the central nervous system and can cause injury to the cerebellum and cortex. Methylmercury is believed to interfere with neuronal migration, permanently destroying neurons in the brain, creating chromosomal aberrations, and disturbing cell division in the brain (REF 11). These processes are integral in a developing brain and therefore, fetuses, infants and young children through the age of 6 years old are most at risk of brain damage due to methylmercury contamination.

Although the most severe effects reported in humans followed the high-dose poisoning episodes in Iraq and Japan, chronic low-dose methylmercury exposure from the consumption of fish by mothers during pregnancy has been associated with a variety of neurodevelopmental effects in children. In addition, one of the particularly concerning characteristics of methylmercury contamination is that high levels can build up in a fetus without a mother showing any signs of illness.

In general, health effects caused by chronic, low-dose in utero exposure to methylmercury comprise a long list of symptoms that include: impaired motor functions, learning disabilities, impaired vision, impaired memory and a variety of other symptoms related to neurological damage. In addition, there is evidence that methylmercury exposure in utero can have adverse effects on the developing cardiovascular system, particularly blood-pressure regulation, heart rate variability and heart disease, as well as, already mentioned, immune and reproductive systems.

Many organizations, including EPA, the Centers for Disease Control (CDC) and Prevention, the National Research Council of the National Academies of Sciences, and the World Health Organization have determined that important public health risks exist from widespread exposure to methylmercury in utero, specifically due to consumption of contaminated fish and shellfish. In addition, the available science also indicates that adverse health effects associated with methylmercury exposure are not reversible, resulting in permanent disabilities (REF 12).

In 2000, Congress requested that the National Research Council (NRC) of the National Academies of Sciences and Engineering provide an independent scientific review of all the available scientific data on human exposure to mercury. A prestigious Committee on Toxicological Effects of Methylmercury was convened by the Council who ultimately concluded that the findings of a study conducted in the Faroe Islands provides the most appropriate public health basis for developing a guideline value for EPA (REF 5).

In the Faroe Islands study and an additional study performed in New Zealand, children exposed to methylmercury in utero appeared entirely normal during infancy, but later displayed neurological deficits when tested. These included poor performance on neurobehavioral tests, particularly on tests of attention, fine motor function, language, visual-spatial abilities (drawing) and memory (REF 5). The NRC also concluded that neurobehavioral deficits of the magnitude reported in the Faroe Islands and New Zealand are likely to be associated with increases in the number of children who develop learning disabilities and have to struggle to keep up in a standard classroom or who may require remedial classes or special education.

The severity of health effects caused by exposure to methylmercury depends largely upon the magnitude and timing of its exposure (i.e. during fetal development or as a child or adult). Because the developing brain in a fetus is especially sensitive to a neurotoxin, such as methylmercury, women of childbearing age (i.e. 15 to 44 years old) and pregnant women are of special concern with methylmercury exposure (REF 13). The previous studies cited have made it obvious that methylmercury exposure during pregnancy can place a developing fetus at risk. However, since methylmercury persists in body tissue and is only slowly excreted from the body, maternal exposure to methylmercury months BEFORE pregnancy can also pose a significant risk to a developing fetus.

A New Understanding of Methylmercury-Contaminated “At Risk” Children

A National Academy of Sciences study in 2000 estimated that 60,000 US infants a year face increased risk of brain damage because their pregnant mothers had elevated mercury levels (REF 14).

A more recent biomonitoring effort through the National Health and Nutrition Examination Survey (NHANES) estimated approximately 8% of US women 16 to 49 years of age (one in 12) had blood mercury concentrations at or above the EPA RfD of 5.8 ppb (REF 15). Based on current birth rates that percentage relates to more than 300,000 babies/year at risk. However, the true number of US babies at risk of mercury damage is still unfolding and a recent analysis by EPA scientists has shown that the mercury exposure problem may be greater than previously believed. A new EPA study has revealed that about 630,000 of the roughly 4 million babies born annually in the US (16% of the total number of newborns) are exposed to dangerous concentrations of methylmercury in the womb (REF 16).

The EPA’s analysis represents a new understanding among scientists that umbilical cord blood has significantly higher methylmercury concentrations than that of mother’s blood. Previously, scientists believed that the concentration of methylmercury in mother’s blood was identical to that in the umbilical cord. The “safe” level of methylmercury in blood (or the level where no adverse health effects are expected) has been previously established by EPA to be 5.8 micrograms per liter (or parts per billion, ppb) when an “uncertainty factor” of 10 is used in the calculation.

What was found in tests conducted during 2003 was elevated concentrations of mercury well above the 5.8 limit in umbilical cord blood (by a factor of 1.7). Since umbilical cord blood represents blood going to the brain of a fetus, a developing fetus may be exposed to methylmercury levels of almost 10 ppb even though a mother’s blood has a concentration of 5.8 ppb, the “safe” level established by the EPA. Given the new findings, the EPA now believes that the “safe” level for methylmercury in mother’s blood is 3.5 ppb, a limit already exceeded by a significant percentage of the US population. This is evidenced by the EPA’s recent estimate

that 16% of newborns may now be at risk of brain damage annually due to exposure to elevated levels of methylmercury in utero.

It must be noted that the EPA researcher responsible for these new findings quantifying the relationship between methylmercury concentrations in maternal blood versus umbilical cord blood has cautioned that this information is preliminary and will be verified in future studies. However, whether the number of babies born in the US at risk of brain damage due to methylmercury contamination is 60,000, 300,000 or 600,000, the point remains in the US we are apparently willing to risk hurting our own children for what appears to be “economic reasons” and that should not be acceptable.

How Much Mercury is the US Population Consuming?

Historically, the responsibility for regulating mercury in the US has been shared by two federal agencies: EPA and the Food and Drug Administration (FDA). The FDA is charged with regulating commercially sold food products, including fish and shellfish, in relation to potential health effects caused by consumption of those food products. The FDA is supposed to provide health-related fish advisory information to consumers applicable to commercially sold fish in the US. The EPA monitors concentrations of mercury in the environment and regulates industrial releases of mercury to soil, water and air. In addition, the EPA has historically had the responsibility for issuing health-related fish advisories for recreationally caught fish that are caught in US waters. This division of health-related fish advisory responsibility is undoubtedly a major contributing factor to the confusion that has existed with fish advisories in this country.

In 1969 the FDA established a methylmercury contamination “action level” of 0.5 part per million (ppm) for fish and shellfish sold in interstate commerce. Fish and shellfish with methylmercury concentrations above that level were not to be sold. However, since methylmercury contamination has risen in commercial fish stocks over the years, it was realized that this level would soon impact the ability to sell some species of fish in the US. In 1979, litigation brought by commercial fishing interests in the US caused the FDA to reconsider the action level for mercury on the basis of “economic reasons.” As a result, the FDA raised the action level of methylmercury contamination in fish to 1.0 ppm in the US (REF 17). This 1.0 ppm concentration in fish was then used to calculate a quantity of methylmercury that could be “safely” consumed everyday over a lifetime without effect.

It should be pointed out that many governmental agencies in the US and around the world that have cognizance over public health issues have created limits for methylmercury ingestion that take into consideration the most sensitive portion of their population - pregnant women and children. The FDA numbers, however, were based upon a healthy adult population, as a whole, without consideration of those that are more sensitive than the general adult population (specifically, the developmental stages of infancy and early childhood). In hindsight, the FDA's raising of its methylmercury action level should have been a “red flag” to the US health-care community concerned with child safety. In the absence of an effective national information/warning system from FDA concerning methylmercury contamination and because contamination is so prevalent in US freshwater fish stocks, health departments in 45 states have issued freshwater fish consumption advisories specifically due to methylmercury concentration (REF 18). Since regulatory decisions of the FDA are supposed to consider health effects of all US citizens, the authors of this White Paper believe it was unconscionable that it chose to ignore the most sensitive segment of the US population in creating its fish and shellfish regulations without a national information/warning system.

Because of the human health risks associated with exposure to methylmercury, several governmental and international health agencies have developed health standards for methylmercury. These standards are utilized in risk assessments, regulatory development and in issuing fish advisories. There is substantial agreement among these agencies on the level of methylmercury exposure that causes adverse effects, with the critical debate relating to how to characterize and quantify uncertainties. An “uncertainty factor” tries to accommodate unknowns in order to avoid surprises that may adversely affect health. An example of such a surprise is the EPA’s recent finding of elevated umbilical cord blood concentrations of methylmercury compared to maternal blood samples. Table 2 shows a range of health standards for methylmercury established by a variety of sources.

As mentioned, and as Table 2 shows, all governmental organizations have a similar number for the highest acceptable level of mercury in maternal blood and hair, but they have very different uncertainty factors. The uncertainty factor has been a significant issue since it has a profound effect on the final number associated with a calculation of risk factor. Uncertainty factors have generally been derived from studies performed on methylmercury contamination in communities where high fish and shellfish consumption is a natural occurrence due to geographical location. These studies include some or all of those performed in the Faroe Islands, the Republic of Seychelles and New Zealand. In addition, some of the uncertainty factors include information resulting from the high-dose mercury poisonings in Japan and Iraq.

Table 2 Methylmercury Health Standards

Population Group	Highest acceptable level of mercury in maternal hair (parts per million)	Uncertainty Factor	Amount of methylmercury that can safely be consumed everyday over a lifetime without effect
Women of Reproductive Age, Pregnant Women and Children			
U.S. EPA Reference Dose (RfD)	12	10	0.1 µg/kg/d ^a
ATSDR Minimal Risk Level (MRL) *	15.3	4.5	0.3 µg/kg/d ^b
Canada Provisional Tolerable Daily Intake (pTDI)	10	5	0.2 µg/kg/d ^c
Joint FAO/WHO Expert Committee on Food Additives	14	6.4	0.23 µg/kg/d ^d
Adults			
FDA Tolerable Daily Intake (TDI)	NA	NA	0.47 µg/kg/d ^e

^a Based on Faroe Islands study to protect fetal brain development.

^b Based on no observed effects in Seychelles study of infants up to 66 months of age.

^c Based on no effect level in maternal hair from Iraq, New Zealand, Seychelles, and Faroe Islands studies.

^d Based on no effect level in umbilical cord blood and maternal hair from Iraq, New Zealand, Seychelles, and Faroe Islands studies.

^e Based on tolerable daily intake (TDI) with a reasonable certainty of no harm to adults.

Source: Mercury Emissions from Coal-Fired Power Plants - The Case for Regulatory Action. Northeast States for Coordinated Air Use Management (NESCAUM). October 2003. (p.1-3).

* ATSDR stands for the Agency for Toxic Substances and Disease Registry, a US agency affiliated with the Centers for Disease Control (CDC).

The uncertainty factor significantly changes the numbers that physicians actually look for in tests of blood and hair when evaluating mercury contamination in patients. For example, EPA's current "highest acceptable level" of mercury in maternal hair is 12 ppm, but with an uncertainty factor of 10, the actual level in maternal hair thought to be acceptable is 1.2 ppm (12/10 = 1.2). This 1.2 ppm level in hair correlates with the previously discussed level of 5.8 ppm in maternal blood (shown in Table 3) and both these numbers correlate to EPA's 0.1 µg/kg/d maximum consumption level of methylmercury (also called EPA's Reference Dose) shown in Table 2. Because of the wide range of numbers that result from using differing uncertainty factors, this subject is very confusing. Therefore, it is further discussed in more detail in a section of this report entitled "Uncertainty Factors."

Also shown in Table 2, is the fact that FDA's historical guidance, the "tolerable daily intake" quantity, has no uncertainty factor because it is not based upon any significant scientific calculation that relates to a risk factor.

Table 3 Methylmercury Health Standards **

Population Group – Women of Reproductive Age, Pregnant Women and Children	Highest acceptable level of mercury in maternal blood/hair * (parts per million)	Uncertainty Factor	Actual highest acceptable level of mercury in maternal blood/hair with uncertainty factor applied (parts per million)
U.S. EPA Reference Dose (RfD)	58 / 12	10	5.8 / 1.2
ATSDR Minimal Risk Level (MRL)	61 / 15.3	4.5	13.6 / 3.4

** Please note: the numbers shown in Table 3 do not reflect the new EPA findings that umbilical cord blood may have higher concentrations of methylmercury compared to maternal blood by a factor of 1.7. As mentioned, this new information, if confirmed, will reduce EPA's "highest acceptable level of mercury in maternal blood to 3.5 ppm (from 5.8 ppm) and will also reduce the "acceptable level" for maternal hair from its present level of 1.2 ppm.

Table 4 Methylmercury Health Standards

US Government Agency Guidance For Methylmercury ingestion	Highest acceptable level of mercury in blood – current recommendation (parts per billion)	Amount of mercury actually in fetal blood – If EPA's recent test results are confirmed (parts per billion)	Amount of methylmercury that can safely be consumed everyday over a lifetime without effect
U.S. EPA Reference Dose (RfD)	5.8	9.9	0.1 µg/kg/d ^a
FDA Tolerable Daily Intake (TDI)	27.3	46.4	0.47 µg/kg/d ^b

^a Based on Faroe Islands study to protect fetal brain development; Women of Reproductive Age, Pregnant Women and Children.

^b Based on tolerable daily intake (TDI) with a reasonable certainty of no harm to adults.

It is worthwhile to take a closer look at the FDA Tolerable Daily Intake (TDI) to see what its influence has had in terms of public health. Table 4 shows the FDA TDI guidance concentrations versus the EPA's RfD based on each organization's "safe" methylmercury daily ingestion limit. Since the FDA guidance is 4.7 times greater than that of the EPA, it is logical to assume that the methylmercury concentration that would result from following the FDA guidance would produce mercury measurements 4.7 times greater than the EPA's recommended RfD.

As shown, following FDA's guidance results in a methylmercury blood level of 27.3 ppb (with no uncertainty factor) compared to 5.8 ppb resulting from the EPA recommended "safe" ingestion level (with EPA's uncertainty factor applied). There is little question there exists a great deal of confusion surrounding all methylmercury information in the US. Because of the recent results of EPA's methylmercury concentration measurements in umbilical cord blood (as well as previous studies), it can be assumed that a significant percentage of pregnant mothers do not know what species of fish should not be consumed, as well as the relationship between their "safe" mercury ingestion limit and the health of their developing fetus. Also shown in Table 4, if EPA's recent studies prove to be correct, the actual methylmercury concentration in blood going to the fetal brain may be 46.4 ppb if the FDA's guidance was followed by a mother, compared to 9.9 ppb resulting from the EPA's recommended RfD.

The high concentration of methylmercury that results from following FDA's "safe" ingestion limit may indeed be the reason that EPA's recent studies indicate a large percentage of the US female population has concentrations of methylmercury that far exceed what any health-related organization would recommend.

It is unfortunate that the FDA has chosen to use an action level for mercury contamination based upon a healthy adult population, while leaving it up to state fish advisories to warn more sensitive segments of the population to restrict their intake of certain types of fish. The authors of this White Paper believe that health advisories specifically for "women of reproductive age, pregnant women and children" have not made a significant impact on fish and shellfish consumption in women and children because these warnings are not identified on packaging of fish and shellfish products sold in the US. It is a mystery to the authors of this White Paper how "women of reproductive age, pregnant women and children" in the US are supposed to learn about important methylmercury ingestion limits they should be very concerned with.

The reality is no one in the US is adequately informed of what fish contains what concentrations of methylmercury specifically because the FDA has capitulated to the commercial fishing industry. It is commercial fishing interests that do not want methylmercury warnings placed on fish and shellfish products because they are afraid of the effect that such warnings would have on the consumption of fish and shellfish in the US. It is interesting to note this exact same argument was given by tobacco industry representatives for many years before warning labels were eventually added to cigarette packaging.

The most effective information/warning system for mercury contamination would be labeling placed on fish and shellfish packaging that educates consumers on the amount of methylmercury they are consuming and how it relates to the amount that can be safely consumed to eliminate damaging health effects to themselves and their children. In the absence of an effective information/warning labeling system, the authors of this White Paper believe the FDA should base its action level on the most sensitive segment of the general population - pregnant women and children. Fish consumption advisories found on the Internet are a poor substitute for establishing safe contamination levels for a notoriously toxic substance,

such as mercury. One way or another, the FDA should take responsibility to protect the entire US population from methylmercury contamination.

Through its policy to set methylmercury contamination levels in food with consideration of “economic reasons”, the FDA allowed the citizens of the US to consume fish and shellfish with more than twice the concentration of methylmercury than other countries, such as Canada, allow. And this concentration is almost five times the EPA Reference Dose established for methylmercury formulated as a result of scientific studies of mercury contamination worldwide and using a scientifically derived uncertainty factor. Clearly, the FDA’s “tolerable daily intake” and fish advisories have not worked to protect US citizens as evidenced by the 630,000 babies annually born in the US that are now thought to be at risk of being exposed to dangerous concentrations of methylmercury in utero.

Having said the above, recent coordination in 2003 between the EPA and FDA has resulted in a combined fish advisory guidance for fish consumed in the US (REF 19). This guidance is reported to be based upon data collected and analyzed through the NHANES survey and takes into account the EPA RfD. The NHANES survey is a significant body of biomonitoring evidence whose objective is to assess the health and nutrition status of adults and children in the US. Beginning in 1999, the survey started sampling 5,000 persons annually in 15 geographical locations in the US. It is planned for data to be released in 2-year cycles. The NHANES mercury component has a host of collaborators that include: Centers for Disease Control and Prevention, FDA, EPA, National Oceanic and Atmospheric Administration, and the National Institutes of Health. As mentioned, it was the NHANES survey that estimated approximately 8% of US women 16 to 49 years of age had blood mercury concentrations at or above the EPA RfD of 5.8 ppb (REF 15)

The newly combined EPA/FDA fish advisory is a welcomed departure from the confusing separate EPA and FDA fish advisories that have caused so much of the mercury ingestion confusion in the US. The key points of the combined EPA/FDA fish advisory is included in Appendix 1 at the end of this White Paper (REF 20).

Although mercury pollution is a national and global problem, it is certainly recognized that there is an increased risk to people and communities who physically live near coal-fired power plants, especially from consuming US native freshwater fish species. This is evidenced by an EPA study that found up to 74% of the total mercury exposure to people within 1.5 miles from a medium-sized 375-Megawatt plant came from that particular power plant (REF 21).

Uncertainty Factors

As pointed out in this White Paper, there have been a variety of uncertainty factors associated with the level of mercury that may be “safe” to ingest without causing an adverse health effect in a human being. However, the uncertainty factor that has received the most scrutiny from the scientific community, by far, is the “10-factor”, the one used by US EPA. As mentioned, this uncertainty number was investigated and confirmed by the Committee on Toxicological Effects of Methylmercury that was convened by the National Research Council (NRC).

As shown previously in Tables 2 and 3, the two uncertainty factors historically used by US governmental agencies are 10 and 4.5 (EPA and ATSDR, respectively) resulting in very different “safe” consumption levels for mercury-contaminated fish and shellfish. There is no question that having these different health-related uncertainty factors associated with two health-related government agencies has contributed in a significant way to the confusion that

surrounds questions of how much mercury is actually “safe” to ingest. In addition, superimposed on this uncertainty factor debate is the FDA’s “tolerable daily intake” based upon no scientifically related uncertainty factor.

It is interesting to note the obvious irony in the realization that a scientific calculation employed by EPA and ATSDR, uses an uncertainty factor, but the FDA guidance number, which has a profound effect on actual methylmercury ingestion, is based on virtually no science and does not require an uncertainty factor. It is no wonder that the public has been thoroughly confused and therefore does not understand information concerning mercury advisories for fish and shellfish in the US. This confusion has created an intolerable situation since it has put a large segment of the US population at risk of developing neurological damage in utero.

It should be pointed out that there is an ongoing scientific debate led by researchers from the University of Rochester that the EPA uncertainty factor is too conservative in light of their results from studies in the Seychelle Islands. The neurological symptoms observed in children in the Faroe Islands and New Zealand have not been observed in an ongoing study in the Republic of Seychelles despite the fact that mothers there report consuming 12 meals of fish per week (REF 22). A couple of differences pointed out by the Seychelle Islands researchers comparing their study to that performed in the Faroe Islands is the fact that the Faroe Islanders eat pilot whales in addition to fish and both fish and whale species contain elevated concentrations of PCB’s in addition to mercury. Apparently, PCB concentrations in fish eaten by Seychelles Islanders is low. Understandably, the Seychelle Islands study has caused an uncertainty in terms of health effects that may be caused by eating mercury contaminated fish (REF 23). This uncertainty was emphasized by several presenters at the recent conference: Mercury: Medical and Public Health Issues in Tampa Florida, April 28-30, 2004. This conference, co-sponsored by the US Department of Health and Human Services and the EPA, was the first conference of its kind to bring together researchers that are engaged in studying health effects that have been attributed to eating mercury contaminated fish.

Legal Requirements to Regulate Mercury Emissions from Power Plants

Section 112(n)(1)(A) of the Clean Air Act Amendments of 1990 required EPA to conduct a study of hazardous air pollutant (HAP) emissions from electric utility steam generating units by 1993 and after considering the results of that study, to determine whether regulation limiting those emissions was appropriate and necessary. The results of EPA’s study were finally documented in February 1998 in the *Study of Hazardous Air Pollutant Emissions from Electric Steam Generating Units: Final Report to Congress*. In that report, EPA stated that of 67 air pollutants emitted from coal-fired power plants, mercury was the HAP of greatest concern for public health. Unfortunately, the report did not include a determination, which EPA deferred to a later unspecified date.

Because EPA did not make a regulatory finding when the report was issued, environmental groups sued to require the Agency to: (1) collect additional information on mercury emissions and control technologies; (2) issue a regulatory finding by December 15, 2000; (3) issue a proposed regulation (in the case of a positive regulatory determination) by December 15, 2003; and (4) issue a final regulation by December 15, 2004. EPA entered into a judicially approved settlement agreement accepting these conditions. After a data collection effort for mercury emissions from coal-fired power plants, further study of the health effects of mercury, and additional testing of various mercury emission control technologies, EPA announced in December 2000 that regulation of HAP emissions from oil-fired and coal-fired electric utility steam generating units was necessary and appropriate.

Section 112 of the Clean Air Act establishes a two-part process for regulating hazardous air pollutant emissions. In the first phase of this process, sources within defined source categories are required to comply with emission standards that reflect “Maximum Achievable Control Technology” (MACT), as defined by Section 112(d). These are the MACT regulations that EPA was required to propose by December 2003. The second phase of the regulatory process – the so-called residual risk assessment – occurs within eight years after MACT standards have been finalized for the subject source category.

For existing sources of emissions, MACT cannot be less stringent than the average emission limitation achieved by the best performing 12 percent of the existing sources for which the Agency has emissions information. This is known as the “MACT floor.” For new sources, MACT is defined as the maximum degree of emission reduction achieved by the best-controlled similar source in the source category. Cost of control does not figure into the definition of the MACT floor. However, for “beyond the floor” analysis (i.e., emission limits more stringent than the MACT floor), the Agency must take into account the cost of achieving such emissions reductions, any non-air quality health and environmental impacts, as well as energy requirements.

The issue of what emission limitation the best performing 12 percent of sources actually achieve is complicated. EPA’s data collection efforts included emission tests from about 80 coal-fired boilers. These boilers can be ranked with reference either to their mercury emission rate or to their percent reduction as measured from the mercury content of the combusted coal. If the boilers are ranked by percent reduction, the average of the top 12 percent is a 91% reduction from the mercury in the combusted coal, as shown in Table 5.

Table 5 Determination of MACT Floor Based on Percent Reduction in Mercury

Top 12% (10 Plants) from EPA 1999 I CR Data

Plant Name	Calculated Hg Reduction (% from coal)
1. Scrubgrass Generating Company, L.P.	99
2. Clover Plant Station	97
3. Mecklenburg Cogeneration Facility	96
4. Logan Generating Plant	96
5. Dwayne Collier Battle Cogeneration Facility	92
6. Stockton Gogen Company	90
7. DEI-Birchwood Power Facility	87
8. Clay Boswell	86
9. Intermountain	84
10. Big Bend	84
Average of Top 12%	91.10%

Source: Memo to the Utility MACT Workgroup from the Ranking Subgroup. February 5, 2002.

Online. Available: <http://www.epa.gov/ttn/atw/combust/utiltox/feb5memo.pdf>.

Source: Mercury Emissions from Coal-Fired Power Plants - The Case for Regulatory Action. Northeast States for Coordinated Air Use Management (NESCAUM). October 2003. (p.3-2).

However, it has been understood by all parties waiting EPA's deliberations that this was not necessarily the end of the inquiry, as EPA has the discretion to subcategorize source categories based on class, type, and size of boilers. Standing alone (i.e. without adjustment for subcategorization) and using the current estimate of elemental mercury in the coal combusted by all coal-fired power plants in the US of about 75 tons, a 90 % reduction appears to be logical and justified and would result in mercury emissions from coal-fired power plants in the US to be reduced significantly to about 7.5 tons (REF 24). Please note – since the estimate for mercury being emitted annually from coal-fired power plants in the US is 47.8 tons (as shown in Table 1), only 36% of the mercury present in coal is currently removed at power plants by existing pollution control devices, such as electrostatic precipitators and fabric bag filters, that are present to remove pollutants other than mercury in flue stack emissions.

Technologies and Costs to Remove Mercury from Coal-fired Power Plant Exhaust

In the US, approximately 65% of coal-fired power plants currently use an electrostatic precipitator (ESP) for particulate control, 10% use only a fabric baghouse for particulate control, and the remaining 25% use a combination of an ESP and a wet flue gas desulfurization (FGD) scrubbing system (REF 25). The FGD system is designed to remove SO₂ gas. Today, specific control devices are not installed for controlling mercury emissions from power plants, but the aforementioned technologies remove mercury emissions to some degree as a co-benefit of their operation. Without any modifications, average reductions of mercury from an ESP, a baghouse and an FGD system are 26%, 39%, and 45% respectively (REF 25).

During combustion of mercury-containing fuels, such as coal, mercury is completely volatilized and transformed into a gas. Because of this, it is not effectively controlled by conventional particulate control devices unless a solid material first traps the mercury through sorption mechanisms. Unfortunately, this does not occur naturally to a significant degree by ash material that may be collected by the power plant. Therefore, reduction of mercury emissions requires additional control technologies. In particular, injection of activated carbon or other sorbents upstream of a particulate control device is one method for controlling mercury emissions from coal-fired utility boilers (REF 25).

Activated carbon injection (ACI) upstream of either an ESP or baghouse appears to be an attractive technique to greatly increase the mercury removal efficiency of particulate control devices because 1) it has the potential to control all forms of gaseous mercury, 2) would be relatively easy to retrofit, and 3) would be applicable to both industrial and utility boilers. In addition, it does not require a significant amount of extra equipment and only a relatively small amount of a sorbent may be necessary since the amount of mercury in the gas stream from coal combustion is usually very low (about 6 parts per million and sometimes less) (REF 26). ACI has been used with municipal waste combustion in the US and is routinely achieving greater than 90% reductions, with some units achieving reductions as high as 98% (REF 27).

As indicated, ACI refers to the injection of activated carbon in its dry powder form into the flue gas duct before a collection device such as an ESP or baghouse. Mercury is adsorbed onto the activated carbon surface and the carbon powder is then caught by the baghouse fabric filter or ESP. A major difference, however, in the two collection technologies is the fact that in a baghouse, removal of additional mercury occurs as mercury emissions continue to flow past previously caught carbon powder. This is because the powder creates a layer (or "cake") inside the filter bag through which all subsequent mercury emissions must pass. For this reason, the baghouse method of particulate removal is much more efficient at removing mercury from flue-gas than an ESP.

Recent results from EPA tests indicate that sorbent capacity is highly dependent on temperature, mercury species, mercury concentration, and other flue gas constituents. An oxidized form of mercury is adsorbed to carbon at a greater rate than elemental mercury and generally, the mercury adsorption rate increases as temperature in the flue gas decreases. During tests, spray cooling was shown to be an effective method for reducing the temperature of a flue gas stream, which, in most cases, reduced the amount of carbon sorbent required for mercury capture (REF 8, 25).

In addition to these EPA tests, the Department of Energy (DOE) has conducted several full-scale demonstrations of ACI installations using both bituminous coal and subbituminous coal with both baghouses and ESP equipment. The results show that ACI in conjunction with a baghouse can remove mercury emissions over 90% with modest quantities of carbon being injected into the flue gas stream (about 4 pounds of carbon per million cubic feet of exhaust gas – lb/Mcf). The ESP equipment performed much less efficiently requiring 20 pounds of carbon to achieve a 90% mercury emission removal with bituminous coal and the best removals achieved using ESP equipment with subbituminous coal was 65% regardless of carbon injection amounts (REF 28). Also, it has been subsequently shown that lignite coal responds similarly as subbituminous coal in terms of mercury removals with ACI/ESP equipment. Clearly, for the control of mercury emissions using conventional technologies, fabric baghouse equipment in conjunction with ACI is superior to the use of ESP equipment and it is available to be implemented today.

In addition to utilizing conventional ESP equipment, baghouse and ACI, there are several proprietary technologies worth mentioning that are in different stages of development. The Electric Power Research Institute (EPRI), a non-profit organization of members consisting of power plant owners and associated companies, has patented a process called TOXECON. This technology, designed to remove mercury emissions, consists of a series of processes as follows: an ESP followed by sorbent injection (such as activated carbon), followed by a special baghouse called a compact hybrid particulate collector or COHPAC. The COHPAC is a compact design with a high air-to-cloth ratio baghouse. This array of equipment (ESP/carbon injection/COHPAC baghouse) appears to be the most efficient system that has been tested to date on a full scale for removal of mercury from emissions while providing a power plant operator with a saleable product of unadulterated (or clean) flyash. If not contaminated, collected flyash is typically sold by power plants for use in concrete manufacturing. Since flyash is removed almost entirely by an ESP and since carbon is injected after the ESP, the carbon does not come in contact with flyash and therefore cannot contaminate the flyash product.

It is also worth mentioning that the use of a fabric baghouse for filtering emissions from a coal-fired power plant will reduce a host of fine particulates, some of which are associated with a variety of other hazardous air pollutants, such as arsenic, chromium, lead, manganese and nickel (REF 29).

There are a variety of estimates for the costs associated with those technologies shown to remove mercury effectively from power plant flue gases. For example, the capital expenditure for the proprietary TOXECON process for a 500MW power plant (including ESP, carbon injection and COHPAC equipment) is about \$50 million while operation and maintenance costs total about \$3 million, including activated carbon costs. Amortized over a 15-year period, the capital cost would translate to an annual cost of about \$5 million. Therefore the total cost of implementing the TOXECON process would be \$8 million for a 500MW plant size (REF 30).

An estimate for the capital cost for a conventional baghouse is about \$40 per kW or \$20 million for a 500 MW plant (REF 31). The complementary capital cost of activated carbon injection equipment for the same 500 MW coal-fired power plant is estimated to be about \$1 million at a cost of \$2/kW (REF 32) and the yearly cost for carbon for the same plant is estimated to be about \$3 - \$4 million per year based on DOE-sponsored tests run at the 272MW Gaston power plant in Alabama (REF 33).

The ACI/baghouse and the TOXECON processes are very promising technologies for the removal of mercury emissions from coal-fired power plant flue gas. In addition, there are several other technologies that use non-carbon sorbents for removal or no sorbents at all by oxidizing mercury for removal in wet scrubber equipment (REF 34, 35). It is therefore recognized that further research is needed to provide the best sorbent injection method or oxidation technique coupled with the best particulate removal equipment to provide the most effective mercury capture at the lowest cost. In addition, waste disposal methods for the contaminated (used) carbon, or other sorbent, that does not allow release of adsorbed mercury must be identified so as not to re-contaminate the environment. However, without governmental motivation in the form of regulatory laws, it is unlikely that any technology will be implemented to remove mercury from gaseous emissions soon.

The bottom line to this technology discussion is the fact that activated carbon adsorption used in conjunction with a fabric baghouse is a conventional technology that has already been shown to effectively remove mercury in DOE, EPA and EPRI power plant evaluations. It is used today extensively in the municipal waste combustion industry and is ready to be optimized for its mercury adsorption characteristics in coal-fired power plant emissions. This technology can be implemented now. Other technologies, if eventually shown to be more cost-effective, can be implemented, as they become available.

One note of caution - the cost to remove mercury by the pound (of mercury) can be misleading since relatively small amounts of mercury are actually being removed by the emission control technology that must process a large volume of stack gases. Therefore this costing technique will result in a relatively large number that is apt to be used by those who do not favor mercury emission control. As an example, the Wisconsin Mercury Sourcebook states that the Minnesota Pollution Control Agency's analysis of mercury damage costs provide rough estimates of the environmental harm caused by mercury emissions. Their 1995 estimates range from \$4,400 to \$9,800 per pound of mercury (one can assume that neurological damage to children was not considered in this estimate) (REF 36). The sourcebook goes on to say that mercury emission control can be very expensive with EPA and EPRI estimates in the range of \$5,000 to \$174,000 per pound of mercury (REF 37).

What is the Current US Governmental Response?

Former EPA Administrator, Carol Browner endorsed a plan in 2000 to achieve at least a 90% reduction in mercury emissions from coal-fired power plants by 2008. This endorsement meant very little, however, since a new Administrator came into office in 2001.

In January 2004, the current EPA administration announced its plan to reduce mercury emissions for power plants. Its proposal included three scenarios in order to accomplish its goals. These scenarios include reducing mercury emissions by 29 % by 2007 and reducing emissions by 70 % by 2018 (above and beyond the level of mercury removed currently). As mentioned, mercury is already being removed as a by-product of existing pollution control equipment by about 36 % (27 tons of mercury removed now / 75 tons of mercury in coal). The

government's first goal of reducing mercury emissions will remove an additional 14 tons of mercury from the current 48 tons of emitted mercury for a removal of 29 % (14 tons of mercury removed / 48 tons of mercury now emitted). This will result in 34 tons of mercury being emitted annually by coal-fired power plants in the US or, said another way, about 45 % of the mercury found in coal will be emitted (34 tons of mercury to be emitted / 75 tons of mercury in coal), while about 55 % will be removed (41 tons of mercury removed / 75 tons of mercury in coal). By all measures this is a modest reduction in mercury emissions realizing the capability of current technologies that have been demonstrated to remove 90 % of the mercury emitted by coal-fired power plants.

In addition, the proposal includes a state-by-state "cap and trade" formula to accomplish these reductions (REF 38). This market based "cap and trade" program would allow some power plants to continue operation without mercury emission controls if other power plants in the same state removed more than the 29% - 70% levels. For the first level of reduction, one can envision that if a "cap and trade" program is implemented one plant could remove 90% of its mercury contamination (using current technologies) while two other plants could have no mercury emission controls. This would provide an average of 30% mercury emission reduction for the three plants. The authors of this White Paper believe this type of emission trading system is inappropriate given the greater health and environmental hazards of mercury pollution compared to other less toxic pollutants that may use this technique, such as carbon dioxide and sulfur dioxide. In addition, communities near those power plants without emission control modifications would receive no relief whatsoever from localized mercury contamination.

In the absence of strong Federal leadership, several states have created their own regulations for power plants operating within their borders. Table 6 identifies four states with regulations either passed by their State Legislature, or proposed for a future vote (REF 39).

Table 6. Recent Mercury Control Regulations of Four States

<u>State</u>	<u>Legislation Requiring Mercury Reductions</u>
Connecticut	90% Reduction (by 2008) PASSED
Massachusetts	85% Reduction (by 2006) PROPOSED 95% Reduction (by 2012) PROPOSED
New Jersey	90% Reduction (by 2007) PROPOSED
Iowa	83% Reduction (current regulation for a power plant now under construction)

Unfortunately, much of an individual state's contamination from power plant emissions often comes from power plants operating in other states. For this reason, it is imperative that power plant emissions be regulated on a national basis, not state-by-state.

Conclusion

The EPA's own Children's Health Protection Advisory Committee, which includes academic, industry and environmental professionals called the current EPA's mercury reduction goals completely "inadequate." They went on to say the proposed goals, as written, "do not go as far

as is feasible to reduce mercury emissions from power plants, and thereby does not sufficiently protect our nation's children." The authors of this White Paper thoroughly agree with that assessment.

There is an overwhelming body of evidence that indicates there has been blatant negligence by a variety of entities for not reducing the amount of mercury contamination that the US population comes in contact with on a daily basis.

These entities include:

- a) The coal-fired power industry for continuing to discharge mercury emissions while simultaneously influencing the US government to delay regulating mercury emissions;
- b) Inaction by EPA who could have forced power plants to reduce mercury emissions years ago;
- c) Misleading mercury ingestion guidance by the FDA who has ignored the most sensitive segment of the US population – children; more conservative mercury limits for commercially-sold fish by the FDA may have forced the EPA into regulating mercury emissions from power plants more aggressively.

This negligence was allowed to occur with concurrence of the Executive and Legislative Branches of the US Government.

The lack of leadership on this issue has allowed mercury pollution throughout this country, which, in turn, has encouraged international mercury pollution by the developed and the developing world. The result is extensive pollution of freshwater rivers, streams and lakes in the United States, as well as contributing to mercury pollution levels of the world's oceans. In so doing, this negligence has permitted the contamination of many fish and shellfish species used for human consumption throughout the world with levels of methylmercury that can cause neurological developmental damage in children.

In addition, health-related US Government Agencies have greatly exacerbated the mercury contamination problem in the US because of the following factors:

- a) By the FDA not setting realistic mercury contamination "action levels" in fish to protect all segments of the US population, particularly children. It is admitted and understood throughout the FDA that their mercury action level has been formulated with respect to "economic reasons" in support of the commercial fishing industry. What the FDA does not admit is that this action level has been established in preference to the health of US citizens. If the FDA had not revised the mercury action level upward in 1979 by doubling it, it is doubtful that the current level of contamination of the US population would have occurred. The bottom line is - following FDA guidance on methylmercury ingestion limits results in concentrations of methylmercury in pregnant mothers and fetal blood that are too high. Without specific information/warnings for pregnant mothers and mothers with small children, the FDA's action level has put the most sensitive segment of the US population at risk.
- b) By the EPA and ATSDR not agreeing on a single uncertainty factor that would have resulted in a single reference dose (RfD); this would have made calculations concerning mercury contamination levels in fish and mercury ingestion limits less confusing for state fish advisory agencies and others.

c) By the FDA not creating a national program to place mercury concentration information on commercial fish and shellfish packaging to provide, at the very least, information/warnings for pregnant mothers and mothers of small children; this information could have also included a particular fish product's mercury contamination level that a consumer could read when purchasing, as well as how that contamination level relates to the maximum "safe" level of mercury ingested per day over a lifetime; because of this lack of information to consumers, there has been no significant warnings for the American public in regards to mercury contamination of commercially-sold fish and shellfish.

It is clear that the US Government has allowed mercury contamination of fish and shellfish to continue unabated, while at the same time restricting information concerning that contamination from the American public. And it is also clear that both of these conditions have been allowed to happen for "economic reasons." The bottom line to this discussion is the fact that the American public continues to not fully grasp the dangers of mercury contamination and because of this, a significant percentage of pregnant mothers are unknowingly endangering their children by ingesting levels of mercury that are too high for a developing fetus.

Recommendations

Specifically, these are the recommendations of this White Paper:

1. **Reduce mercury emissions from EACH coal-fired power plant in the US by 90% compared to the mercury content of the coal being burned;** the time period for this to be accomplished is 4 years. Conventional technologies (such as ESP/carbon injection/baghouse) exist today to accomplish this. Further reduce mercury emissions from coal-fired power plants by 98% compared to the mercury content of the coal being burned within 10 years.
2. **The Federal Government should consider subsidizing new mercury pollution control devices for power plants in order to facilitate their timely installation.** The power industry produces power for the entire country to function and this contributes in a most fundamental way to the gross national product of the US. The US absolutely needs a consistent power industry, but the American public should not have to bear the brunt of damaging health effects because of that. The authors of this White Paper believe the Federal Government should take responsibility for curtailing those pollutants that affect the nation as a whole when it is apparent that significant health-damaging effects may be occurring in the national population due to that pollutant. If there ever was a case for government subsidies, it is believed that helping industry control its national and international public health-damaging pollutants is that case. Consumers now pay for pollution control in one form or another, usually by paying higher prices for a product. Government subsidies for pollution control would be just another way for consumers to pay and it would reduce the politics now so evident in the bureaucratic decision-making process when it comes to pollution prevention.
3. **The Federal Government should continue funding research into mercury emission reductions in order to reach the 98% level due in 10 years.** This research should be coordinated with other pollution reduction technologies (such as that for sulfur dioxide, nitrogen oxide, and particulates) to confirm if it is more efficient to remove these pollutants together or, perhaps more likely, in a particular order to maximize removal efficiency.

4. ***The concept of emissions trading—which has been allowed for other less toxic pollutants (such as carbon dioxide and sulfur dioxide) at the Federal level - must not be allowed for such toxic substances as mercury.*** The so-called “cap and trade” scenario is not appropriate for a national, and in the case of mercury, international pollutant as it would allow some power plants to continue contaminating the US and the world at current levels. In addition, this trading concept would not reduce localized mercury contamination that is elevated near and downwind of power plants.
5. ***All other significant sources of mercury emissions in the US must also be controlled on a national level and not left up to the discretion of individual states.*** These include: reducing emissions of solid waste incineration, recovering mercury-laden dental amalgam wastes, banning most mercury switch and gauge components, especially in the automobile industry to be compatible with current European mercury-reduction regulations, drastically curtailing the sale of mercury used for cultural and religious ceremonial activities, as well as mercury thermometers, gas flow regulators and novelties.
6. ***Warning labels must be placed at the point of purchase on all fish packaging of species that are known to contain levels of mercury that may impact health.*** Such warnings should contain methylmercury concentrations thought to be present in a particular product, as well as information on the recommended maximum “safe” ingestion quantities of mercury based upon scientifically calculated numbers, for example, the numbers created by the combined EPA/FDA fish advisory. In particular, pregnant mothers and parents of young children must be warned of the specific dangers of eating certain types of fish for themselves and their children. This warning must include clear and concise “Plain English” information that can be readily understood by consumers. Fish species that must include methylmercury warnings include, at the very least: swordfish, shark, tilefish (from the Gulf of Mexico), king mackerel and white albacore tuna.
7. ***There must be one health recommendation (i.e. reference dose) from all US government health-related agencies based upon one uncertainty factor in order to eliminate confusion.*** In other words, the ATSDR uncertainty factor should be abandoned in preference to the EPA’s factor so that recommendation #6 can be more easily implemented. This would appear to be a relatively straight-forward goal now that there is a combined EPA/FDA fish advisory for mercury contamination.
8. ***The FDA “action level” of 1 ppm should be reviewed based upon the EPA’s reference dose of 5.8/3.5 for blood.*** Now that more is known about the health risk caused by ingestion of methylmercury, a review of the FDA “action level” should be performed to assess the health risk to all Americans. A realistic “action level” could be based upon a healthy adult with a warning system that will educate mothers-to-be and parents of young children as they purchase fish and shellfish. One way or the other, children, the most sensitive segment of the US population, must be protected.
9. ***Reducing mercury emissions from coal-fired power plants in the US is a necessary first step, but the goal for reducing mercury emissions must be an international effort.*** Therefore, it is recommended that global mercury pollution be a topic for United Nations discussion with the objective of creating an international treaty for curtailing mercury emissions from all sources in the future. The mercury reduction technology developments by EPA, DOE and EPRI should be a model for the rest of the world to help them understand the alternatives for reducing mercury emissions by coal-fired power plants in their countries.

Authors' Notes

As Executive Director of Global Water *, and Executive Director of the Wishtoyo Foundation ** and Ventura Coastkeeper® ***, we feel it is important to understand the critical issues affecting us all in terms of mercury pollution.

We believe that once the truth about methylmercury is better understood in terms of its damaging health effects, it may be a defining moment for the US and, hopefully, the world. Leaving it up to government agencies that are influenced by political and economic persuasions has allowed an entire industry, the coal-fired power industry, to pollute our wonderful country to the point that we no longer can eat many of our native fish without wondering if we may be poisoning ourselves. What's worse is that hundreds of thousands of newborn babies born in the US every year are being encumbered with the potential for neurological damage that may cause many to have learning disabilities for the rest of their lives.

This information begs to ask the question - What in the world are we doing to ourselves? Are corporate profits really worth polluting our air and waters to the point that we are poisoning ourselves? The answer, of course, is no, it is not worth it. It is never worth it. Our government officials who have the mandate to protect the health of our citizens are simply not doing their job.

With the wide variety and quantities of chemicals used throughout the developed world and the lack of controls placed upon many liquid discharges and exhaust emissions of industry, it is not at all surprising that eventually something released into the environment would cause an observable health problem within the human population. It is also logical that the segment of the population that is physiologically most sensitive would be the one showing symptoms of that pollutant. The poisoning of the human race has been ongoing at an ever-increasing rate since World War II and is now apparently beginning to reveal itself as neurological problems in children born to mothers who eat fish and shellfish. For this reason, mercury contamination has become the first global pollutant emergency requiring a swift and focused approach to correct.

One of the many insightful quotes from Mahatma Gandhi is one that tells us all of the potential dangers of modern governments - **“There is no human institution that does not have its dangers. The greater the institution, the greater the chances of abuse. Democracy is a great institution and therefore it is liable to be greatly abused. The remedy therefore is not avoidance of democracy but reduction of the possibility of abuse to a minimum.”**

With Gandhi's quote in mind, government officials appear to have a greater sense of urgency to send a manned mission to Mars than to correct pollution that is already adversely affecting the health of our country's citizens. This is the result of a misguided priority system that is illogical and damaging for the country, at large, but beneficial in the short-term for a small number of power plant owners. By not being required to remove pollutants from their emissions, power plant corporations force all Americans to endure a bombardment by mercury and other pollutants everyday of their lives. Private industry should not be in a position to dictate to the American people their quality of life. And yet, that is exactly what happens because of extraordinary influence over the bureaucratic decision-making process by the very corporations that should be regulated by the bureaucratic process.

Lastly, this White Paper is not meant to be a report that merely documents facts; it is meant to be a “call to arms.” Just as Paul Revere yelled as he rode past farmhouses to wake up his countrymen to tell them of impending danger, so too the mounting data of neurological damage

in children cries to us that we are hurting the children of the world and we must act. Therefore, in order to assemble this information quickly, we have used many well-researched reports. We have included all of the reports used to create this document in the reference section. In particular, much of the core information in this White Paper was extracted from the excellent report written by the Northeast States for Coordinated Air Use Management (NESCAUM) entitled *Mercury Emissions From Coal-Fired Power Plants, The Case For Regulatory Action*.

Respectfully Submitted,

Ted Kuepper, REM
Executive Director
Global Water
Project Management Office
3600 S. Harbor Blvd. #514
Oxnard, CA 93035
Phone: 805.985.3057
Email: info@globalwater.org

Mati Waiya
Executive Director
Wishtoyo Foundation/Ventura Coastkeeper®
3600 S. Harbor Blvd., Suite 222
Oxnard, CA 93035
Phone: 805.382.4540
Email: matiwaiya@wishtoyo.org

* Global Water is an international non-profit humanitarian organization focused on creating safe water supplies for rural populations of developing countries (www.globalwater.org).

** Wishtoyo Foundation is a non-profit native-American organization focused on preserving the cultural heritage of the Chumash people through educational programs for schools and at public events. Wishtoyo is also working to strengthen legislation that protects culturally significant historical sites for the benefit of all Californians. (www.wishtoyo.org)

*** Ventura Coastkeeper® (VCK), a project of Wishtoyo, is a member of the International Waterkeeper Alliance®, founded and directed by Robert Kennedy Jr. (www.waterkeeper.org). VCK has an ongoing program to monitor Ventura County watersheds and agricultural runoff and works to ensure enforcement of the Clean Water Act laws.

References

1. Cone, Marla. *Ancestral Diet Gone Toxic*. Los Angeles Times. Jan 13, 2004.
2. Rao, C.S., Environmental Pollution Control Engineering, Page 169-176. John Wiley & Sons, Inc. 1991; Reference found in report entitled: *Control of Mercury Emissions From Coal-Fired Power Plants* by Tan, Zhongchao. February 21, 2004. Report retrieved from Internet 2/24/2004.
3. National Institute of Neurological Disorders and Stroke. *NINDS Neurotoxicity Information Page*. Retrieved 2/24/2004 from the Internet: http://www.ninds.nih.gov/health_and_medical/disorders/neurotoxicity.htm
4. Delaney, Brian. *Health Effects of Exposed to Methylmercury Presentation Notes*. Wisconsin Division of Health 1995. Wisconsin Mercury Sourcebook. (p. 69).
5. Committee on the Toxicological Effects of Methylmercury. Board on Environmental Studies Toxicology. Commission on Life Sciences. National Research Council. *The Toxicological Effects of Methylmercury*. 2000. National Academy Press. Retrieved 2/24/04 from the Internet: <http://www.nap.edu/execsumm/0309071402.html>
6. *Frequently Asked Questions About Mercury Thermometers*. Great Lakes Bi-national Toxics Strategy, U.S. Environmental Protection Agency. May 11, 2000; and Swain, E. B., D. R. Engstrom, M. E. Brigham, T. A. Henning and P. L. Brezonik. 1992. *Increasing*

rates of atmospheric mercury deposition in midcontinental North America. Science 257: 784-787.

7. Wooltorton, Eric. *Facts on mercury and fish consumption.* Canadian Medical Association Journal. October 15, 2002.
8. Brown, T.D., Smith, D.N., O'Dowd, W.J., and Hargis Jr., R.A., *Control of mercury emissions from coal-fired power plants: a preliminary cost assessment and the next steps for accurately assessing control cost.* Fuel Processing Technology. 2000. 65-66:311-341; Reference found in report entitled: *Control of Mercury Emissions From Coal-Fired Power Plants* by Tan, Zhongchao. February 21, 2004. Report retrieved from Internet 2/24/2004.
9. Personal communication with Dr. Timothy W. Foresman, former Executive Science Advisor to the United Nations Environment Programme (UNEP), and former Director of the Division of Early Warning and Assessment of UNEP in Nairobi, Kenya.
10. How Mercury is Methylated. Wisconsin Mercury Sourcebook. (p.65).
11. Clarkson, Tom. *Mercury Toxicity: An Overview.* EPA 823-R-002. Wisconsin Mercury Sourcebook (p. 68).
12. Brown, D. and M. Tatsutani. *Northeast States and Eastern Canadian Provinces Mercury Study: A Framework for Action.* Chapter 3. Health Effects of Mercury and Strategies to Protect Public Health. February 1998. Article found in Mercury Emissions from Coal-Fired Power Plants - The Case for Regulatory Action Northeast States for Coordinated Air Use Management (NESCAUM). October 2003. (pp.1-2).
13. U.S. EPA. *Characterization of Human and Wildlife Risks from Mercury Exposure in the United States.* Volume VII of Mercury Study Report to Congress. 1997b. (EPA-452/R-97-009).
14. Rock, L.B. Sandy and Steven G. Gilbert. *Be quick to end mercury pollution.* Guest columnists on Internet website. January 3, 2003.
15. Schober, Susan, PhD, *Mercury Exposure in US Women and Children – Estimates from the National Health and Nutrition Examination Survey (NHANES)*, Report presented at Mercury: Medical and Public Health Issues Conference, April 28-30 2004.
16. Mahaffey, Kathryn R., Ph. D., USEPA, *Methylmercury: Epidemiology Update*, presentation given at the Fish Forum, San Diego, CA, February 2004.
17. Mercury Emissions from Coal-Fired Power Plants - The Case for Regulatory Action. Northeast States for Coordinated Air Use Management (NESCAUM). October 2003. (pp.1-6).
18. US EPA Fish Advisories Website: <http://www.epa.gov/ost/fish>. Information found in Mercury Emissions from Coal-Fired Power Plants - The Case for Regulatory Action Northeast States for Coordinated Air Use Management (NESCAUM). October 2003. (pp.1-4).
19. Keehner, Denise, PhD, *How We Got Here: The Process FDA and EPA Used in Developing the Advisory*, Report presented at Mercury: Medical and Public Health Issues Conference, April 28-30 2004.
20. Acheson, David, MD, FRCP, *What you Need to Know About Mercury in Fish and Shellfish – The Public health Message*, Report presented at Mercury: Medical and Public Health Issues Conference, April 28-30 2004.
21. The National Wildlife Federation and member groups of the New England Zero Mercury Campaign. *90% Reduction in Mercury Emissions From Power Plants.* May 28, 2003.
22. Clarkson, Thomas W. et al, *Prenatal Methylmercury Exposure from Ocean Fish Consumption in the Seychelles Child Development Study.* Lancet. 2003 May 17;361 (9370):1686-92.

23. Persky, Victoria, MD, Health Effects of Exposure to Methylmercury in Great Lakes Fish Consumers, Report presented at Mercury: Medical and Public Health Issues Conference, April 28-30 2004.
24. Mercury Emissions from Coal-Fired Power Plants - The Case for Regulatory Action. Northeast States for Coordinated Air Use Management (NESCAUM). October 2003. (pp.3-2).
25. Brown, T.D., Smith, D. N., Hargis Jr., R.A., and O'Dowd, W.J. *Mercury measurement and its control: what we know, have learned, and need to further investigate*. Journal of the Air and Waste Management Association. 1999. 49:628-640; Reference found in report entitled: *Control of Mercury Emissions From Coal-Fired Power Plants* by Tan, Zhongchao. February 21, 2004. Report retrieved from Internet 2/24/2004.
26. *DOE Works With Alabama Power to Remove Hg from Coal*, Pollution Engineering Magazine, April 2003. (p. 22).
27. Gallagher, Dawn R., oral testimony on behalf of the Northeast States for Coordinated Air Use Management (NESCAUM) on the US EPA Proposed Rule to Reduce Interstate Transport of Fine Particulate and Ozone and Proposed National Emission Standards for Hazardous Air Pollutants; and in the Alternative, Proposed Standards of Performance for New and Existing Stationary Sources: Electric Utility Steam Generating Units (69FR 4652-4752). February 26, 2004. (pp. 7-8).
28. Durham, M. *Tools for Planning and Implementing Mercury Control Technology*. American Coal Council. 2003. (pp 43-46). Information found in Mercury Emissions from Coal-Fired Power Plants - The Case for Regulatory Action. Northeast States for Coordinated Air Use Management (NESCAUM). October 2003. (pp. 4-5).
29. Mercury Emissions from Coal-Fired Power Plants - The Case for Regulatory Action. Northeast States for Coordinated Air Use Management (NESCAUM). October 2003. (pp. 4-6).
30. Personal communication with EPRI representative describing cost data found in EPRI report # 1004262, 4/9/04.
31. Mercury Emissions from Coal-Fired Power Plants - The Case for Regulatory Action. Northeast States for Coordinated Air Use Management (NESCAUM). October 2003. (pp. 4-6).
32. Durham, M., Testimony Before the U.S. Senate Committee on Environment and Public Works on Status of Sorbent Injection Mercury Control Technology, January 29, 2002.
33. *DOE Works With Alabama Power to Remove Hg from Coal*, Pollution Engineering Magazine, April 2003. (p. 26).
34. Powerspan Licenses Mercury Removal Technology for Power Plants from the U.S. Department of Energy, Powerspan Corp. Press Release, March 9 2004.
35. Mercury Emissions from Coal-Fired Power Plants - The Case for Regulatory Action. Northeast States for Coordinated Air Use Management (NESCAUM). October 2003. (pp. 4-7/8).
36. Minnesota Pollution Control Agency Grant Request, Market-Based Incentive Grant Program, memo to Rick Tonelli, USEPA Region 5 from Peder Larson, MPCA, September 20, 1996; information found in Wisconsin Mercury Sourcebook. (pp.14).
37. Wisconsin Mercury Sourcebook. (pp.23).
38. US EPA. *EPA Proposes Options for Significantly Reducing Mercury Emissions from Electric Utilities*. January 29, 2004. Information retrieved 2/24/2004 from the Internet.
39. Gallagher, Dawn R., oral testimony on behalf of the Northeast States for Coordinated Air Use Management (NESCAUM) on the US EPA Proposed Rule to Reduce Interstate Transport of Fine Particulate and Ozone and Proposed National Emission Standards for Hazardous Air Pollutants; and in the Alternative, Proposed Standards of Performance for New and Existing Stationary Sources: Electric Utility Steam Generating Units (69FR 4652-4752). February 26, 2004. (p. 8).

Appendix 1

**Joint EPA/FDA Advisory
What You Need to Know about Mercury in Fish and Shellfish
2004 EPA AND FDA ADVICE FOR:
WOMEN WHO MIGHT BECOME PREGNANT,
WOMEN WHO ARE PREGNANT,
NURSING MOTHERS,
YOUNG CHILDREN**

Draft Joint Advisory has three main elements

- A) Risk Message**
- B) Consumer Advice**
- C) Additional Information**

A) Risk Message

Who is at risk?

WOMEN WHO MIGHT BECOME PREGNANT, WOMEN WHO ARE PREGNANT, NURSING MOTHERS, AND YOUNG CHILDREN

Why they are at risk.

Fish and shellfish are an important part of a healthy diet. Fish and shellfish contain high-quality protein and other essential nutrients, are low in saturated fat, and contain omega-3 fatty acids... Yet some fish and shellfish contain higher levels of mercury that may harm an unborn baby or young child's developing nervous system. The risks from mercury in fish and shellfish depend on the amount of fish eaten and the levels of mercury in the fish and shellfish.

B) Consumer Advice

Benefits and Risk

If you follow advice given by FDA and EPA women and children will receive the benefits of eating fish and shellfish and be confident that they have reduced their exposure to the harmful effects of mercury

How Much Fish?

Three recommendations:

- 1. Do not eat Shark, Swordfish, King Mackerel, or Tilefish because they contain high levels of mercury**
- 2. Eat up to 12 ounces (2 average meals) a week of a variety of fish and shellfish that are lower in mercury.**
 - Five of the most commonly eaten fish, low mercury: shrimp, canned light tuna, salmon, Pollock, catfish
 - Another commonly eaten fish, albacore ("white") tuna has more mercury than canned light tuna. So, when choosing your two meals...you may eat up to 6 ounces (one average meal) of albacore tuna per week.

3. Check local advisories about the safety of fish caught by family and friends in you local rivers and coastal areas. If no advice is available, eat up to 6 ounces (one average

meal) per week of fish you catch from local waters, but don't consume any other fish during that week.

Follow these same recommendations when feeding fish and shellfish to your young child, but serve smaller portions.

C) Additional Information

1. What is mercury and methylmercury?

Mercury occurs naturally in the environment and can also be released into the air through industrial pollution. Mercury falls from the air and can accumulate in streams and oceans and is turned into methylmercury in the water. It is this type of mercury that is harmful to your unborn baby. Fish absorb the methylmercury as they feed in these waters and so it builds up in them. It builds up more in some types of fish and shellfish than others, depending on what the fish eat, which is why the levels in the fish vary.

2. I'm a woman who could have children but I'm not pregnant-so why should I be concerned about methylmercury?

If you regularly eat types of fish that are high in methylmercury, it can accumulate in your blood stream over time. Methylmercury is removed from the body naturally, but it may take over a year for the levels to drop significantly. Thus, it may be present in a woman even before she becomes pregnant. This is the reason why women who are trying to become pregnant should also avoid eating certain types of fish.

3. Is there methylmercury in all fish and shellfish?

Nearly all fish contain traces of methylmercury. However, larger fish that have lived longer have the highest levels of methylmercury because they've had more time to accumulate it. These large fish (swordfish, shark, king mackerel and tilefish) pose the greatest risk. Other types of fish are safe to eat in the amounts recommended by FDA and EPA.

4. I don't see the fish I eat in the advisory. What should I do?

- If you want more information about the levels in the various types of fish you eat, see the FDA food safety website www.cfsan.fda.gov/~frf/sea-mehq.html or the EPA website at www.epa.gov/ost/fish.

5. What about fish sticks and fast food sandwiches?

Fish sticks and "fast food" sandwiches are commonly made from fish that are low in mercury.

6. The advice about canned tuna is in the advisory, but what's the advice about tuna steaks?

Because tuna steaks generally contain higher levels of mercury than canned light tuna, when choosing your two meals of fish and shellfish, you may safely eat up to 6 ounces (one average meal) of tuna steak per week.

7. What if I eat more than the recommended amount of fish and shellfish in a week?

One week's consumption of fish does not change the level of methylmercury in the body much at all. If you eat a lot of fish one week, you can cut back for the next week or two. Just make sure you average the recommended amount per week.

8. Where do you get information about the safety of fish caught recreationally by family or friends?

Before you go fishing, check your Fishing Regulations Booklet for information about recreationally caught fish. You can also contact your local health department for information about local advisories. You need to check local advisories because some kinds of fish and shellfish caught in your local waters may have higher or much lower than average levels of mercury. This depends on the levels of mercury in the water in which the fish are caught. Those fish with much lower levels may be eaten more frequently and in larger amounts.

- For further information about the risks of mercury in fish and shellfish call the U.S. Food and Drug Administration's food information line toll-free at 1-800-SAFEFOOD or visit FDA's Food Safety Website www.cfsan.fda.gov
- For further information about the safety of locally caught fish and shellfish, visit the Environmental Protection Agency's Fish Advisory website www.epa.gov/ost/fish or contact your State or Local Health Department. A list of state or local health department contacts is available at www.epa.gov/ost/fish. Click on Federal, State, and Tribal Contacts.