MERCURY USE: HOSPITALS AND CLINICS

Mercury reduction activities in the medical field are receiving much attention. There are currently nine projects in the midwest alone that focus on this subject! This is becuase mercury or mercury- containing products are used in a wide variety of settings in a hospital or clinic. Mercury containing products appear in pathology labs, patient areas, and in clinical procedures and medicines. Mercury is found in blood pressure monitors (sphygmomanometers), dental amalgam, thermometers or thermostats, esophageal dilators (also called Maloney or Hurst bougies), Cantor tubes and Miller Abott tubes (used to clear intestinal obstructions), and histology fixatives and stains. Many mercury-containing cleaners and degreasers are found in labs, housekeeping departments, and maintenance areas. *(Terrane Institute)* There are mercury-free alternatives for almost all of these items. Your reduction efforts can make a difference!

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ABOUT THIS HANDOUT

This is one chapter of the "Wisconsin Mercury SourceBook." The Sourcebook was written as a guide for communities to help identify and reduce the purposeful use of mercury. The SourceBook contains background information on mercury contamination and provides a seven-step outline for drafting a mercury reduction plan.

This handout is one of the nineteen sectors that were highlighted in the SourceBook as a potential contributor of mercury in any given community.

What you will find in this handout:

- ★ Information on mercury-containing products and that are unique to the automotive industry
- ★ Information on mercury-containing products that are found both in the automotive industry and in a wide variety of other sectors (e.g., fluorescent lamps, switches)
- ★ Case studies that describe the source substitution experiences of businesses in the automotive industry
- ★ Action ideas that describe pollution prevention, recycling, and management practices for a mercury reduction plan for a business the automotive industry. This provides a good overview of the types of mercury-containing products and alternatives that may exist in the automotive industry.
- ★ A sample proclamation that explains the mercury issue and possible mercury minimization options for the automotive industry
- ★ Current mercury projects in the automotive industry

For more information, please contact:

WHY SHOULD I BE CONCERNED ABOUT MERCURY?

Some of you may remember playing with mercury when you were a child. Its silvery white shimmer was entrancing, and the ability of its glistening mass to split and come back together again was magical. But scientists are now beginning to realize that there is another side to mercury's wily nature. In fact, it is some of mercury's most elemental qualities that make it a difficult substance to handle.

Mercury is a common element that is found naturally in a free state or mixed in ores. It also may be present in rocks or released during volcanic activity. However, most of the mercury that enters the environment in Wisconsin comes from human uses.

Because mercury is very dense, expands and contracts evenly with temperature changes, and has high electrical conductivity, it has been used in thousands of industrial, agricultural, medical, and household applications.

It is estimated that half of the anthropogenic mercury releases in Wisconsin are the result of the purposeful use of mercury. The other half of mercury emissions originate from energy production.

Major uses of mercury include dental amalgams, tilt switches, thermometers, lamps, pigments, batteries, reagents, and barometers. When these products are thrown in the trash or flushed down a drain, the mercury doesn't go away.

The good news is that the majority of products that use mercury purposefully have acceptable alternatives. For example, electric vacuum gages, expansion or aneroid monitors are good alternatives to mercury blood pressure monitors. Mechanical switches, magnetic dry reed switches, and optic sensors can replace mercury tilt switches.

Replacing mercury-laden products with less toxic alternatives is referred to as *source reduction.* Source reduction allows us to eliminate the use of mercury in certain waste streams. This is especially beneficial considering the volatile nature of mercury, because mercury can so easily transfer from air to soil to water.

Practicing source reduction in combination with recycling the mercury already in the waste stream can have a significant impact on reducing mercury levels in the environment.

HEALTH EFFECTS OF ELEMENTAL MERCURY

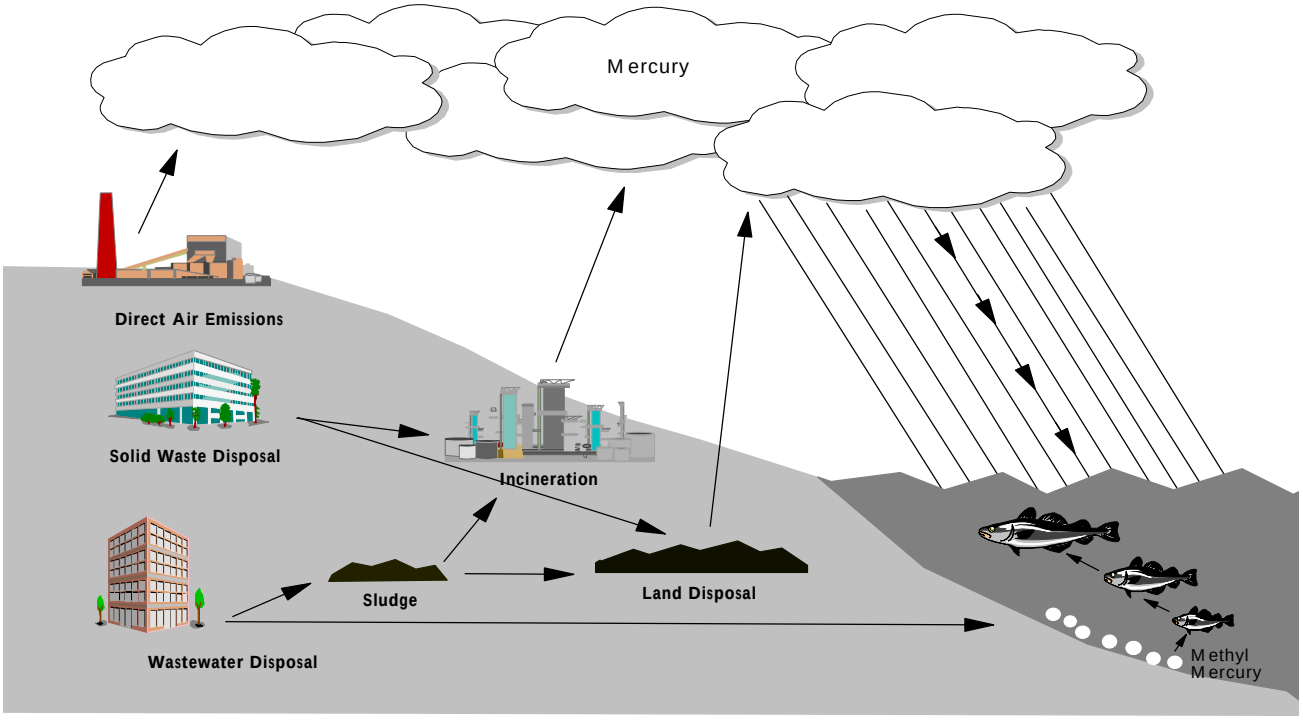
The toxicity of mercury has long been known to humans. Hat makers during the 19th century developed symptoms of shaking and slurring of speech from exposure to large amounts of inorganic mercury, which was used to give a metallic sheen to felt hats. This gave rise to the term "mad as a hatter."

The hat makers were suffering from neurological damage from the inhalation of mercury fumes. Exposure to elemental mercury vapors can cause acute respiratory problems, which are followed by neurologic disturbances and general systemic effects. Acute exposure to inorganic mercury by ingestion may also cause gastrointestinal disturbances and may effect the kidneys.

SO WHAT'S THE BIG DEAL?

Mercury is a bioaccumulative, persistent, toxic substance that threatens the health of humans and wildlife throughout North America. The USEPA, Environment Canada, the International Joint Commission, the Commission for Environmental Cooperation and many state and provincial governments have identified mercury as one of the most critical pollutants for significant elimination and/or reduction.

Mercury Transport and Bioaccumulation



Mercury can enter the environment from a number of paths. For example, if a mercury-containing item is thrown into the garbage, the mercury may be released into the atmosphere from landfill vapors or leachate, or the mercury may vaporize if the trash is incinerated. If mercury is flushed through a wastewater system, the mercury will likely adhere to the wastewater sludge, where it has the potential to volatilize and be deposited elsewhere. Mercury can enter the atmosphere through these various means because it evaporates easily. It then travels through the atmosphere in a vaporized state.

Once mercury is deposited into lakes and streams, bacteria convert some of the mercury into an organic form called *methylmercury*. This is the form of mercury that humans and other animals ingest when they eat some types of fish. Methylmercury is particularly dangerous because it *bioaccumulates* in the environment. Bioaccumulation occurs when the methylmercury in fish tissue concentrates as larger fish eat smaller fish. A 22-inch Northern Pike weighing two pounds can have a mercury concentration as much as 225,000 times as high as the surrounding water.

These concentrations are significant when one considers the potential toxic effects of methylmercury. Methylmercury interferes with the nervous system of the human body and can result in a decreased ability to walk, talk, see, and hear. In extreme examples, high levels of methylmercury consumption has resulted in coma or death.

Many animals that eat fish also accumulate methylmercury. Mink, otters, and loons in Wisconsin have been found to have high levels of mercury in their tissue. Mercury can interfere with an animal's ability to reproduce, and lead to weight loss, or early death.

Fish Consumption Advisories

There are currently 260 lakes and more than 350 miles of rivers in Wisconsin that have fish consumption advisories because of mercury. Approximately 1 out every 3 sites that is tested is listed on the advisory; no sites have ever been removed. Forty-eight states now issue fish consumption advisories to protect human health. Most of these warnings are related to mercury contamination.

Where is mercury found in a hospital?

Laboratories

✔ Histology fixatives and stains

For example, B5 solution contains 37 grams (g) of mercury per liter; Zanker's solution contains 72g of mercury per liter!

Patient Areas

✔ Blood pressure monitors (sphygmomanometers)

✔ Thermometers or thermostats

Clinical Procedures

✔ Esophageal dilators (also called Maloney or Hurst bougies)

✔ Cantor tubes and Miller Abott tubes (used to clear intestinal obstructions or trace the GI tract)

Medicines

Many of the medicinal uses of mercury have been discontinued. However, mercury still appears in thimerosal that is present in eye drops, nasal sprays, etc. See chart below for more information.

Storage Rooms or Maintenance Areas

✔ Old, damaged, or outdated equipment

✔ Rooms where blood pressure monitors are stored and calibrated

Sewer Pipes

Mercury was used extensively in medical settings in the past. Often times the mercury may have found its way into the pipes of a hospital when items were broken, disposed of, or spilled. This mercury can settle at a low point such as a sump or trap and remain in the pipes of a hospital for many years. Often the slow dissolution of the mercury in a sump, trap, or pipe is enough to cause violations of wastewater discharge standards even after poor management practices have been eliminated. Hot spots in a hospital's piping may appear where laboratories or equipment maintenance areas were located. Whenever traps or sumps are moved or cleaned, the solid contents should be treated as a hazardous waste unless proven otherwise. Mercury may also collect in lime chip tanks. For more information, please see the excerpts from the MWRA/ MASCO Infrastructure Subcommittee Maintenance Guidebook that appear in the "Resources" section of this SourceBook.

Common Items

✔ Batteries

✔ Cleaning solutions

✔ Fluorescent lamps

✔ Generators

✔ High intensity lamps

✔ Manometers

✔ Switches

✔ Thermostats

Keeping Mercury-Containing Items out of Wastewater

There are a number of ways mercury can enter the wastewater stream of a hospital. When a mercury-containing product such as a thermometer is broken over a sink or improperly cleaned up after a spill, the mercury could get flushed down the drain. Laboratories using mercury-containing chemicals or reagents may release mercury into the sewer system. Mercury may also be present in a hospital's sewer pipes and traps from historical use of mercury.

Once mercury enters a wastewater treatment plant, most of it concentrates in wastewater biosolids during treatment. Since most treatment plants dispose of generated solids by land spreading, mercury enters the terrestrial environment by this process. Some of this mercury spread on land may, over time, be volatilized to the atmosphere. This mercury may then be deposited into lakes and streams, methylated, and ingested by fish, eventually reaching wildlife and humans.

To prevent such occurrences, it is important to have effective spill response measures. Instruments containing mercury should be labeled and proper procedures should be followed when cleaning or refilling instruments that contain mercury. Instrument cleaning or refilling should take place in a well ventilated area, and, if possible, over a tray to contain any spills. Additionally, laboratory workers should be familiar with policies on the proper disposal practices when working with mercury solutions in a laboratory.

Keeping Mercury-Containing Items out of Medical Waste Incinerators

There are approximately 5,000 Medical Waste Incinerators (MWIs) distributed evenly throughout the United States. About 3,000 of these are hospital incinerators, 150 are commercial units, and the rest are distributed among veterinary facilities, nursing homes, laboratories, and other facilities. Approximately 3,700 incinerators burn general medical waste and 1,300 burn pathological waste. In Wisconsin, we have 14 medical incinerators.

MWIs are a large source of mercury to the environment. There is up to 50 times more mercury in medical waste than in general municipal waste, and the amount of mercury emitted from general medical incinerators averages more then 60 times that from pathological incinerators.

In Wisconsin, MWIs are responsible for approximately 25 percent of emissions in Wisconsin that are associated with the purposeful use of mercury.

Mercury is a very volatile metal that evaporates easily. When a mercury-containing product finds its way into a medical waste red bag and is incinerated, the mercury becomes gaseous and exits through smokestacks into the air. The mercury then settles on land and in water where it can be changed into its organic form, methylmercury. Fish bioconcentrate the mercury to such levels that it can harm wildlife and can be a potential human health risk. It is very important to educate hospital employees about the dangers of putting mercury-containing items in the red waste bags to prevent this contamination.

Mercury Sources in a Health Care Environment

Compiled from City of Detroit, MPCA, Terrane Institute

Product	Applications	Alternatives
Analytical Instruments (mercury chloride as reagent)	SMAC AU 2000	ISE (Ion Selective Electrode)
Barometer	weather condition	
Batteries Mercuric Oxide Silver Oxide	• hearing aids • pacemakers • defibrillators • fetal monitors • hofler monitor • pagers • picker caliber • spirometer alarm • telemetry transmeter • temperature alarm • blood analyzer	lithium, zinc, alkaline
Blood Gas Analyzer Reference Electrode	Radiometer (brand)	
Cathodray Ociloscope	cathode ray tube	
Dental Amalgams (capsule/waste)	tooth restoration	gold, silver, porcelain and polymer
DC Watt Hour Meters	e.g., Duncan, no longer manufactured but may still be in use	
Displacement/Plunger Relay	power supply switching (1 to 4 poles, NO, NC, many voltage and current ratings, generally for high current, high voltage applications)	
Electron Microscope	mercury used as vibration dampner	
Esophageal Dilators (also called Maloney or Hurst Bougies)/Cantor tubes/ Miller Abott Tubes/ Feeding Tubes	mercury is used as a weight at the bottom of the tube	tungsten, water (used as weight) Anderson Tube can replace the Cantor tube
Flame Sensor/Safety Valve	• Some infrared heaters (Robertshaw and Harper-Wyman) • Some furnaces (White Rodgers)	
Hitachi Chem Analyzer	Hitergent Reagent has 65 ppb mercury	

Product	Applications	Alternatives
Lamps	• fluorescent - bilirubin blue - general purpose straight - U-bent, circline, compact - high output • germicidal lamps - cold cathode - hot cathode - slimline • metal halide • high pressure sodium vapor • ultra-violet (TB patient) • spectral lamps • high intensity discharge	ordinary glow lights; opticals; high-energy, long lasting lights • low pressure sodium • forced draft and well lighted room can be designed for the TB patient
Lead Analyzer Electrode	ESA (brand) model 3010B	
Commercial-Industrial-Laboratory Manometers	Many types and uses	
Sphygmomanometers	blood pressure	electronic vacuum gauge, expansion, aneroid
Switches	Displacement/Plunger Relays: • high currant/voltage lighting • power supply switching • tungsten lighting • wetted reed relay/wetted reed switch: test, calibration, measurement equipment Tilt Switches • airflow/fan limit control • building security systems • chest freezer lid switches • fire alarm box switch • fluid level control • lap-top computer - screen shut off when closed • pressure control • silent light switches • washing machine lids	• silent light switches believed to be totally discontinued (GE in 1991), reportedly also manufactured by Leviton, which now produces a non-mercury device • mechanical switches
Thermometers	• blood bank • clerget sugar test • fever/temperature • incubator/water bath • minimum/maximum • tapered bulb (amored)	electronic (digital), expansion, aneroid
Thermostats	• ovens (laboratories) • nursing incubators • room temperature control • refrigerators	• thermostat with bi-metallic strip or with other alternatives

Mercury Sources in Health Care Laboratory Tests

Compiled from City of Detroit, MPCA, Terrane Institute

Test Type	Reagent	Mercury	Alternative
Albumin	Million's reagent	Thimerosal; Mercury-Nitric Acid solution	
ANA	Buffer		
Anti Bacterial Agent	Mercurochrome		OTC Neosporin, Sulfa
Antifungal/ Anti-infective/ Bacteriostatic Enzyme/ Ammonia	Merthiolate Mercury Nitrate	Thimerosal (26% of mercury)	Neosporin, Mycin Ammonia/Copper Sulfate
Ammonia Nitrogen	Nessler's Solution Channing's Solution	Mercury Potassium Iodide	
Arsenic-Calcium Reagent		Mercury 260 ppm	
Blood Bank Saline	Immu-Sal		
BUN Test Enzyme Non Protein Nitrogen	Nessler's Solution		
CA 125		Thimerosal	
Cleaning Supply (commercial grade)	Caustic Soda		
Clostridium Difficile EIA		Thimerosal	
Colorimetric Chloride Analysis			Ion-Selective Electrode Method
CPK Reagent		Mercury 2.7 ppm	
Cytology	Mucolexx	Thimerosal	
Drugs of Abuse	All	Thimerosal	
Epstein Barr Virus	Buffer		
Fixatives	B 5 Fixative Zenker Solution Helly Ohlamacher Carnoy-Lebrun Shardin	Mercuric Chloride (11)	
Flame Photometer (obsolete use)	Mercury (11) Sulfate		Silver Nitrate, Potassium Sulfate, Chromium (111) Sulfate
FTA	Buffer		

Test Type	Reagent	Mercury	Alternative
Gangolion Cell	Cajol's		-Possible substitute is Proclain for mercury compound
Giardia EIA		Thimerosal	
Group A Strap ID		Thimerosal	
Harris Hematoxylin	Mercuric Oxide		Sodium Idoate, Copper Catalyst
HBFT	Alum Hematoxylin (Solution A)	0.25 mg mercury in 100 ml	
Hepatitis B Core		Thimerosal	
Hepatitis C		Thimerosal	
Hepatitis B AG & AB		Thimerosal	
Herpes EIA	Buffer	Thimerosal	
Histology	Mercuric (11) Chloride		Zinc Formalin, Freeze Drying
Histology	Stains: Carbol-Fuchin Mercury Chloride Carbol Gentian Violet Gomori's	Mercuric Chloride or Thimerosal	-Possible substitute is Proclain for mercury compound
HIV		Thimerosal	
Identification of White Cell	Camco		
Lithium	Cesium Internal Std.	2.5 ppb	
Lyme	Buffer		
Mercurial Diuretic (known as mercupurin)	Mercurophylline		
Microbiology	Stain: Gram Iodine	Mercuric Chloride or Thimerosal	
pH	Buffer		
Pharmaceutical Preservative	Phenol Mercuric Acetate		
Progesterone		Thimerosal	
Protain Test (contain Hydroxy phenol group)	Millon's Reagent		
Sodium/Potassium		Thimerosal	
Takata-ara	Takata's Reagent		
Thyroid Antibodies	Buffer		
Urine Analysis	Stabilur Tablets	Mercuric Oxide	
Use in delineating nerve cell	Golgi's		

Mercury-Containing Chemicals and Alternatives

Compiled from City of Detroit, MPCA, Terrane Institute, Michigan M2P2 Task Force

Chemical	Alternative
Mercury (II) Oxide	Copper catalyst
Mercury Chloride	None Identified
Mercury (II) Chloride	Magnesium Chloride/Sulfuric Acid or Zinc Formalin, Freeze drying
Mercury (II) Sulfate	Silver Nitrate/Potassium/Chromium-(III) Sulfate
Mercury Nitrate (for corrosion of copper alloys) for antifungal use (mercurochrome)	Ammonia/Copper Sulfate Neosporin, Mycin
Mercury Iodide	Phenate method
Sulfuric Acid (commercial grade; mercury as impurity)	Sulfuric acid from a cleaner source
Zenker's Solution	Zinc Formalin

Medical/Pharmaceutical Use of Mercury - Human Contact

John Gilkeson of the Minnesota Pollution Control Agency has been working on a project to identify mercury use in products. Here is what he reports finding about mercury use in medical products:

Mercury use in human drugs and biological products is regulated by the Food and Drug Administration (FDA). For topical and over the counter (OTC) products, the FDA is preparing several Final Rules that will likely eliminate mercury use from these products. These Final Rules will limit mercury to prescription medications and require that they go through the New Drug Approval (NDA) process to ensure safety and efficacy. It is quite likely that manufacturers will simply withdraw the mercury-containing products from the market rather than go through the approval process. Current prescription medications will also need to go through the NDA process in the near future in order to remain on the market, and manufacturers will likely withdraw these also.

A Freedom of Information Act request was submitted to the FDA to obtain product names, manufacturers and concentrations in biologic products. The FDA supplied the requested product name and manufacturer information. Thimerosal is used primarily in haemophilus, hepatitis, rabies, tetanus, influenza, diphtheria, and pertussis vaccines.

For OTC products, thimerosal, phenylmercuric acetate, phenylmercuric nitrate, and a few other compounds are still in use as preservatives. Primary uses are in ophthalmic products, contact lens solutions, and nasal sprays. Topical anti-microbals (e.g., tincture of Merthiolate) can still be sold, but they have largely disappeared from the market. A mercuric preservative (PMN) was used until quite recently in one brand of hemorrhoid products. The availability of many similar or otherwise identical products without mercury preservatives indicates that mercury use in these products is not essential.

Mercury was used commonly in conventional medicine well into the 1980's. However, virtually all uses have been discontinued and the few remaining uses are likely to be knocked out by the requirements of the New Drug Approval process which requires a manufacturer to demonstrate that the medication is safe and effective. Mercury is acutely and chronically toxic at levels of parts per million and parts per billion, respectively, if there is continuous intake. Moreover, mercury used in medication will be excreted and will contribute to the global pool of mercury.

Medical/Pharmaceutical Use of Mercury - Human Contact

Information from The Minnesota Pollution Control Agency

Product	Notes
Diuretic	Mersalyl and salts are still manufactured. Extent of use unknown
Eye area cosmetics	Up to 65 ppm mercury (preservative)
Hemorrhoidal ointments and creams	Preservative, discontinued early 1995
Merbromin/water solution	Used in plastic/reconstructive surgery as a disinfectant and marker
Mercuric chloride peritoneal lavage in cancer surgery	Great Britain
OTC ophthalmic and contact lens products	Preservative
OTC disinfectants	"Mercurochrome" [merbromin], tincture of Merthiolate; both are alcohol solutions
OTC nasal sprays	Preservative
Skin bleaching creams	OTC discontinued in US by early 1970s, available by prescription?
Teething powder	Discontinued in early 1950s
Vaccines and other biologic products	US FDA has responded to FOIA request

Case Study: Corning Clinical Laboratory

Corning Clinical Laboratory, located in Wyoming, Michigan, has instituted a wide range of mercury pollution prevention measures to meet the city's strict water guidelines of 0.5 ppb. Corning isolated manufacturer contributions of mercury within its wastewater system by testing its list of reagents for mercury content. Manufacturers might not list mercury on their Material Safety Data Sheets because the amount is so small; therefore Corning did not know the sources of mercury until test results were finalized. Once the sources were determined, a formal mercury reduction policy to continually decrease mercury in its effluent, as well as evaluating mercury contents of the reagents it purchases, was instituted. If the vendor cannot provide mercury-free reagents, Corning will locate a vendor that does or where possible change methodologies to processes that do not involve mercury.

The following is a list of the top nine mercury-containing reagents discovered at Corning Clinical Laboratory. It should be noted that their survey of these reagents occurred over time and the manufacturers may have reduced their mercury content since the original testing.

Reagent/Kit

- ✔ Prostatic Specific Antigen (Hybertech)
- ✔ Cryptococcus antigen wash (Meridian)
- ✔ Clostridium difficile wash (Meridian)
- ✔ Cesium Diluent for Lithiums (CMS)
- ✔ BMD Hytergent wash solution - Hitachi analyzers (BMC)
- ✔ FTA antibody test kit (Zeus)
- ✔ Lyme antibody test kit (Mardx)
- ✔ EBV antibody test kit (Organon)
- ✔ Herpes antibody test kit (Biowhittak)

Mercury Product Focus: Batteries

✔ Mercuric Oxide Batteries

Prior to the 1980s, most primary batteries and some storage batteries contained mercury in the form of mercuric oxide (HgO), zinc amalgam (Zn-Hg), mercuric chloride ($HgCl_2$), or mercurous chloride (Hg_2Cl_2). Although the amount of mercury used in each of these batteries was very small, the number of batteries sold in the US was enough to make alkaline batteries the largest component of mercury in the solid waste stream in 1989.

Great pollution prevention progress has been made in this field. In the last decade, the US battery industry has achieved a 99 percent reduction in their use of mercury! The use of alternative materials and different manufacturing techniques have eliminated the use of mercury in almost all battery applications.

Mercury does exist in mercury zinc, carbon zinc, silver oxide, and zinc air batteries. The amount of mercury discarded in mercury zinc batteries is expected to decline in the future as the use of silver oxide and zinc air batteries increases. The use of mercury in zinc air and silver oxide batteries is expected to be discontinued.

Today, mercuric oxide batteries are the only batteries that use mercury to any measurable degree. There are two basic types of mercuric oxide batteries: button cell and larger sizes. The button cell batteries are the types that are most often sold for personal use; they are used in hearing aids, watches, and other items requiring a small battery.

Mercuric oxide batteries offer a reliable and constant rate of discharge. Therefore, the larger mercuric oxide batteries (which look like 9-volt or fat AA batteries) are often used in military, hospital, or industrial uses. The mercury content in these mercury oxide batteries total 33 to 50 percent mercury by weight of the battery.

1993 Wisconsin Act 74

The 1993 Wisconsin Act 74 prohibits the sale in Wisconsin of any alkaline manganese battery manufactured after January 1, 1996, unless the manufacturer can prove that the alkaline manganese battery contains no intentionally introduced mercury. Alkaline manganese button cells can only be sold if they contain no more that 25 mg of mercury.

Zinc Carbon batteries manufactured after July 1, 1994 for sale in Wisconsin must contain no intentionally introduced mercury. Beginning July 1, 1994 mercuric oxide batteries, except button cells, may not be sold in Wisconsin unless the manufacturer identifies a collection site that meets prescribed standards, informs each purchaser of the collection site and a telephone number to call for information on recycling batteries, and informs the Department of Agriculture, Trade, and Consumer Protection and DNR of this collection site. The law also states that only a certified collection site may treat, store, or dispose of mercuric oxide batteries, and they must be recycled if possible.

Batteries and Mercury Content

From "Household Batteries Waste Management Study," by Gershman, Brickner, and Bratton, Inc., 1992; "Managing Used Dry-Cell Batteries: A Household Hazardous Waste Fact Sheet," MPCA

Type of Battery	Example of Use	Mercury Content
Alkaline		
Cylindrical or rectangular cells; the most commonly recognized battery. Labeled "alkaline."	Flashlight, radios, toys, calculators, remote controls, electronic games, portable radios and televisions, garage door openers.	Previously contained an average of 0.5 percent mercury to control the zinc reaction. 1993 Wisconsin Act 74 mandates that all alkaline manganese batteries sold in Wisconsin after January 1, 1996 be mercury free. Alkaline manganese button cell batteries to contain no more than 25 milligrams of mercury .
Zinc Carbon		
Cylindrical or rectangular cells; labeled as "General Purpose", "Heavy Duty" , or "Classic"	Best used in slow drain applications like clocks, garage door openers, pagers, and smoke detectors. Have much shorter life span than Alkaline batteries.	Use of mercury in these batteries is being phased out. 1993 Wisconsin Act 74 mandates that all zinc carbon batteries for sale after July 1, 1994 be mercury free.
Silver Oxide		
Button shaped with no distinguishing marks	Watches, calculators, toys, greeting cards, musical books	Contain about one percent mercury by weight. Mercury use in these batteries is expected to be discontinued.
Zinc Air		
Usually button shaped. Identify by pin hole on one side	Hearing aids	Contain about one percent mercury by weight. Mercury use in these batteries is expected to be discontinued.
Mercury Zinc (Mercuric Oxide)		
Button shaped, marked with + ; larger mercuric oxide batteries look like 9-volt or fat AA batteries	Hearing aids, watches, and other items requiring a small battery. In consumer applications, mercuric oxide batteries are being replaced by zinc-air button cells. The larger mercuric oxide batteries are often used in military, hospital, or industrial uses.	Contain significant amounts of mercury ; total 33 to 50 percent by weight of the battery. Wisconsin Act 74, requires a collection system for those selling mercuric oxide batteries, and requires the recycling of mercuric oxide batteries unless no reasonable alternative exists.

Case study: Battery Substitution

Broward county, Florida, used a source substitution program to divert nearly 1 ton of mercury per year in medical batteries from incinerators or landfills. To implement the change from mercury battery use, the county surveyed the types, uses, and quantities of medical mercury batteries in use at county hospitals. It was found that individual hospitals were using from 100 to 16,000 batteries per year, which were disposed of in regular or biohazardous waste containers. 8.4 Volt mercury batteries were widely used to power portable Holter cardiac monitors used in intermediate care or "stepdown" units.

County staff explained to area hospitals the problems with and options for battery disposal. Hospitals gladly changed battery use and waste management procedures when staff were educated about the mercury content of batteries and alternatives to mercury battery use. The preferred course of action was a change from mercury batteries to zinc air batteries.

While zinc air batteries are more expensive, they also last longer. One disadvantage of the zinc air battery is that is continues to discharge when not in use, potentially elevating the cost of the batteries over the long run. However, hospital monitors are usually in constant use anyway, so this was not considered a significant factor.

Taking into account the higher cost of alternative batteries and the avoided costs of managing mercury waste, most hospitals achieved net savings by the switch to zinc air batteries. One hospital was even able to purchase alternative batteries at a cost equal to that for mercury batteries.

- from "Mercury in Medical Waste: No. 3: Use of Alternative Products," EPA

More than 63,000 8.4 volt mercury batteries entered Broward county's waste stream each year from hospitals alone. Each battery weighs about 1.8 ounces, nearly 0.5 ounces of which is mercury. That amounts to 1,800 pounds - nearly one ton of mercury. Area hospitals were able to divert this mercury through a source substitution and recycling program - and they saved money in the process!

Mercury Product Focus: Detergents and Cleaners

The Massachusetts Water Resources Authority (MWRA), in conjunction with MASCO (a consortium of Longwood Medical and Academic Area Institutions), has been working with their area hospitals and academic institutions to identify and address the problem of mercury contamination in hospital and medical waste streams. As part of this process, the MWRA group also worked to identify "other sources" of mercury contaminants. These are common products, such as bleach, alcohol, laboratory lids, not otherwise thought to be of significant importance or concern, that might contain low levels of mercury. Thus far, a total of 118 products has been identified by this team. This information is applicable in a variety of settings.

Included among their findings:

- Tissue Tek stainless steel process covers used in embedding were tested for mercury after soaking. In one round of tests, Decal-E lids were shown to leach 0.016 mg/l (16 ppb) of mercury and Zinc_Form E lids leached 0.004 mg/l (4 ppb) of mercury into the soaking solution;
- The T3 (Wallac) Kit contained thimerosal which was verified to be a significant source of mercury;
- At least four (4) cleaners, nine (9) soaps, embedding tissues and other miscellaneous items such as photo processing fixer and developer solutions each contain significant levels of mercury.

"Other Sources of Mercury"

Information from the Massachusetts Water Resources Authority/MASCO

Product	Mercury Content (ppb)
Ajax Powder	0.17
Comet Cleaner	0.15
Lysol Direct	<0.011
Soft Scrub	<0.013
Kodak Fixer	6.9; 3.7
Kodak Developer	2.65; 6.0
Alconox Soap	0.004 mg/kg 0.005 mg/kg <0.0025 mg/kg
Derma Scrub	<5.0 <2.5
Dove Soap	0.0027
Ivory Dishwashing Liquid	0.061
Joy Dishwashing Liquid	<0.01
Murphy's Oil Soap	<0.012
Soft Cide Soap (Baxter)	8.1
Sparkleen Detergent	0.0086
Sunlight Dishwashing Detergent	<0.011

Mercury Product Focus: Lamps

- ✔ fluorescent
  - bilirubin blue
  - general purpose straight, U-bent, circline, compact
  - high output
- ✔ germicidal lamps
  - cold cathode
  - hot cathode
  - slimline
- ✔ metal halide
- ✔ high pressure sodium vapor
- ✔ mercury vapor
- ✔ spectral lamps - monochromatic light source
- ✔ high intensity discharge
  - "CS - Compact Source" mercury lamps
  - special mercury lamps (UV properties)

There are a number of electric lamps that use mercury as an intrinsic part of their functioning. These lamps include fluorescent, mercury vapor, metal halide, and high pressure sodium lamps. These lamps may be used indoors or outdoors in heat lamps, film projection, photography, dental exams, photochemistry, water purification, or street lighting.

Fluorescent lamps contain mercury in a vapor form. The electric current of the lamp "excites" the mercury atoms, which then give off invisible ultraviolet light. The ultraviolet light then "excites" a powdery phosphorus coating inside the tube that emits visible light. The mercury that is contained in these lamps is emitted into the atmosphere when the lamps are broken, disposed of in landfills, or incinerated.

Fluorescent lamps are still a good option. They last longer and cost less to run than incandescent lights because they use up to 50 percent less electricity. This energy savings helps reduce mercury emissions because small amounts of mercury are present in coal that is burned in power plants. The less energy we use, the less mercury will be released into the environment when coal is burned.

New Low Mercury Fluorescent Lamp

Phillips Electronics has developed a long-life fluorescent that contains so little mercury it is no longer considered a hazardous waste. "Typically fluorescent lamps have an overabundance of mercury, because mercury loses its effectiveness due to physical and chemical reactions. So manufacturers put in an overdose of mercury to compensate for these reactions," said George Preston, a scientist at Philips Lighting Co. Currently, a four-foot lamp contains about 22.8 milligrams of mercury, down from 38.4 milligrams in 1990. Philips's new lamp contains less than 10 milligrams of mercury. The new lamp, named ALTO™, relies on a "buffering mechanism" that blocks the physical and chemical reactions that cause the mercury to lose its effectiveness over time. The lamp also uses a new form of phosphorus patented by Philips.

-From "Philips Unveils a Fluorescent Lamp With Less Mercury and a Long Life," Wall Street Journal, June 9, 1995

Recycling Your Fluorescent Lamps

Several Wisconsin companies are in the business of recycling fluorescent lamps and incandescent bulbs. The copper coils, and aluminum or brass end pieces are smelted and reused as raw materials for non-food products. The glass can be purified and used to make fiberglass. The mercury is distilled from the phosphor powder and reused in new lamps and thermometers.

State hazardous waste regulations prohibit businesses from disposing of waste lamps and light bulbs in sanitary landfills if those lamps and bulbs contain levels of heavy metals that exceed hazardous waste limits. For information on the storage, collection, and transport of fluorescent lamps, please see the informational handout, "Recycling Your Fluorescent Lamps," in the "Resources" section of this SourceBook.

Types of Bulbs and Lamps that Contain Mercury

- **Fluorescent Lamps -** the tube-style were first used as overhead lighting in offices, now they also come in compact globe shapes for a variety of home and office uses
- **Mercury Vapor Lamps -** the first high intensity discharge (HID) lamps with blue-white light, originally used as farmyard lights
- **Metal Halide Lamps -** newer, more efficient HID lights found in homes and offices
- **High-Pressure Sodium Vapor Lamps -** white-yellow HID lights used for street lamps and outdoor security lighting
- **Neon Lamps -** brightly colored lamps typically used in advertising; most colors contain mercury except red, orange, and pink

- From the Wisconsin Recycling Markets Directory

Mercury Product Focus: Switches

- ✔ cathode tubes
- ✔ bubbler/trap - laboratory use: seals reaction vessel; for monitoring gas evolution, uses oil or mercury

Displacement/Plunger Relays:
Mercury to Steel or Tungsten Contact; Mercury to Mercury Contact

- ✔ high current/voltage lighting
- ✔ power supply switching
- ✔ tungsten lighting
- ✔ wetted reed relay/wetted reed switch: test, calibration, measurement equipment

Tilt Switches
Including SPST, SPDT, NO, NC, wide angle, omnidirectional, circuit board mount

- ✔ airflow/fan limit control
- ✔ building security systems
- ✔ chest freezer lid switches (for light)
- ✔ fire alarm box switch
- ✔ fluid level control
- ✔ lap-top computer - screen shut off when closed
- ✔ pressure control

  silent light switches (single pole and three way; discontinued in 1991)
- ✔ temperature control (mounted on bimetal coil or attached to bulb device)
- ✔ thermostats
  - room temperature control
  - refrigerators
- ✔ washing machine lids (for spin cycle shut-off; believed to be no longer in production)

Another source of mercury that medical facilities may encounter is mercury switches. A small electrical switch may contain 3,500 milligrams of mercury; industrial switches may contain as much as eight pounds of mercury. Mercury is used in temperature-sensitive switches and in mechanical switches. The mechanical (tilt) switches are activated by a change from a vertical to a horizontal position. These are used in products like thermostats and silent switches. Mercury-containing tilt-switches may also be present in or under the lids of clothes washers and chest freezers - they stop the spin cycle or turn on a light. Mercury tilt switches are also found in motion-sensitive and position sensitive safety switches in clothes irons or space heaters. If a mechanical switch is not visible in these items, a mercury switch is probably being used.

Mercury tilt switches have been used in thermostats for more than 40 years. According to Honeywell, Inc., a major manufacturer of thermostats, more than 50 million mercury-containing thermostats have been sold since the 1950s for use in homes and offices. Mercury in these thermostats provide accurate and reliable temperature control, require little maintenance, and do not need a power source. However, each mercury switch in a thermostat contains about 3 grams of mercury. (There may be one or more of these switches in a single thermostat, each switch in a sealed glass bulb.) Alternatives to these products include electronic thermostats, which can be programmed to set room temperatures at predetermined times. *(blue brochure: the waste connection)*

Float control switches may be used in septic tank and sump pumps to turn the equipment on and off when water is at a certain level. Often, these switches are visible. Temperature-sensitive switches may be used in thermostats. Yet another type of mercury switch, the plunger or displacement relay, is used in high current, high voltage applications that could include lighting, resistance heating, or power supply switching *(M2P2)*.

Reduction Works!

Honeywell Corporation has been running a free take-back program in Minnesota to collect any brand of used mercury-containing thermostat through either a reverse distribution system or a recycle by-mail system.

Honeywell works with heating, ventilating, and air-conditioning (HVAC) wholesalers who sell their products. Honeywell has one license (called a network license) for all the wholesalers who are participating as a consolidation point for the thermostats. HVAC wholesalers contact their Honeywell customer service representatives to order containers for used thermostats, and Honeywell sends the wholesaler a plastic container with an attached lid that holds 100 thermostats.

Homeowners who replace their own thermostats without contractor assistance or with contractors who are not currently participating in the Honeywell program may recycle their thermostats through the free recycle-by-mail system. These individuals can call a toll-free number to receive a free postage paid thermostat mailer.

Mercury Switches in Electrical Applications

(so: Michigan Mercury Pollution Prevention Task Force, 1996)

Switch	Quantity of Mercury	Available Alternatives
Tilt Switch		
· Thermostats	3,000 - 6,000 mg	Electronic type and snap switches
· Float Control (septic tank and sump pumps)	?	Magnetic dry reed switch, optic sensor, or mechanical switch
· Freezer Light	2,000 mg	Mechanical switch
· Washing Machine (power shut off)	2,000 mg	Mechanical switch
· Silent Switches (light switches prior to 1991)	2,600 mg	Mechanical switch
Thermo-Electrical Applications		
· Accustat (“mercury in glass thermostat,” a calibrated device resembling a thermometer is used to provide precise temperature control for specialized applications)	~ 1,000 mg	?
· Flame Sensor (used in residential and commercial gas ranges, mercury is in capillary tube when heated mercury vaporizes and opens gas valve or operates switch. Used for both electrical or mechanical output.)	2,500 mg	Hot surface ignition system for devices or products that have electrical connections.

Mercury Product Focus: Gauges: Manometers, Barometers, and Vacuum Gauges

(from blue waste connection pamphlet)
Medical facilities may encounter liquid mercury in the gauges found in manometers or vacuum gauges. The mercury in these gauges responds to air pressure in a precise way that can be calibrated on a scale. Mercury-free alternatives to these gauges operate on the same principle as these gauges but use mercury-free liquids in the tube.

Needle or bourdon gauges operate under a vacuum with a needle indicator. Electronic gauges can be used to measure pressure, but they must be calibrated with a mercury manometer. Equipment manufacturers recommend that service technicians use a needle or digital gauge to test the systems they are servicing, but that they calibrate the gauges they use in the field with a mercury manometer kept at their shop.

Mercury manometers occasionally need servicing to maintain their accuracy, and elemental mercury often remains as a waste. If the manometer is hard to read because of dirt and moisture in the tube, the mercury needs to be removed and replaced.

Mercury Product Focus: Thermostat Probes (also known as mercury thermocouples)

(from blue waste connection pamphlet)

- ✔ Some infrared heaters (Robertshaw and Harper-Wyman)
- ✔ Some furnaces (White Rodgers)

  Stainless steel bulb, capillary tube, bellows/control device: Used for "unsupervised burners" in certain gas fired devices with standing pilot or electronic ignition pilot.

Mercury-containing thermostat probes may be found in several types of gas-fired appliances that have pilot lights such as ranges, ovens, clothes dryers, water heaters, furnaces, or space heaters. The metal probe consists of a metal bulb and thin tube attached to a gas-control valve. The mercury is inside the tube and expands or contracts to open and shut the valve. A high percentage of gas stoves, ovens, and space heaters contain a mercury thermostat probe. Electric stoves and hot water heaters (gas, electric, and oil) may contain mercury thermostat probes. Although non-mercury thermostat probes have been used in these appliances, you should treat all probes as though they contain mercury, unless you know that they do not.

Mercury thermostat probes, also known as flame sensors or gas safety valves, are most commonly present as part of the safety valve that prevents gas flow if the pilot light is not lit. In this application the bulb of the thermostat probe projects into or near the pilot light. These are commonly present in gas ovens and may be present in any other appliance with a pilot light.

A mercury-thermostat probe may also be present as part of the main temperature controlling gas valve. In this application, the probe is in the air or water that is being heated and is not directly in contact with any flame. These are typically found in older ovens, clothes dryers, water heaters, or space heaters.

Mercury Product Focus: Thermometers

- ✔ blood bank
- ✔ clerget sugar test
- ✔ fever/temperature
- ✔ incubator/water bath
- ✔ minimum/maximum
- ✔ tapered bulb (amored)

Digital or aneroid thermometers are good alternatives for most applications of mercury thermometers.

MERCURY SPILLS

It is essential to handle these mercury and mercury-containing items safely. Small droplets of spilled mercury may lodge in cracks and sinks, mix with dust, accumulate on work surfaces, and adhere to knit fabrics, shoe soles, watches, gold, and other jewelry. This allows for mercury to potentially be transported to other locations, homes, or businesses.

The Costs of Mercury Spills

Mercury spills can be expensive for a number of reasons. Here are some examples:

The Cost of Clean-up

- A mercury-containing sphygmomanometer broken on a carpeted floor at Butterworth Hospital cost $2000 to clean up.

Labor costs

- It took Riverside Hospital 8 to 16 hours to clean up a mercury spill (the mercury had fallen in tile crevices).

Facility Down-Time

- The room in which a mercury spill occurs will be unavailable for use until the site is decontaminated. Riverside Hospital found that their room was out of service for at least one day.

Equipment Loss

- A mercury-containing switch in an oven in a University of Michigan Hospital cafeteria exploded. It cost $3500 to clean up the spill. The oven, a $25,000 piece of equipment, was irreparably damaged.

Training Time

- Continuing to use mercury containing items can be expensive for your facility because of the needed staff training for spill response plans. However, if you are still using mercury-containing products, don't neglect this important step! An improperly handled spill can end up costing even more to decontaminate.

Handle Mercury Safely!

- ✔ Use mercury only in uncarpeted, well-ventilated areas. Provide troughs on smooth surfaced tables and benches to collect mercury spills. Reserve the room for mercury use only; restrict traffic in the area.
- ✔ Ask workers to remove all watches and other jewelry - especially gold jewelry since mercury readily combines with gold - and have them wear a mercury vapor respirator and protective clothing: gloves, disposable gowns, and shoe coverings.
- ✔ Prohibit smoking, eating, and drinking in the area.
- ✔ Train all workers to understand the properties and hazards of mercury and to carry out safe handling procedures and specific policies related to mercury disposal.
- ✔ Clean and calibrate all mercury-containing equipment according to the manufacturer's recommended handling procedures and the formal procedures posed by your communications or safety program supervisors.
- ✔ Ask your safety supply vendor for a mercury vacuum sweeper and spill cleanup kit. Having the right equipment on hand will limit the amount of mercury released into the atmosphere.

- From "The Case Against Mercury: Rx for Pollution Prevention," The Terrane Institute

Who should get involved in a mercury reduction program at your facility?

Because mercury appears in so many different locations in a hospital or clinic, it takes a team effort to reduce or eliminate its use. Staff that could be involved in such an effort include doctors, nurses, engineers, safety officers, suppliers, housekeeping, purchasing department and maintenance personnel. Construction and demolition contractors need to know about trap and drain cleaning.

You may wish to set up a mercury reduction display in your cafeteria to help educate a wide audience. You also may consider articles in in-house newsletters, stories in local papers, and updates that include annual reports and statistics of your program.

The $1,500 Vacuum Cleaner

A major mercury spill occurred in a hospital in a carpeted room at 2:00 am. No one knew what to do; a nurse made the unfortunate decision to vacuum it with a regular vacuum cleaner. The vacuum cleaner had to be wrapped up and made ready for hazardous waste disposal, at a cost of $1,500!

Case Study: Butterworth Hospital, Grand Rapids, Michigan

Butterworth Hospital is a 529 bed hospital that has made a commitment to reach mercury-free status. They are attempting to reach that goal by instituting a purchasing department policy stating unless there is no suitable, mercury-free alternative, no mercury-containing devices are to be purchased. It has been estimated that there is 1-1/2 pounds of mercury used per bed in this facility. Here are some of Butterworth's outstanding mercury reduction efforts:

- ✔ The hospital is in the process of removing all the mercury from the hospital's sphygmomanometers; they estimate that they will have harvested 290 pounds of mercury when they are finished
- ✔ The surgery department switched their esophageal dilators
- ✔ Mercury-containing thermometers and batteries will no longer be purchased
- ✔ Butterworth no longer sends mercury-containing devices overseas in their humanitarian projects
- ✔ They found pneumatic tubes that have mercury switches and are changing these out
- ✔ The hospital is doing drain trap testing to justify lab replacements
- ✔ A mobile fluorescent lamp recycling unit will go to the hospital to crush the lamps on site

Butterworth's mercury reduction activities are not without difficulties though; the labs were resistant because of the pathologists reliance on mercury chloride slide fixatives. The pathologists believe there are no alternatives as precise and accurate.

ACTION IDEAS FOR HOSPITALS TO CONSIDER

Pollution Prevention

- ✔ Phase out mercury-containing medical products such as blood pressure monitors (sphygmomanometers), thermometers, esophageal dilators (also called Maloney or Hurst bougies), Cantor tubes and Miller Abott tubes (used to clear intestinal obstructions), and histology fixatives and stains. Physicians need information on substitutes; consider case studies and other clinical evaluations.
- ✔ Substitute zinc air or silver oxide batteries for your mercuric oxide (mercury-zinc) batteries.
- ✔ Discontinue the practice of sending mercury thermometers home with new mothers.
- ✔ Use safe, non-mercury cleaners and degreasers in labs, housekeeping departments, and maintenance areas.
- ✔ When remodeling or replacing old equipment, replace thermostats containing mercury switches with thermostats containing electronic type and snap switches, and replace "silent" light switches with mechanical light switches.
- ✔ Purchase septic tank and sump pumps that contain magnetic dry reed switches, optic sensors, or mechanical switches instead of mercury tilt switches.
- ✔ Research your use of plunger or displacement relays (used in high current/high voltage applications including lighting, resistance heating, power supply switching); consider replacing these relays with mechanical switches.
- ✔ Examine use of other mercury-containing products in your facility and consider the alternatives for these:
    - generators
    - high intensity lamps
    - manometers
- ✔ Purchasing departments need to know the cost of alternatives and the suppliers for the alternatives. They should consider disposal costs when evaluating a product; total product cost should include disposal costs and costs for cleaning up accidents.
- ✔ Consider the use of an Administrative Directive, either formal or informal, to end the purchase of mercury-containing products.

Recycling

- ✔ Establish a battery collection program.
- ✔ Continue to use fluorescent lamps! Even though fluorescent lamps contain mercury, they are a good choice because they use much less energy than regular bulbs. Consider the use of low-m fluorescent lamps; recycle your fluorescent lamps currently in use. Try not to break these lamps because some of the mercury will escape into the air.
- ✔ Recycle or dispose of mercury-containing products in your facility in an environmentally sound manner

Good Management Practices

- ✔ Label instruments containing mercury.
- ✔ Be sure workers are familiar with the laboratory's policies on the proper disposal practices when working with mercury solutions in a laboratory.
- ✔ Follow proper procedures when cleaning or refilling instruments that contain mercury. Instrument cleaning or refilling should take place in a well ventilated area, and, if possible, over a tray to contain any spills.
- ✔ Start an intensive educational program to keep mercury-containing products (thermometers, batteries, etc.) out the medical waste red bags. When these bags are incinerated, the mercury vaporizes and enters the atmosphere.
- ✔ Don't put your broken mercury-containing thermometers into the sharps containers! The mercury in the thermometer will vaporize when the box is incinerated.
- ✔ Establish effective spill response measures to ensure the mercury already in your facility is handled in a safe and proper manner. To minimize the risk of an accidental spill, never handle mercury over a sink. The educational program for spill prevention and cleanup should be visual and simple. You may want to consider a video.
- ✔ Clean or flush the traps, sumps, and pipes in your sewer lines to rid your facility of historical uses of mercury. See excerpts from the MWRA/MASCO Infrastructure Subcommittee Maintenance Guidebook that appear in the "Resources" section of this SourceBook for more information.

SAMPLE PROCLAMATION

Your facility may wish to formally declare your commitment to mercury reduction. You may use the proclamation below, or adapt it to suit your needs.

WHEREAS mercury is an elemental substance, that once released into the environment, easily and rapidly changes forms to several organic and inorganic states that transfer from soil to air to water and back again;

WHEREAS the organic form of mercury, methylmercury, bioaccumulates in aquatic ecosystems to magnify concentrations in animal tissue in increasing degrees up to 250,000 times;

WHEREAS methylmercury, the most toxic form of mercury, can affect the reproductive efforts of top predators in aquatic environments such as loons, otters, mink, and panthers;

WHEREAS the neurotoxic effects of high levels of methylmercury poisoning in humans has been established, and low-level doses of methylmercury consumption can potentially effect human health, especially that of a fetus;

WHEREAS elemental mercury is a highly toxic substance which can vaporize easily and cause both acute and chronic health effects including severe respiratory irritation and damage to the central nervous system;

WHEREAS mercury has been identified internationally as a toxic substance of concern, and mercury contamination has led to fish consumption advisories for more than 235 lakes and 350 miles of rivers in Wisconsin;

WHEREAS the majority of mercury entering Wisconsin comes from anthropogenic sources, and one-quarter of these emissions are the result of the purposeful use of mercury;

WHEREAS mercury is used widely in consumer and industrial products, where, in most cases, alternative, mercury-free products are available;

WHEREAS pollution prevention or product substitution is a progressive approach to protecting the environment that eliminates or minimizes the generation of mercury-bearing waste, making it one of the most favorable strategies for maintaining a clean environment;

WHEREAS pollution prevention for mercury can help environmental conditions, as well as protect the health and safety of workers;

WHEREAS recognizing mercury minimization as an active opportunity to improve the environment of Wisconsin and the environment of our business, we, the undersigned, do hereby declare our business to be a mercury minimization participant;

WE commit to research the following mercury minimization opportunities in our facility and implement those we find most feasible:

Pollution Prevention

- Phase out mercury-containing medical products
- Substitute zinc air or silver oxide batteries for mercuric oxide (mercury-zinc) batteries
- Discontinue the practice of sending mercury thermometers home with new mothers
- Use safe, non-m cleaners and degreasers in labs, housekeeping departments, and maintenance areas
- Replace mercury-containing thermostats and switches with mercury-free alternatives when remodeling or replacing old equipment
- Purchase septic tank and sump pumps that contain magnetic dry reed switches, optic sensors, or mechanical switches instead of mercury tilt switches
- Examine use of other mercury-containing products in your facility and consider the alternatives for these: generators, high intensity lamps, manometers

Recycling

- Establish a battery collection program
- Recycle fluorescent lamps
- Recycle or dispose of mercury-containing products in an environmentally sound manner

Good Management Practices

- Label instruments containing m
- Familiarize workers with the laboratory's policies on the proper disposal practices when working with mercury solutions in a laboratory
- Follow proper procedures when cleaning or refilling instruments that contain mercury.
- Start an intensive educational program to keep mercury-containing products (thermometers, batteries, etc.) out the medical waste red bags.
- Establish effective spill response measures to ensure the mercury already in your facility is handled in a safe and proper manner.

_____

Facility

_____ _____

Name Date Signed

BIBLIOGRAPHY

The information included in this pamphlet is essentially a compilation of the best mercury pollution prevention work to date. Information was gathered from the documents below; some material may have been quoted directly from these sources:

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"Business Waste Reduction and Recycling: A Guide For The Workplace," Wisconsin DNR, 1995

"DNR Briefing Paper: How to Handle Your Waste Fluorescent Lamps and Incandescent Bulbs," Wisconsin DNR 1995

"Household Batteries Waste Management Study," by Gershman, Brickner, and Bratton, Inc., 1992

"Household Fluorescent Lights: A Household Hazardous Waste Fact Sheet," MPCA, August 1994

"Hospital Mercury Work Group Operations Subcommittee Final Report," Massachusetts Water Resources Authority (MWRA) and MASCO Mercury Work Group, August 21, 1995

"Hospital Success Stories" (presentation), Jennifer Carver, University of Michigan Hospitals, presented at "Mercury Pollution Prevention: Healthcare Providers Protecting People and the Great Lakes," Novi, Michigan October 4, 1996

"How to Design and Administer a Hospital Mercury Reduction Plan" (presentation), David Smith, Riverside Hospital, presented at "Mercury Pollution Prevention: Healthcare Providers Protecting People and the Great Lakes," Novi, Michigan October 4, 1996

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"Mercury Pollution Prevention in Michigan," A Report by the Michigan Mercury Pollution Prevention Task Force, April, 1996

"Mercury, Power Plants and the Environment: Basic Facts about Mercury and Coal-fired Power Plants, the Environment, Fish and Wildlife, and Human Health," compiled by Steven Ugoretz, WDNR

"Mercury Products Study," John Gilkeson, Minnesota Pollution Control Agency, May 1996

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"Strategies for Mercury Control in Minnesota," MPCA Mercury Task Force, July 1994

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"The Hunt for Quicksilver," presented at AERB's Wastewater Discharge Compliance Conference, November 17, 1992 by Frank Altmayer, Scientific Control Labs, Inc.

"Waste Household Battery Management in Wisconsin," SHWEC Waste Education Series

"Wisconsin Recycling Markets Directory," Wisconsin DNR, May 1995

Current Mercury Work – Hospital/Clinics

Specific Outreach/Research	
Project:	*Data Acquisition: Emissions from Medical Waste Incinerators*
Description:	Two year study of emissions from three rural hospital completed in 1991
Agencies working on this project:	MPCA/OEA
Project:	*Mercury Health Care Outreach*
Description:	"The Case Against Mercury: Diagnosis, Treatment, Alternatives," a regional educational/outreach brochure for hospitals, nursing homes, and doctor's offices
Agencies working on this project:	EPA
Project:	*Mercury Pollution Prevention in the Medical Waste Stream*
Description:	Targeted education and outreach, promoting awareness, partnerships, and recycling
Agencies working on this project:	EPA MEQ MPCA/OEA Terrene Institute WDNR
Project:	*Mercury Pollution Prevention Education and Technical Assistance for Medical Facilities in Wisconsin*
Description:	EPA-funded grant for SHWEC to distribute information to hospitals; develop hospital task forces, assessment programs, and workshops
Agencies working on this project:	SHWEC
Project:	*Grant and Working Partnership to Reduce Health Care Mercury Emissions*
Description:	EPA (GLNPO) funded grant to reduce/eliminate mercury use in health care establishments. Will produce a plan for reduction and will educational activities and workshops
Agencies working on this project:	NWF
Project:	*Study of Healthcare Sources and Alternatives*
Description:	A section of the Michigan Mercury Pollution Prevention Task Force examine sources and alternatives for mercury use in health care settings. Includes 6 case studies.
Agencies working on this project:	MDEQ
Project:	*Outreach to Medical Waste Incinerators*
Description:	"MDEQ-EAD received an EPA grant to do education outreach to medical waste incinerators in southeast Michigan
Agencies working on this project:	MDEQ

Current Mercury Work – Hospital/Clinics

Specific Outreach/Research	
Project:	*Mercury Minimization for Hospitals*
Description:	As part of Detroit's Mercury Minimization Program, DWSD is establishing a pilot program to determine the effectiveness of voluntary reduction efforts. Three hospitals are participating in the pilot.
Agencies working on this project:	
Detroit Water and Sewerage Department	
Project:	*Rochester Embayment Watershed Mercury Pollution Prevention Program*
Description:	Focus on hospital mercury sources and alternatives
Agencies working on this project:	
Monroe County Health Department	

MERCURY SPILL RESPONSE PLAN

for

BUTTERWORTH HOSPITAL

GENERAL OVERVIEW

This procedure applies to all units and departments that generate or have the potential to generate mercury or mercury-containing wastes. In general, if the department has mercury thermometers, sphygmomanometers, esophogeal dilator tubes, or other mercury-containing equipment or instrumentation, the department must comply with this procedure.

To provide guidance in proper response, handling, management, and disposal of mercury and mercury-contaminated wastes.

Each unit and/or Department is responsible for the proper handling of mercury-containing devices and reporting of spills and other releases and exposures to employees and patients. The Environmental Services Department coordinates all spill cleanup, disposal, and transportation activities.

ACTIONS TO BE TAKEN WHEN MAINTAINING OR ROUTINELY CHANGING OUT MERCURY-CONTAINING EQUIPMENT

1. Never attempt any repair or maintenance activity on mercury-containing devices without placing a tray under the equipment to collect any spills of mercury. All work must be performed under a Biological Control Hood (BCH).
2. Note the quantity of mercury in the device before initiating repairs or maintenance.
3. Place any spilled mercury into a specimen cup, seal it, date, and identify its contents.
4. Notify the Environmental Services Department for disposal and transportation activity.

ACTIONS TO BE TAKEN IN THE EVENT OF A MERCURY SPILL

In the event of a spill, sudden release or leak of mercury, the following prompt actions will be taken to minimize any adverse effect on the surrounding environment and hospital staff and visitors.

The person causing or discovering the spill or release ➜ notifies the On-Duty Nursing Administrator Associate ➜

The On-Duty Nursing Administrative Associate ➜ verifies location and identification of material released and notifies the on-duty shift Environmental Services (ES) Department Supervisor, if necessary ➜

1st	7:00am to 3:30pm	x1329	pager 7529
2nd	3:30pm to 11:00pm	x1641	pager 7508
3rd	11:00pm to 7:00am	x1381	pager 7509

The On-Duty Shift ES Department Supervisor ➜ go to the spill and access the level and degree of hazard and initiate *required response* plan.

"*Required Response*" is determined by the level and degree of hazard and can be responded to by either the designated mercury Spill response Team or by HAZWOPER Response.

Training, or ES Supervisor only, includes full HAZWOPER training and certification. This HAZWOPER training is required for those persons responsible for determining the level and degree of hazard and proper course of action.

The **Mercury Spill Response Team** is comprised of 2 ES Department staff/shift, minimum. Additionally, 4-5 supervisor are trained in mercury spill response and serve as backups to the primary spill response team.

One spill kit is kept in each ES shift supervisor's office (Rooms A407, A192A, and A190A) and contains "Hg Absorb Powder", vapor absorbent, "Absorb" sponges, "Absorb" indicator powder, a scoop, disposable gloves, and safety goggles. A mercury Spill Control Station is kept in the Director of Environmental Services' office and in addition to the items mentioned above, this station contains mercury vacuum.

The Mercury Spill Team will Follow manufacturer instructions when using those response items found in the commercial mercury spill kits, under the direction of the ES Department Shift Supervisor. The Mercury Spill Team is responsible for informing the ES Department Shift Supervisor of any depleted cleanup kit inventory so that the ES Supervisor can replenish necessary inventory.

TRANSPORTATION AND DISPOSAL

The Director of Environmental Services or his designee is responsible for coordinating all aspects of waste disposal issues resulting from the mercury spill cleanup activities. These activities include characterization of mercury-contaminated waste generated from spills or releases packaging, labeling, storage, transportation and disposal, as required by hazardous waste regulations. The Director of Environmental Services maintains a file of these procedures and approved facilities. Additionally, the Director of Environmental Services maintains a file listing of approved facilities for recycling of elemental mercury recovered during routine maintenance.

RECORDKEEPING

All documents, data, and notes pertaining to the sampling, removal, and disposal of mercury-contaminated wastes or recovery of elemental mercury are maintained by the Director of Environmental Services or his designee.

MERCURY SPILL RESPONSE PROCEDURES

In the event of a spill, sudden release or leak of mercury, the following prompt actions will be taken to minimize any adverse effect on the surrounding environment and hospital staff and visitors.

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3rd	11:00pm to 7:00am	x1381	pager 7509

The **On-Duty Shift ES Department Supervisor ➜** go to the spill and access the level and degree of hazard and initiate *required response* plan.

If the response is "initiate **Mercury Spill Response Team**" **➜**

The Mercury Spill Team will follow manufacturer instructions when using those response items found in the commercial mercury spill kits, under the direction of the ES Department Shift Supervisor.

One spill kit is kept in each ES shift supervisor's office (Rooms A407, A192A, and A190A) and contains "Hg Absorb Powder", vapor absorbent, "Absorb" sponges, "Absorb" indicator powder, a scoop, disposable gloves, and safety goggles. A mercury Spill Control Station is kept in the Director of Environmental Services' office and in addition to the items mentioned above, this station contains mercury vacuum.

Blood Pressure Measurement: Mercury vs. "Other"

Antonicelli, R., Partemi, M. Spazzafumo, L. Amidio, L. & Paciaroni, E. (1995) Blood pressure self-measurement in the elderly. Differences between automatic and semi-automatic systems. Journal of Human Hypertension 9:229-31.

This study "evaluated, in an elderly population, the differences in the self-recording of blood pressure with automatic & semi-automatic equipment using a mercury sphygmonanometer by a physician as a 'gold standard' control." The findings indicated that there was no difference between the mercury and automatic methods of BP measurement. Interestingly, they found significant differences when the semi-automatic system was used. This was thought to be related to the "patient" performance of their component of the measurement (e.g.: several patients couldn't inflate the cuff).

Appel, L., Whelton, P., Seidler, A., Patel, A., & Klag, J. (1990) The accuracy and precision of the Accutracker ambulatory blood pressure monitor. American Journal of Epidemiology 132(2): 343-54.

This study evaluated the Accutracker automatic BP monitor against readings with a mercury sphygmomanometer. The authors were cautious to draw direct correlations since "the cuff, deflation system and deflation rate. As all of these factors substantially influence the accuracy of blood pressure measurement."

Atkins, N., Mee, F., O'Malley, K., & O'Brien, E (1990) The relative accuracy of simultaneous same arm, simultaneous opposite arm and sequential same arm measurements in the validation of blood pressure measuring devices. Journal of Human Hypertension 4:647-9.

"For validation of automated BP measuring devices, simultaneous measurements in the same arm with the test device and a mercury sphygmomanometer is the recommended procedure. However, in practice it is rarely possible..." "If...simultaneous measurement in the same arm is not possible, it is important that a mathematically sound alternative is available." This study looked at the identified options a alternatives to simultaneous same arm testing techniques. They found that "sequential measurements in the same arm...are superior to simultaneous measurements in opposite arms." "It is unlikely that the change in BP between a test device pressure with the mean of two bracketing mercury readings... This causes a bias against the device being tested..."

Bottini, P., Carr, L., Prisant, L, & Rhoades, R., (1992) Variability and similarity of manual office and automated blood pressures. Journal of Clinical Pharmacology 32: 614-9.

The use of the mercury sphygmomanometer "is limited by factors such as observer bias, which confound the ability to discern the true blood pressure value." "Automated blood pressures...demonstrated less within subject variability during repeated measures than" with mercury sphygmomanometers. "Hourly blood pressure profiles recorded throughout 24 hours by automated and manual methods from then hypertensive patients were nearly identical. These data suggest that blood pressures measured by auscultatory automated methods are similar to and representative of those obtained manually."

Brown, J., Buddle, M., Cario, G., & Whitworth, J. (1993) Ambulatory blood pressure monitoring during pregnancy. Comparison with mercury sphygmomanometer. American Journal of Hypertension 6(9); 745-9.

This study was done to determine the appropriateness of using ambulatory monitors (Accutracker II) for detection/monitoring of BP in women with high-risk pregnancies. "Agreement between methods was generally good for systolic & Diastolic phases." Recommends studying the mercury method and ambulatory method to intraarterial readings to determine the "real" accuracy of each.

Clark, S., Hofmeyr, G., Coats, A., & Redman, C. (1991) Ambulatory blood pressure monitoring during pregnancy. Validation of the TM-2420 monitor. Obstetrics & Gynecology 77(1): 152-5.
This study compared the identified automatic BP monitor with a mercury sphygmomanometer and found that the device was appropriate for clinical use. This study recognized that independent BP readings were the result of a variety of readings. They chose to overcome these variables by having 2 people independently determine a patient's BP with a mercury system; the mean of these 2 were compared to the mean f 2 readings with the automatic device.

Foster, D., McKinley, S. Cruickshank, J., & Coats, A. (1994) Accuracy of the Omron HEM706 portable monitor for home measurement of blood pressure. Journal of Human Hypertension 8: 661-4.
This study was done to determine the accuracy of this automatic meter. Again, it was measured against the mercury sphygmomanometer and was found to "perform in a highly satisfactory manner, particularly in the mild-moderate hypertensive range." The researches determined that this device "can be recommended for clinical use."

Gravlee, G., & Brockschmidt, J. (1990) Accuracy of four indirect methods of blood pressure measurement, with hemodynamic correlations. Journal of Clinical Monitoring 6(4): 284-98.
These researchers hoped to find the "best" non-invasive method of measuring BP by comparing a variety of techniques (including automatic with direct intra-arterial pressure readings. They found that "the relationship between non-invasive and directly measured arterial blood pressure varies substantially between patients, over time, and with systemic hemodynamic conditions. In some patients the IPB and ABP correlate so weakly as to render one or more IPB methods diagnostically ineffective. Aside from unexplained wide variation in IBP, clinic clues suggesting this occurrence appear elusive." Single measurements of IPB by 4 different methods correlate moderately well with ABP, but are disappointing in comparison with ideal clinical performance. With present techniques, only auscultatory MBP fell within the accuracy guidelines proposed by AAMI." *This report raises good questions....are we using correct "gold standards"...they did not indicate whether the auscultatory method was performed with a mercury or aneroid system; however, considering that one of the other methods used involved an aneroid meter, it would seem that it was used for the auscultatory method as well.*

Imai, Y., Hashimoto, J., Minami, N., Munakata, M., Watanabe, N., Sakuma, H., Sekino, H., & Abe, K. (1994) Accuracy and performance of the Terumo ES-H51, a new portable blood pressure monitor. American Journal of Hypertension 7(3): 255-60.
This study compared this new device to the mercury sphygmomanometer. This device works by measuring pressure and detecting the sounds (used in the manual method to determine the blood pressure. This device is determined to be as accurate as the mercury method of measuring blood pressure.

Ling, J., Ohara, Y., Orime, Y., Noon, G., & Takatani, S. (1995) Clinical evaluation of the oscillometric blood pressure monitor in adults and children based on the 1992 AAMI SP-10 standards. Journal of Clinical Monitoring 11(2): 123-30.
This study focused on the application of the standards for medical instrument accuracy. The authors focused on using the proper components of the equipment (e.g., correct cuff size) to eliminate potentially significant variances in readings.

Modesti, P., Gensini, G., Brogi, E., & Semen, G. (1990) Clinical evaluation of a novel ambulatory automatic blood pressure monitoring system. Angiology: The Journal of Vascular Diseases 855-61.
This was a study of a newly devised ambulatory BP meter. The set-up of this study focused on ensuring that the cuff was accurately placed on the arm (size, location, & snugness) to ensure that the readings were in fact with 5mmHg of that reading with the mercury sphygmomanometer. *This study supports the premise that there are many variables that impact the BP reading besides the equipment alone.*

Nash, C. (1994) Ensuring the accuracy of digital sphygmomanometers for home use. Mayo Clinic Preceedings 69: 1006-10.
This report described a mechanism to test the accuracy of digital home meters against mercury meters. This used a "simulated" arm and "y"ed tubing to ensure that both devices were exposed to exactly the same pressure. However, this method eliminates the potential variables & concerns associated with working with the human body.

Nuutinen, M., Turtinen, J., & Uhan, M. (1992) Random-zero sphygmomanometer, Rose's tape, and the accuracy of the blood pressure measurements in children. Pediatric Research 32(2): 243-7.
These authors described "one of the well-known observer biases is TDP, i.e., the observer's preference to use a certain digit as the terminal digit of the BP reading." The also described checking the equipment "daily for zero error and dirt in the tubes."

Stewart, M., Gough, K., & Padfield, P. (1995) The accuracy of automated blood pressure measuring devices in patients with controlled atrial fibrillation. Journal of Hypertension 13(3): 297-300.
This study was designed to look at the efficacy of different devices for patients with irregular heart beats and associated beat to beat pressure variability. Determined that care should be taken in selecting the automatic monitor used in this special patient group. *However, this study did not address the concerns about the accuracy of the mercury method of measuring pressure in this patient population as well.*

Vidt, D., Bolen, K. Gifford, R., Mendendrop, S. (1991) The Telelab personal blood pressure transmitter. Accurate and reliable home monitoring for hypertensive patients. Cleveland Clinic Journal of Medicine 58(1): 28-32.
This study compared this new device to the mercury sphygmomanometer. "The differences were well within the accepted prange (±5mmHg) recommended by the AAMI for validating the accuracy of blood pressure monitors (*issued in 1985*)"

Walma, E., vanDooren, D., vanderDoes, E., Prins, A., Mulder, P., & Hoes, A. (1995) Accuracy of an oscillometric automatic blood pressure device: the Omron HEM403C. Journal of Human Hypertension 9: 169-74.
This study is from the Netherlands. It involved a large number of adult subjects comparing this automatic meter with the mercury sphygmomanometer. There was some differences noted but the authors determined that this device is accurate enough for use in the clinical setting.

Impressions

- For bedside use, there is no obvious accuracy benefit to using the mercury sphygmomanometer routinely.
- In light of the health risk (and associated patient/staff safety as well as spill clean-up & waste management costs) associated with use of mercury in the clinical areas, it appears that it is most appropriate to use non-mercury system on a broad scale.
- It is highly recommended (no matter whether mercury, anaroid, or electronic BP devices are used) that:

⇨ Appropriate sixe, placement, & suggness of cuff placement is ensured
⇨ Integrity of all system components is ensured (via routine preventative maintenance)
⇨ Accurate calibration of the device is ensured (via routine preventative maintenance)
⇨ Appropriate technique for inflation, deflation, and auscultation is ensured
⇨ The users are aware of, and efforts are made to counteract, common error points prone to casue inaccurate blood pressure determinations