



Mercury-Added Products Found at Drinking Water & Wastewater Treatment Facilities

**Prepared By: The Northeast Waste Management Officials' Association (NEWMOA)
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Introduction

The Massachusetts Department of Environmental Protection (MassDEP) contracted with the Northeast Waste Management Officials' Association (NEWMOA) and the New England Interstate Water Pollution Control Commission (NEIWPCC) to prepare a report on mercury-containing devices likely to be found at drinking water and wastewater treatment facilities. The main purpose of this Report, entitled, *Mercury-Added Products Found at Drinking Water & Wastewater Treatment Facilities* is to support MassDEP outreach efforts during the upgrades of primary and secondary wastewater and drinking water treatment facilities under the American Recovery and Reinvestment Act (ARRA) and state revolving fund (SRF).

Mercury-added products may be found at drinking water, wastewater, and sewage treatment plants, as well as public water supply facilities, including pumping stations and distribution stations, (collectively referred to as "water treatment plants" throughout the rest of this Report). These products may be in use or stored at these facilities.

This Report provides descriptions and photographs of mercury-added products likely to be found at these facilities; describes the amount of mercury in the products (if known), their potential for breakage and spills, and possibility of human exposure to mercury if broken; and notes the availability of non-mercury alternatives (where applicable). Appendix A presents an alphabetical listing of the mercury-products covered in this Report and their attributes.

NEWMOA substantially relied on the checklist, *Wastewater Treatment Plant Self Assessment Inventory: Products, Chemicals, and Equipment That May Contain Mercury*, developed by the Northeast Ohio Regional Sewer District (NEORSDD) for use during their wastewater treatment facility assessments and upgrades in compiling the information in this Report. Appendix B presents a copy of their checklist.¹ Additional information about mercury-added products compiled from correspondence with facilities through telephone calls, emails, an online survey, the Interstate Mercury Education and Reduction Clearinghouse (IMERC) mercury-added

¹ Similar versions of this checklist have been used by the Madison Metropolitan Sewer District in Wisconsin (MMSD), Western Lake Superior Sewer District in Minnesota (WLSSD), Indiana Department of Environmental Management (IN DEM), and South Carolina Department of Health and Environmental Control (SC DHEC), as well as by other environmental engineering firms and consultants (e.g., Delta Institute and HydrolQual, Inc). NEWMOA consulted the checklists developed by these agencies and organizations for additional information.

products database, and onsite visits at drinking and wastewater treatment facilities in Massachusetts are also included in this Report.

Some of the mercury-added products identified in the NEORSD checklist and other sources have since been phased-out and are no longer common at water treatment plants.² Examples include older appliances (e.g., chest freezers, furnaces, gas ovens, and silent light switches); batteries; certain chemicals; DC watt hour meters; gyroscopes; mercury rings, seals, and balances; paints (e.g., latex and marine); rectifiers; and trickling filters. In addition, research suggests that some of the other products included in the list (e.g., pressure transducers and semi-conductors) are not currently or have not been historically used at water treatment plants, although they are used in commercial and industrial settings.

Many of the mercury-added products included in this Report are still in use at facilities and are being sold today (unless otherwise noted). As more states institute regulations restricting the sale and distribution of certain mercury-added products, and as non-mercury alternatives become readily available, the number of mercury-added products found in use at water treatment plants is likely to decline.

The first step when conducting a mercury audit at a facility is to conduct an inventory of possible sources of mercury. A complete mercury inventory identifies all of the sources of potential mercury contamination. This can be done by having the facility complete a checklist of mercury-added products (in use or stored). The NEORSD checklist in Appendix B is an example of one possible mercury inventory form. It includes columns where facility personnel can identify the number of mercury-added products, as well as their location(s) in the plant.

Facilities should verify the information included in the mercury inventory by conducting a tour of the different areas of the plant to confirm that the checklist is complete – especially if the facility has never conducted an inventory of mercury products before. The information included in this Report, especially the photographs, may help identify a mercury device compared to a non-mercury alternative.

Following the site assessment, facilities should organize a meeting with personnel and their contractors (if applicable) to discuss future mercury reduction opportunities, such as removing some of the mercury-added products in use and replacing them with non-mercury alternatives, and identifying mercury-added products that are no longer in use and making recommendations for proper disposal/recycling.

All of the mercury-added products covered in this Report should be disposed of as a hazardous waste in accordance with local, state, and federal regulations, or properly recycled at their end of useful life because of their mercury content.

² There are a few products listed in this checklist that NEWMOA could not find any information for during our online research (e.g., permeter and mercury-cadmium batteries). Additional follow-up at drinking water and wastewater treatment facilities in the form of phone calls, surveys, and site visits, indicated that these products are not used at water treatment facilities. In some cases, facilities were not aware of what these products were used for, indicating that they are likely obsolete.

The format of this Report follows the order of mercury-added products listed in the NEORSO checklist and covers the following product categories:

- Bulk Chemicals
- Laboratory Chemicals & Equipment
- Process Control & Measuring Equipment
- Switches & Relays
- Building Equipment
- Lamps
- Batteries
- Paint
- First Aid / Medical Equipment
- Miscellaneous

Each of these categories is described briefly below, along with detailed descriptions of the individual products in them. These descriptions include photographs and mention of non-mercury alternatives, where available. The products within each category are organized in alphabetical order.

Bulk Chemicals

Various types of chemicals are found at drinking water and wastewater treatment facilities. These chemicals and chemical compounds are used to clean and sanitize the water to acceptable standards and make the water safe for human use and/or consumption.

The following types of chemical compounds may contain mercury and may be found in bulk quantities at water treatment facilities:

- Chlorine
- De-chlorination chemicals
- Ferric and ferrous chloride
- Sludge thickening polymers
- Nitric acid
- Phosphorus removal chemicals
- Pickling liquor
- Potassium hydroxide
- Sodium chloride
- Sodium hydroxide
- Sodium hypochlorite
- Sulfuric acid



Sodium Bi-sulfite, a de-chlorination chemical
Photo Source: Northeast Ohio Regional Sewer District

The exact concentrations of mercury in these chemicals vary. In most cases, mercury is used in the process for making many of these chemical compounds and is present only in trace amounts (e.g., mercury cell electrolysis used for producing chlorine and sodium hydroxide).

Examples of de-chlorination chemicals used at water treatment facilities include: sulfur dioxide and aqueous solutions of sulfite or bi-sulfate, such as sodium bi-sulfite. Examples of phosphorus removal chemicals used in water treatment processes include: calcium carbonate (aka lime), alum, hydrated aluminum sulfate, and ferric chloride or ferrous sulphate.

Laboratory Chemicals & Equipment

Most water treatment facilities do at least some of their water testing onsite and have laboratories dedicated to testing water quality and compliance. Depending on the types of water testing done, the facility may have elemental mercury and mercury compounds and/or other laboratory devices onsite, such as barometers, hydrometers, and thermometers that contain mercury.³

Elemental Mercury

Elemental mercury is a very dense, shiny, silver metal that is liquid at room temperature. It conducts electricity and easily bonds to other metals. Because of its unique chemical and

³ To be consistent with the NEORS D checklist in Appendix B, these mercury-added measuring devices are covered in a different section, *Process Control & Measuring Equipment*, because they are also likely to be found in areas of the building outside of the laboratory.

physical properties, elemental mercury is used in a variety of applications and products at water treatment plants. Facilities may store jars of elemental mercury onsite for refilling mercury-containing equipment. During routine servicing, equipment is emptied and filled with new mercury. As a result, spills are common. Elemental mercury exposure occurs as a result of a spill when the mercury vaporizes. Inhaled mercury can be absorbed through the lungs and then into the bloodstream. Elemental mercury can cause various neurological effects and high exposures can lead to kidney damage, respiratory failure, and even death.

Mercury Compounds

The following types of inorganic mercury compounds and other mercury-containing chemicals can be found in laboratories at water treatment facilities:

- Mercuric chloride
- Mercuric iodide
- Mercuric nitrate
- Mercuric oxide
- Mercuric sulfate
- Merthiolate / Thimerosal
- Nessler reagent
- Sodium hypochlorite
- Zenker's solution



Elemental Mercury
Photo Source: NYS DEC



Mercuric Oxide, Mercuric Nitrate
Photo Source: Cuoco & Cormier



Mercury Compounds
Photo Source: NEORSD

The exact concentrations (and relative toxicity) of mercury in these compounds vary. For example, thimerosal (sometimes marketed under the trade name, Merthiolate), is a mercury compound that consists of 49.6 percent of mercury by weight. Other compounds contain only trace amounts of mercury. For example, sodium hypochlorite, commonly known as bleach, may have minute traces of mercury, although the levels are usually undetectable. Nessler's reagent, also known as mercuric potassium iodide, is generally prepared from potassium iodide and mercury chloride. Zenker's solution is a form of mercury (II) chloride.

Although these mercury compounds are generally less toxic than elemental mercury, they can still pose health risks to the gastrointestinal track, kidneys, and nervous system, when they are ingested by mouth or absorbed through the skin.

For more information on mercury compounds, see the IMERC Fact Sheet entitled, *Mercury Use in Formulated Products*, at:

www.newmoa.org/prevention/mercury/imerc/FactSheets/formprods.cfm.

Polarographic Analyzers – Mercury Drop Electrodes

Polarographic analyzers measure the electrical current in a particular liquid or solution. The terms “polarographic analysis,” or “polarography,” refer to a voltammetric measurement that uses a technique in which the electric potential (i.e., voltage) is varied between two sets of electrodes while the electrical current is monitored. A polarographic analyzer consists of a

potentiometer for adjusting the electric potential, a galvanometer for measuring current, and a cell which contains two electrodes. The reference electrode has an electric potential that is constant, and the indicator electrode has an electric potential that varies according to the change of the applied voltage. Often, the indicator electrode is a dropping mercury electrode (DME) or a hanging mercury drop electrode (HMDE), also known as static mercury drop electrode (SMDE). The DME steadily releases drops of mercury during the experiment, while the HMDE produces a partial mercury drop of controlled geometry and surface area at the end of a capillary tube. Eventually, the capillary tube becomes clogged and the built-up mercury collected in the reservoir must be removed. It is uncertain exactly how much mercury the device contains. As indicated previously, there are health hazards associated with the exposure to elemental mercury, which in this case, must either be disposed of as hazardous waste or reused in the experiment. Non-mercury electrodes consist of inert metals, such as gold, silver, and platinum, or inert forms of carbon, such as glassy carbon or pyrolytic carbon (e.g., graphite).



Polarographic Analyzer with DME



Close-up of Dropping Mercury Electrode

Photos Source: University of Adelaide, Australia

Water Purification Systems – Ion Exchange Cartridges

Water purification is the process of removing undesirable chemicals, metals, biological contaminants, and other materials from water. Some water purification systems use ion exchange resins to remove or replace unwanted ions. Ion exchange cartridges used for laboratory water purification systems may be contaminated with mercury as a result of filtering and removing toxic ions such as arsenic, lead, and mercury from the water. Contaminated cartridges need to be disposed of as a hazardous waste.

Process Control & Measuring Equipment

The category of *Process Control & Measuring Equipment* is the largest and most varied group of mercury-added products that could be found at water treatment plants. The products included in this category are often found throughout the facility, including the administration buildings, control rooms, laboratories, and pump stations.

For more information on all types of mercury-added measuring equipment, see the IMERC Fact Sheet entitled, *Mercury Use in Measuring Devices*, at:
www.newmoa.org/prevention/mercury/imerc/FactSheets/measuring_devices.cfm.

Barometers

A barometer is an instrument used for determining the pressure of the atmosphere. A mercury barometer consists of a glass tube that is closed at one end with a mercury-filled reservoir at the base. Often, the other end of the tube is open to the atmosphere so that the elemental mercury is exposed to air. The mercury rises and falls with changes in atmospheric pressure. Barometers used in industrial, scientific, or laboratory settings can contain up to 500 grams of mercury, which is approximately 1 pound. This large amount of mercury, combined with the fact that one end of the barometer is open, creates a high potential for mercury releases or a spill. Aneroid, digital, and Eco-celli liquid-gas silicon barometers are non-mercury alternatives.



Close-up Views of Mercury-Added Barometers; Photos Source: NEWMOA

For more information on mercury-added barometers, see:

www.newmoa.org/prevention/mercury/projects/legacy/antiques.cfm#bar.

Counterweights / Dampers

Counterweights and dampers are enclosed devices that use liquid mercury for weight or dampening (i.e., to restrain, absorb shock, or reduce friction/sound/vibration). Mercury dampers may also be used as components in other devices, such as switches and relays, to ensure proper stability and balance. The amount of mercury they contain varies depending on the size and function of the device. Non-mercury weights are available.

Flow Meters

Flow meters measure the flow of gas, water, air, and steam. A mercury-added flow meter can contain as much as 5,000 grams of elemental mercury (over 10 pounds). The mercury is typically encased in a manometer, which is attached to an assembly or pipe system. The mercury in this manometer rises and falls with changes in the rate of flow of the liquid or gas. Mercury flow meters can be identified because they usually have a needle indicator. As long as the device is intact there is little risk for a mercury leak or spill. However, because of the large amount of mercury that flow meters contain, facilities should have an emergency response plan to address proper cleanup in the event of a spill. Non-mercury alternatives include digital, optical, and ball-actuated flow meters.



Old Flow Meter

Photo Source: Purdue University

For more information on mercury-added flow meters, see:

www.newmoa.org/prevention/mercury/projects/legacy/measdev.cfm#fm.

Gas Flow Regulators

The purpose of a gas flow regulator is to regulate the flow of natural gas. The mercury in the regulator aids in maintaining the gas flow pressure and acts as a seal to the relief vent in the event of a pressure surge. Mercury-containing gas regulators typically have horizontal disc-shaped bodies. These regulators contain between one and two teaspoons of liquid elemental mercury, which is equivalent to approximately 100-135 grams, or about a quarter of a pound. Mercury gas flow regulators generally do not create a risk while in service, but mercury spills are common during removal. Non-mercury regulators have been the norm since the 1960's when manufacturers stopped making mercury gas flow regulators. These non-mercury devices are easily distinguishable because they are mounted vertically.



Disc-Shaped Gas Flow Regulator



Low-Pressure System Device

Photos Source: Minnesota Department of Health

For more information on mercury-added gas flow regulators, see:

www.newmoa.org/prevention/mercury/projects/legacy/appliances.cfm#gfr.

Gyroscopes

A gyroscope is a device used for measuring or maintaining orientation. A gyroscope consists of a spinning wheel or disk whose axle rotates according to its orientation. Liquid-bearing gyroscopes may contain a mercury ring or damper for stability. At this time, information about the use of gyroscopes in water treatment plants is not available, and it is likely that these devices are no longer being used at facilities. Mechanical gyroscopes that use ball bearings or a pendulum are non-mercury alternatives.

Hydrometers

A hydrometer is an instrument used to measure the specific gravity of a liquid – the ratio of the density of the liquid to the density of water. Hydrometers are typically made of glass and consist of a cylindrical stem and weighted bulb, which makes the device float upright in the liquid solution. A small amount of elemental mercury (less than one gram) is sometimes used as the weight. Because hydrometers are made of glass, they are susceptible to breakage and could result in a mercury spill. Non-mercury hydrometers that use lead ballast for the weight are available.



Mercury Hydrometer
Photo Source: NEWMOA

For more information on mercury-added hydrometers, see:

www.newmoa.org/prevention/mercury/projects/legacy/measdev.cfm#h.

Level & Rotation Sensors

Level sensors may be used to detect the level of a liquid substance, such as water, wastewater, or sewage sludge. Rotation sensors measure the rotation, angle, or tilt of an axis. These devices work similarly to float switches and tilt switches, respectively, and therefore may contain mercury, although the exact amount is unknown. Electrical, mechanical, and ultrasonic sensors, as well as non-mercury pressure transmitters are available for measuring the liquid levels of a substance. Mechanical, magnetic, and optical sensors can be used to measure rotation.

Manometers

Manometers measure the pressure of liquids and gases. Mercury manometers are generally U-shaped glass or plastic tubes containing elemental mercury that have one end closed and the other open to the atmosphere. The difference in the levels of mercury in each side of the tube indicates the pressure of the substance being measured. Depending on the size, manometers can contain 50 to 500 grams of mercury. The amount of mercury in manometers, combined with the fact that they often have an “open-system” (i.e., one end of the U-tube containing the mercury is open), creates a high potential for a mercury release or spill. Non-mercury manometers are available and include dial or digital models.



Mercury Manometer

Photo Source: Cuoco & Cormier

For more information on mercury-added manometers, see:

www.newmoa.org/prevention/mercury/projects/legacy/measdev.cfm#dm.

Mercury-sealed Pistons

A piston is a component used in gas flow calibrators for calibrating flow meters and other gas flow measurement devices. Gas is collected in a vertically mounted glass cylinder under a mercury-sealed piston. When gas enters the glass tube, the piston rises in the cylinder, and the volume can be measured. The seal between the piston and the cylinder is formed by a mercury o-ring which reduces friction during movement of the piston. At this time, information on non-mercury seals that would be suitable for use in these devices or other non-mercury piston devices is not available.

Pressuretrols™

Pressuretrols™ are a specific brand of pressure-limit switches used in commercial boilers to maintain the steam pressure in the boiler. Pressuretrols™ act similarly to mercury pressure switches in that they are used to shut-off the burner when enough pressure is built up in the system. They can contain greater than 1,000 milligrams (1 gram) of mercury in a sealed glass tube. The manufacturer of mercury-added Pressuretrols™, Honeywell, discontinued their manufacture and sale in 2007. Non-mercury pressuretrol sensors are now available.



Pressuretrol™

Photo Source: Honeywell

Pressure Gauges / Vacuum Gauges

Like manometers, pressure gauges and vacuum gauges are used for measuring the pressure of a liquid or gas. They are used in conjunction with vacuum pumps and are able to measure pressure down to very low readings. Examples of mercury gauges include: Stokes Gauges and McLeod Vacuum Gauges. Depending on the size, style, and use, pressure/vacuum gauges may contain 50 to 500 grams of mercury. Needle/bourbon gauges operate under a vacuum with a needle indicator as opposed to a liquid mercury column. Electronic gauges can also be used to measure pressure, but they must be calibrated with a mercury manometer. Digital, non-mercury-liquid, and aneroid low-pressure gauges used specifically for testing gas piping, drainage, and vent systems are also available.



Pressure Gauge
Photo: Cuoco & Cormier



McLeod Vacuum Gauge
Photo Source: NEWMOA



Close-up of Vacuum Gauge
Photo Source: NEWMOA

Pressure Transducers / Transmitters

A pressure transducer or pressure transmitter is a device used to convert pressure into an electrical signal (i.e., current or voltage). They are included in the NEORS checklist, however, recent research and conversations with manufacturers of these devices indicates that mercury pressure transducers are limited to use by the plastics industry. The pressure transmitters used in water treatment facilities to measure water or chemical levels in in-ground storage tanks and sewage lift stations do not contain mercury.

Pyrometers

A pyrometer is specific type of thermometer that can measure extremely hot temperatures. A typical pyrometer consists of a temperature-sensing stem known as the thermocouple, which is a thin glass tube connected to a dial gauge. When the thermocouple is inserted into the firing chamber, kiln, furnace, engine, boiler, or other heating system, the mercury column rises and falls to indicate the degree of heat. The amount of mercury in a pyrometer ranges from five to ten grams. Non-mercury alternatives include devices with nitrogen-containing stems and digital instruments.

For more information on mercury-added pyrometers, see:

www.newmoa.org/prevention/mercury/projects/legacy/measdev.cfm#py.

Rectifiers

A rectifier is an electrical device that converts alternating current (AC) to direct current (DC), a process known as rectification. Rectifiers installed and used in high-voltage power transmission systems and industrial process prior to 1975 likely contained mercury; they are known as mercury arc rectifiers or mercury arc valves. Operation of these rectifiers relies on an electrical

arc discharge between electrodes in a sealed envelope containing mercury vapor. Glass envelope rectifiers consist of a curved glass bulb, with several pounds of liquid mercury sitting in the bottom as the cathode. If broken, these fragile glass envelopes could release mercury. For larger systems, a metal tank with ceramic insulators for the electrodes is used, with a vacuum pump to counteract slight leakage of air into the tank around imperfect seals. However, these vacuum pumps continually emit small amounts of mercury vapor. These devices are no longer manufactured and since the mid-1970's most mercury rectifiers have been replaced with non-mercury alternatives, including solid state rectifiers, silicon semiconductor rectifiers, and high power thyristor circuits.



Mercury Arc Rectifier; Photo Source: Wikipedia

Ring Balances

Similar in use to mercury seals and dampeners, ring balances consist of a ring of elemental mercury inside layers of sealed flexible tubing. They are components that are used in larger products for balance in rotation and vibration equipment. The amount of mercury they contain is unknown and varies depending on the equipment in which they are being used. Because mercury ring balances are integrated into large products, they are most likely not sold separately.

Semiconductors / Infrared Detectors / Solar Cells

These devices are included in the NEORS checklist, however, the actual use of semiconductors, infrared detectors, and solar cells in water treatment facilities is uncertain; recent research has indicated that these devices are limited to highly specialized and technological applications. Some types of semiconductors contain mercury-cadmium-telluride (HgCdTe), commonly known as MCT, which exhibits a proportional wavelength for detecting infrared radiation. Common semiconductors used for thermal or infrared imaging contain between five and ten milligrams of mercury. Infrared detectors have a semiconductor chip for thermal imaging and sensitivity that contains less than five milligrams of mercury (in the form of MCT compound). Photo-electrochemical solar cells contain a similar alloy, mercury-cadmium-selenide, in its electrodes. Non-mercury alternatives include silicon-based bolometers (i.e., infrared cameras) and infrared detectors manufactured with non-mercury semiconductor materials, such as indium antimonide (InSb), gallium arsenide (GaAs), and aluminum gallium arsenide (AlGaAs). However, these alternatives are not suitable for all applications.

Shunt Trip

A shunt trip is similar to a mercury tilt switch or relay that works with a normal circuit breaker by preventing sudden surges in electrical current caused by short circuits, power surges, or damage to wiring, by disconnecting the power source from the main power supply. At this time,

the exact amount of mercury they contain is unknown, but because they are similar to tilt switches, they may contain between 50 and 5,000 milligrams (5 grams) of mercury. They are often a required safety feature in industrial and commercial settings. Shunt trips may be found as a component of sprinkler systems and elevators and are used for emergency power shut-downs. They may also be used as an accessory to standard circuit breaker systems and panel boards in place of a “panic button.” In case of an emergency, one or all of the circuit breakers can be tripped by pressing the button, or switch. Non-mercury shunt trips appear to be the only produces available for sale today; these are also called solenoid shunt trips or limit switches. They consist of a metal coil with a mechanical or “limit” switch that can be energized externally to trip the breaker.



Circuit Breaker with Shunt Trip



Close-up of Shunt Trip

Photos Source: IAEI Magazine (International Association of Electrical Inspectors)

Sump Pumps / Bilge Pumps

Sump pumps, bilge pumps, and pump systems may contain mercury-added float switches that are used to turn the equipment on and off when water reaches a certain level. When pumping out accumulated water, the mercury float switch keeps the circuit closed until the water level and float reach a certain height. When the water and float drop below this level, the mercury in the float slides down, opening the circuit and shutting off the pump. Depending on its complexity, a pump typically employs either one or two mercury switches, and each switch may contain as little as 1 gram or as much as 250 grams of mercury. As long as the pump remains intact, there is a low probability of a mercury release. Non-mercury pumps use dry reed switches, optic sensors, or mechanical ball switches instead.



Bilge Pump



Sump Pump

Photos Source: Vermont Agency of Natural Resources (VT ANR)

For information about the mercury-added switches used in pumps and pump systems, see the IMERC Fact Sheet entitled, *Mercury Use in Pumps*, at:

www.newmoa.org/prevention/mercury/imerc/factsheets/pumps.cfm.

For more information on mercury-added sump pumps, see:
www.newmoa.org/prevention/mercury/projects/legacy/appliances.cfm#sp.

Thermometers

Thermometers are used to measure temperature. They are most often found in laboratories at water treatment plants, but they are also used in other areas of the facility as they are incorporated into such other devices as ovens, heating systems, and boilers. Mercury-added laboratory thermometers contain mercury encased in a thin plastic or glass tube. The mercury level rises and falls with changes in the temperature. Typical laboratory thermometers contain 5 grams of mercury, but some industrial models can contain up to 50 grams. Thermometers are usually made of glass, making them susceptible to breakage and a potential mercury spill. Several types of non-mercury thermometers are available, including alcohol and mineral spirit glass bulb thermometers, and digital thermometers. Digital thermometers are required for high temperatures and for high-precision temperature reporting requiring fractional degrees.



Mercury Lab Thermometers
Photo Source: H-B Instruments



Mercury (silver), Enviro-Safe (green), and Alcohol (red)
Photo Source: Sargent Welch

Trickling Filters / Pivot Arm Bearings

Trickling filters are used in wastewater treatment facilities primarily for reducing the levels of biological oxygen demand (BOD) and total suspended solids (TSS) in wastewater, as well as aiding in the oxidation of ammonia to nitrates. Pivot arms used in settling tanks separate solids from the solid-liquid suspension. A large amount of mercury may be contained in the center columns of the trickling filter and pivot arm bearings. Mercury was used as a water seal because of its high density and low friction (i.e., lubricating qualities). It also helped to balance the pressure as the wastewater is pumped through the filter. However, there have been documented instances of mercury seals leaking hundreds of pounds of mercury into the tanks, resulting in contamination. As a result, mercury seals are rare and no longer recommended for this use. Companies stopped manufacturing and selling new trickling filters with mercury bearings approximately 30 years ago. Mechanical ring seals are a common non-mercury alternative.



Trickling Filter in a WWT Plant; Photo Source: Food & Agriculture Organization (FAO)

Switches & Relays

Switches and relays are products or devices that open or close an electrical circuit, or a liquid or gas valve. As long as the switches and relays remain sealed and intact there is little to no risk of a mercury spill, however a mercury leak or spill could result when removing the switch or relay from the larger component.

Mercury-added switches include float switches, actuated by a change in liquid levels; pressure switches, actuated by a change in pressure; temperature switches and flame sensors, actuated by a change in temperature; and tilt switches, actuated by a change in the switch position. These different types of switches are described in further detail in this section.

For more information on all types of mercury-added switches and relays, see the IMERC Fact Sheet entitled, *Mercury Use in Switches & Relays*, at: www.newmoa.org/prevention/mercury/imerc/factsheets/switches.cfm.

Flame Sensors

Flame sensors, also called automatic gas shut-off valves, are used as safety devices in industrial furnaces, boilers, gas ovens, space heaters, and other appliances. A flame sensor stops the flow of gas if the open flame does not produce heat, such as when the pilot light is out or the product is malfunctioning. Mercury is contained within the bulb of the sensor, and the heat from the pilot light vaporizes and expands the mercury, causing the gas valve to open. The amount of mercury varies depending on the size of the flame sensor and its intended use. Household applications contain greater than one gram of mercury; flame sensors used in industrial products would presumably contain an even greater amount of mercury. Non-mercury thermocouples are a suitable alternative for many applications. Electronic ignition systems may also be used.



Mercury Flame Sensor
Photo Source: White Rodgers

For more information on mercury-added flame sensors used in cooking equipment, see the IMERC Fact Sheet entitled, *Mercury Use in Gas & Electric Cooking Ranges & Other Cooking Equipment*, at: www.newmoa.org/prevention/mercury/imerc/FactSheets/factsheet_ranges.cfm.

Float Switches

Float switches are used for monitoring various types of liquids, including water, wastewater, sewage, and wet sludge in tanks, wells, chambers, and other containers found at wastewater treatment plants. Mercury float switches are typically located in the buoyant float housing of pumps and pump systems and are actuated based upon the rise and fall of the liquid. Depending on its size and intended use, mercury-added float switches may contain 0.1 to 70 grams of mercury. There are many types of non-mercury alternatives to float switches, including:

mechanical, magnetic dry reed, optical, conductive, metallic ball, sonic/ultrasonic, pressure transmitter, alloy, thermal, and capacitance level float switches.



Float Switches for Sump Pump System; Photo Source: NEORS D

For information about the mercury-added float switches used in pumps and pump systems, see the IMERC Fact Sheet entitled, *Mercury Use in Pumps*, at: www.newmoa.org/prevention/mercury/imerc/factsheets/pumps.cfm.

Pressure Switches

A pressure switch is a device that converts a change in pressure into an electrical function. Mercury-added pressure switches contain greater than one gram of mercury. A diaphragm, piston, bellows, or other pressure-responsive sensor is used to activate the switch. Pressure switches may be used in numerous applications, including heating, ventilation, and air conditioning (HVAC) equipment, heat pumps, injection water systems, pump systems, sanitary systems, hydraulic systems, and fire protection systems. Mechanical (e.g., snap-switch) or solid-state switches are non-mercury alternatives.

Temperature Switches

A temperature switch, also known as a thermocouple or resistance temperature detector (RTD), is a device that opens or closes an electrical circuit based on changes in temperature. Mercury-added temperature switches contain between 50 and 5,000 milligrams (5 grams) of mercury. They may be used in pumps, motors, heaters and boilers, and other appliances. Mechanical or solid-state switches are non-mercury alternatives.

Tilt Switches

Tilt switches sense changes in position or rotation. They are used to activate and control various types of alarms and equipment. Mercury-added tilt switches consist of small tubes with electrical contacts at one end of the tube. As the tube lifts, the mercury collects at the lower end, providing a conductive path to complete the circuit. When the switch is tilted back the circuit is broken. They contain between 50 and 5,000 milligrams (5 grams) of mercury. Non-mercury alternatives to tilt switches include metallic ball, electrolytic, mechanical, solid-state, and capacitance switches, as well as non-mercury potentiometers.



Mercury Tilt Switch
Photo Source: NEWMOA

Relays

Relays are products or devices that open or close electrical contacts to control the operation of other devices in the same or another electrical circuit. Relays are often used to turn on and off large current loads by supplying relatively small currents to a control circuit. Mercury-added relays include: mercury displacement relays, mercury contact relays, and mercury wetted reed relays. The amount of mercury in individual relays varies greatly, from less than 10 milligrams to more than 150 grams. Mercury relays are hermetically sealed; however they have been known to burst and cause a mercury leak/spill if the relay is overheated or if the load is short-circuited. Non-mercury alternatives include dry magnetic reed, electro-mechanical, and solid-state relays, as well as silicon rectifiers.



Mercury displacement relays are used in high current, high voltage industrial applications such as process controllers, power supply systems, heating and lighting systems, and appliances.

Mercury Displacement Relay
Photo Source: Mercury Displacement Industries (MDI)



Mercury contact relays, or mercury contactors, are used for switching electric motors and lighting loads.

Mercury Contactor
Photo Source: Durakool



Mercury wetted reed relays are primarily used in testing, calibration, and measurement equipment applications.

Mercury Wetted Reed Relay
Photo Source: Comus International

Building Equipment

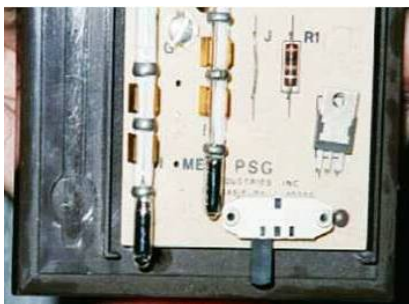
The category of *Building Equipment* includes products that may be found throughout the various buildings at water treatment plants, often as part of the building structure (e.g., thermostats). Because of the large number of them and the fact that changing the devices may require full system upgrades, these products are often replaced with non-mercury devices all at once.

Large appliances and equipment found in the building's cafeteria and/or kitchen are also included in this category (e.g., gas ovens and refrigerators), although most new appliances do not contain mercury or components with mercury (unless they have a fluorescent or other mercury-containing lamp).

Accustat® Thermostats

An accustat is a specific type of mechanical thermostat control that contains several sealed glass sensors or ampoules filled with mercury. They are often used in commercial and industrial

settings where a tamper resistant control and multiple fixed temperature points are needed. Pre-set and adjustable Accutherm® mercury-based sensors are sold separately and are designed to snap in to Accustat® thermostat models. These sensors provide accurate temperature control. Each of the individual sensors contains greater than one gram of mercury. The manufacturer of Accustat® thermostats, PSG Controls, recently developed a non-mercury line called the Accustat® Independence that uses preset electronic temperature set points to maintain the desired temperature.



Accustat Thermostat® with two mercury sensors; Photo Source: NEWMOA

Capillary Tube / Bellows Control Device

A stainless steel bulb, capillary tube, or bellows control device may be used for unsupervised burners in certain gas-fired devices with a standing pilot or electronic ignition pilot. It acts similarly to a mercury-added flame sensor and is used in such gas appliances as boilers, furnaces, heaters, infrared heaters, and ovens. These devices contain greater than one gram of mercury. Information about non-mercury alternatives for these components is included in the descriptions of the larger products that include these components.

DC Watt-Hour Meters

A watt-hour meter is a device that measures how much electricity something uses. It consists of a small electric motor and a counter, which is attached to the rotor and displays the amount of electricity used (in kilowatt hours, kWh). In a mercury-added DC watt hour meter (i.e., direct current), the mercury serves as a low friction bearing in the electric motor. The Duncan Electric Mfg. Co. manufactured mercury-added watt-hour meters in the early-mid 1900's; however these devices are no longer manufactured. Non-mercury watt-hour meters include commutator-type meters for measuring direct current. Induction-type meters for measuring alternating current (i.e., AC meters) may also be used.



Old DC Watt Hour Meters; Photo Source: Duncan Manufacturing

Fire Alarm Systems / Fire Alarm Pull Boxes

Old commercial and municipal facilities may have mercury-based fire alarm systems. These systems consist of overhead sensors connected by brass tubing to individual reservoirs containing approximately a half teaspoon of mercury, which are grouped into wall-mounted manifolds. When a fire heats the room, air in the sensor bulb expands, creating positive air pressure and displacing mercury in the reservoir enough to cover two electrodes, completing a circuit and setting off the fire alarm. There are potential environmental and health hazards associated with these mercury reservoirs, which could leak and emit mercury vapors. Fortunately, these types of fire alarm systems were rare and are no longer used. Old fire alarm pull boxes contained a mercury tilt switch, which could be activated by vibration from manually pulling the handle. The switches are small tubes of less than one gram of mercury with electrical contacts at one end of the tubes. When the tube is tilted, the mercury flows to either end cutting off the circuit on one end, while opening it on the other side. Fire alarm boxes that contain a snap action or push button switch are non-mercury alternatives.



Elemental Mercury Fire Alarm System

Photo Source: New Hampshire Dept. of Environmental Services



Old Fire Alarm Pull Box

Photo Source: Cuoco & Cormier

For more information on mercury fire alarm systems, see:

www.newmoa.org/prevention/mercury/projects/legacy/schools.cfm#fa.

Furnaces

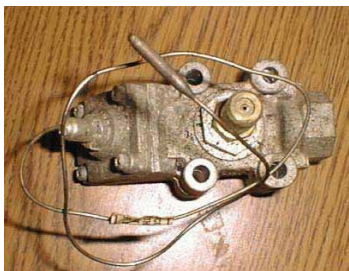
Gas-fired furnaces, or boilers, rely on a standing pilot light, which is a continuously burning gas flame that ignites the gas flow once the furnace is turned on. A mercury flame sensor may be used as a safety device. When the pilot light goes out, the contraction of the mercury (due to changes in temperature) results in enough pressure to turn on an electrical switch that stops the flow of electricity and shuts off the gas supply. The flame sensor will also shut down the furnace completely if the temperature inside the furnace exceeds a certain threshold, preventing the risk of fire. Mercury flame sensors generally contain more than one gram of mercury. There are no risks when the device is intact; however, if the device is broken during removal, a mercury leak or spill may occur. Electronic ignition systems (e.g., intermittent pilot or hot-surface ignition) that do not rely on a standing pilot flame are a non-mercury alternative.

For more information on gas furnaces, see:

www.newmoa.org/prevention/mercury/projects/legacy/appliances.cfm#gf.

Gas Ovens

Both commercial and residential gas ovens/stoves/ranges may have a mercury flame sensor to regulate the flow of gas. As the mercury is heated, it expands, causing a diaphragm to open and allowing the gas valve to supply gas to the pilot light. If the pilot light goes out, or if a spark ignition pilot fails to light, the mercury in the flame sensor cools and contracts thereby shutting off the gas supply. Mercury flame sensors generally contain more than one gram of mercury. The flame sensors found in gas ovens consist of a three-piece device that, if broken, could result in a mercury leak or spill. Electronic ignition systems (e.g., intermittent pilot or hot-surface ignition) that do not rely on a standing pilot flame are a non-mercury alternative.



Mercury Flame Sensor removed from a Gas Oven
Photo Source: Vermont Agency of Natural Resources (VT ANR)

For more information on gas ovens, see:

www.newmoa.org/prevention/mercury/projects/legacy/appliances.cfm#go.

Hydronic and Warm Air Controls

The category of “hydronic and warm air controls” is a generic term that includes aqua-stats, pressure-stats, fire-stats, fan limit controls, and pressure or flow controls. Devices in this category control a variety of functions, including water pressure, air pressure, on/off control, and flow control. They are often used in air handling units, heating, ventilation, and air conditioning (HVAC) systems, boiler systems, walk-in cooler equipment, and other applications that require temperature control. Many of these devices contain a mercury tilt switch inside the control panel. The tilt switch can contain between 50 milligrams and 5 grams of mercury (5,000 milligrams). Non-mercury devices utilize a mechanical snap-action switch.

Infrared Heaters / Space Heaters

Infrared heaters emit infrared rays that easily get absorbed by individual items, gently increasing the ambient temperature of the room. Robertshaw and Harper-Wyman used to manufacture mercury-added flame sensors as a safety device for use in infrared heaters. Similarly, radiant space heaters manufactured by Presto contained a mercury tilt switch that would turn off the heat if the heater tipped over. As long as the heater remained intact, there was a low probability of a mercury release. Most companies stopped using mercury devices in heaters by 1995; the last known manufacturer, Presto Industries, Inc., ceased the manufacture and sale of their heaters in 2002. New heaters use a non-mercury pendulum switch as the safety feature.

For more information on space heaters, see:

www.newmoa.org/prevention/mercury/projects/legacy/appliances.cfm#sh.

Refrigerators / Freezers

Refrigerators and freezers, especially chest freezers, may have mercury tilt switches located on the doors or lids that are connected to a light socket. The switch is used for convenience lighting purposes, (e.g., when the lid of the chest freezer is opened, the light turns on). A mercury tilt switch used for this purpose contains approximately one gram of mercury. These appliances are no longer manufactured with mercury tilt switches. In 2000, manufacturers changed the design of chest freezers to incorporate a non-mercury switch. Non-mercury mechanical switches are now used.



Mercury switch removed from a Chest Freezer; Photo Source: Assoc. Municipal Recycling Coordinators (AMRC)

For more information on chest freezers, see:

www.newmoa.org/prevention/mercury/projects/legacy/appliances.cfm#cf.

Silent Light Switches

Silent light switches are the same as traditional light switches mounted on the wall, except for the fact that they do not make the audible “click” sound when activated and are totally silent, hence their name. They also glow faintly when they were turned off to aid people in finding them when the room darkens. Mercury in a silent light switch is used to complete an electrical circuit. When the switch is lifted up, the mercury flows from one end to the other, submerging an electrical contact point and closing the circuit, thereby turning the light on and off. There is approximately two grams of liquid mercury in the switches located in a metal-encased glass button in the light switch. These types of switches were popular in the 1970’s but are no longer manufactured. Traditional light switches are a non-mercury alternative.



Silent Light Switch

Photo Source: Elemental Services & Consulting, Inc. (ESCO)

For more information on silent light switches, see:

www.newmoa.org/prevention/mercury/projects/legacy/appliances.cfm#sls.

Thermostats / Thermo-regulators

Mercury tilt switches are components of mercury-added thermostats and thermo-regulators. They are commonly used in commercial buildings because they do not require a power source. Unlike Accustat® models, which have several glass ampoules each containing one gram of mercury, mercury thermostats usually contain one or two mercury tilt switches, which have approximately three grams of mercury each. Therefore, the total amount of mercury in a

standard thermostat may be up to six grams. Industrial-sized thermostats have multiple switches and thus have greater amounts of mercury. They are designed to withstand high temperatures and harsh environments. Examples of industrial thermostats that may be used in wastewater treatment facilities include a low-voltage multi-stage wall thermostat and a heat pump thermostat. Non-mercury alternatives include electromechanical (i.e., air-controlled, reed switch, vapor-filled diaphragm, and snap-switch) and electronic programmable thermostats (i.e., digital). However, non-mercury thermostats may not be suitable for all industrial settings because of their extreme environmental conditions.



Examples of Mercury Switch Thermostats; Photo Source: NEWMOA

For more information on mercury-added thermostats, see the IMERC Fact Sheet entitled, *Mercury Use in Thermostats*, at:
www.newmoa.org/prevention/mercury/imerc/FactSheets/thermostats.cfm.

Vibration Meters

Vibration meters, or vibration monitors, are located on motors, pumps, pump systems, compressors, generators, rotating machinery, and other vibrating structures at wastewater treatment facilities. Some models contain a mercury switch that detects vibration. When the meter vibrates, a mercury switch inside the probe closes an electrical circuit. The switches inside these meters contain between 100 and 1,000 milligrams of mercury (less than 1 gram). Analog and digital vibration meters are available non-mercury alternatives.

Lamps

Mercury is used in a variety of light bulbs. Mercury-added bulbs are generally more energy efficient and last longer than incandescent and other equivalent forms of lighting. While the bulbs are being used, the mercury within them poses no health risk. However, because of the mercury that they contain, facilities must properly manage and dispose of the bulbs as a hazardous or universal waste, or recycle them through a mercury reclamation facility at their end-of-life.

Mercury-added lamps include: fluorescent (all types), high intensity discharge (HID), metal halide, ceramic metal halide, high pressure sodium (HPS), mercury vapor, mercury short-arc, mercury xenon short arc, mercury capillary, and neon lights. Some of the different types of lamps likely to be found at water treatment plants are described in further detail in this section.

For more information on all types of mercury-added lamps, see the IMERC Fact Sheet entitled, *Mercury Use in Lighting*, at:
www.newmoa.org/prevention/mercury/imerc/factsheets/lighting.cfm.

Fluorescent & Other Mercury-Added Lamps

Fluorescent and other mercury-added bulbs are generally more energy efficient and last longer than incandescent and other equivalent forms of lighting. Fluorescent lamps include: linear (straight), U-tube (bent), and circline (circular) fluorescent lamps/tubes; bug zappers; tanning lamps; black lights; germicidal lamps; high output lamps; cold-cathode fluorescent lamps; and compact fluorescent lamps (CFLs). Other mercury-added lamps likely to be found in commercial and industrial settings, such as wastewater treatment facilities, include: high-pressure sodium, mercury arc, and metal halide. Depending on the type of bulb, its size, and its use, the amount of mercury in each individual bulb can range from less than 1 milligram, to over 1,000 milligrams (1 gram). Light-emitting diode (LED) lamps are an energy-efficient alternative to mercury lighting.



Examples of Fluorescent, High Pressure Sodium (HPS), and High-Intensity Discharge Lamps
Photo Sources: Florida Department of Environmental Protection and Osram Sylvania, respectively

Ultraviolet Disinfection Lamps

Ultraviolet disinfection lamps, also known as germicidal lamps, are often used in water treatment facilities for sterilization because the UV light they emit ionizes oxygen to ozone and kills germs and bacteria (including E. coli, salmonella, and coliform). Each UV lamp contains less than 5 milligrams to greater than 1,000 milligrams (1 gram) of mercury. The use of UV disinfection lamps for drinking and wastewater sanitation is often preferred to their non-mercury alternative of using chlorination chemicals.

Batteries

Mercury is commonly used in button-cell batteries. Button-cell batteries are small, thin, energy cells that are not rechargeable and are used in small portable devices. Button-cell batteries include: zinc air, silver oxide, and alkaline manganese oxide batteries. These different types of batteries are described in further detail in this section.

For more information on all types of mercury-added batteries, see the IMERC Fact Sheet entitled, *Mercury Use in Batteries*, at:
www.newmoa.org/prevention/mercury/imerc/factsheets/batteries.cfm.

Button-cell Batteries

Some button-cell batteries, including alkaline manganese oxide, silver oxide, and zinc air, contain mercury in the insulating paper surrounding the battery and/or in the anode itself. As the battery is used, zinc in the battery gets corroded, causing the build-up of hydrogen gas in the button-cell, which in turn, can cause the battery to leak and limit its function. The mercury suppresses this corrosion. A single button-cell may contain up to five milligrams of mercury; stacked button-cell batteries contain a larger amount. Non-mercury lithium, alkaline manganese, silver oxide, and zinc air button-cell batteries are alternatives. However, many of these models are more expensive than their mercury counterparts and may not be commercially available in the U.S. Non-miniature cylindrical alkaline batteries may also sometimes be used.



Button-Cell Battery; Photo Source: Washington State Department of Ecology

Mercuric Oxide Batteries

Mercuric oxide batteries are useful in applications that require a high energy density and a flat voltage curve. Small, consumer-use mercuric oxide button-cell batteries were banned in 1996 in accordance with the “Mercury Containing and Rechargeable Battery Management Act” and are no longer sold in the U.S. However, large mercuric oxide batteries (i.e., non-button-cell) may still be used in such applications as military, medical, and industrial equipment. They look like 9-volt or fat AA batteries and contain 33 to 50 percent mercury by weight of the battery.

Paint

While no longer manufactured or sold in the U.S., paints that contain mercury were once commonly used for commercial and industrial settings and may be stored in basements, closets, or other storage areas at water treatment facilities.

Latex Paint

Interior and exterior latex paint (water-based paint) manufactured prior to 1992 may contain phenyl-mercuric acetate (PMA), which was used as a fungicide and bactericide to prolong the paint’s shelf-life. However, mercury-containing vapors emitted from paint are an inhalation hazard, contributing to negative indoor air quality and posing a health risk. There is also a risk of spills from cans of liquid paint stored at facilities. Each gallon of paint contained as much as two parts per million (ppm) of mercury. Use of mercury as a preservative in both indoor and outdoor latex paint was banned by the Environmental Protection Agency (EPA) by 1992. Non-mercury alternative paint preservatives are now used.

Marine Paint

Various heavy metals give marine paint anti-fouling and anti-corrosive properties. In the past, mercury was added to marine paints as a biocide. The concentration of mercury is somewhat uncertain, but as much as five percent could have been added to the paint. The Environmental

Protection Agency (EPA) banned the use of mercury compounds in marine paint in 1972. Anti-fouling marine paint used today typically contains copper; epoxy and vinyl paint may also be used. Although these paints do not contain mercury, they are toxic to marine life. Non-toxic paints, including silicon and Teflon coatings, are more eco-friendly options as they rely on a slick surface to inhibit growth, rather than toxic ingredients.

First Aid / Medical Equipment

All commercial, municipal, and industrial facilities have at least one first aid kit onsite to address minor injuries. Most first aid kits in use today contain standard bandages, rubbing alcohol, and other first aid ointments. However, very old or expired first aid kits may have mercury-containing items as well.

Eye Wash Solutions – Thimerosal

Thimerosal is a preservative that may be found in eye wash solutions in first aid kits, as well as personal care products (i.e., contact lens solutions, eye drops, and eye ointments). Products that contain thimerosal may cause eye sensitivity. Thimerosal-free saline solution is available and often preferred.

Fever Thermometers

Fever, or basal, thermometers are used to measure body temperature. Mercury-added fever thermometers contain approximately one gram of mercury encased in a thin plastic or glass tube. Although they contain a small amount of mercury, they are fragile and susceptible to breakage and a potential mercury spill. Non-mercury alternatives include solar, digital, non-mercury liquid (e.g., indium-gallium-tin), instant-read digital (e.g., SURE-Temp™), and tympanic fever thermometers.



Mercury Fever Thermometer; Photo Source: Utah Department of Environmental Quality (UT DEQ)

Mercurochrome

Mercurochrome, generically known as merbromin, is a topical antiseptic that was often used to treat minor cuts and scrapes. Mercury was used in this ointment as a disinfectant, stopping bacteria from reproducing and spreading. In 1998, the U.S. Food and Drug Administration (FDA) banned mercurochrome as an over-the-counter antiseptic for sale in the U.S. Other antiseptic and antibacterial ointments, such as Bacitracin and Neosporin, are now commonly used. However, bottles of mercurochrome may be found at facilities in old first aid kits.

Sphygmomanometers

Sphygmomanometers, or blood pressure devices, are specific types of manometers used for measuring blood pressure. Small hand-held (i.e., portable) blood pressure cuffs are generally found in first aid kits, but wall-mounted and mobile devices also exist. Mercury-added

sphygmomanometers contain 50 to 150 grams of elemental mercury inside a plastic or glass tube. There is potential for a mercury release if the device is broken – especially during removal from the wall. Non-mercury alternatives include digital and aneroid blood pressure devices.



Examples of portable, wall-mounted, and mobile sphygmomanometers
Photo Source: NEWMOA and Sargent-Welch, respectively

Miscellaneous

This category (included under “Other” in the NEORDD checklist) includes miscellaneous items that may contain mercury and may be found at water treatment facilities and associated buildings.

Computer Monitors / Flat Panel Displays

Computer monitors, televisions, instrument panels, and other screens and monitors contain either a cathode ray tube (CRT) or liquid crystal display (LCD) – both of which contain mercury in the bulbs that illuminate the screen. Less than five milligrams of mercury is contained in the bulb. Potential hazards arise with improper disposal of computers and other equipment – these products should be recycled as electronic waste. Light emitting diode (LED) monitors are an energy-efficient alternative that do not contain mercury.

Pesticides / Fungicides / Herbicides

Pesticides, fungicides, herbicides, and biocides produced before 1994 used mercury compounds to kill fungus, weeds, and other pests. By 1995, all U.S. registrations for mercury-containing pesticides had been cancelled. New pesticides manufactured today are non-mercury.

Tree Root Growth Control Products

Specific pesticides used to control tree root growth may be stored at wastewater treatment facilities. Older products may have contained mercury, because it acted as a biocide, killing or stopped the roots from growing and potentially penetrating underground pipes or treatment systems. As indicated above, currently available pesticides do not contain mercury.

Resources & Checklists

Burlington Board of Health, *Guide for Identifying Mercury Switches/Thermostats in Common Appliances*, December 27, 2000:

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Delta Institute, *A Guide to Mercury Reduction in Industrial and Commercial Settings*, July 2001:

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HydroQual, Inc., *Mercury Checklist for Water and Sewer Treatment Plants*:

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Indiana Department of Environmental Management, *Municipal Streamlined Mercury Variance (SMV) Application*, 2005:

<https://forms.in.gov/Download.aspx?id=6288>.

Interstate Mercury Education & Reduction Clearinghouse, *Mercury-Added Products Database*:

www.newmoa.org/prevention/mercury/imerc/notification/index.cfm.

Interstate Mercury Education & Reduction Clearinghouse, *Mercury-Added Project Fact Sheets*:

www.newmoa.org/prevention/mercury/imerc/factsheets/.

Lowell Center for Sustainable Production at the University of Massachusetts, Lowell, *An Investigation of Alternatives to Mercury Containing Products*, January 22, 2003:

www.maine.gov/dep/mercury/lcspfinal.pdf.

Massachusetts Department of Environmental Protection, *Identification and Best Management Practices of Mercury-Containing Equipment at Public Drinking Water Systems*, December 2006:

www.mass.gov/dep/water/drinking/mercbmp.pdf.

Minnesota Western Lake Superior Sanitary District, *Blueprint for Mercury Elimination: Mercury Reduction project Guidance for Wastewater Treatment Plants*, January 2002:

www.wlssd.com/WLSSD_Blueprint_Mercury_Reduction.pdf.pdf.

Northeast Ohio Regional Sewer District, *Wastewater Treatment Plant Self Assessment Inventory: Products, Chemicals, and Equipment That May Contain Mercury*:

This checklist is not available online – see the Excel spreadsheet in Appendix B for a copy.

Northeast Waste Management Officials' Association, *Getting Mercury Out of Schools*, 2007:

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Northeast Waste Management Officials' Association, *Mercury Legacy Products*:
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Northeast Waste Management Officials' Association, *P2Rx Mercury Topic Hub*TM:
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University of Wisconsin – Extension, *Conducting an Internal Mercury Audit for Manufacturing Facilities*, May 1994:
www.uwex.edu/erc/pdf/HHW/MerAudit_SHWEC.pdf.

Wikipedia:
www.wikipedia.org.

Wisconsin Mercury Sourcebook, *Mercury Use: Wastewater Treatment Plants*, May 1997:
www.epa.gov/glmpo/bnsdocs/hgsbook/waste.pdf.

Appendix A

Matrix of Mercury-Added Products Likely to be Found at Wastewater Treatment Facilities

Mercury-Added Product	Amount of Mercury	Potential Hazards	Non-Mercury Alternatives
Accustat Thermostats®	Each sensor contains > 1 gram	Individual sensors are made of glass and susceptible to breakage.	Non-mercury Accustat Independence® models.
Barometers	500 grams (1 pound)	One end of tube is open to the atmosphere, could result in a large mercury spill.	Aneroid, digital, and Eco-celli liquid-gas silicon barometers.
Batteries: <ul style="list-style-type: none"> • Alkaline Manganese Oxide • Mercuric oxide • Silver Oxide • Zinc Air 	All button-cell batteries contain < 5 milligrams of mercury. Mercuric oxide batteries contain 30 – 50 percent mercury by weight.		Lithium, zinc air, silver oxide, and alkaline manganese button-cell batteries. Non-miniature cylindrical alkaline batteries.
Bulk Chemicals: <ul style="list-style-type: none"> • Chlorine • De-chlorination chemicals • Ferric and ferrous chloride • Sludge thickening polymers • Nitric acid • Phosphorus removal chem. • Pickling liquor • Potassium hydroxide • Sodium chloride • Sodium hydroxide • Sodium hypochlorite • Sulfuric acid 	Varies.		N/A
Capillary Tube / Bellows Control Device	> 1 gram		
Computer Monitors	< 5 milligrams		LED monitors.
Counterweights / Dampers			Non-mercury weights.

Mercury-Added Product	Amount of Mercury	Potential Hazards	Non-Mercury Alternatives
DC Watt-Hour Meters			Commutator-type meters for measuring DC. Induction-type meters for measuring AC. *The company stopped manufacturing mercury DC meters in the mid 1900's.
Elemental Mercury	N/A	There is a high potential for spills, as stored elemental mercury is sometimes used to refill equipment. Mercury vapor may be inhaled and absorbed through the lungs into the bloodstream where it can impact the central nervous system. Neurological effects include tremors, mood swings, irritability, excessive shyness, and insomnia, loss of coordination, slurred speech, and "pins and needles sensation." Very high exposures can cause kidney and respiratory damage.	N/A
Eye Wash w/ Thimerosal	N/A	May cause eye sensitivity.	Thimerosal-free saline solution.
Fever Thermometers	1 gram	Made of thin plastic or glass – susceptible to breakage.	Indium-gallium-tin thermometers. Digital, instant-read, and tympanic fever thermometers.

Mercury-Added Product	Amount of Mercury	Potential Hazards	Non-Mercury Alternatives
Fire Alarm Systems / Fire Alarm Boxes	Each reservoir in an entire fire alarm system contains ½ teaspoon of mercury. Fire alarm boxes contain < 1 gram of mercury.	These types of fire alarm systems have been known to leak, causing a mercury spill. Mercury vapor emitted from the reservoirs could potentially exceed safe indoor air levels.	Fire alarm boxes with a snap-action or push-button switch.
Flame Sensors	> 1 gram		Non-mercury thermocouples. Electronic ignition systems.
Float Switches	0.1 – 70 grams		Mechanical, magnetic dry reed, optical, conductive, metallic ball, sonic/ultrasonic, pressure transmitter, alloy, thermal, and capacitance level float switches.
Flow Meters	5,000 grams (10 pounds)	Devices contain a significant amount of mercury.	Digital, optical, and ball-actuated flow meters.
Furnaces	> 1 gram	Mercury leaks or spills may result during removal of the flame sensor.	Electronic ignition systems that do not rely on a standing pilot flame – intermittent pilot or hot-surface ignition.
Gas Flow Regulators	100 – 135 grams (¼ pound)	Mercury spills are common during removal/replacement of gas flow regulators – extreme caution should be taken during removal.	Non-mercury regulators are mounted vertically. *Stopped manufacture and sale of mercury regulators in the 1960's.
Gas Ovens	> 1 gram	The flame sensor is a three-piece device – a break may result in a mercury leak or spill.	Electronic ignition systems that do not rely on a standing pilot flame – intermittent pilot or hot-surface ignition.
Gyroscope			Mechanical gyroscopes that use ball bearings or a pendulum.
Hydrometers	< 1 gram	Made of glass – susceptible to breakage.	Hydrometers that use lead ballast as a weight.

Appendix A

Mercury-Added Product	Amount of Mercury	Potential Hazards	Non-Mercury Alternatives
Hydronic and Warm Air Controls			Devices with a mechanical or snap-action switch.
Infrared Heaters / Space Heaters			Heaters with a non-mercury pendulum switch. *These devices are no longer manufactured with mercury flame sensors or tilt switches.
Laboratory Chemicals: <ul style="list-style-type: none"> Mercury chloride Mercury iodide Mercuric nitrate Mercuric oxide Mercuric sulfate Merthiolate / Thimerosal Nessler reagent Sodium hypochlorite Zenker's solution 	Varies	Elemental mercury and inorganic mercury compounds can enter the body through ingestion, inhalation, and absorption (i.e., through skin). They may cause damage to the GI tract, kidneys, and central nervous system. High exposures can lead to skin rashes, dermatitis, mood swings, memory loss, mental disturbance, and muscle weakness.	N/A
Lamps: <ul style="list-style-type: none"> Fluorescent High Pressure Sodium Mercury Short-arc Mercury Xenon Short-arc Mercury Vapor Metal Halide Ceramic Metal Halide Ultraviolet Disinfection 	< 1 milligram to over 1 gram In the form of mercury vapor and phosphor powder/dust.	If a mercury bulb breaks it will release mercury vapor immediately. Mercury vapor will also be emitted from the phosphor powder.	Incandescent lamps. Light-emitting diodes (LEDs).
Latex Paint	As much as 200 ppm (i.e., mercury concentration 0.02 percent). In the form of phenyl-mercuric acetate (PMA).	Mercury vapors emitted from paint are an inhalation health hazard. There is a risk of spills from cans of liquid paint stored at facilities.	Non-mercury preservatives. *EPA banned the manufacture and sale of latex paint with mercury in 1992.

Mercury-Added Product	Amount of Mercury	Potential Hazards	Non-Mercury Alternatives
Level & Rotation Sensors			Non-mercury float/tilt switches (e.g., electrical, mechanical, magnetic, and optical).
Manometers	50 – 500 grams	One end of tube is open to the atmosphere, could result in a large mercury spill.	Dial or digital manometers.
Marine Paint	Mercury concentration in paint approximately 5 percent.	Toxic to marine life.	Anti-fouling marine paint made with copper. Epoxy and vinyl paint. Non-toxic paints = silicon and Teflon coatings. *EPA banned the manufacture and sale of marine paint with mercury in 1972.
Mercurochrome	N/A		Antiseptic / antibacterial ointment. *FDA banned the sale of mercurochrome as an over-the-counter treatment in 1998.
Mercury-sealed Pistons			
Pesticides / Fungicides / Herbicides	N/A		*Pesticides produced since 1995 do not contain mercury.
Polarographic Analyzers – Mercury Drop Electrodes		High potential for mercury spills and exposure to mercury vapors due to regular cleaning, and possible refilling of the elemental mercury, in the device.	Inert metals = gold, silver, and platinum. Inert forms of carbon = glassy carbon, pyrolytic carbon (graphite).

Mercury-Added Product	Amount of Mercury	Potential Hazards	Non-Mercury Alternatives
Pressure Gauges / Vacuum Gauges	50 – 500 grams		Needle/bourbon gauges. Electronic gauges – must be calibrated w/ mercury manometer. Digital gauges, non-mercury-liquid, and aneroid low-pressure gauges for testing piping, drainage, and vent systems.
Pressure Transducers / Transmitters	Pressure transducers have < 1 gram of mercury but are not used in WWT facilities Pressure transmitters do not contain mercury		*Pressure transmitters used in water treatment plants do not contain mercury.
Pressuretrols™	> 1 gram		Non-mercury pressuretrol sensors. *Discontinued the manufacture of mercury pressuretrols and remaining inventory was sold in 2007.
Pressure Switches	> 1 gram		Mechanical (e.g., snap-switch) or solid-state switches.
Pyrometers	5 – 10 grams	The thermocouple is a thin, glass, tube – susceptible to breakage.	Devices with nitrogen containing stems. Digital instruments.
Rectifiers	Several pounds	Glass rectifiers are fragile – susceptible to breakage. Metal tanks use a vacuum pump which can emit mercury vapor.	Solid state rectifiers, silicon semiconductor rectifiers, and high power thyristor circuits. *Stopped installation of new mercury rectifiers in 1975.

Mercury-Added Product	Amount of Mercury	Potential Hazards	Non-Mercury Alternatives
Refrigerators / Freezers	1 gram		Mechanical switches. *Stopped manufacture and sale of chest freezers with mercury tilt switches in 2000.
Relays: <ul style="list-style-type: none"> • Displacement Relays • Mercury Contact Relays • Mercury Wetted Relays 	> 10 milligrams to over 150 grams	Have been known to burst and cause a mercury leak/spill if the relay is overheated or if the load is short-circuited.	Dry magnetic reed, electro-mechanical, and solid-state relays. Silicon rectifiers.
Ring Balances			
Semiconductors / Solar Cells / Infrared Detectors	> 5 milligrams In the form of mercury-cadmium-telluride (MCT) or mercury-cadmium-selenide.		Silicon-based bolometers and infrared cameras. Infrared detectors manufactured w/ semiconductors made of indium-antimonide, gallium-arsenide, or aluminum-gallium-arsenide.
Shunt Trips	Estimate 50 – 5, 000 milligrams		Metal coil with a mechanical or “limit” switch.
Silent Light Switches	2 grams		Standard light switches. *Manufacturers stopped making these devices in 1991.
Sphygmomanometers	50 – 150 grams	There is potential for a mercury release if the device is broken – especially during removal from the wall.	Digital and aneroid blood pressure devices.
Sump Pumps / Bilge Pumps	1 – 250 grams		Pumps that use dry reed switches, optic sensors, or mechanical ball switches.
Temperature Switches	0.05 – 5 grams		Mechanical or solid-state switches.

Mercury-Added Product	Amount of Mercury	Potential Hazards	Non-Mercury Alternatives
Thermometers	5 – 50 grams	Made of thin glass or plastic – susceptible to breakage.	Alcohol and mineral-spirit glass bulb thermometers. Digital thermometers – required for high temperatures.
Thermostats / Thermo-regulators	Standard wall thermostats contain 3 – 6 grams of mercury.		Electromechanical = air-controlled, reed switch, vapor-filled diaphragm, and snap-switch. Electronic programmable = digital.
Tilt Switches	0.05 – 5 grams		Metallic ball, electrolytic, mechanical, solid-state, and capacitance switches. Non-mercury potentiometers
Tree Root Growth Control Products	N/A		See pesticides (above).
Trickling Filter / Pivot Arm Bearings	Several hundred pounds	Mercury seals can burst or leak resulting in a mercury spill and tank contamination.	Mechanical ring seals. *Companies stopped manufacturing and selling trickling filters with mercury bearings approx. 30 years ago.
Vibration Meters	100 – 1,000 milligrams		Analog and digital vibration meters.
Water Purification Systems – Ion Exchange Cartridges	Slight		N/A

**Wastewater Treatment Plant Self Assessment Inventory
Products, Chemicals, and Equipment That May Contain Mercury**

Source			Number	Location
Laboratory Equipment				
a.	Manometers			
b.	Barometers			
c.	Thermometers			
d.	Ion exchange cartridges for lab water purification system			
e.	Hanging mercury drop electrodes for polarographic analyzers			
Laboratory Chemicals				
a.	Sodium hypochlorite (Clorox)			
b.	Mercury or mercurous chloride			
c.	Mercury iodide			
d.	Mercury nitrate			
e.	Mercury (II) oxide			
f.	Mercury (II) sulfate			
g.	Merthiolate			
Bulk Chemicals				
a.	Phosphorus removal chemicals			
b.	Dechlorination chemicals			
c.	Sludge thickening polymers			
d.	Potassium hydroxide			

Source			Number	Location
Bulk Chemicals (continued)				
	e.	Sodium hydroxide		
	f.	Sodium chloride		
	g.	Chlorine		
	h.	Sodium hypochlorite		
	i.	Sulfuric acid		
	j.	Nitric acid		
	k.	Ferric or ferrous chloride		
	l.	Pickling liquor (for phosphorus removal)		
Process Control and Measuring Equipment				
	a.	Accustats		
	b.	Barometers		
	c.	Counterweights		
	d.	Elemental mercury for refilling mercury-containing equipment.		
	e.	Flow meters		
	f.	Gas regulators and meters		
	g.	Gyroscopes		
	h.	Hydrometers with thermometers		
	i.	Level and rotation sensors		
	j.	Manometers, pressure gauges and vacuum gauges		
	k.	Mercury-sealed pistons		
	l.	Perimeters		
	m.	Pressure-trols		
	n.	Pyrometers		
	o.	Rectifiers		
	p.	Ring balances		
	q.	Shunt trips		

Source			Number	Location
Process Control and Measuring Equipment (continued)				
r.	Steam flow meters			
s.	Stokes gauges			
t.	Switches and relays:			
	1. displacement plunger relays			
	2. mercoird control switches			
	3. pressure control switches (mounted on bourdon tube or diaphragm)			
	4. relay switches			
	5. mercury wetted relays			
	6. mercury displacement relays (found in motors)			
	7. sump pump, bilge pump and other float controls			
	8. tilt switches			
u.	Thermometers (including industrial dial face thermometers w/ capillary tubes)			
v.	Thermostats and thermoregulators			
w.	Transmitters			
Buildings				
a.	DC watt-hour meters			
b.	Flame sensors (found in the pilot light and burner assembly on gas-fired furnaces, boilers, unit heaters, and space heaters)			
c.	Hydronic and warm air controls with tilt switches such as:			
	1. aquastats			
	2. pressurestats			
	3. firestats			
	4. fan limit controls			
	5. pressure/flow controls on air handling units			

Source			Number	Location
Buildings (continued)				
	d.	Switches and relays:		
		1. fire alarm box switches		
		2. silent light switches		
		3. relay switches		
		4. mercury wetted relays		
		5. mercury displacement relays (lighting, resistance heating, and motors)		
		6. sump pump, bilge pump and other float controls		
		7. tilt switches		
	e.	Thermostats		
	f.	Safety valves		
	g.	Vibration meters		
	h.	Some infrared heaters (Robert Shaw and Harper Wyman)		
	i.	Some furnaces (White Rodgers)		
	j.	Stainless steel bulb, capillary tube, bellows/control device. Used for unsupervised burners in certain gas-fired devices with standing pilot or electronic ignition pilot.		
	k.	Ovens		
	l.	Refrigerators		
Trickling Filter Pivot Arm Bearings (mercury bearings/water seals)				
Batteries				
	a.	Mercury-zinc (button)		
	b.	Mercury-cadmium		
	c.	Mercury alkaline		
	d.	Mercury oxide		

Source			Number	Location
Lamps				
	a.	Fluorescent		
	b.	High-pressure sodium		
	c.	Mercury arc		
	d.	Mercury vapor lamps		
	e.	Metal halide		
	f.	Ultraviolet disinfection		
Paint				
	a.	Old latex (pre-1 990)		
	b.	Marine paint		
First Aid/Medical				
	a.	Mercurochrome		
	b.	Sphygmomanometers		
	c.	Thermometers		
	d.	Thimerosal (in eye wash)		
Other				
	a.	Old pesticides, fungicides and herbicides		
	b.	Tree root growth control products		
	c.	Computer monitors		