Identification and Best Management Practices of Mercury-Containing Equipment at Public Drinking Water Systems

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Acronyms and Abbreviations Used in Report

ANSI	American National Standards Institute	**MassDEP**	Massachusetts Department of Environmental Protection
AWWA	American Water Works Association	**mg**	milligrams
EPA	Environmental Protection Agency	**mg/L**	milligrams/liter
g	grams	**NSF**	NSF International
LED	Low Emitting Diode	**RCRA**	Resource Conservation and Recovery Act
HID	High Intensity Discharge	**TCLP**	Toxicity Characteristic Leaching Procedure
IMERC	Interstate Mercury Education & Reduction Clearinghouse	**TRC**	Thermostat Recycling Corporation
Kg	Kilograms	**UV**	Ultra Violet
lb	pound		

Introduction

There are over 1700 public drinking water systems in Massachusetts responsible for ensuring communities have access to safe, potable water. Pollutant impacts to drinking water supplies pose a threat to human health, the environment, and the economic viability of communities. Mercury is of particular concern due to its toxicity and associated health risks, environmental impacts, and high cost of cleanup from spills. Certain types of equipment used at public water systems may contain mercury. Precautions should be taken when using, maintaining, and removing this equipment to prevent accidental releases into the environment, especially in close proximity to drinking water supplies. This report describes mercury-containing equipment that may be present at systems, best management practices to minimize operator exposure and environmental contamination from that equipment, and alternative technologies.

Mercury is a unique metal with many industrial applications. Mercury conducts electricity, has a high surface tension, and is very dense. As a liquid, mercury has a high surface tension that causes it to form its trademark small spherical beads. These properties make it a useful metal in industrial equipment such as electrical switches and seals. As a vapor, mercury is used in lighting such as fluorescent lamps, ultraviolet lights, and street signs. However, mercury can also pose a threat to public health and the environment if not managed properly. For management of mercury in Massachusetts (Chapter 190 of Acts of 2006 amending MGL Chapter 21H) see MassDEP website for mercury: http://www.mass.gov/dep/toxics/stypes/hgres.htm.

Health Effects of Mercury

Mercury is a potential toxin when released into the environment. Health effects depend on the intensity, duration, and route of exposure as well as the form of mercury.

Elemental mercury can evaporate at room temperature, creating mercury vapor. Inhalation of mercury vapor can cause respiratory and neurological disorders and is of concern to system operators working around elemental mercury or exposed to a mercury spill. Spills of even one gram of mercury can have adverse impacts on human health from the inhalation of resulting mercury vapor.

If mercury enters the environment through spills or improper disposal, it can bioaccumulate in food chains and, thus, poses a risk to human health and ecosystems. In water, mercury may undergo chemical reactions to become methylmercury, which builds up in tissues of organisms such as fish. People who eat these fish are exposed to mercury, which can lead to gastrointestinal and heart problems, kidney failure, and neurological disorders.

The health effects from ingested mercury are less well known. National limits on contaminant levels in drinking water have been set to ensure that the water is safe for human consumption. These limits are known as maximum contaminant levels (MCLs). The MCL for mercury is 0.002 milligrams per liter (mg/L). In Massachusetts, systems are required to test for inorganic compounds, including mercury, every three years unless granted a waiver.

Mercury-Containing Equipment at Public Water Systems

Mercury is found in electric switches, sensors, gauges, and meters used by a variety of industries, including public water systems, where equipment may be used to pump, distribute, treat, and monitor water (U.S. EPA, 2002; IMERC, 1999; Huber, 1997). However, many manufacturers have phased out mercury-containing components and developed alternative technologies for use at public water systems. Nevertheless, older equipment and some newer types of equipment may still contain mercury. System operators should be aware of the presence of mercury in system equipment and take appropriate precautions to protect against spills. (Table 1)

In Massachusetts, all equipment must meet construction, operation and maintenance standards for Public Water Systems, in accordance to 310 CMR 22.04.

There are several companies that test equipment for American Water Works Association (AWWA), American National Standards Institute (ANSI), and NSF certification. Certified equipment may still contain mercury. Certified equipment is tested to ensure it does not leach pollutants into the water. The MCL for mercury in drinking water in Massachusetts is 0.002 mg/L. The single product allowable concentration for mercury under standard 61 is 1/10 the MCL or 0.0002 mg/L. Products that meet the standard 61 requirement do not contribute more than 0.0002 mg/L of mercury under normal operation.

TABLE 1. POTENTIAL MERCURY-CONTAINING EQUIPMENT AT PUBLIC WATER SYSTEMS[1]

Component	Part of System	Quantity of Mercury (Approximate)
Mercury Seals	Submersible Well Pump	~5.4 kg (12 lbs)
Flow Meters	Piping and Distribution Treatment Systems	< 5.0 kg (11 lbs)
Pressure Gauges	Piping and Distribution Treatment Systems	100 to 500 g (0.2 to 1.1 lbs)
Switches (tilt, float, and relay)	Control Panels Holding and Storage Tanks Thermostats	0.1 g to 3.6 kg 0.2 (0.0002 to 8 lbs)
Fluorescent Light Bulbs	Facility and Well House Lighting	4 to 12 mg (0.000009 to 0.00003 lbs)
Ultraviolet Light Bulbs	Ultraviolet Disinfection System	3 mg to 1 g (0.000007 to 0.002 lbs)

[1] Mercury Seals: U.S. EPA, 2001; Flow Meters, Pressure Gauges, Thermometers: U.S. EPA, 2002; Switches: Small electrical switches contain approximately 3.5 g of mercury. Industrial switches may contain up to eight lbs of mercury. (U.S. EPA, 1997) Switch manufacturers listed in the Interstate Mercury Education and Reduction Clearinghouse (IMERC) Products Database report quantities of between 100 mg and 1,000 mg per switch to over 1,000 mg per switch, IMERC 1999; Fluorescent Lighting: NEMA, 2001; UV Lighting: IMERC, 1999; Thermostats: Huber, 1997.

Thermometers	Facility Well House Testing Laboratory	0.5 to 3 g (0.001 to 0.007 lbs)
Thermostats	Facility Well House	3 to 6 g (0.007 to 0.01 lbs)
Chlorine Products	Disinfection Chemicals	Unknown

Best Management Practices: Protecting Operators and Communities

Under normal operations, mercury-containing equipment should be safe. However, the potential for breakage, accidents, and spills exists. Spilled mercury must be managed carefully to avoid inhalation of vapors. Workers should take precautions to avoid tracking spilled mercury beyond the spill site.

Mercury spills down a well can result high clean-costs from remediation, removal, and testing. Remediation costs for two Ohio mercury spills at public water systems were estimated at $24,600 and $45,000. Remediation at just one of these wells resulted in more than 10 drums of contaminated water and 12-15 drums of contaminated sediment (Ohio EPA, 2001). After a mercury release in Kauai, the Kauai Water Department estimated removal and replacement of pumps at about $60,000 per well (Sommer, 1999). Other costs from mercury spills may include decontamination of workers and the site, temporary water supply for the community, testing, and monitoring.

Last, mercury containing-equipment that is improperly disposed of may impact the surrounding environment. Mercury spilled onto soils may run into surface waters or leach into ground water. Mercury disposed of in unlined landfills or dumped illegally may impact ground waters, surface waters, and surrounding soils.

Operators should adopt best management practices to minimize spills and worker exposure from mercury in mercury-containing equipment. In addition, spent equipment containing mercury should be carefully and properly disposed of, preferably through a recycler (retorter) specializing in mercury recovery. Best management practices for mercury-containing equipment include:

- Identify and label mercury-containing components. Assume a component contains mercury unless proven otherwise and handle accordingly.
- Train staff in safe mercury management, spill clean-up processes, and safe disposal procedures.
- Dispose of mercury and mercury-containing equipment according to federal, state, and local regulations. Mercury is a regulated hazardous waste due to its toxicity and must be handled accordingly.
- Purchase mercury-free replacement equipment, if possible.

The following sections list common components found in public water systems that may contain mercury, their use and location, mercury-free alternatives, and best practices when working around them. Operators should evaluate their own systems and take precautions where these types of components are likely to exist.[2]

[2] This report identifies components in a typical public water system that may contain mercury. It may not reflect all mercury components or locations in which mercury-containing components may be found. This report also lists potential replacement parts. This may not be a complete list of all alternatives. This information is presented as general guidance only. Systems should consult with their engineering staff or vendors to identify the appropriate replacement parts to meet their system needs.

Mercury Seals in Water Pumps

Water pumps are comprised of a motor, moving parts that pump the water, and a water intake area. Dynamic seals create a barrier between the electrical parts of the motor and the water intake area. Seals prevent water from entering the motor casing and damaging the electrical components of the motor. The seal must stop water from entering the motor enclosure but must allow for movement of parts that extend from the motor into the intake area. A seal typically includes a main barrier, made of metal or other material. However, where moving parts extend from the motor to the intake area or at the edges of the main barrier, gaps will exist.

Because of its high surface tension, mercury's physical properties make it useful as a seal material to fill in these gaps. The mercury also acts as a lubricant, keeping the moving parts moving and preventing friction from overheating the unit. Mercury quantities in submersible pump seals can be as high as 12 lbs (U.S. EPA, 2001). Mercury seals have been identified in submersible well pumps at public water systems. While most manufacturers contacted report using alternative sealing technologies, mercury sealing technology may have been common as recent as the 1990s (Spear, 2004). As many companies have changed ownership, and use of mercury has been phased out. Currently, at least one manufacturer, Flowserve, offers mercury seals upon request for its deep well, oil-filled design submersible well pump (Table 2).

TABLE 2: EQUIPMENT WITH MERCURY[3]

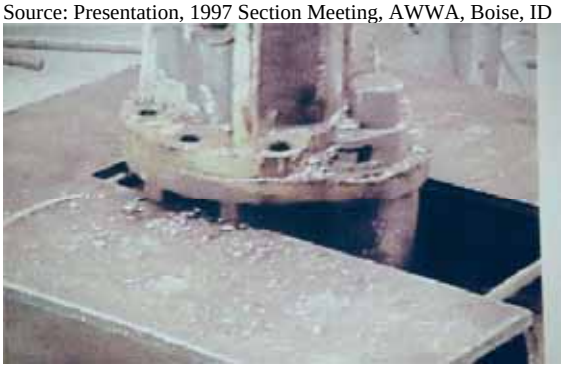
Equipment	Type
Mercury seal	Byron Jackson oil-filled design submersible pump. (Byron Jackson is associated with the following companies: Flowserve, Plueger, Durmettalic). Flowserve reports all equipment is NSF certified.

Mercury seal breakages have been reported around the country at public water systems and irrigation systems which use the same technology.[4] (Figure 1) Breakages may have many causes including in-well failure and operator error. Several systems reported spills caused during pump disassembly as the pump was removed from the well for maintenance. To remove a large submersible pump, it is often necessary to break the pump down into several components. If the pump is disassembled directly below the seal, mercury may be exposed and spill. If the system is disassembled above the seal, mercury can be spilled from the top if the components are tipped. Therefore, operators should consult all equipment manuals for proper disassembly instructions prior to any work on the pump.

[3] May not represent all companies/brands producing mercury equipment.
[4] Idaho, U.S. EPA, 2001; Ohio, Tristate Digest, 1999, Arizona, Mercury Update, 2004, Hawaii, Honolulu Star-Bulletin, 1999.

Cleanup costs associated with spills can include incident response; worker decontamination; and cleanup, removal, and disposal of the mercury from the well and surrounding soils. If mercury spills into the well, the existing well may need to be sealed and a new well drilled resulting in additional costs. Communities also may need to supply emergency water supplies for customers. Workers cleaning up an Idaho spill at an irrigation well tracked mercury home, resulting in additional clean up of residential areas (U.S. EPA, 2001).

FIGURE 1: MERCURY SPILL AT PUBLIC WATER SYSTEM FROM MERCURY SEAL
Source: Presentation, 1997 Section Meeting, AWWA, Boise, ID



Mercury-Free Alternatives

Alternative sealing technologies are available for submersible pumps. Operators should contact their vendors or consult technical staff to determine which mechanical seal alternative will meet their specific operations. Some alternatives include:

- Packing-type seals use a rope-like material, wrapped around the pump shaft and held in place against the pump housing with a compression collar. This collar applies forward pressure against the rope-like packing material creating a seal.
- Non-mercury mechanical seals use a circular, rotating ring made of a chemical resistant material (generally a ceramic) pressed against a stationary sealing surface in the pump housing. Using internal springs and a holding collar, the smooth surface of the rotating seal ring is pressed into the stationary surface in the pump housing. Very tight clearances and pressure from the springs prevent the water from leaking out. A double mechanical seal uses two mechanical seals for more watertight enclosure, but may cost more. Pumps with mechanical seals can range in price from approximately $39,000 to over $60,000 depending on water volume and well depth.[5]
- Oil-filled seals are mechanical seals that use oil to help isolate the pump shaft and the process fluid. The vegetable-based oil acts as a lubricant and a way to dissipate the heat buildup due to friction from the rotating shaft.

In some cases, a mercury seal may be retrofitted with a mechanical seal. Costs will depend on the condition of the pump and pump components and shipping charges, but can be as low as $13,000.

[5] Replacement pricing from Sunstar Electric, Texas (retrofits) and Honolulu Star Bulletin, 7/22/1999 (new well costs).

Best Management Practices

Operators should be cautious when working with submersible pumps that have mercury seals. Best practices include:

- Identify if submersible well pumps used at your system contain a mercury seal. Equipment manuals or specifications, manufacturers, and vendors may be sources of this information.
- Assume a mercury seal exists if the pump is ten years or older, and/or information on the sealing technology cannot be determined.
- Consult equipment manuals and follow maintenance instructions when conducting routine maintenance on mercury-sealed submersible pump.
- Use a cover or barrier to protect the wellhead and secondary containment if work must be performed over wellhead. Check the operations manual to see if procedure for covering well is specified.
- Consult operations manual for removal instructions if pump must be removed for repair or maintenance. Pumps can often be broken down into several components for easier removal. Disassembly may expose the mercury seal; incorrect disassembly may cause mercury to spill. Follow all instructions and use a barrier to protect the wellhead in case of spill.
- Work on mercury containing pumps over a secondary containment to contain any spills that may occur. Secondary containment may include some kind of tarp or impermeable surface that can contain the mercury if spilled.
- Have a mercury spill cleanup kit on site and train staff in its use.
- Consider a more frequent testing schedule for mercury in drinking water. Massachusetts Regulations requires testing for inorganic compounds including mercury every three years. Although not required by rule, a more frequent testing schedule may uncover in-situ leaks from mercury seal.
- Replace equipment with non-mercury alternatives, when feasible.
- Dispose of older mercury containing equipment according to hazardous waste management guidelines. Check with local landfill or Massachusetts Department of Environmental Protection Regional Office for assistance in identifying disposal and recycling options.

Flow Meters and Pressure Gauges

Flow meters and pressure gauges measure the rate of flow and/or pressure of a liquid or gas. At public water systems, flow meters may be used to measure the rate of chemical feed in disinfection and other water treatment systems or water flow rates through piping and distribution systems. Pressure measurement may be used to monitor pumping systems, pipelines, or storage tanks.

Liquid mercury responds to pressure or flow in a precise way that can be read on a calibrated scale and has been used historically in flow or pressure measurement devices. These devices can house from 100 grams (g) to 5 kilograms (kg) of mercury (U.S. EPA, 2002). Equipment used to calibrate gauges and flow meters may also contain mercury.

Mercury is no longer commonly used in pressure gauges and flow measurement devices. However, older mercury-containing equipment may still be in use.

Meters at water systems fall into two categories: rate type meters that measure gallons/minute and totalizing meters that measure gallons of water used. Totalizing meters are used at smaller systems or at customer connections where the amount of water used is a prime consideration. These meters are unlikely to contain mercury.

Rate meters include venturi, elbow, and orifice meters. These meters are generally used at larger systems or where the rate of water flow is a consideration. Prior to the 1970s, these devices were commonly hooked into a mercury manometer. In addition, there are two main types of displays used for pressure gauges and flow meters; analog and digital. Analog gauges have a needle display. (Figure 2) Mercury containing flow meters and gauges are generally analog models.

Mercury-Free Alternatives

Today, mercury-free and digital technologies have replaced the mercury manometer in flow measurement. (Table 3) All manufacturers contacted report using non-mercury flow metering technologies. Manufacturers report additional benefits of these alternatives including remote reading access, larger range, and better accuracy.

TABLE 3: GAUGE/METER ALTERNATIVES

Meter Type	Description
Positive Displacement Meters	Positive displacement meters measure the flow of liquid by dividing it into known volumes and measuring the volumes over time. Gears, actuating disk, propellers, or rotating pistons are commonly used to separate and measure the flow. For example, for a piston model, each piston revolution is equivalent to a known volume of water.
Velocity-type meter	Velocity-type meters are similar to positive displacement meters. Water flows spins a rotor blade whose velocity is proportional to water flow. Often used with magnetic drive, where the rotor motion creates a measurable current.
Electromagnetic Flow Meters	Electromagnetic flow meters measure liquids or slurries that have a minimum electrical conductivity. The conductive liquid is passed through a magnetic field, creating a measurable current. This technology is mostly used for wastewater and industrial applications, but may be found in systems where suspended solids are present. (e.g., measuring surface water intake.)
Optical sensors	This non-mechanical sensing technology uses light to transmit and read signal for above meter types.
Register Type	**Description**
Analog	Non-mercury analog meters have needle/dial type displays using alternative liquids such as glycerin, water or alcohol.
Digital	Uses electric components to convert measurement into useable signals that are read on a numeric display.

Best Management Practices

- Identify mercury-containing gauges and flow meters. These are generally older rate-type meters with analog displays. Equipment manuals or specifications, manufacturers, and vendors may be sources of this information.
- Assume a gauge or flow meter has mercury if information proving otherwise cannot be found.
- Monitor mercury containing gauges and flow meters for wear.
- Site mercury-containing gauge and flow equipment away from high traffic areas.
- Replace equipment with non-mercury alternatives.
- Train staff in mercury management and spill response.
- Dispose of old mercury-containing gauges according to federal, state, and local regulations.

Switches and Relays

Switches are used to turn an electric current on and off. Relays are switching devices that use a small current to turn the larger current of switches on and off. Mercury conducts electricity and therefore can be used to complete the circuit in electric switches and relays.

Depending on the switch type and use, mercury switches may contain from 1 g to 3.6 kg of mercury (Huber, 1997; IMERC, 1999). Several types of switches can be found at public water systems including tilt switches, mercury wetted-relays, and float switches. These switches and relays are found as parts of electrical systems that activate pumps (including sump pumps), alarms, and other automated systems.

Tilt switches are commonly used in control panels and thermostats. A tilt switch uses a glass or metallic bulb with electrical contacts at one or both ends. Some tilt switches contain a conductive liquid, such as mercury, inside the bulb. The liquid moves from side to side when tilted, completing or breaking the circuit.

Float switches are used by public water systems to indicate changing water levels in surface storage areas or water tanks, and activate related equipment such as pumps or alarms. A float switch is comprised of a tilt-type switch housed within a buoyant float. When water levels change, the mercury inside the switch slides to one side or the other, completing or breaking the circuit. Because the switch component may be inside a buoyant float, it may not be readily apparent whether a float contains mercury based on visual inspection. Operators should check with vendors or manufacturers to identify the presence of mercury.

Control panels and electrical equipment are found throughout ground and surface water systems and often contain mercury switches and relays. (Figure 3) In a ground water system, look for mercury switches and relays in well houses, pump stations, disinfection systems, and storage facilities. In a surface water facility enclosure, check control panels used to operate pumps, pretreatment delivery systems, flocculation and settling systems, filtering systems, and disinfectant/sterilization units. In many drinking water systems, older electrical systems are being replaced by fully automated, computerized systems, making the old control panels defunct. Precautions should be taken when disposing of older systems to ensure mercury components are handled appropriately.

FIGURE 3. CONTROL PANEL IN GROUNDWATER WELLHOUSE WITH A MERCURY SWITCH

Source DEQ

Mercury-Free Alternatives

Many manufacturers have moved away from mercury containing switches and relays. (Table 4) Operators should work with vendors, electricians or technical staff to identify appropriate replacements. Replacement technology and cost will depend on use, size and other system specific operations.

In general, the most direct, drop-in replacement for a tilt switch is a mechanical tilt switch that uses a mechanical ball in place of mercury. Drop-in replacements for float assemblies containing mercury include floats or containing snap switches, microswitches, mechanical/metallic ball switches, and magnetic reed switches. Any of these non-mercury switches can be encapsulated into a sealed, submersible float. In addition, there are other technologies that measure water level including pressure sensors and optical and conductive sensors.

The cost of switch replacements varies depending on application and type. Float alternatives are generally priced less than $100, but costs can approach $1,000 depending on use. Tilt switches alternatives range from several dollars to over $25. Prices are based on low volume and do not include any additional expenses such as installation, auxiliary equipment, controllers, data transmittal, etc.

TABLE 4: SWITCH AND RELAY ALTERNATIVES[6]

Alternative	Description
Mechanical switch (metallic ball, snap switch, microswitch)	Uses a solid such as metallic ball that moves back and forth completing or breaking the circuit. Price for float switch replacement runs from $25 to $250. Price for free-floating float with inverter microswitch ranges from $93 to $175. Price for tilt switch ranges from $1 to $25.
Magnetic dry reed/magnetic switch	Metal reeds are drawn together completing the circuit in the presence of a permanent magnet. Prices for magnetic reed float switch range from $4 to $600 depending on use and features.

[6] Costs are approximate, based on low volume purchase and do not include any additional expenses such as installation, auxiliary equipment and controllers, data transmittal options, etc. Systems should work with suppliers to identify the alternative that best meets their needs and price range.

Continuous level transmitters	Use relay switches in a series. Price ranges from $450 to over $1,200 depending on length. Allows for continuous data transmission capability.

Other Types of Non-Mercury Level Sensors

Other types of instruments or sensors do not rely on switch technology and can be used to measure water level and trigger associated equipment. (Table 5) Non-mercury detection sensors for measuring water level are typically more sophisticated and more expensive than switch replacements, but may offer advantages which offset the higher initial cost. These advantages may include decreased maintenance, continuous level monitoring (as opposed to single- or multiple-point), improved weather and corrosion resistance, and less frequent replacement and therefore, lower hazardous waste disposal costs. Sensors can range in price from several hundred to thousands of dollars depending on sensor type, data transmittal options and remote access capability.

TABLE 5: SENSOR ALTERNATIVES[7]

Alternative	Description
Submersible pressure transmitter or transducer	The sensor probe is suspended by cable from the top of the tank and continuously measures pressure based on the water level above the sensor. Suppliers and manufacturers contacted report that these are low maintenance, come in no corrosion (titanium) models, and are easy to install. Prices range from $350 to $800.
Electronic pressure transmitter (non-submersible)	The transmitter is connected to plumbing at the bottom of the tank and measures pressure based on the water level above the sensor. Suppliers and manufacturers report that these are no or low maintenance, weather proof, and easy to install. These sensors measure the exact water level as opposed to the presence or absence of water at a certain level. Costs range from $560 to $900.
Ultrasonic, sonic, radar	Sound waves or radar travel down the measurement tube and reflect against the surface of the tank contents before returning back to the receiver. Electronics measure the time and calculate water level. Prices range from $200 to over $1,000 depending on features and accessibility.
Capacitive, radio frequency (RF)	Measures water level by applying a radio frequency signal between a probe and the water vessel wall. Costs range from $220 to $800, with continuous data models pricing higher than single point collection.

[7] Costs are approximate, based on low volume purchase and do not include any additional expenses such as installation, auxiliary equipment and controllers, data transmittal options, etc. Systems should work with suppliers to identify the alternative that best meets their needs and price range.

Optical	A pulsed beam of infrared light reflects on the sensor tip. If the tip is dry, the light beam is recognized; if it is wet, the beam reflects back into the liquid. Optical sensors are submersible and can be mounted at any orientation. Prices are generally less than $400.
Vibratory/tuning fork (piezometer)	Tuning forks with dual tines vibrate at a high frequency. As the tuning fork is submerged in liquid, a shift in frequency occurs and activates the relay output. Prices range from $270 to $300.
Conductive	A solid-state device detects the presence or absence of an electrically conductive liquid. Each sensor contains integral, high-temperature-rated electronics that generate an alternating voltage to the sensor tip. The presence of an electrically conductive liquid completes the circuit and changes the condition of the transistor output. Conductive sensors are usable in potable water if not highly softened or treated and cost around $160.
Radio frequency, solid state	A radio frequency-balanced, impedance bridge circuit detects if a probe is in contact with the liquid. Suppliers and manufacturers report these sensors are rugged, with simple calibration and installation. Costs are generally under $460.

Best Management Practices

While switches are often housed away from direct water contact or found enclosed in control panels, floats or motor pumps, they may still pose a risk to public water supplies if broken or faulty. Spills have been reported from mercury switches in wastewater systems (NC Department of Health and Human Services, 2003).

Purchase and Operation

- Identify and inventory existing level sensing equipment and document where and how many mercury switches are currently in use. Equipment manuals or specifications, manufacturers and vendors may be sources of this information. Another source of information is the Interstate Mercury Education and Reduction Clearinghouse (IMERC) Products Database at:
  www.newmoa.org/Newmoa/htdocs/prevention/mercury/imerc/notification/index.cfm

- Replace equipment with non-mercury alternatives, when feasible. Work with procurement staff and vendors to identify the best non-mercury alternatives for specific applications.
- Evaluate all specifications and options to ensure non-mercury components when purchasing equipment packages such as a tank alarm systems, level sensors, or pumps. Many manufacturers purchase subcomponents such as switches and floats from other companies and may not be aware of the presence of mercury. In addition, systems may come standard with a mercury component (such as a float), but offer a non-mercury option.

- Look for switches in metal enclosure, such as stainless steel, rather than glass to minimize breakage if a mercury switch must be used. However, if switch is in contact with water, consider corrosion-resistant enclosure to maintain equipment integrity.[8]
- Use caution around mercury switches and relays in glass bulbs. These may be more likely to break.
- Follow manufacturer recommended maintenance, inspection and replacement schedules.
- Install surge protection on all wiring to switches. Shorting of the current will not likely cause a mercury release, but may cause the need for more frequent switch replacement.

Switch Removal

- Use certified electrical contractors or staff that are trained to follow safe collection procedures and secondary containment during removal.
- Store collected mercury switches in a leak-proof, sealable container. Cushion glass bulbs to minimize chance of breakage.
- Label each container "Mercury Recycling."
- Store a mercury spill kit next to each container or collection area.
- If breakage occurs, take immediate steps to contain and clean up the spill.
- Ensure mercury switches are sent for recycling to an approved hazardous waste management company or appropriate recycler.
- Keep records on the number and weight of mercury switches recycled, including shipping invoices and destination of shipment.

[8] Hampson, Jim. Technical assistance, Druck. Stainless steel may not be best enclosure for potable water. Many manufacturers state that stainless steel and some plastics are suitable in potable water applications. However, for metal enclosures, stainless steel has the potential to corrode over time. Druck recommends more corrosion-resistant material such as titanium. PWS should ensure material meets NSF standards if in contact with water.

Fluorescent Lamps

Fluorescent and high intensity discharge (HID) lighting are widely used in homes, offices, and business operations due to their energy efficiency. Public water systems may use fluorescent lighting in well houses, facilities, and offices. HID lighting may be used for security lighting or other outdoor applications.

Mercury content varies by manufacturer and lamp type. A typical fluorescent lamp is 50% more efficient than an incandescent lamp. However, fluorescent lamps are glass tubes coated with phosphor powders, filled with rare gases such as argon, neon, and krypton, and charged with a drop of mercury. Fluorescent lighting can contain 4 to 12 mg of mercury per bulb depending on the bulb type (NEMA, 2001). A HID lamp can contain between 20 and 250 mg of mercury per lamp (U.S. EPA, 2002).

Mercury-Free Alternatives

Due to their energy saving potential, fluorescent and HID lamps are common in residential and commercial applications. However, new technologies, and mercury-free or low mercury alternatives are being developed. For example:

Low-mercury Fluorescent Bulbs: Low mercury T-8 bulbs contain 25 to 40% less mercury than traditional T-8 bulbs. Check with a local electrician to see if your facility can utilize these bulbs and for information on cost and availability.

Light Emitting Diode (LED) Lighting: LED lights are now commonly used in traffic lights, exit signs, and stairway/aisle safety lighting. In addition to being mercury-free, LED lighting is energy efficient.

Universal Waste Rule

All businesses, including public water systems, must evaluate the wastes they generate to determine whether or not they are deemed hazardous under federal and state regulations. Mercury and mercury containing products may be considered hazardous wastes and must be evaluated under hazardous waste regulations.

Fluorescent lamps fall under the "Universal Waste Rule." The Universal Waste Rule streamlines management requirements for certain widely generated hazardous wastes known as universal wastes. Universal wastes are still hazardous wastes and must be managed accordingly. However, if appropriate disposal or recycling requirements are followed, universal wastes are subject to streamlined management provisions intended to ease the regulatory burden and facilitate recycling.

Best Management Practices

- Take care when replacing fluorescent lights and ballasts to avoid breakage.
- Do not site fluorescent lights directly over open water tanks if possible. Breakage over these tanks may cause mercury to enter the system.
- Train staff in appropriate cleanup procedures for mercury lighting in case of breakage.
- Refer to the following MassDEP web page for information regarding the proper handling and disposal (recyling) of broken and unbroken fluorescent bulbs: http://www.mass.gov/dep/toxics/stypes/flampbiz.htm.
- Work with vendors to identify and use low mercury or mercury-free lighting options where feasible. Look for lamps that pass the Toxicity Characteristic Leaching Procedure (TCLP) for hazardous waste determinations.

Ultraviolet Disinfection Systems

Ultraviolet light (UV) in a specific wavelength range is accepted as a reliable solution for water disinfection and is effective in killing a wide variety of pathogenic microorganisms. (Figure 4) In Massachusetts, UV disinfection is generally used in combination with other treatment processes to meet state requirements for residual disinfectant in treated water.

Ultraviolet light is generated by applying an electric current across a mercury gas mixture encased in a glass tube in a similar fashion as a fluorescent lamp. The mercury in low pressure and medium pressure UV lamps is liquid when the lamp is not in use and vaporizes to gas when the lamp is in operation.

FIGURE 4: UV DISINFECTION SYSTEM
Source: Brown Environmental

The exact quantity of mercury in a UV bulb depends on the lamp model, type, manufacturer and application. Many manufacturers list their lamps in the IMERC Mercury-Added Products Database.[9] Mercury quantities reported in the IMERC database range from less than 5 mg per lamp to 1,000 mg or more per lamp. The quantity of mercury in a specific bulb can often be obtained from the Material Safety Data Sheet (MSDS) or manufacturer specifications.

Mercury-Free Alternatives

Mercury free or low mercury options may be somewhat limited as some UV disinfection systems may only accept one type of lamp. Mercury content varies by lamp type and lower mercury options may be available upon request. Suppliers also indicate that new low-mercury bulbs are being developed (Geller, 2004). Before changing bulb type, consult manufacturers to ensure lower-mercury bulb will still meet disinfection requirements.

In addition, mercury-free UV disinfection systems using a pulsed xenon UV lamp and an excimer lamp are available. Systems should evaluate various UV options and systems before purchasing to ensure the system will meet disinfection requirements.

Best Management Practices

- Consult a UV system manufacturer to inquire about the availability of low mercury bulbs. Look for lamps that pass the TCLP for hazardous waste determinations. The mercury content may affect system performance and should be evaluated carefully to ensure resulting output meets disinfection requirements.
- Maximize UV lamp life by following manufactures' recommended maintenance, sleeve cleaning, and inspection schedules.
- Train staff to follow safe removal and collection procedures and have access to secondary containment during removal. If lamps are broken, store the material in sealed container.

[9] NEWMOA maintains the IMERC Mercury-Added Products Database at www.newmoa.org/Newmoa/htdocs/prevention/mercury/imerc/notification/

- Because the mercury is in liquid form at time of disposal, the spent lamp should be sent to a mercury retorter for proper mercury recovery and recycling (Table 6).

Table 6: Massachusetts Recycling Companies and services

Company	Location	Phone
Dooley And Fortin Disposal	770 Broadway, Raynham MA 02767	(508) 824-0023
Veolia Environmental Services	Marlborough, MA	(716) 879-0600
Complete Recycle Solutions	One Father Devalles Blvd, Fall River, MA 02723	(866) 277 9797
Bulbs	410 Jackson Street Worchester, MA 01608.	(888) 455-2800
Dooley And Fortin Disposal	770 Broadway, Raynham MA 02767	(508) 824-0023

Chlorine Disinfection Chemicals

Chlorine disinfection is the most common disinfection method used by public water systems. Chlorine can be manufactured via the electrolysis of a sodium chloride solution (brine). The chlorine is extracted from the solution by electrolysis using one of three methods. The oldest method uses a mercury cell and may introduce mercury into the final chemical product. Therefore, common chlorine disinfection chemicals such as chlorine gas, sodium hypochlorite, and calcium hypochlorite, may contain trace amounts of mercury.

Mercury-Free Alternatives

Two other forms of chlorine production include diaphragm cell electrolysis, which uses an asbestos diaphragm or membrane cell electrolysis. The presence or absence of mercury will depend on the manufacturing process.

Under Massachusetts drinking water regulations, disinfection chemicals must be approved under ANSI/NSF standard 60. ANSI accredited testing agencies, such as NSF International and Underwriters Laboratories, test all chlorine products annually for metals including mercury and certify only those products that introduce levels less than 1/10 of the MCL allowable by the U.S. Environmental Protection Agency.

Best Management Practices

- Per Massachusetts Code, ensure chlorine products used are approved under ANSI/NSF standard 60. Visit www.nsf.org/certified/pwschemicals/ and www.ul.com/water/waterqry.htm for product information.
- Work with vendors and suppliers to determine if chlorination products used contain mercury, to certify the mercury content, and to identify mercury-free alternatives.
- Purchase mercury-free chlorine chemicals if possible

Thermometers

Mercury has a uniform volume expansion over a wide temperature range, from -30 to 900°F, and is commonly used in industrial thermometers. Thermometers can contain up to 3 grams of mercury and are commonly found at public water systems in water testing labs, buildings, control or alarm indicators for liquid cooling systems, pressure and temperature monitors, and recirculating water cooling systems.

Mercury-Free Alternatives

Many replacement alternatives are available for a mercury-in-glass thermometer including digital, aneroid (liquid-free) models and thermometers that use other liquids such as alcohol in place of mercury (Table 7).

TABLE 7: ALTERNATIVES FOR MERCURY-CONTAINING THERMOMETERS.

Component	Description
Thermometer	**Mercury-free liquid thermometer. Uses alternative liquid (commonly gallinstan or alcohol) in place of mercury.** **Digital thermometers.**

Best Management Practices

- Identify mercury-containing thermometers. Consult your manufacturer/vendor or the IMERC Products Database at www.newmoa.org/Newmoa/htdocs/prevention/mercury/imerc/notification/index.cfm.
- Store mercury-containing thermometers in sealable container to avoid breakage.
- Replace mercury thermometers with mercury-free alternatives. Work with vendors for assistance.
- Train staff in spill cleanup response and associated hazards in case of spill.

Thermostats

Thermostats may contain a mercury switch consisting of a durable glass tube attached to a metal strip that absorbs shocks. Switches may contain up to 3 g of mercury and a single thermostat may contain multiple switches (Huber, 1997). In a drinking water system, mercury switches may be found in wall mounted thermostats used to control building heating and cooling systems and furnaces.

Mercury-Free Alternatives

Digital electronic thermostats that use thermistor technology to measure temperature may not contain mercury switches. Many digital thermostats are programmable providing the added benefit of automatically setting heating and cooling for maximum energy efficiency.

Best Management Practices

- Identify and label mercury thermostats in your facility. Contact manufacturer and/or vendors and/or visit the IMERC Products Database at: www.newmoa.org/Newmoa/htdocs/prevention/mercury/imerc/notification/index.cfm.
- Monitor mercury switches and thermostats for signs of wear.
- Recycle mercury-containing thermostats at end of life.
- Replace thermostat with non-mercury alternatives if feasible.
- Specify non-mercury thermostats with your vendor, as some programmable thermostats may still contain a mercury switch (Huber, 1997).

The Thermostat Recycling Corporation (TRC) is a non-profit group organized by electrical supply manufacturers. TRC facilitates the collection of all brands of used, wall-mounted mercury-switch thermostats so that the mercury can be purified for re-use. Three Massachusetts facilities participate in the TRC program and may be able to assist with recycling mercury thermostats. (Table 8)

TABLE 8. MASSACHUSETTS PARTICIPANTS IN THE THERMOSTAT RECYCLING CORPORATION
Source: Thermostat Recycling Corporation

Company	Address	Town	State	Telephone
The Center for Ecological Tech	112 Elm St	Pittsfield	MA	(413) 445-4556
S & A Supply	1311 East Street.	Pittsfield	MA	(413) 443-9681
F. W. Webb	35 Commercial Street,	Pittsfield	MA	(413) 442-7913
Waste-Cap of MA	68 Hopkinton Road	Westborough	MA	(781) 679-2176

Hazardous Waste Regulations and Public Water Systems

Public water systems may be subject to specific requirements under the Resource Conservation and Recovery Act (RCRA) depending on the volume, rate and type of waste generated.

What is Waste and How do I Know if it's Hazardous?

A waste is any material (solid, liquid or contained gas) that is discarded by being abandoned (disposed, burned, or incinerated), recycled, or is considered inherently waste-like. Wastes include anything that needs to be reclaimed or reprocessed prior to reuse. Examples of waste include water down a drain, an empty pop can, and spent chemicals or solvents. Some wastes can be reprocessed or recycled into useable products. Some can be treated prior to disposal to make them less hazardous. Some must simply be placed in a landfill.

Hazardous wastes are particularly dangerous to human health and the environment and must be disposed of in an approved manner. Regulations govern the storage, transportation, treatment, and disposal of hazardous waste. Many common wastes, such as fluorescent lighting, cleaners and computer monitors, may be classified as hazardous.

There are two types of hazardous waste:

- **Characteristic Wastes**: Wastes that exhibit one or more of the four hazardous waste characteristics of ignitability, corrosivity, reactivity, or toxicity. Each characteristic is defined by regulation.

- **Listed Waste**: Wastes that appear on any of four specific lists of hazardous wastes issued by the EPA. Some listed wastes are so dangerous that they are called acutely hazardous wastes. Examples include some pesticides, which can be fatal to humans at even small doses.

Understanding Your Requirements

All companies, including public water systems, generate wastes and some generate hazardous wastes. Every company is required to track the amount of waste it generates, determine whether or not each waste is hazardous, and ensure all wastes are disposed of according to federal, state, and local requirements.

Summary of Best Management Practices

When working in areas where mercury is present, good work practices can aid in avoiding exposure and contamination. "Best management practices" for mercury are those which prevent its release into the environment. The preferred best management practice is to replace the unit with a mercury-free alternative. When ordering new equipment, specify that it contain only mercury-free components and ensure that spent components are appropriately recycled or disposed.

However, it may not be possible to replace all units at once and, in a few cases, there may not be a reliable, cost-effective substitute. For these products, best management practices include education, labeling, and monitoring until a replacement becomes available or until new equipment is procured. Suggested practices include:

Identify Mercury Containing Components in Your System

- Assume the presence of mercury unless proven otherwise.
- Label mercury-containing equipment and educate workers as to its location.

Maintenance

- Develop a maintenance protocol for when mercury-containing equipment needs to be calibrated, handled, repaired, or replaced.
- Monitor mercury-containing equipment for wear. Follow manufacturers' recommended maintenance, inspection, and replacement schedules.
- Consider a more frequent testing schedule for mercury in drinking water. Massachusetts Regulations require testing for inorganic compounds including mercury every three years. Although not required by rule, a more frequent testing schedule may uncover in-situ leaks from mercury-containing equipment.
- Work on mercury-containing equipment away from the well, well house, and open water tanks.
- Work on mercury-containing equipment over a secondary containment barrier in case of a spill.
- Install surge protection on all wiring to mercury switches. While shorting of current will not likely result in mercury release, it may reduce the life-span of the switch, resulting in higher purchasing frequency and hazardous waste disposal costs.

Equipment Replacement

- Add "mercury-free" to procurement policies and bids.
- Budget for mercury recycling. It may not be legal to throw mercury-containing equipment into local landfills. Check with your landfill prior to disposal. Recycle equipment if possible. Include costs for recycling or hazardous waste disposal in replacement costs.
- Ensure all contractors and staff are trained to follow safe collection procedures, use secondary containment during removal, and are knowledgeable and follow appropriate recycling and disposal options.

- After removal, place small mercury parts in a sealable mercury collection container. Label the container, "Mercury Recycling."
- If a mercury component must be purchased, evaluate the mercury content and equipment uses carefully. Some products may use less mercury than others and product integrity may vary in water applications.

Spills

Mercury spills can be hazardous to human health and the environment. Even a few drops of mercury can severely impact your health. One of the biggest dangers from spills is inhalation if the mercury volatilizes. Mercury also can spread easily and become embedded in fabrics such as curtains, carpets, and rugs. If a spill occurs:

For large spills, spills of unknown quantity, or unconfined spills or when children or pregnant women are present:

- Contact the Massachusetts Emergency Management Agency, Executive Office of Public Safety at (617) 727-7775. Emergency Response Network, which consists of state and local hazardous materials specialists who evaluate your situation and provide assistance.
- Isolate the area to keep people and animals from walking through the spill area.
- To limit circulation, turn off the ventilation system and close interior doors.
- If the spill is greater than one pound (approximately two tablespoons), it is mandatory to call the National Response Center (NRC). The NRC hotline operates 24 hours a day, 7 days a week. Call (800) 424-8802.

For small spills, less than the amount contained in a thermometer:

According to EPA, the general public can clean up small mercury spills no greater than the amount contained in a thermometer if spilled on a flat surfaces. If your spill is larger, is not on a flat surface, or uncertainty exists to the clean up method, spill size, or exposure, isolate the contaminated area and call the Massachusetts Emergency Management Agency at (617) 727-7775.

Spill clean up with a mercury spill kit:

If the mercury-containing components are to be managed in place, a good safety practice is to have a spill kit available. (Figure 5, Table 9A) The spill kit should contain powders or sprays specific to mercury. Chemical or universal absorbent pads will not absorb and contain mercury, due to its high surface tension and other special properties. The powder or spray bonds the mercury droplets so that they can be easily collected. Wipes, sponges, and jars in mercury spill kits will pick up tiny droplets. For extra security, some kits contain an indicator to show mercury that may have been missed. Spill kits range in price from $50 to $300 depending on contents. [10]

- Remove everyone including pets from the area where cleanup will take place. DO NOT allow or gain assistance from children.
- Put on rubber or latex gloves.

[10] Mercury spill kit costs estimated from costs provided by vendors or vendor web sites listed in Table 9.

- Use a mercury spill kit, following the kit directions.

FIGURE 5: MERCURY SPILL KIT
©Photo courtesy of Lab Safety Supply, Janesville, WI

TABLE 9A : MANUFACTURERS OF MERCURY SPILL KITS[11]

Manufacturer	Address	Telephone	Web Address
Cartier Chemicals Ltd.	445-21 Avenue Lachine, Quebec, Canada H8S 3T8	(800) 361-9432 (514) 637-4631 (514) 637-8804 FAX	www.vytac.com
EPS Chemicals, Inc.	EPS Chemicals, Inc. P.O. Box 570 Point Roberts, WA 98281-0570	(800) 663-8303 (604) 521-6646 (604) 521-6695	www.epsross.com
Lab Safety Supply	P.O. Box 1368 Janesville, WI 53547-1368	(800) 356-0783 (608) 754-7160 (608) 754-1806 FAX	www.labsafety.com
Lamp Environmental Industries, Inc.	46257 Morris Rd, P.O. Box 2962 Hammond, LA 70404-2962	(800) 309-9908 (504) 345-0022 (504) 345-4775 FAX	www.lei-inc.net
New Pig Corporation	1 Pork Avenue Tipton, PA 16684-0304	(800) 468-4647 (814) 684-0101 (814) 684-0644	www.newpig.com
Safetec of America	1055 East Delevan Avenue Buffalo, NY 14215-3145	(800) 456-7077 (716) 895-1822 (716) 895-2969 FAX	www.safetec.com

Table 9B shows various companies, the type of waste accepted, services available and the recycle classification of the listed company. Portions of this information were obtained from:
http://www.des.state.nh.us/nhppp/options.htm.

[11] Provided for information only. MassDEP does not certify or endorse any companies on this list.

Table 9B : Recycle Companies and Type of Waste Accepted

Company Information **Address** **Phone** **Webpage**	**Types of Waste Accepted** **E=Electronic devices** **S=Compounds/Solutions/Salt /Solids** **L=Lamps/ballasts** **C=Contaminated Soils** **D=Contaminated debris** **A= of the above Amalgams** **B=Batteries** **T= All of the above**	**Full Services Available *** **Yes or No**	**Recycling Classification** **B=Broker** **S=Storage** **R=Distillation and reclamation** **T=All**
Clean Harbors, Inc. Braintree**, MA** Phone: 781-849-1800 http://www.cleanharbors.com/	T	Yes	B, S
Global Recycling Technologies, Inc. 218 Canton St. Stoughton**, MA** 02072 Phone: 781-341-6080 http://www.grtonline.com	T	Yes	T This is the only licensed complete R in New England
Safety Kleen 221 Sutton St North Andover, **MA** Phone: 978-685-2121 *Note: Bought out Laidlaw*	T	Yes	B, S
Advanced Environmental Recycling Co. (AERC) 2591 Mitchell Ave. Allentown, PA 18103 Phone: 800-554-AERC (2372) http://www.aerc-mti.com/	T	Yes	T
ALR-American Lamp Recycling, LLC 22 Stage Door Rd. Fishkill, NY 12524 Phone: 800-315-6262	L	Yes	T

Bethlehem Apparatus Co. Inc. Resource Recovery and Recycling Division 890 Front St., P.O. Box Y Hellertown, PA 18055 Phone: 610-838-7034 Fax: 610-838-6333	T	Yes	T
Dental Recycling North America, Inc. P.O. Box 1069 Hackensack, NJ 07601 Phone: 800-525-3793	A	Yes	B
Dorell Refinery 533 Atlantic Ave. Freeport, NY 11520 Phone: 800-645-2794	A	Yes	B, S
EnviroChem 21821 Industrial Blvd. Rogers, MN 55374 Phone: 612-428-4002	A	No Can provide containers but customer responsible for transportation	B, S
Full Circle, Inc. 509 Manida St. Bronx, NY 10474 Phone: 800-775-1516 718-328-4667	L, B	Yes	B
Garfield Refining 810 E. Cayuga Philadelphia, PA 19124-3892 Phone: 800-523-0968, ext. 300	A	Yes Suggested that customers to provide transporation for small quantities	B, S
Mercury Refining Co. (MERCO) 1218 Central Ave. Albany, NY 12205 Phone: 800-833-3505 518-459-0820	A	No Can provide containers but customer responsible for transportation	B, S Partial R done on site (remainder handled by 3rd party)
Northeast Lamp Recycling, Inc. 250 Main St. E. Windsor, CT 06088 Phone: 860-292-1992	L	Yes	B, S Partial R done on site (remainder handled by 3rd party)

Recyclights 401 W. 86th St. Bloomington, MN 55420-2707 Phone: 800-831-2852 http://www.recyclights.com *Under the umbrella of Superior Special Services*	T	Yes	B, S R done on site for some materials (remainder handled by 3rd party)
Superior Special Services P.O. Box 556 Port Washington, WI 53074-0556 Phone: 800-556-5267 *Note: Bought out Recycle Lights and Dynex*	T	Yes	B, S

If you do not have a mercury spill kit:

1. Put on latex gloves.

2. If you are using powdered sulfur, sprinkle it over the spill area at this time. The sulfur does two things: (1) it makes the mercury easier to see since there is a color change from yellow to brown and (2) it keeps the mercury from vaporizing. Powdered sulfur may be purchased at garden supply stores or pharmacies. Please note that powdered sulfur may stain fabrics a dark color.

3. If there are any broken pieces of glass or sharp objects, pick them up with care. Place all broken objects on a paper towel. Fold the paper towel and place in a zipper-type bag. Secure the bag and label the bag accordingly (i.e., broken glass).

4. Use a squeegee or cardboard to gather the mercury beads. Use slow sweeping motions to keep the mercury from becoming uncontrollable. Use a flashlight to look for any additional mercury beads that may be sticking to the surface or in small cracked areas of the surface.

5. Use an eyedropper, piece of paper, or cardboard to collect or draw up the mercury beads. Slowly and carefully squeeze the mercury onto a damp paper towel. Place the paper towel in a zipper-type bag and secure. Make sure to label the bag.

6. Place all materials used with the cleanup in a trash bag. Place all mercury beads and objects into the trash bag. Secure and label the trash bag. Remember to remove your gloves and place them in the trash bag.

7. Contact your landfill or a waste management company for disposal in accordance with local, state, and federal laws.

8. Remember to keep a window open for at least 24 to 48 hours **after** your successful cleanup. Continue to keep pets and children out of cleanup area. If sickness occurs, seek medical attention immediately.

9. Sprinkle sulfur powder on the spill area after cleaning up the mercury; a color change from yellow to brown indicates that mercury is still present.

10. Mercury can be cleaned up easily from wood, linoleum, tile, and any other like surfaces. If a spill occurs on carpet, curtains, upholstery, or a similar surface, the contaminated items should be thrown away in accordance with the disposal means outlined above. Only cut and remove the effected portion of the contaminated carpet for disposal.

Additional cautions for cleanup of spills:

- Never use a vacuum cleaner to clean up mercury. The vacuum will put mercury vapor into the air and increase exposure. The vacuum may become contaminated and need to be thrown away.
- Never use a broom to clean up mercury. It will break the mercury into smaller droplets.
- Never pour mercury down the drain. It may lodge in the plumbing and cause future problems with the septic or sewer system.
- Never wash mercury contaminated items in a washing machine. Mercury may contaminate the machine.
- Never walk around if your shoes or socks might be contaminated. This will only spread the mercury around making it harder to clean.
- Do not wear gold jewelry when cleaning up a mercury spill. Mercury will adhere to the gold and can lead to contamination.

References

Information provided in this report was researched using the Web, phone calls, and literature searches. Manufacturers were contacted for information on mercury use, mercury-containing equipment, and equipment alternatives.

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Ohio EPA, Briefing on New Carlisle's Problems with Mercury Seals in Well Pumps, (2001) (personal communication by John Arduini, 2004).

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U.S. EPA, *Safe Mercury Management Guidelines*, www.epa.gov/epasower/hazwaste/mercury /spills.htm, U.S. EPA website, 2004, (accessed 12/17/04)

U.S. EPA, *Mercury in Buildings*, U.S. EPA Region 5/ Purdue University, version 1.0, January 2002, www.epa.gov/seahome/mercbuild/src/devicepage.htm (accessed 12/20/04)

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Suppliers/Vendors/Companies Contacted

Many suppliers, vendors, and companies contacted for this study. Most report phasing out mercury use or availability of mercury-free alternatives. Public water system staff should verify mercury content of products before purchase.

Float Switch/Level Sensors

Comus
(973) 777-6900
Mercury-free products available.
Offers mercury recycling program for customers.

Dywer, Inc.
(219) 879-8000

Sensors Northwest (Druck Representative)
(206) 542-09810

Gems Sensors Inc.
(800) 378-1600
Mercury-free products.

Heally Ruff (Control Panels)
651-633-7522
Mercury switches used in Legacy Control Panels. Steel encapsulated mercury switch available that reduces chance of breakage.

Innovative Concepts
(800) 789-2851

MDI Inc.
(800) MDI-4077
Mercury-free products available.
Reports mechanical switches are most popular sales. Mercury and non-mercury floats primarily for sump applications available. No NSF certified products.

Monitor Technologies
(800) 601-6302

Omega Engineering, Inc.
(888) TC-OMEGA
Mercury-free products.

SJE Rhombus
(888) DIAL-SJE
Mercury-free products available.
Sells mercury floats for wastewater systems and control systems. Non-mercury floats available for potable water.

TEI (Control Panels)
(512) 259-2977
Mercury-free products.

Pump Seals and Pumps

Centrilift
(307) 527-7807
Mercury-free products.

Crown Pumps
(254) 893-5700
Mercury-free products.

Goulds Pumps
(315) 568-2811
Mercury-free products.

Grundfos Pumps
(913) 227-3400
Mercury-free products.

Dykman Electric (Supplier of Emerson Motors)
(208) 336-3988
Mercury-free products.

Fairbanks Morse (Division of Pentair)
(913) 371-5000
Mercury-free products.

Flowserve (Division of Byron Jackson)
Mercury-free products available. The NSF certified Byron Jackson oil-filled design submersible pump comes with mercury or mechanical seal. Flowserve is a division of Byron Jackson and is also associated with Plueger and Durmettalic.

Franklin Electric (motors)
(260) 524-2900
Mercury-free products.

Hydroflow Pump Company
(612) 662-2708
Mercury-free products.

Layne and Bower (Division of Pentair)
(913) 371-5000
Mercury-free products.

Sta-Rite (Division of Pentair)
(800) 472-0884
Mercury-free products.

SunStar Electric
(806) 793-2812

UV Technologies

International Ultraviolet Association
(519) 632-8190

EcoLights Northwest
(206) 343-1247

EPRI Technology Application Center
(559) 642-2082

Heraeus Noblelight
Volker.adam@heraues.com

South Fork Lodge
(208) 483-2112

PulsarUV
(916) 677-1956

Philips Lighting
Henk Geller (personal communication)
h.giller@philips.com

Trojan Technologies
(360) 456-2948

LightStream Technologies
(703) 480-2464

Ushio America
(800) 838-7446

Meters/Guages

Amco Meters
(800) 874-0890
Mercury-free products.

Ashcroft Meters
(800) 328-8258
Mercury-free products.

Hydro Specialties
(supplier for Badger Meter Company)
(801) 562-9130
Mercury-free products.

Dwyers, Inc.
(219) 879-8000
Mercury-free products available. Dwyers reports manufacturing mercury containing manometers and gauges. Mercury free alternatives available. Does not specify a particular meter or technology for use at public water systems.

Hersey Meters
(800) 323-8584
Mercury-free products.
Master Meter (800) 741-8223
Mercury-free products.

Neptune Meters Omega (pressure gauges)
(334) 283-7321
(888) TC-OMEGA
Mercury-free products. Mercury-free products.

For more vendors selling mercury containing equipment, visit the IMERC Products Database at www.newmoa.org/Newmoa/htdocs/prevention/mercury/imerc/notification/index.cfm.

Supplier Web Sites Reviewed

Additional supplier web sites reviewed. Sites accessed between January 1 and December 31, 2004).

AMCO, www.amcowater.com/en/industrial_products.shtml
Aurora Pumps, www.aurorapump.com/
Badger Meter, www.badgermeter.com/
Barnes Pumps, www.cranepumps.com/barnes/index.asp
Berkeley Pumps, www.berkeleypumps.com/
Centrilift, www.bakerhughes.com/centrilift/SPS/SPS_Pump.htm
Comus International, www.comus-intl.com/
Crane Pumps, www.cranepumps.com
Crown Pumps, www.crownpump.ca/crown/
Dwyer Instruments, www.dwyer-inst.com/
Endress + Hauser Flowtec, www.endress.com/
Fairbanks Morse, www.fairbanksmorsepump.com/
Flowserve, www.flowserve.com/
Ford Meter, www.fordmeterbox.com/
Franklin Electric, www.franklin-electric.com/
Gems Sensors/Warrick Controls,www.gemssensors.com/
Goulds Pumps, www.goulds.com/
Grundfos, www.grundfos.com/
Healy Ruff, www.healyruff.com/
Hersey Meters, www.herseymeters.com
Layne and Bowler, www.pentairpump.com/fr_lvtitle.htm
Master Meter, www.mastermeter.com
MDI, www.mdius.com/
Metron-Farnier, www.metronfarnier.com/
Neptune Technology Group, www.neptunetg.com/
Omega Engineering Inc., www.omega.com/
Paco Pumps, www.paco-pumps.com/HomePages/FlowHome.htm
Rosemount/Emerson Process Mgmt, www.rosemount.com/products/flow/eng_assemblies.html
Sensus Metering Systems, www.sensus.com/newdesign.asp
SJE Rhombus, www.sjerhombus.com/
Sta-Rite Pumps, www.staritepumps.com/
TEI Controls, www.teicontrols.com