

# Implementation of Methylmercury Criterion in NPDES Permits



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## Disclaimer

This internal management directive (IMD) represents the Department of Environmental Quality's (DEQ) current directions to staff on how to determine if a discharging facility has the reasonable potential to cause or contribute to the exceedance of the methylmercury water quality criterion. This IMD is not final agency action and does not create any rights, duties, obligations, or defenses, implied or otherwise, in any third parties. This directive should not be construed as rule, although some of it describes existing state and federal laws. The recommendations contained in this directive should not be construed as a requirement of rule or statute. DEQ anticipates revising this document from time to time as conditions warrant.

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# 1. Introduction

Mercury is emitted by natural sources, such as volcanoes, geothermal springs, geologic deposits, and the ocean. Human-related sources primarily include coal combustion, waste incineration, industrial uses, and mining. During the last 150 years, human activities have more than doubled natural amounts of mercury in the atmosphere<sup>12</sup>. The form of mercury that presents the greatest risk to humans and the environment is methylmercury (MeHg). MeHg present in the water column can build up (bioaccumulate) in fish tissue to the point where it can cause neurotoxicity in humans and wildlife that regularly consume fish. Though the highest concentrations of MeHg are typically associated with upper trophic level fish species (i.e. predators), many of Oregon's sport fish also show high concentrations. This has resulted in fish advisories in the Willamette River as well as other waterbodies in Oregon.

Because MeHg bioaccumulates so readily, the levels of MeHg in the water column sufficient to cause harm to fish consumers may not actually be measurable (using traditional analytical methods). Total mercury is easier to detect, however the fraction of total mercury that is MeHg is not static over time. As explained in more detail in *Section 5.3*, this amount will vary with temperature, pH and other factors.

Because of the difficulties associated with detecting MeHg in the water column, EPA and Oregon Department of Environmental Quality (DEQ) have adopted criteria for MeHg that are expressed in terms of fish tissue concentration instead.<sup>3,4</sup> The criteria for MeHg are unique in this respect. This has implications for the promulgation of the criterion generally, and for the development of NPDES permit limits in particular.

To help States and authorized Tribes in the implementation of the fish tissue-based criterion, in April of 2010 EPA published their [Guidance for Implementing the January 2001 Methyl-Mercury Water Quality Criterion](#) (EPA Guidance). The EPA guidance describes the use of the new fish tissue-based criterion and presents a number of pathways to incorporate it into NPDES permits and Total Maximum Daily Loads (TMDLs). DEQ opted to use the pathway that:

- describes a process to determine if there is a reasonable potential to cause or contribute to the exceedance of the methylmercury water quality criterion using total mercury as an indicator,
- and establish appropriate (non-numeric) WQBELs comprised of a Mercury Minimization Plan (MMP), continuing effluent monitoring and antidegradation provisions.

These elements are described below in *Sections 4* and *5* of this directive.

The purpose of this directive is to provide direction to staff on how to:

- determine if a facility is required to evaluate potential MeHg in their effluent,
- use total mercury monitoring data to determine reasonable potential for the MeHg criterion,
- establish effluent limits when reasonable potential is indicated,
- assist affected parties in the development of Mercury Minimization Plans.

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1 Atmospheric Mercury Deposition during the Last 270 Years: A Glacial Ice Core Record of Natural and Anthropogenic Sources, Schuster and others, 2002. USGS

<sup>2</sup> Inorganic mercury (the form emitted to the environment) is generally not a health concern—it is poorly absorbed by the digestive tract.” Mercury in Stream Ecosystems—New Studies Initiated by the U.S. Geological Survey

<sup>3</sup> In January of 2001, the U.S. Environmental Protection Agency (EPA) promulgated the MeHg water quality criterion (0.3 mg/kg based on a fish consumption rate of 17.5 g/day) as part of the Section 304(a) of the Clean Water Act. This is the concentration of MeHg in fish and shellfish tissues that should not be exceeded to protect consumers of fish and shellfish.

<sup>4</sup> On June 16, 2011 the Oregon Environmental Quality Commission approved a state water quality criterion of 0.040 mg/kg for MeHg. This criterion is based on the fish consumption rate established for Oregon which is 175 g/day.

## 2. Which Facilities are Subject to the MeHg Criterion and Must Monitor?

This directive applies to the development of individual National Pollutant Discharge Elimination System (NPDES) permits for domestic and industrial dischargers that are required to monitor for total mercury. As described in *Section 2 of the Reasonable Potential Analysis IMD (RPA IMD)*, the following facilities are required to provide effluent characterization data for total mercury as part of their permit development/renewal process:<sup>5</sup>

- All Major Domestic and Primary Industrial facilities
- All Minor Domestic and Non-Primary Industrials facilities where total mercury is “known”<sup>6</sup> to be present in source water or effluent

For minor domestic facilities with an average dry-weather design flow of less than 0.1 MGD, the permit writer may use existing ambient data and a “knowledge of process” approach to characterize the effluent and additional sampling would not be required.

For facilities discharging to a water body where a TMDL for total mercury has already been completed, the permit writer should evaluate if the provisions (including the Waste Load Allocations) in the TMDL adequately address the MeHg criterion.<sup>7,8</sup> If the TMDL does not address MeHg in the methodology or waste load allocations, then the permit writer should consider evaluating MeHg separately through the traditional RPA process.

## 3. Determining Reasonable Potential

The EPA guidance indicates that effluent monitoring data for total mercury should be used as an indicator to determine whether reasonable potential analysis for MeHg is necessary. If there is not a quantifiable<sup>9</sup> amount of total mercury in the discharge, “...*the permitting authority may reasonably conclude that the discharge does not have reasonable potential (for MeHg) (to cause an exceedance of water quality criteria) and that no water quality based limits are necessary.*”<sup>10</sup> Conversely, if a quantifiable concentration of total mercury is detected in a facility’s discharge it must be evaluated for reasonable potential.

For facilities where the only source of mercury in the discharge is from the intake water taken directly from the “same body of water” to which the facility discharges, and that there are no known sources or additional contributions of mercury at the facility, the permit writer may reasonably conclude that the discharge does not have reasonable potential to exceed the criterion. An example of this is a facility that uses a surface water as a source of cooling water and that discharges immediately downstream of the intake location. In these situation where there are no known sources or additional contributions of mercury at the facility, the permitting authority could reasonably conclude that

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<sup>5</sup> The general federal monitoring requirements are detailed in 40 CFR 122, including the requirement to monitor for total mercury where total mercury is “known” to be present for industrial facilities. All other monitoring requirements where the pollutant is “known” or the facility discharges to a water quality limited water body is a state requirement stemming from a Settlement Agreement with EPA and other third parties. Please refer to *Section 2.2.1 of the RPA IMD* for further information.

<sup>6</sup> For example, the source water is taken from a source listed as “water quality limited (303d)” for “total mercury” or from ground water where drinking water monitoring or clean-up records indicate the presence of mercury.

<sup>7</sup> For example, in 2006 the Willamette River Basin Mercury TMDL and Water Quality Management Plan were approved by EPA.

<sup>8</sup> If necessary, the permit writer should consult with the basin coordinator and TMDL staff to determine if the in-stream water quality criterion for MeHg is met by the provisions described in the TMDL.

<sup>9</sup> Method used should be sufficiently sensitive with a minimum Quantitation Level of 0.005 µg/l (5 ng/l) for total mercury (for example Methods 1631 E or 245.7). At the time that this directive was issued, DEQ is in the process of evaluating the regional availability of analytical methods and their readily achievable performance levels. This process is expected to be completed by the end of 2013 and may result in a further reduction of the QL for total mercury to a level around 0.0005 µg/l (0.5 ng/l).

<sup>10</sup> EPA’s *Guidance for Implementing the January 2011 Methyl-Mercury Water Quality Criterion*, page 95.

there is no reasonable potential to cause or contribute to an exceedance. Furthermore, any slight increase in concentration after discharge (due to evaporation or other water loss) should not increase the bioaccumulation of MeHg in fish tissue unless the fish are known to regularly reside within the mixing zone of the outfall. Please refer to *Section 7.5.1.3* of the EPA Guidance for more information on the use of this provision. This provision is somewhat different from the Department's "Intake Credit Rule" (OAR 340-045-0105) in that it addresses the overall mass loading of mercury and allows an increase in mercury concentration to occur<sup>11</sup>.

*Reasonable Potential Determination:* Where quantifiable concentrations of total mercury are identified in a discharge, it is necessary to determine whether fish tissue concentrations of MeHg in the receiving water are close to or exceeding the human health water quality criterion. Normally, EPA recommends that state water quality programs include special permit conditions into their permits that require the permittees to conduct a fish tissue survey of the receiving water body along with a re-opener clause to complete the reasonable potential evaluation once the survey is complete. Recognizing the substantial costs associated with these surveys and the assumption that a majority of the State's waters routinely exceed the water quality criterion for mercury, DEQ has chosen an alternative (although allowable per EPA Guidance) pathway and directs the following:

- Any facility contributing<sup>12</sup> significant and consistent<sup>13</sup> concentrations of total mercury to the receiving water body is considered to have the reasonable potential to exceed the water quality criterion unless a site-specific survey determines otherwise.

## 4. Establishing Effluent Limits

Because the water quality criterion for MeHg is a fish tissue-based concentration rather than a water column concentration, permit limits for MeHg cannot be expressed in terms of a concentration (with out a translation factor). Instead, for facilities where a reasonable potential to exceed the criterion is assumed or determined, the permit writer must:

- As a Schedule D permit condition, require the permittee to develop and implement an MMP (Mercury Minimization Plan) tailored to the facility's potential to discharge mercury. Depending on the particular facts, the permitting authority may include in the MMP a trigger level, reduction goal, or enforceable numeric level (e.g., existing effluent quality) to further manage mercury discharges.
- Require continued effluent monitoring (total mercury) using a sufficiently sensitive EPA-approved method to enable evaluation of the effectiveness and implementation of the MMP.
- Include a reopener clause to modify the permit conditions if the MMP are not found to be effective or if a water column translation of the fish tissue criterion is developed.

For facilities where no reasonable potential is determined, effluent limits are not required and no further mercury evaluation is necessary for the current permit renewal.

*Implement Antidegradation:* If a permittee undertakes or proposes to undertake an activity that may result in an increase in MeHg loading to the receiving waterbody, then DEQ may develop additional permit conditions to prevent or minimize the impact of the increased loading. These permit conditions will be consistent with the directives contained in DEQ's *Antidegradation IMD*.

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<sup>11</sup> However, should the facility be disqualified from this provision due to additions of mercury from the process or collection area, the Department's intake credit rule might still be available to address intake sources on a flow-weighted basis.

<sup>12</sup> When determining if a "contribution" is occurring, the permit writer may consider an Intake Credit pursuant to the OAR 340-045-0105 and the *Appendix F* of the *RPA IMD* (Intake Credit Guidance).

<sup>13</sup> Significant concentrations are those results greater than the Quantitation Level of the method. When determining the "consistency" of the concentrations, the permit writer should consider all of the available sample results (min. of 4) to determine if the presence of total mercury is a chronic condition or a statistical or analytical aberration. When reviewing the Tier 1 monitoring data, the permit writer should be aware that elemental mercury concentrations are higher in the winter and spring (methylation decreases), while MeHg concentrations are higher in the summer and fall periods (methylation increases).

## 5. Mercury Minimization Plans

Mercury Minimization Plans (MMPs) can vary widely from “very simple” to “complex”, depending upon the type of facility (i.e. industrial, small domestic or large domestic) and mercury source potential. The minimization practices should focus on sources and wastes that originate with and are under the reasonable control of a facility, and not on the pollutants in the rainwater or source water. Furthermore, sources of MeHg or conditions that may lead to the formation of MeHg should be prioritized over the removal of total mercury. The permittee will develop and submit for permit writer review the MMP. Besides providing technical assistance in the development of the MMP, the permit writer will review the MMP to ensure that it will achieve the following results:

- Reduction or elimination of potential sources of MeHg and total mercury within the production process or collection area
- Improved public and business awareness of mercury issues
- Reduction in the transfer of mercury from effluent to the watershed or airshed via biosolids
- Quantification of the effectiveness of the MMP to eliminate or reduce mercury in the discharge

At a minimum, the MMP should include the following:

- Identification and evaluation of current and potential mercury (both MeHg and total) sources
- Identification and evaluations of conditions (i.e. anaerobic conditions) that contribute to the methylation of elemental mercury in the collection and treatment systems
- For POTWs, identification of both large industrial sources and other commercial or residential sources that could contribute significant mercury loads to the POTW
- If applicable, monitoring to confirm current or potential sources of mercury (Monitoring Plan)
- Identification of potential methods for reducing or eliminating mercury, including requiring BMPs or assigning limits to potential industrial and commercial sources of mercury to a collection system, material substitution, material recovery, spill control and collection, waste recycling, process modifications, housekeeping and laboratory use and disposal practices, and public education (Action Plan)<sup>14</sup>
- Identification of potential methods for reducing or eliminating conditions that contribute to the methylation of elemental mercury (Action Plan)

**Figure 1** is an excerpt of the EPA Guidance (Table 6, Page 122) that describes different types of facilities and provides recommendations for the types of minimization plans that are appropriate.

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<sup>14</sup> For example, the Oregon Chapter of the American Dental Association has been a leader in the state on the capture and proper disposal of mercury containing substances.

**Figure 1**

Type of facility	Suggested content
Publicly (or privately) owned treatment works serving a purely residential area. No dental or medical offices or hospitals. No industrial users.	Recommended distribution of outreach materials on fish-consumption advisories and properly disposing of mercury-containing products.
POTW whose service area contains dental offices.	Recommend or require that dental offices follow American Dental Association BMPs. <sup>a</sup> Collect any bulk mercury in the offices. Develop an approach for using amalgam separators.
POTW whose service area contains one or more hospitals.	Recommend or require that hospitals follow the practices recommended by the American Hospital Association. <sup>b</sup>
POTW whose service area contains schools or medical offices.	Recommend or require that schools and medical offices properly dispose of bulk mercury in their possession (including, for example, mercury-containing sphygmomanometers).
Industrial direct or indirect dischargers that use mercury as an intentional component of their process or recover mercury as a by-product of their process.	Generally, such a case would involve a thorough analysis of opportunities to reduce their releases of mercury.
Industrial direct or indirect dischargers that do not use mercury as an intentional component of their process and do not recover mercury as a by-product of their process.	Such facilities should investigate opportunities to reduce their incidental releases of mercury such as recycling fluorescent lamps, switches, thermostats, etc. and replacing them with low-mercury or non-mercury products.
<p><i>Notes:</i></p> <p><sup>a</sup> For more information on the American Dental Association BMPs, see Best Management Practices for Amalgam Waste (September 2005) at <a href="http://www.ada.org/prof/resources/topics/topics_amalgamwaste.pdf">http://www.ada.org/prof/resources/topics/topics_amalgamwaste.pdf</a>.</p> <p><sup>b</sup> For more information on American Hospital Association practices, see Replacing Mercury in Healthcare Facilities—A Step-by-Step Approach at <a href="http://www.h2e-online.org/hazmat/mercguid.html">http://www.h2e-online.org/hazmat/mercguid.html</a>.</p>	

The following sub-sections describe the requirements for the MMP in more detail. *Appendix A* includes a sample format for an MMP with suggested activities that a permittee could include in its plan. *Appendix B* includes important links to MMP guidance and MMPs developed in other states. *Appendix C* includes a series of short discussions regarding common sources of mercury in industrial and commercial settings. *Appendix D* includes a description of the monitoring determination and RPA process flowchart overview of the MeHg implementation process. Applicable permit language is included in the current Permit Template Language located on the Permit Writers Corner of QNET.

## 5.1 Contact information

This section of the MMP should include the following basic contact information from the permit holder:

- Facility (Legal name and address)
- Legal Contact (Name, position, email address, phone number)
- Program Contact (Name, position, email address, phone number)
- Web Link to facilities mercury reduction program, if applicable.

## 5.2 Identification of potential sources of mercury

The permittee should conduct an inventory of potential sources of mercury by reviewing existing information sources and, if applicable, sampling at various points within the collection system. See *Section 4.3.3* of the *RPA IMD* for more information on developing and conducting a source investigation. *Figure 2* describes many of the likely sources of non-industrial, mercury pollution for collections systems and facilities. *Figure 3* describes many of the likely manufacturing processes that actively use mercury in their production processes. *Figure 4* describes many of the likely sources of non-process mercury often found at industrial facilities. Finally, the permit writer should also consider any naturally-occurring sources of mercury such as mine tailings or volcanic soils.

**Figure 2**  
**Consumer and Commercial Products Containing Mercury**

- [Antiques](#)
- [Batteries](#)
- [Dental Amalgam](#)
- [CFLs and Other Fluorescent Light Bulbs](#)
- [Necklaces and other Jewelry](#)
- [Paint](#)
- [Skin-lightening creams](#)
- [Switches and Relays](#)
- [Thermometers](#)
- [Thermostats](#)
- [Thimerosal in Vaccines](#)

Note: Links are to EPA Web page with more specific information. In Oregon, there are requirements for dentists to capture mercury-containing materials and follow the [Oregon Dental Association's Best Management Practices](#).

**Figure 3**  
**Manufacturing Processes That Use or Generate Mercury**

- Chlorine production (Chlor-alkali)
- Portland cement
- Mining – i.e. gold mining
- Caustic soda production
- Sulfuric acid production
- Emissions treatment (wet pack scrubbers)
  - Municipal waste combustors
  - Hospital, medical and infectious waste incinerators
  - Hazardous waste

**Figure 4**  
**Sources of Mercury in Industrial Facilities**

- Auto Brakes
  - ABS Breaking Systems\*
- Auto Switches
  - Hood Lighting\*
  - Trunk Lighting\*
  - Collision Sensors
  - Acceleration sensors for air bags and seatbelts
  - Tilt switches
  - Heated car rear windows
- Batteries
  - Alkaline-manganese batteries
  - Zinc-carbon batteries with mercury added
  - Button cell mercuric-oxide batteries
- Battery chargers
- Bilge Pumps
- Boilers
- CRT's – Cathode Ray Tube
- Central clocks and time clocks
- Circuit breakers
- Cosmetics
  - Dishwashers / Parts Washers (electrical switches)
  - Door bells ("ding-dong")
  - Dyes & Pigments
  - Electronics with Liquid Crystal Display (i.e. cameras, camcorders, etc.)
  - Electrical Distribution Boxes
  - Float switches and level meters
  - Flow meters
  - Freezers (automatic lights)\*
  - Fungicides\*
  - HVAC Equipment
    - Central Air Conditioning Units
    - Gas Ovens – Flame sensor contains mercury
    - Electric Ovens – Flame sensor contains mercury
  - Interlock switches
  - Laboratory Reagents

- Lamps
  - Neon Lights
  - High Intensity Discharge (HID)
  - Mercury Vapor Lights
  - Fluorescent Lamps
  - Metal Halide Lamps
  - High Pressure Sodium Lamps
  - Ultraviolet Lamps
- Lifts for disabled
- Measuring and control instruments
- Microwave Ovens
- Paint Additives (suspended in 1991)\*
- Pesticide Additives\*
- Pesticides\*
- Pharmaceuticals
- Preservative for human and animal medical products – vaccines, etc.
  - “Rubber” Flooring (the type frequently used in gyms and sports facilities in the 1970’s)\*
  - Signal alarms
  - Skylifts (leveling)
  - Solvents
  - Sprinkler Systems (Old)\*
  - Sump Pumps
  - Thermostats
  - Thermometers
  - Time switches/landing switches
  - Transformers (gas-operated relays)
  - Volumeters

\* Mercury is no longer added. Mercury may be found in older materials and goods.

## 5.3 Identification of conditions that promote methylation

The permittee should evaluate its production/treatment process and collection area to identify any conditions that might promote methylation of mercury. Although MeHg is typically a small percentage ( $\leq 1\%$ )<sup>15</sup> of the overall raw sewage load of mercury present in a WWTP influent, its high toxicity and bioavailability present the bulk of environmental health concerns for mercury. Methylation of mercury occurs mainly under anaerobic conditions and is greatly affected by the availability of inorganic mercury, pH, organic matter concentration, microbial activity, redox potential, sulfate concentration and temperature. The methylation of mercury is seasonally/temperature-dependent, with methyl mercury levels likely to increase in summer and fall and decrease in winter and spring. Accordingly, the MMP should consider strategies to minimize the methylation of mercury, along with strategies for the removal or reduction of total mercury.

*Natural Conditions:* In natural ecosystems, the methylation of mercury occurs through the one of the following pathways:<sup>16</sup>

- Biological activity by various species of microorganisms, mainly bacteria
- Chemical reactions in soils or water that may occur through contact with organic matter and humic substances
- Photochemical processes

Mercury methylation is generally thought to be facilitated by sulfate-reducing bacteria, which thrive in organic-rich, anaerobic sediments of many of aquatic systems (e.g., wetland soils, lake sediments). Accordingly, it is widely recognized the wetlands, especially those rich in organic matter and receiving appreciable atmospheric mercury inputs, may be important sites of MeHg production.<sup>17</sup> However, recent monitoring in California<sup>18</sup> has shown that not all wetlands are sources of methyl mercury, and that some wetlands can act as sinks or are neutral in regards to methyl mercury production, emphasizing the point that site specific characteristics and water quality do influence the methylation of mercury in the environment.

*Sewer Collection Area:* Although the majority of MeHg originating in a sewer collection area typically originates from sources such as dental amalgam, chemical production processes or contaminated source waters, the permittee/permit writer should be aware of the processes that may promote methylation when evaluating potential

<sup>15</sup> [San Jose/Santa Clara Water Pollution Control Plant Mercury Fate and Transport Study](#), Tetratech, 2007

<sup>16</sup> [Determination of Methyl mercury in a Pilot-Scale Activated Sludge Wastewater treatment Plant](#), G.D. Pavlogeorgatos, 2006

<sup>17</sup> [Wetlands as Principal Zones of Methylmercury Production in Southern Louisiana and the Gulf of Mexico Region](#), B.D. Hall, 2007

<sup>18</sup> Delta Mercury Control Program Wetland Study, June 25, 2009, California Regional Water Control Board, Sacramento Delta Methyl Mercury TMDL

sources. Of particular interest are scenarios where un-treated surface or groundwaters are used in manner that generally creates reducing conditions in conjunction with high levels of microbial activity.

*Wastewater Treatment:* Some facility studies (San Jose/Santa Clara<sup>12</sup>) have indicated that modern, advanced wastewater treatment plants incorporating activated sludge processes are able to significantly reduce the amount (~85%) of total mercury and MeHg from an effluent stream. Some of the sludge thickening and anaerobic digestion process have the capacity to cause the methylation of mercury, but this is typically offset by the demethylation that occurs during the sludge removal and aeration processes. Other studies<sup>19</sup> that looked at WWTP facilities in the Sacramento River Valley, have indicated that the facilities that use treatment pond systems (oxidation, facultative, settling or stabilization ponds) routinely had higher effluent methylmercury concentrations than the WWTPs that use one or more of the following treatment processes: nitrification/denitrification, filtration, and ultraviolet (UV) disinfection. Accordingly, the MMP should evaluate the current condition and operational practices of the WWTP and, if necessary, incorporate actions that will prevent the development of conditions that would result in methylation (i.e. anoxic or reducing condition). The study of MeHg in wastewater is still a relatively new area of investigation, and as information becomes available revisions to the IMD will be made.

## 5.4 Action Plan

The permittee should incorporate an action plan into their MMP the actions the permit holder intends to implement to reduce mercury, along with associated goals and milestones. The action plan portion of the MMP should include a discussion of each of the following:

- Potential mercury-reduction activities
- Policy measures that could be enacted by a municipality to reduce or eliminate mercury
- Municipal activities designed to encourage businesses and residents to reduce mercury
- Activities that municipal and industrial dischargers can implement internally to reduce mercury

The plan should be tailored to the size of the facility, availability of resources, and the types of mercury sources that may be contributing to mercury in the facility's effluent and stormwater. A smaller POTW may not need as intensive a plan for mercury reduction and monitoring. For example, the city of Holly, Michigan's plan mainly consists of a program that offers homeowners new mercury-free thermometers in exchange for mercury thermometers, as well as collecting and disposing other mercury-containing equipment from homeowners and businesses. In contrast, Superior, Wisconsin's Mercury MMP includes activities involving homeowners, auto shops, camps, dental offices, fluorescent bulb recycling, mercury-free schools, thermostat recycling, and various methods of outreach. The permit writer should work with the permittee to tailor the plan to the specific condition of the source collection area and facility, and ensure that the minimum requirements are met.

In some cases, there may be opportunities to coordinate MMP development with a permittee's Pretreatment Program. Major POTW's with a pretreatment program are currently required to evaluate discharges by significant industrial users and if needed, establish local limits and monitor for a suite of metals, including mercury. In some cases, the department may require (per 40 CFR 403.5 (c)(2)) a POTW to develop a pretreatment program and local limits to address mercury. Some POTWs may select to voluntarily develop a pretreatment program and develop local limits as a measure to assure their compliance with their NPDES permit and biosolids disposal requirements. The local limits may be structured in a manner to allocate available pollutant loadings to specific industrial dischargers. Any data and information gathered from the pretreatment program should be included as part of the MMP. The pretreatment program may serve as a principal element of the MMP, although other sources outside of the industrial scope of the pretreatment program must still be addressed.

An example table with potential activities, goals, and milestones by sector is included in *Table 2*. These actions may range from various pollution reduction efforts (such as switching to less toxic source materials or community

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<sup>19</sup> A Review of Methylmercury and Inorganic Mercury Discharges from NPDES Facilities in California's Central Valley, California Environmental Protection Agency, 2010

education efforts to reduce pollutants from entering a wastewater treatment facility) to installing more effective treatment technologies.

This section also should describe any methods that the permittee may use to engage specific individuals and businesses who would be implementing activities described in the plan, such as schools, HVAC stores, dentists, and others. Activities could include workshops, mailings, public service announcements, partnerships, websites, and more.

#### **5.4.1 Potential mercury-reduction activities to include in an MMP**

*Table 1* lists activities that could be included in an MMP. The permittee, with the assistance of the permit writer, should determine which activities to include in the MMP based upon the inventory of sources and available resources. The table indicates whether the activity could be implemented by industrial dischargers, municipal dischargers, or both, and to what types of facilities they could apply.

##### **5.4.1.1 Policy measures that could be enacted by a municipality**

Municipalities may wish to enact ordinances or policies that would require businesses and/or residents to implement mercury reduction activities. Such ordinances could include:

- Banning improper disposal of mercury-containing products
- Establishing BMP requirements for construction and other activities to reduce erosion
- Adopt zoning ordinances with requirements for reducing impervious surfaces
- Requiring certain organizations to develop and periodically update mercury inventories

##### **5.4.1.2 Municipal activities designed to encourage businesses and residents to reduce mercury**

The MMP for municipal dischargers should include activities designed to encourage recycling and/or removing mercury-containing instruments from homes and businesses (see *Figures 2 & 3* for typical mercury-containing devices). Types of businesses that may be targeted include dental offices (due to mercury amalgam<sup>20</sup>), laboratories at secondary schools and colleges, medical offices and hospitals, HVAC wholesalers and retailers, electronics supply and manufacturing and any industries that discharge into the municipality's sewer system. Examples of activities the plan may include are as follows:

- Promoting and coordinating events to collect mercury-containing devices
- Conducting inspections on proper use, maintenance, and disposal of amalgam separators
- Providing mercury recycling containers for light bulb or battery collection
- Establishing a mercury collection center
- Publishing a website on mercury risks and mercury minimization
- Conducting outreach to organizations that typically have mercury-containing devices, including education on cleanup procedures, spill prevention, and the risk of mercury exposure
- Encouraging exchange of mercury-containing devices for non-mercury containing devices (for example, providing non-mercury thermostats at cost)
- Mailing BMP literature to facilities that typically have mercury-containing devices
- Conducting onsite visits to businesses, schools, hospitals, and construction sites to perform education, verify BMP implementation and identify mercury containing devices.
- Encouraging businesses to conduct inventories of mercury-containing devices.

##### **5.4.1.3 Activities that municipal and industrial dischargers can implement internally**

Some activities are more applicable to internal operations. For example, both POTWs and industrial dischargers should commit to conducting an internal inventory of mercury-containing devices and identifying ways to eliminate or minimize the use of such devices. Monitoring of influent, effluent, biosolids (as already required), and the collection system also should be included as part of the plan, as appropriate.

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<sup>20</sup> Oregon legislation already requires amalgam separators for any dental offices that use amalgam. However, municipalities may wish to have an inspection program or outreach program to dental offices to ensure that amalgam separators are properly maintained.

**Table 1**  
**Potential mercury reduction activities and applicability to different sectors**

<i>Activity</i>	<i>Type of permittee</i>		<i>Applicable to the Following Sectors</i>						
	<i>Muni</i>	<i>Industrial</i>	<i>General</i>	<i>HVAC</i>	<i>Dental Facilities</i>	<i>Medical Facilities</i>	<i>Construction</i>	<i>Schools and Colleges</i>	<i>POTWs</i>
<i>Ban disposal of mercury-containing products</i>	x								
<i>Establish local limits or BMP requirements</i>	x		x	x	x	x	x	x	x
<i>Mercury collection and recycling events</i>	x		x	x		x		x	
<i>Establish a mercury-collection center</i>	x								
<i>Internal mercury inventories</i>	x	x	x	x	x	x		x	x
<i>Replace mercury-containing products with non-mercury containing products</i>	x	x	x	x	x	x		x	x
<i>Education regarding mercury spill cleanup and risks of mercury exposure</i>	x	x	x	x	x	x	x	x	x
<i>Mail BMP literature</i>	x			x	x	x	x	x	
<i>Outreach activities, such as:</i> <ul style="list-style-type: none"> <li>• Promoting mercury recycling events.</li> <li>• Displays at community events</li> <li>• Public service announcements</li> <li>• Establish a mercury website.</li> </ul>	x		x						
<i>Onsite visits to verify BMP implementation and identify mercury containing devices</i>	x		x	x		x	x	x	
<i>Evaluation of wastes hauled to POTWs and/or landfills</i>	x								x
<i>Influent and effluent monitoring</i>	x	x							x
<ul style="list-style-type: none"> <li>• Identification and evaluations of conditions (i.e. anaerobic conditions) that contribute to the methylation of elemental mercury</li> </ul>	x	x							x

## 5.5 Monitoring Plan

The permittee should incorporate a monitoring plan into their MMP that describes how they plan to quantify the sources of mercury and monitor progress in achieving the stated goals<sup>21</sup> in the program plan. Ideally, any monitoring should be coordinated with any other permit characterization or compliance monitoring to allow for convenience and a more robust dataset. There are potentially four components that the monitoring plan needs to consider:

- Source Investigation: Monitoring to confirm current or potential sources of mercury
- Performance Monitoring: Effluent monitoring to verify the effectiveness of pollution minimization efforts
- Pretreatment Program Monitoring: Source and Influent monitoring to develop and demonstrate compliance with local limits (if applicable)
- Biosolids Monitoring: When required by a DEQ-approved Biosolids Monitoring Plan, monitoring to quantify the loading rates of mercury onto the application area

The first part (source investigation) of the plan should occur as part of the Tier 2 permit renewal monitoring and address the identification of the potential sources of mercury and, if necessary, their quantification through monitoring or knowledge of process. Often times there are readily available sources of monitoring data or information such as drinking water databases, DEQ or USGS water quality data, or pretreatment program information that can be used. Understanding the source, transport and chemical speciation of the mercury will heavily inform the scope of reduction/elimination efforts and any subsequent performance monitoring. Remember, that if it can be demonstrated that the facility or collection area is not contributing to the mass load of mercury to the effluent, further action need not be required. Please refer to *Section 4* of the *RPA IMD* for many of the database links previously discussed and further discussion of conducting a source investigation. Additionally, EPA Region 5 has developed an excellent guidance document entitled *Mercury Pollutant Minimization Program Guidance*<sup>22</sup> that is primarily geared for larger Publicly Owned Treatment Works (POTWs).

The second part (performance monitoring) of the plan should be a reflection of the information developed as part of the source investigation and the BMPs selected to address the mercury. Since each plan will vary with the type, size and sophistication of the facility and collection area, the monitoring requirements can also vary from the minimum Tier 1 requirements (4 samples in 2 years) to on-going influent and effluent testing and biosolids monitoring (per Biosolids Management Plan). In addition to sampling the influent and effluent, the permittee may wish to monitor the collection system (or require pretreatment monitoring) to determine the extent to which they've reduced or eliminated mercury. For example, permittees could survey schools to determine the extent to which they've gone "mercury-free" by replacing mercury thermometers with alcohol-based thermometers, replaced mercury in laboratories with mercury-free chemicals, report out on how many pounds of mercury collected and properly disposed of and/or are recycling mercury-containing fluorescent light bulbs. Monitoring may also include spot-testing or random sampling to verify that sources are reducing mercury use. POTWs should also consider determining the baseline level of BMP implementation for various sectors, which may be important in establishing the potential mercury load reductions for these sectors.

**Pretreatment Program:** Typically a POTW's pretreatment program will have monitoring requirements for the facility and industrial sources in the collection area. These monitoring requirements should be included as part of the MMP and the data results should be used to quantify mass loading rates, source reductions and BMP effectiveness.

Biosolids are regulated under DEQ's water quality program, specifically through a National Pollutant Discharge Elimination System permit, a biosolids management plan and site authorization letters. The permit, management plan, and site authorization letters are specific to a facility and include conditions that are relevant to both state and federal biosolids regulations. Facilities are required to monitor pollutant metals (including mercury) and submit the

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<sup>21</sup> *Quantifying the effectiveness of the MMP to eliminate or reduce mercury in the discharge*

<sup>22</sup> U.S. EPA Region 5, NPDES Program Division. "Mercury Pollutant Minimization Program Guidance." November 2004.

collected data in an Annual Biosolids Report. Ideally, the data collected as part of the facility's biosolids program plan should be integrated into the MMP to help determine the relative effectiveness of the selected actions and BMPs.

## 5.6 Summary of mercury-reduction activities already implemented

The permittee should provide a history of mercury reduction activities along from the preceeding permit cycle. If possible, this section should include information about the amount of mercury that has been recycled and/or removed from the effluent stream and environment.

## 5.7 Monitoring Data

The permittee should include, at a minimum, the following information:

- If available, a summary of any available influent and effluent mercury concentrations data collected (i.e. DMR, priority pollutant scans, SB 737, etc.), at minimum, during the preceding permit cycle.
- A summary of biosolids monitoring data from the preceding permit cycle<sup>23</sup>. Data should include biosolids mercury concentrations and mass loads in the biosolids.
- A summary of applicable pretreatment monitoring data

## 6. Record Management

The permit writer should document Tier 1, Tier 2 and any additional total mercury monitoring results, and decision rational in the *Permit Evaluation Report*. The permit writer should maintain copies of all supporting analytical reports, approved MMPs, compliance reports and correspondence with permittee in the *Permit File* in accordance with the agency record retention policies.

## 7. Revision History

Revision	Date	Changes	Editor
1.0	1/08/12	Initial Publishing	Spencer Bohaboy

<sup>23</sup> DEQ's biosolids program already requires monitoring for total mercury, which is sufficient to meet this requirement.

# Appendix A. SAMPLE Template Mercury Minimization Plan

Example Mercury Minimization Program Plan			
<p><b>Name and Address of Facility:</b></p>   <p><b>Legal Contact, including phone number:</b></p>   <p><b>Technical Contact, including phone number:</b></p>			
Source Inventory (Add rows as needed)			
Name of Source	Address	Contact Information	Sector
Example Mercury Minimization Action Plan			
Sector	Example Activities	Example Performance Measures	Example Goal
<b>Dental clinics</b>	<ul style="list-style-type: none"> <li>- City will conduct inspections of all dental facilities with amalgam separators at least once every three years to ensure proper maintenance.</li> </ul>	<ul style="list-style-type: none"> <li>- % inspections meeting maintenance requirements</li> </ul>	<ul style="list-style-type: none"> <li>- Eliminate mercury discharges from dental facilities.</li> </ul>
<b>Medical clinics, hospitals, nursing homes, veterinarians</b>	<ul style="list-style-type: none"> <li>- City will mail AMA BMP literature to all medical clinics in city, as well as pamphlet regarding alternatives to mercury-containing devices.</li> <li>- City will partner with medical clinics to hold at least one inventory and collection event during permit cycle.</li> </ul>	<ul style="list-style-type: none"> <li>- Date/content of literature sent</li> <li>- Quantity mercury recycled/removed</li> </ul>	<ul style="list-style-type: none"> <li>- Capture and recycle all mercury generated and used.</li> <li>- Eliminate mercury discharges</li> </ul>
<b>Secondary Schools</b>	<ul style="list-style-type: none"> <li>- City will mail <a href="#">BMP literature</a> to school district.</li> </ul>	<ul style="list-style-type: none"> <li>- Date/content of literature sent</li> </ul>	<ul style="list-style-type: none"> <li>- 100% mercury-free schools</li> </ul>



## Appendix B: Useful Links

ODEQ's Mercury Reduction Strategy:

<http://www.deq.state.or.us/lq/pubs/docs/MercuryReductionStrategy.pdf>

The Environmental Council of the States (ECOS) Quicksilver Caucus:

[http://www.ecos.org/section/committees/cross\\_media/quick\\_silver](http://www.ecos.org/section/committees/cross_media/quick_silver)

ECOS Quicksilver Caucus: Mercury Added Products:

[http://www.ecos.org/files/4494\\_file\\_Mercury\\_Added\\_Product\\_White\\_Paper\\_formatted\\_final\\_with\\_MS\\_changes.pdf](http://www.ecos.org/files/4494_file_Mercury_Added_Product_White_Paper_formatted_final_with_MS_changes.pdf)

U.S. EPA Region 10 Mercury Website:

<http://yosemite.epa.gov/R10/HOMEPAGE.NSF/abedd4842d006a6e88256f5f00697f3e/f60e8f81c53471ed88256eef00747a17>

U.S. EPA Region 10 Mercury Strategy:

[http://yosemite.epa.gov/R10/HOMEPAGE.NSF/abedd4842d006a6e88256f5f00697f3e/f60e8f81c53471ed88256eef00747a17/\\$FILE/R10MercuryStrategy2008.pdf](http://yosemite.epa.gov/R10/HOMEPAGE.NSF/abedd4842d006a6e88256f5f00697f3e/f60e8f81c53471ed88256eef00747a17/$FILE/R10MercuryStrategy2008.pdf)

U.S. EPA Region 5, NPDES Program Division. "Mercury Pollutant Minimization Program Guidance." November 2004. ([http://www.epa.gov/reg5oh2o/npdestek/pdfs/2004mercury\\_pmp\\_guidance.pdf](http://www.epa.gov/reg5oh2o/npdestek/pdfs/2004mercury_pmp_guidance.pdf))

Wisconsin Department of Natural Resources. "Mercury Pollutant Minimization Program Guidance Manual For Municipalities." DNR PUB-WT-831. 2006.

(<http://www.ci.superior.wi.us/DocumentView.aspx?DID=126>)

Georgia Pacific LLC, Crossett Paper Operations. Mercury Pollutant Minimization Program. Revised November 8, 2011.

([http://www.adeq.state.ar.us/ftproot/Pub/WebDatabases/PermitsOnline/NPDES/Tech/AR0001210\\_Mercury%20Minimization%20Plan%20Update\\_20111114.pdf](http://www.adeq.state.ar.us/ftproot/Pub/WebDatabases/PermitsOnline/NPDES/Tech/AR0001210_Mercury%20Minimization%20Plan%20Update_20111114.pdf))

Mercury Policy Project: <http://mercurypolicy.org/>

Other websites describing municipal MMP efforts:

- [Appleton, Wisconsin](#)
- [Green Bay Metropolitan Sewer District](#)
- [Hibbing, Minnesota](#)
- [Madison, Wisconsin](#)
- [Central Contra Costa Sanitation District, California, School Mercury Program](#)

Oregon Dental Association's website on dental amalgam.

(<http://www.oregondental.org/i4a/pages/index.cfm?pageid=3542>)

## Appendix C: Common Sources of Mercury

Some common uses for mercury are to conduct electricity, measure temperature and pressure, act as a biocide, preservative, and disinfectant, as well as a catalyst for reactions. Within industry there are all possible types of mercury products installed in distribution boxes, electrical surrounding equipment, boiler rooms, sumps, machinery, measuring instruments, etc. The following provides a brief summary of mercury use in specific industrial products and sources.

### Auto Switches

Mercury switches in Hood and Trunk Lighting, Collision Sensors

### Automobiles

Automobile truck and hood light switches often contain mercury. If the light goes on when the lid is partially up, or if you can see that the bulb housing is deliberately mounted at an angle to the hood, a mercury switch is probably being used. A variety of manufacturing processes use relays to control power to heater or pumps. Relays that contain mercury switches activate: airbags, anti-lock brakes (primarily found in four-wheel drive vehicles), some seat belt systems, and some automatically adjusting suspension systems. Some agricultural equipment, military vehicles, mass transit vehicles, and fire hook and ladder equipment also contain [mercury switches](#).

### Batteries, Mercury-containing

The mercury containing batteries provide a compact and precise voltage source to power metering electronics. Mercuric oxide (mercury zinc) batteries and button batteries are the only batteries made in the United States that may contain added mercury. Mercuric oxide batteries offer a reliable and constant rate of power discharge and can be made in a wide variety of sizes intended for use in electronic devices. New equipment models generally require zinc air batteries. The shelf life of mercuric oxide batteries is up to ten years.

### Bilge Pumps

The float switches within the bilge pump may contain mercury.

### Boiler rooms

Small boiler rooms often contain tube thermometers and other thermometers. Oil level gauges for remote measurements are also common.

### Combustion Sources - Boilers

Combustion sources include utility boilers, medical waste incinerators, municipal waste combustors, commercial/industrial boilers, hazardous waste combustors, residential boilers, wood combustion, sewage sludge incinerators and crematories. Mercury emissions from these sources (excluding wood-fired residential heaters) account for an estimated 125 Mg/yr (138 ton s/yr) or 87 percent of the mercury emissions generated annually in the United States.

### CRTs

Mercury is contained within the fluorescent tubes that provide the source of light in the Liquid Crystal Displays (LCD). Mercury is used the LCD backlights.

No mercury is required in CRT fabrication. Although the quantities of mercury are not large, they cannot be discounted given the toxicity of mercury to both human health and the environment.

### Cosmetics

Historically mercury has been added to cosmetics as a skin whitening additive. Today, the use of mercury compounds as cosmetic preservative ingredients is limited to eye area cosmetics at concentrations not exceeding 65 parts per

million of mercury calculated as the metal (about 100 ppm or 0.01% phenylmercuric acetate or nitrate) and provided no other effective and safe preservative is available for use. Mercury compounds are readily absorbed through the skin on topical application and have the tendency to accumulate in the body. They may cause allergic reactions, skin irritation or neurotoxic manifestations."

#### **Dishwashers / Parts Washers (electrical switches)**

Temperature gauges and various mercury containing switches are installed in industrial parts washers.

#### **Distribution boxes and electric installations**

Mercury is often found in relays located in distribution boxes in buildings, e.g. for regulating stair lights.

#### **District heating plants and furnace rooms**

Large housing estates and industrial areas often have a central heating plant with flue-gas meters, tube thermometers, thermostats, pressure switches, oil level gauges, flow meters, etc.

#### **Drains and old waste pipes**

In dental surgeries and other premises where mercury is used, amalgam and metallic mercury can have collected in waste pipes, leaching mercury into the sewerage.

#### **Dyes & Pigments**

Mercury sulfide has been incorporated into organic pigments used to make paints and inks. The mercury is primary found in the red (vermilion) color family.

#### **Electronics**

Printed circuit cards in electrical components in machinery and equipment can contain mercury. Companies specializing in dismantling electronic equipment will handle this in an environmentally safe way.

#### **Float Switches and Level Meters**

Float switches are used in sump pits, factories and sewage plants to maintain a given level of liquid. The float switch is a round or cylindrical float with a switch attached to it. The switch keeps the circuit closed until the float reaches a certain height. Then, the mercury slides down, opening the circuit and shutting off the pump.

#### **Flow Meters**

Flow meters are used for measuring liquid (water, product) flow. Some flow meters contain large quantities of mercury - 5 kilograms and more.

#### **Freezers**

Freezers and refrigeration equipment may have mercury switches in the internal lid light within the light socket. If a chest freezer has a light in the cover and no visible mechanical switch, then it contains a mercury switch. This device senses when the lid is raised and turns on the light.

#### **Fungicides**

At one time mercury chloride was one of the active ingredients used in fungicide chemicals.

#### **Gauges: Manometers, Barometers, & Vacuum Gauges**

Many barometers and vacuum gauges found in machinery contain mercury. Liquid mercury in the gauges responds to air pressure in a precise way that can be read on a calibrated scale. Several mercury-free alternatives are available. Some operate on the same principle as mercury gauges but use mercury-free liquids in the tube.

Needle or bourdon gauges operate under a vacuum with a needle indicator. Electronic gauges can be used to measure pressure, but they must be calibrated with a mercury manometer. Equipment manufacturers recommend that service

technicians use a needle or digital gauge to test the systems they are servicing, but that they calibrate the gauges they use in the field with a mercury manometer kept at their shop.

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

### **Heating & Ventilation equipment (A/C)**

Here you can find manometers, thermostats, thermometers, relays, etc. containing mercury.

Flame sensors in furnaces may contain mercury. The metal flame sensor consists of a metal bulb and thin tube attached to a gas-control valve. The mercury is contained inside the tube and expands or contracts to open and shut the valve.

Gas meters installed before 1961 contain a mercury regulator attached to the gas meter.

Several types of gas-fired appliances that have pilot lights, like ranges, ovens, clothes dryers, water heaters, furnaces, and space heaters use mercury-containing flame sensors.

### **Interlock Switches**

Mercury switches consist of a mercury filled tube with electrodes at each end. 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. They often function as on/off switches.

### **Industrial Chemicals**

Caustic Soda

The majority of sodium hydroxide (caustic soda) is commercially produced through electrolytic cell processing. The balance is produced through chemical processes. The electrolytic cells used to make the caustic soda contain mercury.

### **Laboratory Reagents**

Mercury is used as a preservative in laboratory reagents and related chemicals. In laboratories, hospitals, and schools mercury has been used as a reagent for different analyses, as well as in thermometers and other measuring instruments.

### **Lamps - Fluorescent & High-Intensity Discharge (HID) Lamps**

Fluorescent and HID lighting is an excellent business and environmental choice because they can use up to 50 percent less electricity than incandescent lighting. However, used fluorescent lamps, mercury vapor lamps, metal halide lamps, high pressure sodium lamps, and neon lamps must be managed properly because they contain mercury. Some HID lamps may also be hazardous due to lead content, primarily due to the use of lead solder.

Disposal Options for Mercury Containing Lamps:

Businesses should manage and dispose of mercury-containing lamps as universal wastes, for which the regulatory requirements are much simpler than hazardous wastes.

Mark the lamp storage area with the words "Fluorescent lamps for recycling". Do not break or crush lamps because mercury may be released. If lamps are accidentally broken, store them in a sealed container. Pick up spilled powder and add it to the sealed container. Arrange with a lamp transporter to pick them up.

### **Lifts for Disabled**

Various electrical switches contained in the lift mechanism contain mercury.

### **Machinery and equipment**

A number of types of machinery and equipment can contain mercury, e.g. level indicators in skylifts and mobile ladders, industrial welding equipment, forestry machinery, gas-operated relays in transformers, manufacturing machinery, etc.

Mercury switches are found in a variety of items ranging from chest freezers to sump pumps. Mercury-containing tilt switches are found in or under the lids of clothes washers and chest freezers. They stop the spin cycle or turn on a light. They are also found in motion sensitive and position-sensitive safety switches in clothes irons and space heaters. If a mechanical switch is not visible in these items, a mercury switch is probably being used. Float switches are commonly used in sump pumps and bilge pumps to turn the equipment on and off when the water is at a certain level. These switch devices are often visible.

### **Measuring & Control Instruments**

In a mercury or alcohol thermometer the liquid expands as it is heated and contracts when it is cooled, so the length of the liquid column is longer or shorter depending on the temperature. Modern thermometers are calibrated in standard temperature units such as Fahrenheit or Celsius.

### **Paint Additives**

Mercury sulfide has been incorporated into organic pigments used to make paints and inks. The mercury is primary found in the red (vermilion) color family. (Suspended in 1991)

### **Pesticides**

Methyl mercury is a key ingredient in pesticides and fungicides used to treat grains and seeds.

### **Pharmaceuticals**

Mercury is used as a preservative for human and animal medical products, i.e. vaccines, etc.

### **Rubber Flooring**

The type frequently used in gyms and sport facilities in the 1970's. Rubber flooring installed in gymnasiums during the early 1970s contained a mercury catalyst (i.e. 3M Brand Tartan Track, and other brands).

### **Thermostat Probes**

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

Mercury thermostat probes, also known as flame sensors or gas safety valves, are most commonly present as part of the safety valve that prevents gas flow if the pilot light is not lit. In this application the bulb of the thermostat probe projects into or near the pilot light. These are commonly present in gas ovens and may be present in any other appliance with a pilot light. A mercury thermostat probe may also be present as part of the main temperature-controlling gas valve. In this application, the probe is in the air or water that is being heated and is not directly in contact with any flame. These are typically found in older ovens, clothes dryers, water heaters, and space heaters.

### **Skylifts**

Level indicators switches containing mercury in skylifts

### **Sprinkler Systems (Old)**

Many of the pressure gauges on these older systems contain mercury.

### **Sumps and tanks**

In low-lying areas in buildings, for example, you may find pumping equipment regulating the water level with sender level switches that can contain mercury. Tanks and cisterns can also have switches containing mercury.

### **Switches** – Tilt switches, volumeters, time switches, landing switches

Mercury is contained in temperature-sensitive switches and mechanical tilt switches. Mercury tilt switches are small tubes with electrical contacts at one end of the tube. As the tube tilts, 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. Reed switches are small circuit controls that are used in electronic devices. Their electronic contacts are wetted with mercury to provide an instantaneous circuit when the switch is closed and then an instantaneous current interruption when the circuit is broken.

### **Thermostats, Thermometers**

Mercury-containing tilt switches have been used in thermostats in homes and offices for more than 40 years. They provide accurate and reliable temperature control, require little or no maintenance, and do not require a power source. However, each switch contains approximately 3 grams of mercury.

Mercury-free thermostats are available. Electronic thermostats, for example, provide many of the same features as mercury thermostats. Both types can be programmed to lower room temperatures at pre-set times. This results in fuel cost savings and the environmental benefits from burning less fuel.

### **Transformers**

Mercury arc rectifiers within electrical transformers operate based on an arc between a pool of mercury and a metal anode that only allows current to pass in one direction. Multiple anodes are typically used, fed from a multiple-phase transformer, the arc jumping from the cathode pool to each anode in sequence. There may be three, six or even twelve transformer phases, each feeding one anode.

# Appendix D: Monitoring Determination and RPA Process Overview

