U.S. Environmental Protection Agency

Great Lakes Toxics Reduction

Reducing Mercury Use in Healthcare Promoting a Healthier Environment

A How-To-Manual

The purpose of this manual is to help hospitals start mercury pollution prevention programs or accelerate programs that have already begun. New federal regulations greatly reduce the amount of mercury that is allowed to be discharged from a municipal wastewater system or an incinerator. By implementing the best management practices described in this manual, you can reduce the level of mercury in the environment and avoid the need for increased regulations in the years to come.

The manual offers general guidance on how to initiate a program and technical guidance for implementing the program. The manual includes:

- Information about mercury and its impact on people and the environment (Chapter 1)
- Overview of pollution prevention strategies (Chapter 1)
- How to start a mercury pollution prevention program in your hospital (Chapter 2)
- How to monitor your program, educate staff and measure success (Chapter 2)
- Alternatives for mercury-containing products (Chapter 3)
- Best management practices for handling, recycling and disposing of mercury-containing products still in use (Chapter 3)
- Contacts for further information, case studies and other information (Appendices)

Available in full as Adobe Portable Document files, suitable for printing

Reducing Mercury Use in Health Care
Promoting a Healthier Environment

Background on Mercury

Mercury is a toxic metal that occurs naturally in the environment. There are both inorganic forms and organic forms of mercury. Many of the forms of mercury circulate in the environment, moving from land or water to air and back again, and the forms of mercury may change from one to another as they circulate.

Human activities significantly redistribute mercury and release it into the environment. They allow mercury that was formerly unavailable to the biosphere to be mobilized and carried to new areas via air and water. In the water or soil, microorganisms can convert inorganic mercury into a more toxic organic form, methylmercury. Fish take in methylmercury from their diet and from water passing over their gills. They bioaccumulate the methylmercury in their bodies because the rate of intake of methylmercury is much greater than its elimination. Methylmercury bioaccumulates in the tissues of a fish throughout its lifetime. It can build up to high levels in predator fish at the top of the aquatic food chain -- levels that are tens of thousands to millions of times above the level found in the surrounding water. Fish with high levels of methylmercury may be caught and consumed by humans, waterfowl or other wildlife.

Health Impacts of Mercury Exposure

All forms of mercury are toxic to humans, but the various forms of organic and inorganic mercury have different toxicity. Generally, organic forms are much more toxic than inorganic forms.

The organic forms of mercury are primarily neurotoxins. Therefore exposure can damage the brain and nervous system. The developing brain of a fetus or child is especially vulnerable to organic mercury exposure. Inorganic forms of mercury primarily affect the kidney, but are also neurotoxins. Other organs and systems of the body can be harmed by exposure to mercury.

A human can be exposed to mercury via all three routes of exposure: inhalation, ingestion, and dermal. The most likely routes of exposure are inhalation of inorganic mercury vapor after a spill or during a manufacturing process, or ingestion of methylmercury from contaminated fish. The fetus of a mother who eats contaminated fish can be exposed to methylmercury via the mother's blood, and an infant can be exposed by ingestion of breast milk. Mercury cannot be removed from fish before they are eaten because methylmercury accumulates in the muscle, not the fat. Most of the states in

the U.S., including New York State, issue cautionary advisories about eating the fish caught in some of their waterways because of the presence of mercury. These advisories represent conservative measures to protect human health.

Mercury in Medical Facilities

The following lists show some of the common uses of mercury that may be found in hospitals.

Medical uses:

- Thermometers
- Sphygmomanometers (blood pressure monitors)
- Esophageal dilators (also called bougie tubes)
- Cantor tubes and Miller Abbott tubes (used to clear intestinal obstructions)
- Feeding tubes
- Dental amalgam
- Laboratory chemicals (fixatives, stains, reagents, preservatives)
- Medical batteries

Nonmedical uses common in medical settings:

- Cleaning solutions with caustic soda or chlorine that were contaminated with mercury during the production process
- Batteries
- Fluorescent lamps and high-intensity lamps
- Non-electronic thermostats
- Pressure gauges
- Some electrical switches used for lights and appliances

More complete lists can be found in Appendix A and Appendix B. There is minimal risk of mercury exposure during normal use of products that are handled correctly. However, problems may occur if the mercury in a product is exposed to air, or if a product is not properly discarded so as to keep mercury out of the environment.

Mercury Pollution Prevention

Concerns about the health impacts of mercury are leading to mercury pollution prevention programs at the federal, state and local levels. The highest priority of any pollution prevention program is source reduction, which means not using mercury in the first place.

For example, some states have banned the deliberate use of mercury in certain products for which alternatives are available.

When adequate mercury alternatives are not avail able and mercury must be used, it may be possible to recycle it. Recycling is the second priority of mercury pollution prevention. Disposal of mercury should be the last resort. It is expensive and increases the potential of mercury being dispersed into the environment.

Pollution prevention programs are driven by voluntary efforts and by increasingly strict federal and state regulations. Some of the regulations govern occupational exposures and waste disposal. Other regulations result from the federal Clean Air Act Amendments of 1990. The 1995 federal Great Lakes Water Quality Guidance (also referred to as the Great Lakes Initiative) sets strict water quality standards for mercury in the eight Great Lakes States. (For contacts for regulatory information, see Appendix C.)

Best Management Practices (BMPs) for the management of mercury within hospitals might involve:

- Use of alternatives for products that contain mercury
- Recycling of mercury-containing products when they can no longer be used
- Correct handling and disposal of mercury,mercury-containing equipment and laboratory chemicals
- Proper cleanup of spills involving mercury
- Hospital policies that support BMPs

The BMPs are intended to result in the greatest reduction in mercury discharge to the environment that is currently feasible for hospitals.

Benefits of Mercury Pollution Prevention

Mercury pollution prevention in the hospital provides many benefits:

- Protection of human health and wildlife by reducing occupational exposures and releases of mercury to the air, water and land from wastewater discharges, spills, landfilling or incineration
- Avoidance of the costs associated with the use of mercury, such as disposal or recycling, collection and storage prior to disposal, paper work for tracking hazardous waste disposal, training and equipment for spill response, training for hospital employees who handle mercury-containing products, and liability for environmental problems or worker exposure
- Avoidance of increased regulation in the future
- Increase in the public's awareness about the dangers of mercury through publicity about the hospital's program

- Enhancement of the positive public image of the medical facility due to publicity about success stories

Last updated on Wednesday, September 3rd, 2003
URL: file:///F:/webserver/wwwroot/ref/19/18076.htm

Introduction

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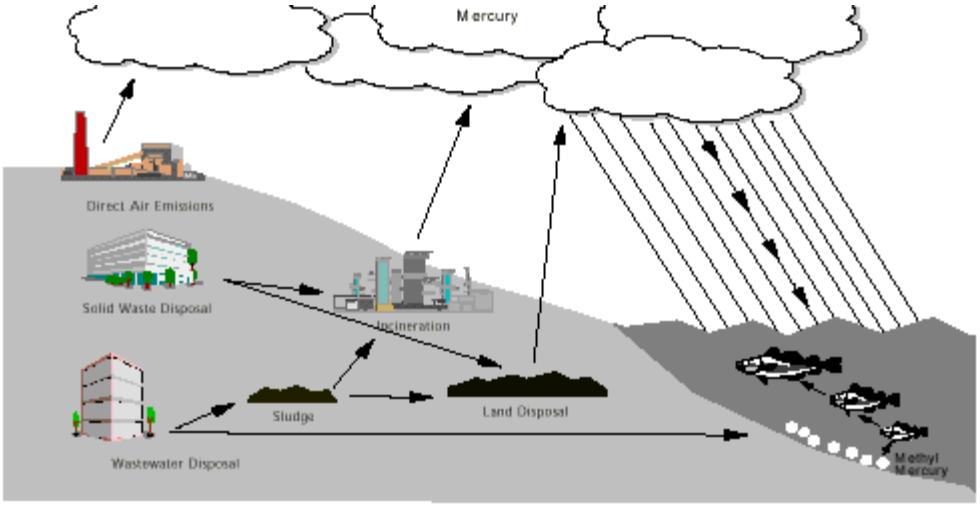
* *Words in italics are defined in the Glossary (Appendix Q).*

Figure 1. Mercury Transport and Bioaccumulation



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How to Establish Mercury Pollution Prevention in Your Hospital

Get Started

(See the flow chart on the following page that corresponds with this section.)

Get support from the top

Support from the hospital's Chief Executive Officer (CEO) is one critical factor in ensuring the success of a mercury pollution prevention program. A first step should be to communicate with the CEO on the benefits of such a program and to request support. A partial listing of program benefits to use in communicating with the CEO is shown in *Appendix D*. When communicating with the CEO, it is important to be clear how the CEO can help. CEO designation of highly respected, knowledgeable individuals to be responsible for policy and operational leadership roles is one important action for the CEO.

Identify and involve staff

The CEO should designate one or more project leaders, including:

- A person to be responsible for developing mercury pollution prevention policy and confirming implementation. The CEO may choose to accept this role or may designate another who is familiar with the workings of the entire hospital and the procedures for approval of policy.
- A person to be responsible for implementing the program. This should be a mercury pollution prevention "champion" who will be enthusiastic about the program and will be dedicated to it. He or she may well be the one who proposed mercury pollution prevention in the first place and who approached the hospital's administration about it. The implementor is often a staff member who is involved in hazardous waste and medical waste management as part of his or her job.

Because mercury appears in so many different locations in a hospital, it takes a team effort to reduce or eliminate its use. The project leaders described above should select a contact from each department who will help to build support for the program and who has the authority to make changes in the department. It may be time-efficient to hold a "kick-off" meeting to introduce the mercury pollution prevention program. However, it would not be necessary to hold meetings as long as the program leaders effectively communicate the objectives of the program to each person who will be involved, and maintain communication until the mercury pollution prevention program has reached its goal.

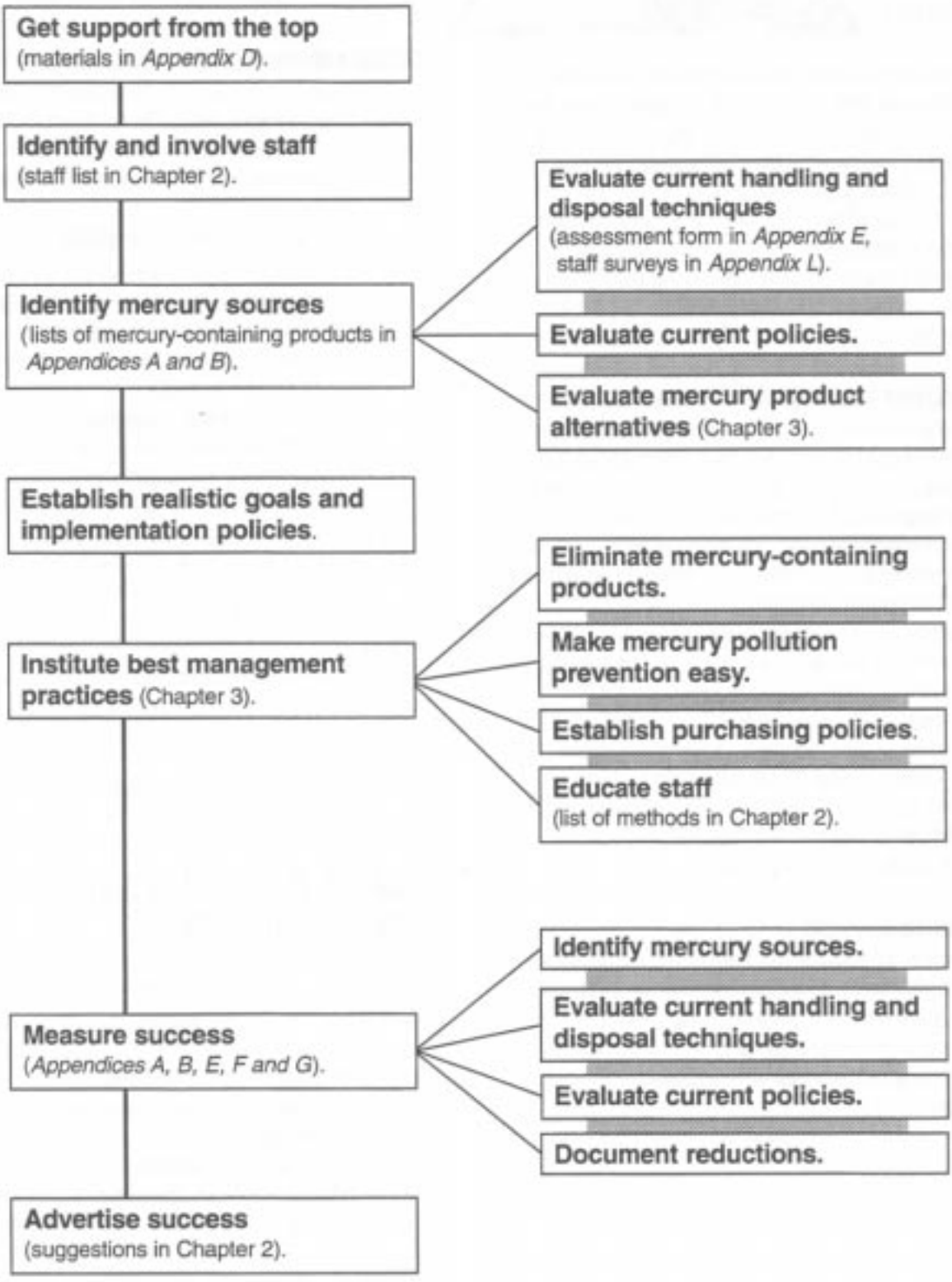
Staff persons that should be directly involved are those with the following functions:

Administrator/policy leader
Safety officer
Champion/implementor
Purchasing officer
Nurse
In-service educator/trainer
Laboratory manager
Maintenance/facilities manager
Engineer
Housekeeping manager
Hazardous waste management coordinator
Supply manager

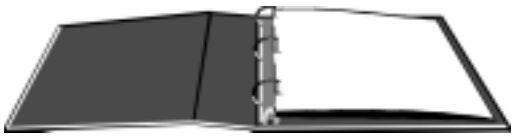
(Note that titles of hospital personnel vary considerably from hospital to hospital.)

All employees of the hospital need to be informed about the program, including employees at off-site locations.

Figure 2. How to Establish Mercury Pollution Prevention in Your Hospital



Gather Data



Identify mercury sources

The first task of the implementor is to create a baseline assessment from which progress can be measured. The department contacts should assist in this effort. Use the checklist of possible mercury-containing products (see *Appendix A*) and/or the checklist of categories of possible mercury-containing laboratory chemicals (see *Appendix B*) as guidelines. The department contacts should perform an audit of all uses and sources of mercury in their own departments.

Evaluate current handling and disposal techniques

The program implementor, with the assistance of department contacts, should assess the status of current hospital practices for handling mercury and staff knowledge about mercury sources and spill prevention and management. (See *Appendix E* for a form for recording your hospital's baseline assessment and four yearly updates.)

If possible, wastewater sample results should be included in the baseline assessment. If the hospital does not currently sample wastewater, work with the hospital's wastewater regulator to learn what data is available or may be collected. Total discharges of mercury in pounds should be calculated. Total discharges are a better indicator of the hospital's impact on the environment than concentration. (See *Appendix F* for further information.)

Evaluate current policies

Department contacts can help to consolidate the hospital's policies that pertain to mercury such as:

- Handling of mercury-containing products
- Mercury spill management
- Recycling or disposal of mercury-containing products
- Purchase of alternatives to mercury-containing products

Policies that address hazardous materials management and laboratory chemical management may be pertinent to mercury, even though mercury may not be mentioned specifically. Hospital policies may be collected by either of the two project leaders.

Evaluate mercury product alternatives

Use the information in Chapter 3 to learn more about mercury-free substitutes for the mercury sources noted on your baseline assessment. Hospital suppliers can also assist you in finding mercury-free alternatives.

Questions to ask when comparing a mercury-containing product and a mercury-free substitute include:

- Is the performance of the substitute as good as the mercury-containing product?
- If the performance is not as good, is it adequate for the purpose?
- What are the costs for purchase? For calibration (if applicable)? For accessories? For maintenance? For disposal?
- Is added cost offset by lower handling, disposal and liability costs?
- Does the substitute introduce new problems for maintenance, handling or disposal?

(For examples of cost/savings worksheets, see *Appendix G*.)

Once a decision has been made to introduce a substitute, it can be decided how to implement the substitution. Some hospitals replace mercury-containing products all at once. Some make substitutions gradually, replacing mercury-containing products when they become unusable.

Establish Realistic Goals and Implementation Plans

The long-term goal of the hospital may be to eliminate the use of mercury entirely. This is true pollution prevention. It will be easier and more satisfying to measure success if the hospital also develops short-term goals, such as eliminating the use of mercury sphygmomanometers within two years. The project leaders should get the support of the CEO for the goals and create a comprehensive plan that lays out how the hospital will achieve its mercury-free status. Contacts from the departments should be key players in

establishing the plan. Key components of the plan could include:

- Best management practices (see Chapter 3)
- Policies for the medical departments, the purchasing department and the waste management department
- Training and continuing education programs for staff and administrators
- A process to review progress regularly

Institute Best Management Practices

Obtain the CEO's stamp of approval for all of the best management practices that are selected to become part of the hospital's mercury pollution prevention program.

Eliminate mercury-containing products

The highest priority of the pollution prevention program is the elimination of mercury. The hospital should phase-in alternatives if evaluation has demonstrated them to be acceptable and cost-effective (taking into account disposal costs).

Make mercury pollution prevention easy

Chapter 3 of this manual describes best management practices to keep mercury out of the environment. The chapter is organized by product (thermometers, laboratory chemicals, electrical equipment, etc.).

The hospital can make proper disposal easy by creating convenient locations for disposal of mercury products, as well as other hazardous materials. Establish an internal "take-back" program for electrical equipment by placing a collection box for old equipment at the point where the new equipment is picked up. Find a way to label mercury-containing products so that each user is aware of his or her responsibility for proper use and disposal.

Establish purchasing policies

Consider a policy that bans the purchase of any mercury-containing item if an adequate alternative exists. The policy could include a requirement for specific authorization by the hospital CEO or other designated official for the purchase of a mercury product. Authorize the purchasing department to make "mercury-free" a part of product specifications, to insist on mercury disclosures on all products coming into the hospital, to specify the use of recovered mercury in all products that do not yet have mercury-free alternatives, and to include disposal costs in cost evaluations.

It is becoming a competitive issue for vendors to ensure that their products do not create unnecessary waste or that they are made from recycled materials. Your vendors need to know that mercury-free alternative products are required by your hospital. Ask them to verify in writing that their products are mercury-free or that they will assist you in selecting mercury-free products. For laboratory chemicals, a Certificate of Analysis can be requested. See *Appendix H* for a sample letter requesting mercury information and a sample Certificate of Analysis. For other products, a vendor product mercury-content disclosure can be requested (see *Appendix I*).

Investigate opportunities for reduction in the cost of mercury-free products or reduction in recycling costs through group purchasing of products and services with other hospitals or clinics.

Educate staff

Employee education in mercury pollution prevention is an important component of successful programs. Determine which groups within the hospital need instruction and identify the most important topics for each group. Each segment of the training program should be adapted for the educational level of the group being trained and the intensity of training needed.

Try to incorporate mercury pollution prevention into existing training programs such as new employee orientation, safety training, right-to-know training, department meetings and grand rounds. Training should be continued on an annual basis until mercury-containing products are eliminated from the hospital.

Educational methods include:

- Train-the-trainer program
- Presentations at meetings

- Display in cafeteria or other common area
- Survey about mercury awareness
- Articles in hospital newsletter and other existing publications
- Distribution of articles from professional journals or newsletters
- Employee handbook page on the guidelines for handling and disposing of mercury
- Paycheck enclosure
- Recycling guide
- Posters, fliers and stickers
- Signs near red bags, sharps containers and sinks, and in supply areas and disposal areas
- Labels on instruments that use mercury materials
- Video
- E-Mail
- Verbal instruction from supervisors and from medical engineers who work throughout the hospital
- Incentive program to reward workers with good ideas that make mercury pollution prevention easier
- Reports on internal audits

(See list of Educational Resources for a Mercury Pollution Prevention Program in *Appendix J*.)

Measure and Document Success

Evaluate the status of the mercury pollution prevention program

Measurement of success is a vital component of pollution prevention that allows the hospital staff and the community to realize the effectiveness of the program. Start by repeating the mercury source identification that was done at the beginning of the program (see *Appendix E*), using the checklist of possible mercury-containing products in *Appendix A* and *Appendix B*. If it is not practical to repeat every measurement, select a few good indicators from the table to track from year to year. If possible, take wastewater samples or have them taken by an independent testing laboratory so that the total mercury discharge can be calculated and compared with the baseline assessment.

Note the sources and quantities of mercury that have been eliminated. Compute the costs or savings to the hospital of the substitution of mercury-free products purchased since the baseline assessment (see *Appendix G*). Quantify and document new policies or changes to former policies since the baseline assessment if they are related to mercury pollution prevention.

The hospital should realize a reduction in:

- Mercury products purchased, used and stored
- Mercury spill incidents
- Quantity of mercury shipped off-site for recycling or disposal, and associated costs
- Mercury concentration in wastewater and in incinerator ash, because mercury is not being improperly disposed

Document the reductions and prepare periodic progress reports about your mercury pollution prevention achievements.

Advertise Success

List entities inside and outside of the hospital who should share in the good news of your success. Develop a communication plan that includes both formal reports and informal updates on progress.

Communicate with:

- The hospital board of directors through an annual report that describes accomplishments, upcoming actions and expected outcomes.
- Other hospitals through hospital association meetings and mailings.
- Employees through individual letters, departmental letters that can be read at meetings, a hospital newsletter or posters. Go beyond a progress report and include congratulations and awards for employees who have made useful suggestions for reducing mercury.
- Local officials, such as wastewater treatment plant officials and the health department, through formal letters.
- The general public through press releases, stories in local newspapers, participation in health and environmental fairs, and pamphlets or posters available for doctors' offices.

Best Management Practices for Mercury-Containing Products in the Hospital

Introduction

"Best management practices" for mercury are the procedures that have been found by experience to effectively prevent the release of mercury into the environment. By implementing best management practices now, the hospital can help to avoid the need for increased regulations in the future. For most mercury-containing products in the hospital, the preferred best management practice is to replace the item with a mercury-free product. However, it may not be possible to replace all of the hospital's mercury products at once and, in a few cases, there may not be a substitute that is considered to be reliable and cost-effective. For these products, best management practices are effective procedures for handling and either recycling or disposing of the mercury-containing products. Recycling is recommended. Disposal should be the last resort.

> ***"For most mercury-containing products in the hospital, the preferred best management practice is to replace the item with a mercury-free product."***

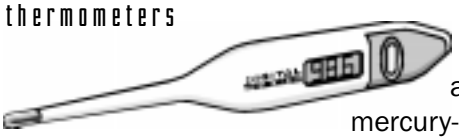
Mercury-containing products can be found almost anywhere in the hospital. They range from medical instruments and clinical laboratory chemicals to electrical equipment and cleaning solutions. This chapter is organized by product (thermometers, laboratory chemicals, etc.). For each product the chapter describes:

- The alternatives for mercury-containing products
- The best management practices for handling and recycling or disposing of mercury-containing products that are still in use

In all cases, when a mercury-containing product is still in use, the hospital's hazardous waste management coordinator will have the ultimate responsibility for its recycling or disposal. All personnel within the hospital who handle mercury-containing products must cooperate with the hazardous waste management coordinator to develop appropriate procedures for the handling of items to be discarded and their transportation to the designated hazardous waste collection point.

Fever Thermometers

Alternatives for mercury-containing thermometers



See the table of alternatives for mercury-containing thermometers following the "Fever Thermometers" section.

Take-home thermometers

If some units of the hospital send thermometers home with their patients, hand out mercury-free thermometers. The take-home thermometer might be digital, chemical strips or a glass thermometer filled with a non-mercury liquid metal alloy. The use of a mercury-free alternative will prevent the release of mercury into the environment when the family breaks or otherwise discards the thermometer.

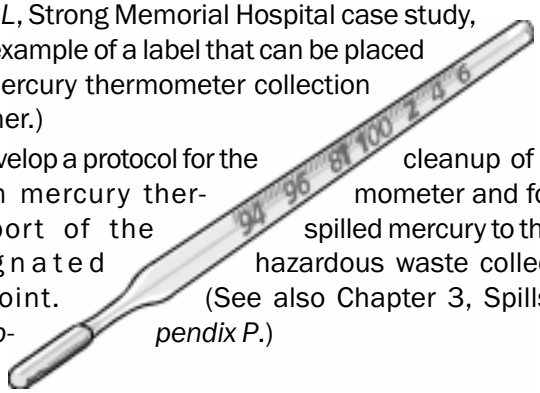
If an alternative has not yet been evaluated and chosen, and mercury thermometers must be distributed in the meantime, educate patients about how to recycle the mercury after a thermometer has been broken or if one is to be discarded. This can be done most easily by handing out written information with the thermometer. This information should also be available at the hospital's information desk. (See *Appendix K* to learn how mercury from thermometers should be recycled in several counties. Use it as a handout to give to your patients.)

Keep mercury thermometers out of red bags and sharps containers

Mercury volatilizes easily. When a mercury thermometer has been placed in a red bag or sharps container that is incinerated or autoclaved, the mercury becomes a gas and enters the air. Mercury that has vaporized in an autoclave may also condense along with the steam and enter wastewater. Mercury thermometers should not be placed in red bags or sharps containers, even in an isolation unit. The hospital's protocol for isolation units should make it clear that thermometers can be removed from the unit as long as they are disinfected first. (See *Appendix L*, Strong Memorial Hospital case study, for an example of a "no mercury thermometers" label that can be placed on a red bag container or sharps container.)

Recycling/disposal of mercury-containing thermometers

Develop a procedure for discarding mercury thermometers. The thermometers could be placed at a collection station that is convenient for nursing personnel and that is designated specifically for the temporary storage of hazardous materials. Make a container available at the collection station for the thermometers and label it clearly. The container could be emptied or picked up on a regular basis or on an as-needed basis, according to the instructions of the hazardous waste management coordinator. (See *Appendix L*, Strong Memorial Hospital case study, for an example of a label that can be placed on a mercury thermometer collection container.)



Develop a protocol for the cleanup of a broken mercury thermometer and for transport of the spilled mercury to the designated hazardous waste collection point. (See also Chapter 3, Spills, and *Appendix P*.)

Type of thermometer	Cost	Accuracy	Time for Reading	Calibration Frequency	Comments
Electronic (digital): oral/rectal	Thermometer: approx. $300. Disposable probe covers: pennies apiece. Take-home can be < $5	Comparable to mercury	Oral: seconds Rectal: seconds	Every 6 mo. - 1 year (Some need initial testing only)	Requires batteries
Electronic (digital): tympanic (also called infrared thermometer)	Thermometer: approx $300. Disposable probe covers: pennies apiece.	Comparable to mercury	Seconds	Every 6 mo.-1 year. (Some need initial testing only)	Requires batteries. Must use "pull and tug" method to get correct placement. Can select to give equivalent oral/rectal reading.
Chemical strip, single-use disposable (plastic or paper strips with dots filled with different chemical mixtures, each formulated to melt and change color at a given temperature)	Pennies apiece	Comparable to mercury	Oral: 1 minute Axilla: 3 minutes	None required	Does not record temperatures below 35° C (95° F)
Glass filled with with alloy of gallium, indium and tin; a liquid at room temperature	Approximately $3.00	Comparable to mercury	3 minutes	None required	Breakable
Mercury	Approximately $0.40	Considered to be the "gold" standard" for accuracy comparisons	Oral: 5 minutes Axilla: 7 minutes	None required	Breakable. Average life expectancy 80 days in hospital setting, if reused. Disposal is expensive.

Table 1. Alternatives for Mercury-Containing Thermometers

Sphygmomanometers

Table 2. Alternatives for Mercury-Containing Sphygmomanometers

Type of Sphygmomanometer	Cost	Comments
Aneroid	Wall model adult: $50-$80; portable model adult: $30-35	Needs calibration annually. Accuracy comparable to mercury.
Electronic	On the order of $2,000	Common where long-term continuous monitoring is needed, such as intensive care.
Mercury	Wall model adult: $60-70; portable model adult $60-70	Requires annual refilling and calibration. Easily breakable. Disposal is expensive. Not recommended for carpeted areas.

Refilling mercury-containing sphygmomanometers

In order to ensure optimal performance, manufacturers of sphygmomanometers recommend that the mercury be removed and filtered at regular intervals. Once a year is a typical interval, but the mercury should also be removed and filtered any time there is a question about the performance of a sphygmomanometer. If a broken device is to be repaired, it too must have the mercury removed and filtered.

If it is not yet feasible for your hospital to replace all of its mercury sphygmomanometers, make sure there is a protocol for their handling and refilling that is consistent with manufacturer's instructions and Occupational Safety and Health Administration (OSHA) standards. The protocol might include the following instructions:

1. Place the sphygmomanometer to be refilled in a clear plastic bag and seal the bag. Do not use a red bag or biohazard bag.
2. Mark the bag: "CONTAINS MERCURY."
3. Place the bag in a plastic basin to contain spills while transporting to the area where the sphygmomanometer is to be refilled.
4. Wear appropriate protective clothing and work within a hood to provide ventilation.
5. Handle over a tray to contain any spills. Never handle mercury over a sink or floor drain.
6. Carry the sphygmomanometer back to the patient room as described in steps 1-3 after refilling.

(See the Chapter 3 section on Spills for other precautions.)

Recycling/disposal of mercury-containing sphygmomanometers

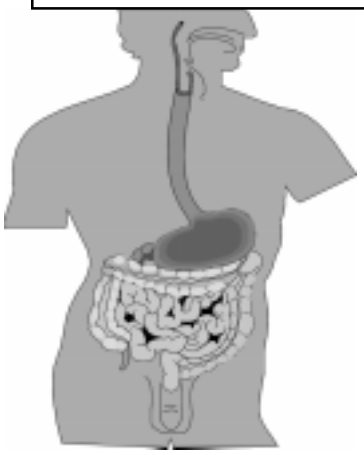
Develop a protocol for the preparation of mercury sphygmomanometers for recycling or disposal that is consistent with U.S. Environmental Protection Agency, New York State Department of Environmental Conservation (NYSDEC) and local regulations, and other pertinent standards. (*See Appendix C* for NYSDEC and local contacts.) Contact your hazardous waste management coordinator for details about packaging, labeling and transporting that are specific to your facility. A suggested protocol might include the following instructions:

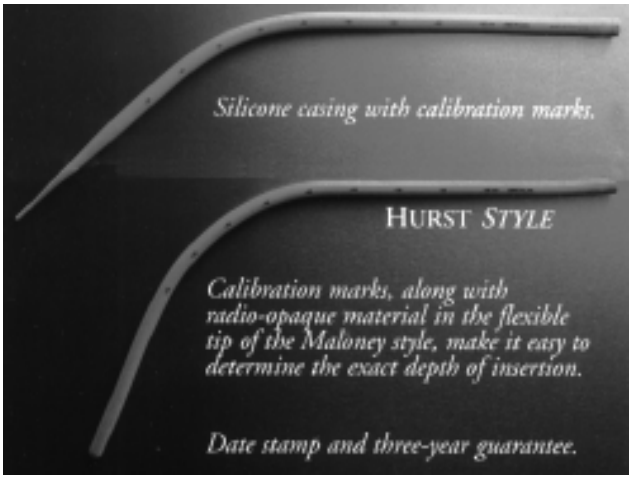
1. Place the sphygmomanometer in a clear plastic bag and seal the bag. Do not use a red bag or biohazard bag.
2. Mark the bag: "CONTAINS MERCURY."
3. Place the bag in a plastic basin to contain any spills during transport to the designated hazardous waste collection point.

Gastrointestinal Tubes

Table 3. Alternatives for Mercury-Containing Gastrointestinal Tubes

Type of GI Tube	Mercury-Free Alternative and Effectiveness
Bougie tubes (esophageal dilators)	Tungsten. Considered to be as effective as mercury.
Cantor tubes (used to trace the GI tract)	Tungsten. Can be purchased empty of weighting and hospital adds the weighting material, either mercury or tungsten. Some feel tungsten weighting is not as effective as mercury because it is not as heavy.
Miller Abbott tubes (used to clear intestinal obstructions)	Tungsten. Can be purchased empty of weighting and hospital adds the weighting material. Tungsten replacement is considered to be as effective as mercury.
Feeding tubes	Tungsten. Considered to be as effective as mercury.





Recycling/disposal of mercury-containing gastrointestinal tubes

Gastrointestinal tubes typically have expiration dates, after which their use must be discontinued. Make sure the hospital has a protocol for the handling and recycling or disposal of mercury-containing tubes that is consistent with U.S. Environmental Protection Agency, New York State Department of Environmental Conservation (NYSDEC) and local regulations, and other pertinent standards. (*See Appendix C* for NYSDEC and local contacts.) Contact your hazardous waste management coordinator for details about packaging, labeling and transporting that are specific to your facility. A suggested protocol might include the following instructions:

1. Place the tube(s) in a clear plastic bag and seal the bag. Do not use red bags or biohazard bags.
2. Mark the bag: "CONTAINS MERCURY."
3. Place the bag in a plastic basin to contain any spills during transport of the tubes to the designated hazardous waste collection point.

Dental Amalgam and Mercury

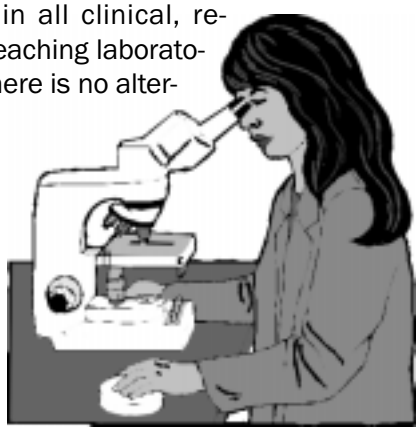
Many hospitals do not have dental facilities. However, some hospitals do have a clinic within the hospital or as part of another facility with which they are affiliated, such as a nursing home. For the benefit of hospitals that have dental clinics, a booklet, "Prevent Mercury Pollution: Use Best Management Practices for Amalgam Handling and Recycling" can be found in *Appendix M*. The mercury pollution prevention best management practices described in the booklet were developed simultaneously with those described in this manual.

Laboratory Chemicals

Whenever laboratories use mercury-containing chemicals, there is the potential for the release of mercury into wastewater. Once mercury in wastewater enters a wastewater treatment plant, most of it concentrates in the sludge. The sludge may either be spread on land or incinerated. Either way, the mercury in the sludge will eventually be released into the environment.

Phase out all nonessential uses of mercury in laboratories:

- Eliminate the use of mercury-containing compounds in all clinical, research and teaching laboratories unless there is no alternative.
- Eliminate all nonessential mercury devices, such as thermometers and barometers, and replace them with mercury-free devices.
- Clear laboratories and storage areas of unnecessary mercury compounds.



See *Appendix B* for categories of laboratory chemicals that may include mercury.

Alternatives for mercury-containing laboratory chemicals

The mercury compound in a chemical formulation may be an active ingredient, a preservative, or a contaminant introduced during the manufacture of one of the ingredients. The alternative depends on the reason that mercury is present. If a mercury compound is an active ingredient, the replacement may be a compound of a less hazardous metal. If a mercury compound is a preservative, the formulation can often be replaced by a formulation that uses a non-mercury preservative. If mercury is a contaminant, a formulation can often be found with ingredients manufactured by a different method. Examples of alternatives to mercury-containing chemicals common in a clinical laboratory are shown in the table.

Because mercury may be present in very small amounts as a preservative or contaminant, it may not be obvious whether or not a chemical reagent or stain contains mercury. Manufacturers might not list the ingredients of a reagent or stain if the formula is under copyright protection. Material Safety Data Sheets

Table 4. Alternatives for Mercury-Containing Laboratory Chemicals

Compound	Possible Alternatives
Histological fixatives (such as B5 and Zenker's Solution) with mercury (II) chloride as a tissue preservative	Zinc formalin; other products are available that are both mercury-free and formaldehyde-free.
Mercury (II) chloride as an oxidizer in hematoxylin	Sodium iodate as oxidizer.
Chemical used for acidic drug analysis of barbiturates and benzodiazepines by thin layer chromatography (such as Toxi-Dip B3)	Gas chromatography/mass spectrometry method. A hospital may need to send samples to a lab that has the equipment and specially trained staff required.
Thimerosal (Trademark Merthiolate) as a preservative in stains and other products in the pH neutral range	Methyl paraben, propyl paraben

might not list mercury in a product if the formula is under copyright protection or if the amount is less than one percent. However, the contribution of many low-concentration sources accounts for a large fraction of the mercury in the wastewater stream.

The hospital purchasing agent should contact the hospital's suppliers and request that mercury-free reagents be supplied. If the usual supplier cannot provide mercury-free reagents, locate one that can. Request that all vendors disclose mercury concentration on a Certificate of Analysis. Products with no or low mercury can then be selected for purchase. The Certificate of Analysis should list mercury content in parts per billion (ppb), not as a percentage. (See a sample letter requesting a Certificate of Analysis and a sample Certificate of Analysis in *Appendix H*.)

Wherever possible, change methodologies to processes that do not involve mercury. For chemicals that normally include a preservative, select chemicals that use a mercury-free preservative. Watch for new products. Many reagents and stains that once contained mercury have been reformulated so that they are now mercury-free.

The cost of mercury substitutes can be comparable and, in some cases, may be less than the cost of mercury-containing chemicals. Some substitutes may also carry some environmental risk, but it will probably be less than the risk associated with mercury.

Recycling/disposal of mercury-containing laboratory chemicals

When the laboratory staff has training on the proper use, handling and disposal of hazardous materials, incorporate the importance of keeping mercury out of wastewater. Make the staff aware of laboratory products that are known to contain mercury. It is important that laboratory chemicals ready for recycling or disposal be kept separately from each other and not mixed. This will minimize any increase in the amount of hazardous waste generated.

If using a mercury product is essential, the mercury-contaminated waste should be collected and disposed as hazardous waste. Check with your local sewer district for information about the proper disposal of mercury-contaminated rinse water.

Even if mercury-containing chemicals are not still in use, they may still be present in storage areas and they must be disposed as hazardous waste. Contact the hospital's hazardous waste management coordinator about transporting the chemicals to the designated hazardous waste collection point. Protective clothing or debris that is contaminated with a mercury compound should be managed in accordance with U.S. Environmental Protection Agency and New York State Department of Environmental Conservation (NYSDEC) regulations. (See *Appendix C* for NYSDEC contacts.)

Pharmaceutical Products

Currently mercury can be present in pharmaceutical products even when it is not listed on the label or on the product information sheet. As can be seen in the table below, the mercury is usually introduced as a preservative.

Alternatives for mercury-containing pharmaceutical products

Be aware of changes in the pharmaceutical industry. In many cases, products with mercury-free preservatives are available, and additional alternatives are likely to be available in the near future. In the meantime, request mercury-free pharmaceutical supplies whenever possible. Ask your vendor to assist the hospital in selecting mercury-free products for the pharmacy. (See sample vendor product mercury-content disclosure in *Appendix I*.)

Table 5. Pharmaceutical Uses of Mercury

Product	Notes
Merbromin/water solution	Used in plastic/reconstructive surgery as a disinfectant and marker
Ophthalmic and contact lens products	May contain mercury preservatives: thimerosal, phenylmercuric acetate, phenylmercuric nitrate
Nasal Sprays	May contain mercury preservatives: thimerosal, phenylmercuric acetate, phenylmercuric nitrate
Vaccines	May contain thimerosal (primarily in hemophilus, hepatitis, rabies, tetanus, influenza, diphtheria and pertussis vaccines)

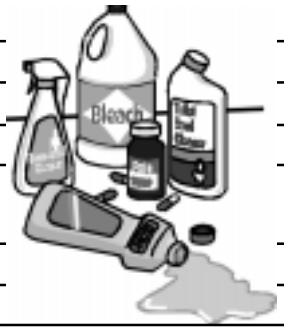
Cleaners and Degreasers

Mercury as a contaminant

The mercury-cell process is one of the processes that may be used to manufacture common ingredients of cleaners and degreasers: sodium hydroxide (caustic soda), potassium hydroxide, chlorine and hydrochloric acid (muriatic acid). When these chemicals are used to make other products, such as bleach or soaps, mercury contamination can be introduced into the final product. The Massachusetts Water Resources Authority (MWRA) and Medical, Academic and Scientific Community Organization, Inc. (MASCO), through a public-private partnership called the MWRA/MASCO Mercury Work Group, performed laboratory analyses on some of these products. (See *Appendix J*, Educational Resources for a Mercury Pollution Prevention Program and the MWRA/MASCO case study in *Appendix L*.)

Table 6. Mercury Content of Selected Cleaning Products*

Information from MWRA/MASCO Mercury Work Group

Product	Mercury Content (ppb)
 Ajax Powder	0.17
Comet Cleaner	0.15
Lysol Direct	<0.011
Soft Scrub	<0.013
Alconox Soap	0.004 mg/kg, 0.005 mg/kg, <0.0025 mg/kg (3 tests)
Derma Scrub	<5.0, <2.5 (2 tests)
Dove Soap	0.0027
Ivory Dishwashing Liquid	0.061
Joy Dishwashing Liquid	<0.01
Murphy's Oil Soap	<0.012
Soft Cide Soap (Baxter)	8.1
Sparkleen Detergent	0.0086
Sunlight Dishwashing Detergent	<0.011

*Testing on cleaning products has been limited and many common cleaning products have not been tested. The data should not be used as a substitute for testing specific products/chemicals.

Alternatives for mercury-containing cleaners and degreasers

To learn the mercury content of the cleaners and degreasers used by the hospital, request Certificates of Analysis from all suppliers when purchasing materials. Choose mercury-free products, if possible. If there are no mercury-free products that meet the needs of the hospital, choose those that are the lowest in mercury concentration.

The Certificate of Analysis should list mercury content in parts per billion (ppb), not as a percentage. A Material Safety Data Sheet is *not* equivalent to a Certificate of Analysis. (See *Appendix H* for a sample letter requesting a Certificate of Analysis and a sample Certificate of Analysis.)

Batteries

Mercury-containing batteries

Mercuric oxide (mercury zinc) batteries and button batteries are the only batteries made in the United States that may contain added mercury if newly purchased (see table). Mercuric oxide batteries offer a reliable and constant rate of discharge and can be made in a wide variety of sizes intended for use in medical devices. In the 1990s, manufacturers stopped designing equipment that requires mercuric oxide batteries. New models generally require zinc air batteries. However, mercuric oxide batteries may remain in hospital stock for many years for use in older equipment. The shelf life of mercuric oxide batteries is up to ten years.

Some of the medical devices that may still require mercuric oxide batteries include cardiac monitors, pH meters, oxygen analyzers and monitors, and telemetry instruments. See *Appendix A* to see the variety of devices in which mercury-containing batteries have been used.

Alternatives for mercury-containing batteries

Table 7. Batteries (Newly Purchased) That May Contain Added Mercury (1998)

Battery	Quantity of Mercury	Use	Voltage	Available Alternatives
Mercuric oxide (mercury zinc)	33-50% by weight	Medical	Multiples of 1.4 v	Zinc-air (may contain up to 25 mg mercury, 0.4-1.0% by weight)
Button batteries: Zinc air	No federal law, but addition of mercury over 25 mg prohibited by some states. Manufacturers use this standard for all button batteries.	Medical	Multiples of 1.4 v	None
Button batteries: Alkaline-manganese	Federal law allows up to 25 mg mercury	Consumer	Multiples of 1.5 v	Silver oxide (lasts longer, costs more, does not come in a full range of sizes)
Button batteries: Silver oxide	Contains some mercury but less than alkaline-manganese button batteries	Consumer	Multiples of 1.5 v	None

The alternative for mercuric oxide batteries is zinc air batteries. However, the alternative may not be mercury-*free*. A zinc air button battery may contain up to 25 mg of mercury. Larger zinc air batteries are made up of stacked button batteries, each of which may contain up to 25 mg of mercury. It is not yet possible to eliminate mercury from these batteries. In the absence of mercury, the zinc electrode corrodes and creates hydrogen gas. Because the batteries are tightly sealed, they can bulge when the gas is created and may even explode. Note that zinc air batteries include a tab that prevents exposure of the internal part of the battery to air (air serves as one of the electrodes). Once the tab on a zinc air battery is pulled off, the internal part of the battery is exposed to air and it begins to discharge.

For medical devices, there are Food and Drug Administration and Underwriters Laboratory certification concerns with replacing a battery. It is important to contact the equipment manufacturer before replacing a mercuric oxide battery with a substitute to ensure that the device has been approved for use with the alternative battery.

Rechargeable (nickel-cadmium) batteries cannot be used as an alternative to mercuric oxide batteries.

Recycling/disposal of batteries

Provide many convenient collection points for batteries throughout the hospital, including areas where replacement batteries are obtained. There are two options for collection:

1. Collect only mercury-containing batteries. This would put the responsibility for knowing mercury content on the person who is discarding the battery. The hazardous waste management coordinator could post written guidance at the collection location. However, this option could be confusing for the user.
2. Collect all batteries. The hazardous waste management coordinator or recycler would take responsibility for sorting the batteries. The coordinator should determine which types of used batteries are hazardous waste, which types can be recycled and which types can be thrown away as trash. Spent mercury-containing batteries should be recycled.

Some battery manufacturers offer recycling programs for mercuric oxide batteries. Check with the hospital's battery suppliers to learn if they have collection plans and if they will coordinate packaging and transportation to their facilities. Check with the New York State Department of Environmental Conservation (NYSDEC) to ensure that the specific program is legal. (See *Appendix C* for the NYSDEC hazardous waste regulations telephone number.)

Lamps

Energy efficiency of mercury-containing lamps

Fluorescent lamps, high-intensity discharge (HID) lamps and ultraviolet lamps (used in biosafety cabinets) are among the few mercury-containing products within hospitals for which adequate non-mercury substitutes do not exist.

Fluorescent and HID lamps are efficient sources of white light, typically 3-4 times more efficient than incandescent lamps. Since fossil fuels contain mercury, power generation releases mercury and other pollutants to the environment, and these releases are greater when less efficient lamps are used. Considering both mercury emissions from power generation and mercury contained in the lamps themselves, incandescent lamps put more mercury into the environment than do fluorescent lamps.

Investigate the mercury content of fluorescent and HID lamps and purchase those with a relatively low mercury content. In recent years, lamp manufacturers have been reducing the amount of mercury in fluorescent lamps. Some lamps are low enough in mercury content to be considered nonhazardous for waste recycling and disposal purposes. Check verifiable product information on Toxicity Characteristic Leaching Procedure (TCLP) testing to learn if this is the case.

Recycling/disposal of mercury-containing lamps

There should be several convenient collection points for spent lamps within the hospital. Lamps from the collection points should be taken by the hazardous waste management coordinator to the hospital's designated hazardous waste collection point. The lamps can be sorted for recycling or disposal at the collection point. *Do not break or crush lamps*, unless using a commercial lamp crusher that captures mercury vapor. Because crushing lamps may be considered to be "treatment," consult with your regional office of the New York State Department of Environmental Conservation (NYSDEC) before purchasing a lamp crusher. (See *Appendix C* for telephone number.)

If a lamp is accidentally broken in the hospital, store all of the debris in a sealed plastic container. Request pick-up by the hazardous waste management coordinator.

The exact procedures for sorting, storage, packing, and recycling or disposal will partly depend on the requirements of the NYSDEC. (See *Appendix C* for the NYSDEC hazardous waste regulations telephone number.) It is important to know your generator status before asking questions. Some of the questions to ask the NYSDEC are:

1. Which lamps can and cannot be recycled?
2. Which lamps must be considered as hazardous waste?
3. How should lamps for recycling be packed for transporting? Should they be whole or crushed in a bulb crusher? What is the cost of a bulb crusher?
4. How should broken lamps be packaged?

Since fluorescent and HID lamps fail TCLP testing for mercury a high percentage of the time, it is suggested that expensive TCLP testing be minimized and that those disposing of these lamps assume them to be hazardous unless verifiable product information states that the lamps are nonhazardous.

Watch for changes in the regulations that affect mercury-containing lamps. Get the latest information from the NYSDEC. (See *Appendix C*. Also see *Appendix N* for a partial list of fluorescent lamp recyclers.)

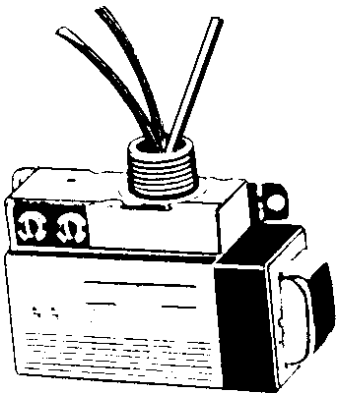
U.S. Environmental Protection Agency (EPA) Green Lights Program

The EPA's Green Lights Program can help the hospital save money on lighting costs and, at the same time, reduce the amount of mercury that is emitted to the air when fossil fuels are burned at the local power plant that supplies electricity.

Organizations, such as hospitals, that join Green Lights sign a Memorandum of Understanding with EPA to become a "Partner." Partners agree to consider available technologies and install the mix of lighting products and controls that maximize energy savings and maintain or improve lighting quality.

EPA offers information, analysis, and planning and communications services to the Partner. For further information, contact the Green Lights Program by phone at 202-775-6650 or by fax at 202-775-6680.

Electrical Equipment



Alternatives for mercury-containing electrical equipment

Mercury can be found in many types of electrical equipment (see table below) and the equipment can have a lifetime measured in decades. Renovation is usually the reason that the equipment is replaced. Even if mercury use in newly manufactured equipment is discontinued, the recycling or disposal of used equipment will require an awareness of the mercury content for a long time to come.

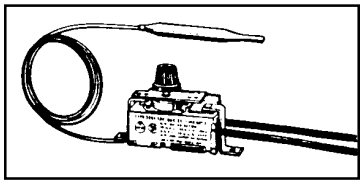
Table 8. Mercury-Containing Electrical Equipment

Type of Switch	Where Equipment is Used	Possible Alternative
Tilt switch	--Airflow/fan limit control --Building security systems --Clothes iron --Fire alarm box --Fluid level, pressure or temperature control devices --Laptop computer screen shutoff --Lids of clothes washers and chest freezers --Silent light switch --Space heater --Thermostats	-Mechanical switch
Float switch	--Bilge pumps --Septic tank --Sump pump	--Magnetic dry reed switch --Optic sensor --Mechanical switch
Thermostat	--Temperature control device may have a mercury tilt switch.	--Electronic thermostat
Reed relay	--Low voltage, high precision analytical equipment such as electron microscope	--Solid state relay --Electro-optical relay --Dry reed relay
Plunger or displacement relay	--High current, high voltage applications such as lighting, resistance heating, power supply switching	--Mechanical switch
Thermostat probe	--Electric stoves --Hot water heaters	--Non-mercury probe

Manufacturers have not eliminated mercury in all electrical equipment due to cost considerations. However, because of an awareness of mercury problems, manufacturers are increasingly making alternatives available. Ask your vendor to assist the hospital in selecting mercury-free products. (See sample vendor product mercury-content disclosure in *Appendix I*.)

Recycling/disposal of mercury-containing electrical equipment

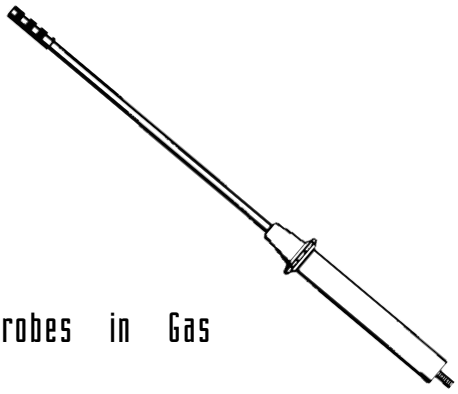
If the hospital is preparing used electrical equipment for recycling or disposal and there is a question about the mercury content, obtain this information from the manufacturers. Remove any mercury-containing parts from the equipment. Store the parts in a tightly covered container labeled as to its contents. Parts from switches, thermostats, relays and thermostat probes (including the thermostat probes described in the section on Thermostat Probes in Gas Appliances) can be stored in the same container. The container could be located in the supply area of the hospital where replacement parts are stored until it is full and ready for transport to the hospital's designated hazardous waste collection point. Recyclers are available that accept these equipment components. (See *Appendix N*.)



Take-back programs for thermostats

Honeywell Corporation has a free take-back program to collect any brand of used mercury-containing thermostats. To use the system, contact a heating, ventilating and air-conditioning wholesaler to learn if the wholesaler is participating in the program. Honeywell provides a special container for thermostats to each participating wholesaler. Do not remove the switches from your thermostats before taking them to the wholesaler. (Call 800-345-6770 for further information.)

Honeywell is one example of a take-back program. Other companies may have such programs. Contact your supplier to learn if this option is available. Take-back programs may be subject to Universal Waste Rules that have been adopted by New York State. Check with the New York State Department of Environmental Conservation (NYSDEC) to ensure that the specific take-back program is legal. (See *Appendix C* for NYSDEC hazardous waste regulations telephone number.)



Thermostat Probes in Gas Appliances

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. They are usually present as part of the safety valve that prevents gas flow if the pilot light is not lit. The metal probe consists of a metal bulb and thin tube attached to a gas-control valve. The bulb of the probe projects into or near the pilot light. The mercury is inside the tube and expands or contracts to open and shut the valve.

A mercury thermostat probe may also be 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.

If there is a question about the mercury content of a thermostat probe, obtain this information from the manufacturer.

Alternatives for mercury-containing thermostat probes in gas appliances

Non-mercury thermostat probes are also used in the appliances listed above. They are:

- Sodium/potassium thermostat probes
- "Dissimilar metals" thermostat probes

Recycling/disposal of mercury-containing thermostat probes in gas appliances

Remove thermostat probes from the appliances to be discarded and store them along with the mercury-containing electrical equipment described in the section on Electrical Equipment. Place them in a covered container that is labeled as to the type of equipment being stored. The container could be located in the supply room of the hospital where the replacements are stored until it is full and ready for transport to the hospital's designated hazardous waste collection point.

Industrial Thermometers

Air and water heating and cooling systems employ thermometers to allow monitoring of the systems' performance. Many of these thermometers are mercury in glass.

Recycling/disposal of mercury-containing industrial thermometers

It will be necessary to properly recycle or dispose of mercury industrial thermometers if the hospital is retrofitting with mercury-free thermometers or if it is replacing an entire heating or cooling system that employed mercury thermometers. The thermometers should be packed for delivery to the designated hazardous waste collection point in a tightly closed container and in a manner that will prevent breakage of the thermometers. Contact the hazardous waste management coordinator for detailed instructions.

Table 9. Alternatives for Mercury-Containing Industrial Thermometers

Type of Thermometer	Approximate Cost	Accuracy	Comments
Digital	$39	Within 1% of scale range	Light-powered, no battery required; interchangeable with mercury thermometer as to threading and well
Bimetal	$45-47	Within 1% of scale range	Contains a glass "window" but glass does not contain a liquid; *not* interchangeable with mercury thermometer as to threading and well
Alcohol-filled	$40	Within 1% of scale range	Red-colored alcohol in glass tube; interchangeable with mercury thermometer as to threading and well
Mercury	$32	Within 1% of scale range	Mercury in glass tube

Pressure Gauges

Devices that measure pressure may contain mercury. These include:

- Laboratory manometers used by biomedical engineers to calibrate other instruments in the hospital
- Barometers
- Sphygmomanometers (see the section on Sphygmomanometers)

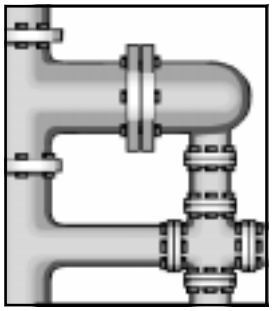
The most common alternative to a mercury-containing barometer is an aneroid barometer.

Table 10. Alternatives for Mercury-Containing Laboratory Manometers

Type of Manometer	Cost	Comments
Electronic (digital)	Several hundred dollars	An order of magnitude more accurate than sphygmomanometers. Used in biomedical laboratory to calibrate other devices. A traceable calibration must be performed with a mercury manometer, onsite or offsite, on a regular schedule. The time interval depends on the manufacturer's recommendation.
Aneroid (Bourdon, diaphragm, piston or capsule types)	Price varies widely depending on accuracy & traceability required	Manufacturers recommend calibration at least annually. Schedule can be based on experience, with annual inspections as a minimum.
Liquid filled	Price varies widely depending on accuracy & traceability required	Inadvisable to move them from place to place. Manufacturers recommend calibration at least annually. Schedule can be based on experience, with annual inspections as a minimum.
Mercury	$100-$150 range	One meter tall. An order of magnitude more accurate than sphygmomanometers. Used in biomedical laboratory to calibrate other devices. Annual calibration recommended to ensure good performance.

Recycling/disposal of mercury from mercury-containing gauges

Store mercury waste from servicing manometers and other mercury-containing gauges in a covered, air-tight plastic container. The container must be clearly labeled: CONTAINS MERCURY. Small amounts can be stored in vials placed in a larger covered air-tight container, such as a five-gallon plastic pail. Recycle the mercury. (See *Appendix N* for a list of recyclers.)



Plumbing

Mercury may be present in a hospital's sewer pipes, sumps and sink traps from the past use of mercury. The mercury may have entered the pipes when items were broken, discarded or spilled in sinks. Mercury in plumbing can settle at a low point such as a sump or sink trap and remain in the plumbing of a hospital for many years. Often the slow dissolution of the mercury in a pipe, sump or sink trap is enough to cause violations of wastewater discharge standards even after best management practices for mercury have been introduced in the hospital.

Whenever sewer pipes, sumps or sink traps are to be moved or cleaned, the plumber must be warned about the potential of finding mercury in the sludge. The sludge must be handled and disposed as hazardous waste unless it is demonstrated, through the Toxicity Characteristic Leaching Procedure (TCLP) or verifiable user knowledge, that it is not hazardous. Procedures for cleaning traps and pipes that were developed by the Massachusetts Water Resources Authority/Medical, Academic and Scientific Community Organization Mercury Work Group can be found in *Appendix O*.

Hospitals have reported success in lowering their wastewater levels after cleaning out their plumbing. After conducting such a cleaning program, a hospital must follow the recommendations in this chapter in order to avoid reintroducing mercury into the plumbing system.

Spills

Accidental spills of liquid mercury can increase the levels of mercury in the air or wastewater of a health care facility. Small droplets of spilled mercury may lodge in cracks, mix with dust and go down drains. Mercury may adhere to fabrics, shoe soles, watches and jewelry on which it can be transported to other locations. A small spill of mercury in a carpeted patient room can become a major clean-up challenge.

Mercury spill prevention

Follow proper procedures when cleaning or refilling instruments that contain mercury:

- Clean or refill instruments over a tray to contain any spills. Never handle mercury over a sink. Reserve the room for mercury use only. Restrict traffic in the area.
- Clean and calibrate all mercury-containing equipment according to the manufacturer's recommended handling procedures and the procedures recommended by your hospital's safety officer.
- Train all workers who use mercury devices about the properties and hazards of mercury, safe handling procedures, and specific policies related to mercury recycling and disposal.

Minimizing the impact of a spill is part of spill prevention. It is preferable to use mercury devices in rooms that do not have carpeting or other floor coverings which are not smooth and easily cleaned. Mercury devices should not be used in units which use beds that have high structures or projections off the beds that can smash wall-mounted sphygmomanometers, or in areas where patients cannot be moved.

Mercury spill response

Mercury spills are very disruptive. A large spill will require removing the patient from the room during cleanup. The room would have to remain vacant until it is ensured that there is no longer mercury vapor in the air.

Be prepared for a spill in any area of the hospital where mercury-containing devices are used. Have a mercury vacuum cleaner or mercury spill kit readily available to consolidate spilled mercury and limit the amount of mercury released into the air. Never use a regular vacuum cleaner to clean up mercury. It will vaporize the mercury and blow it into the air. The mercury vacuum cleaner is designed to clean up liquid mercury spills. An activated carbon filter in this vacuum will absorb and contain the mercury vapors.

The cleanup of mercury spills must be performed by specially trained staff members. Carry out simulated spills and cleanup as part of training.

Create a formal mercury spill policy for the hospital. Consider the following factors when developing the policy:

- Round-the-clock availability of a competent staff person, trained for mercury spill cleanup
- Protective equipment and clothing for cleanup staff
- OSHA requirements
- The circumstances when the patient(s), visitors and staff should be evacuated from the area before cleanup
- How to determine when a room is "clean enough" to re-occupy
- Type of flooring (linoleum, carpet, etc.)
- Determination of the type of equipment to be used for the size and type of spill
- Manufacturer's instructions for the equipment to be used
- Ultimate waste disposal, which may depend on the cleanup method
- Preparation of an incident report that describes the spill, the cleanup method used, unusual circumstances, and follow up
- Mercury spills during a medical procedure

(See also the section on Hospital Employee Health and Safety and *Appendix P*.)

Storage Areas

Mercury-containing products not in use must be stored in nonbreakable containers with tight-fitting lids. The containers must be clearly labeled as to their contents. Rooms where mercury-containing items are stored should be tested periodically using a mercury vapor sniffer.

Even after most uses of mercury have been discontinued in the hospital, mercury-containing products may still be in storage from past uses. All hospital units should check storage areas for old, damaged or outdated equipment. (See *Appendix A* and *Appendix B* for lists of possible mercury-containing products in the hospital.) If mercury-containing products are found, contact the hazardous waste management coordinator. After the removal of the mercury-containing products, the areas should be checked with the mercury vapor sniffer.

Hospital Employee Health and Safety

A major concern with the use of mercury-containing products is the possible exposure of hospital employees to mercury vapor during a maintenance procedure, such as servicing mercury-containing equipment. Understand the properties and hazards of mercury. Check with your health and safety officer prior to doing such work to ensure that you are following correct procedures for:

- Ventilation
- Protective clothing and equipment
- Work habits, such as smoking, eating or drinking in the area and wearing jewelry (mercury readily combines with gold)
- Handling and recycling or disposal of mercury
- Follow-up monitoring

Conduct periodic training for all employees who may come into contact with mercury-containing products. Include new and temporary employees, employees at offsite locations, and contractors.

(See also the section on Spills.)

Appendix A

Instruments and Products, Used in Hospitals, That May Contain Mercury

(This list should not be assumed to be complete.)

- Thermometers
  - Body temperature thermometers
  - Clerget sugar test thermometers
  - Heating and cooling system thermometers
  - Incubator/water bath thermometers
  - Minimum/maximum thermometers
  - National Institute of Standards and Technology calibration thermometers
  - Tapered bulb (armored) thermometers
- Sphygmomanometers
- Gastrointestinal tubes
  - Cantor tubes
  - Esophageal dilators (bougie tubes)
  - Feeding tubes
  - Miller Abbott tubes
- Dental amalgam
- Pharmaceutical supplies
  - Contact lens solutions and other ophthalmic products containing thimerosal, phenylmercuric acetate or phenylmercuric nitrate
  - Diuretics with mersalyl and mercury salts
  - Early pregnancy test kits with mercury-containing preservative
  - Merbromin/water solution
  - Nasal spray with thimerosal, phenylmercuric acetate or phenylmercuric nitrate
  - Vaccines with thimerosal (primarily in hemophilus, hepatitis, rabies, tetanus, influenza, diphtheria and pertussis vaccines)
- Cleaners and degreasers with mercury-contaminated caustic soda or chlorine
- Batteries (medical uses)
  - Alarms
  - Blood analyzers
  - Defibrillators
  - Hearing aids
  - Meters
  - Monitors
  - Pacemakers
  - Pumps
  - Scales
  - Telemetry transmitters
  - Ultrasound
  - Ventilators

- Batteries (non-medical uses)
- Lamps
  - Fluorescent
  - Germicidal
  - High-intensity discharge (high pressure sodium, mercury vapor, metal halide)
  - Ultraviolet
- Electrical equipment
  - Tilt switches
    - Air flow/fan limit control
    - Building security systems
    - Chest freezer lids
    - Fire alarm box switches
    - Lap-top computer screen shut-off
    - Pressure control (mounted on bourdon tube or diaphragm)
    - Silent light switches (single-pole and three-way)
    - Temperature control (mounted on bimetal coil or attached to bulb device)
    - Washing machine (power shut off)
  - Float control
    - Septic tanks
    - Sump pumps
  - Thermostats (non-digital)
  - Thermostat probes in electrical equipment
  - Reed relays (low voltage, high precision analytical equipment)
  - Plunger or displacement relays (high current/high voltage applications)
- Thermostat probes in gas appliances (flame sensors, gas safety valves)
- Pressure gauges
  - Barometers
  - Manometers
  - Vacuum gauges
- Other
  - Devices, such as personal computers, that utilize a printed wire board
  - Blood gas analyzer reference electrode (Radiometer brand)
  - Cathode-ray oscilloscope
  - DC watt hour meters (Duncan)
  - Electron microscope (mercury may be used as a damper)
  - Flow meters
  - Generators
  - Hitachi Chem Analyzer reagent
  - Lead analyzer electrode (ESA model 3010B)
  - Sequential Multi-Channel Autoanalyzer (SMCA) AU 2000
  - Vibration meters

Appendix B

Laboratory Chemicals That May Contain Mercury
(Compiled in 1997)

This list is intended to demonstrate the wide variety of laboratory chemicals that may contain mercury. It was derived from examining the Massachusetts Water Resources Authority Mercury Source Identification Program Database (See *Appendix L*, Mercury Reduction Case Studies, and *Appendix J*, Educational Resources for a Mercury Pollution Prevention Program).

Some of the chemicals may contain added mercury, and others may contain mercury as a contaminant in a feedstock. If the mercury is a contaminant, its presence or absence may vary from lot to lot. In the case of kits, it is necessary to consider separately each of the reagents that make up the kit.

This list should not be assumed to be complete. Request that vendors disclose mercury concentration on a Certificate of Analysis for all chemicals ordered. See *Appendix H* for a sample letter requesting mercury information and sample Certificate of Analysis.

Acetic acid
Ammonium reagent/Stone analysis kit
Antibody test kits
Antigens
Antiserums
Buffers
Calibration kits
Calibrators
Chloride
Conjugate kits
Diluents
Enzyme immunoassay test kits
Enzyme tracers
Ethanol
Extraction enzymes
Fixatives
Hematology reagents
Hormones
Immunoelectrophoresis reagents
Immunofixationphoresis reagents
Immu-sal
Liquid substrate concentrates and diluents
Negative control kits
Phenobarbital reagent
Phenytoin reagent
Positive control kits
Potassium hydroxide
Pregnancy test kits
Rabbit serum
Shigella bacteria
Sodium hypochlorite
Stains
Standards
Substance abuse test kits
Sulfuric acid
Thimerosal
Tracer kits
Urine analysis reagents
Wash solutions

Appendix C

Regulatory Information Contacts for Counties in the Rochester Embayment Watershed

Wastewater Regulations

NYS Department of Environmental Conservation (NYSDEC), Region 8
(Counties of Genesee, Livingston, Monroe, Ontario)
Division of Water
6274 East Avon-Lima Road
Avon, NY 14414
716-226-2466

NYSDEC, Region 9 (Counties of Allegany, Wyoming)
Division of Water
270 Michigan Avenue
Buffalo, NY 14203-2999
716-851-7070

Allegany County, New York
Public Health Director
Allegany County Health Department
County Office Building
Belmont, NY 14813
716-268-9254

Genesee County, New York
NYSDEC Region 8; also contact the municipality

Livingston County, New York
Environmental Health Director
Livingston County Health Department
2 Livingston County Campus
Mount Morris, NY 14510-1691
716-243-7280

Monroe County, New York
Industrial Waste Control Section
Monroe County Department of Environmental Services
444 East Henrietta Road
Rochester, NY 14620
716-274-8102

Ontario County, New York
Cornell Cooperative Extension, Ontario County
480 North Main St.
Canandaigua, NY 14424
716-394-4110

Wyoming County, New York
Public system: NYSDEC Region 9
Private system: Public Health Engineer
Wyoming County Health Department
338 North Main St.
Warsaw, NY 14569
716-237-2666

Hazardous Waste Regulations

NYSDEC, Albany
Bureau of Hazardous Waste Management
Division of Solid and Hazardous Materials
50 Wolf Road
Albany, NY 12233
518-485-8988

NYSDEC, Region 8
(Counties of Genesee, Livingston, Monroe, Ontario)
Division of Solid and Hazardous Materials
6274 East Avon-Lima Road
Avon, NY 14414
716-226-2466

NYSDEC, Region 9 (Counties of Allegany, Wyoming)
Division of Solid and Hazardous Materials
270 Michigan Avenue
Buffalo, NY 14203-2999
716-851-7220

Air Regulations

NYSDEC, Region 8 (Counties of Genesee, Livingston, Monroe, Ontario)
Air Pollution Control Program
6274 East Avon-Lima Road
Avon, NY 14414
716-226-2466

NYSDEC, Region 9 (Counties of Allegany, Wyoming)
Division of Air Resources
270 Michigan Avenue
Buffalo, NY 14203-2999
716-851-7130

Appendix D

Benefits of a Mercury Pollution Prevention Program in Your Hospital (Handouts)

Addresses Human Health Concerns About Mercury in the Environment

- There are human health impacts due to eating mercury-contaminated fish and fish consumption advisories due to mercury
- Health professionals practice preventive medicine for public health.

Reduces Discharge of Mercury into the Environment

- Discharge to the air from incineration, and deposition of the airborne mercury back to the ground or water
- Discharge of mercury in wastewater to sewage treatment plants, and from there to:
  - A waterway, or
  - The air if sludge is incinerated, or
  - The soil if sludge is land spread

Helps to Avoid the Need for Future Environmental Regulations

- As a result of the Federal Great Lakes Water Quality Guidance (also referred to as the Great Lakes Initiative), New York State adopted a stricter water quality standard for mercury that allows virtually no discharge of mercury.
- The hospital may not be able to meet stricter state standards for discharge to the sewage treatment plant without action.
- Implementing best management practices now can help to avoid the need for increased regulations in the future.

Produces Hospital Operations Efficiencies

- Mercury Pollution Prevention avoids:
  - Disruption of services due to spills
  - High disposal costs of mercury
  - Need to train staff for handling mercury
  - Costs of end-of-pipe treatment that may be needed to meet upcoming regulations
- Mercury alternatives are becoming more readily available and in many cases are cheaper.

Demonstrates Leadership

- Your hospital is a leader in the local medical community.

Examples of What Some Hospitals Are Doing

- See tables

Mercury Pollution Prevention in Select Michigan Hospitals
(Table Compiled by the National Wildlife Federation, August 1995)

Pollution Prevention Actions	Bronson, Kalamazoo	Butterworth, Grand Rapids	Henry Ford, Detroit	Genesys, Flint	Riverside, Trenton	U. Michigan Ann Arbor	Corning Labs, Grand Rapids
Administrative directives - (**F**ormal vs. **I**nformal)	✓F	✓F	✓F	✓F	✓I	✓I	✓F
Clean drain traps/catch basins			✓		✓		✓
Educate staff	✓	✓	✓	✓	✓	✓	✓
Install energy efficient lighting			✓		✓	✓	
Inventory mercury uses		✓	✓		✓	✓	✓
Mercury-free batteries	✓	✓	✓	✓	✓	✓	✓
Purchase new mercury-free sphygmomanometers	✓	✓	✓	✓	✓	✓	N/A
Replace broken sphygmomanometers with mercury-free units	✓	✓	✓	✓	✓	✓	N/A
Replace mercury thermometers	✓	✓	✓	✓	✓	✓	
Separate wastes		✓	✓	✓	✓	✓	✓
Substitute pathology lab reagents					✓		✓
Training on spill prevention and management	✓	✓	✓	✓	✓	✓	✓

Mercury Pollution Prevention Activities In Select North American Health Care Facilities
(Table Compiled by Margy Peet, Monroe County Department of Health, Rochester, NY)

Pollution Prevention Actions	Princeton Hospitals, Princeton NJ	Facilities participating in the MWRA/MASCO Mercury Work Group	Hospital for Sick Children, Toronto Hospital & Centenary Health Centre	St. Mary's Hospital, Duluth Minnesota	13 Wisconsin Hospitals
Clean drain traps	✓	✓		✓	
Waste piping power washing		✓			
MOU with POTW (MWRA) to suspend sewer discharge compliance enforcement		✓			
Inventory mercury uses/ waste reduction assessment		✓			✓
Prepared Facilities Loadings Report, Pretreatment Guidance Manual, Technology Identification Report and Mercury Management Guidebook		✓			
Database of mercury content of 8,000 products		✓			
MOU with Government, adopt plans and timetables to reduce or eliminate mercury			✓		
Cost-Effective Alternatives Project			✓		
Replaced mercury thermometers & sphygmomanometers				✓	
Education materials for employees				✓	
Work Group for support & problem solving					✓

Appendix E

Annual Assessment of the Hospital's Mercury Pollution Prevention Program

Use this form for your hospital's baseline mercury assessment before you begin your mercury pollution prevention program. Space is provided to assess progress during four successive years.

Year assessed	Baseline	Year 1	Year 2	Year 3	Year 4
1. Are mercury thermometers still in use? In which departments?					
2. Number of mercury thermometers purchased					
3. Number of mercury thermometers sent home with patients					
4. Are mercury sphygmomanometers still in use? In which departments?					
5. Number of mercury sphygmomanometers purchased					
6. Are mercury gastrointestinal tubes still in use?					
7. Number of mercury gastrointestinal tubes purchased					
8. Is phase-out of mercury laboratory chemicals underway or completed?					
9. Is phase-out of mercury pharmaceutical products underway or completed?					
10. Is phase-out of mercury batteries underway or completed?					
11. Number of mercury batteries purchased					
12. Is phase-out of mercury in electrical equipment underway or completed?					
13. Quantity of mercury waste disposed as hazardous waste					

Year assessed	Baseline	Year 1	Year 2	Year 3	Year 4
14. Quantity of mercury waste recycled					
15. Costs for the recycling and/or disposal of mercury waste					
16. Number of mercury spills					
17. Estimated total quantity of mercury involved for all mercury spills					
18. Is documentation kept for all pertinent staff educated about mercury spill prevention and management?					
19. Percentage of pertinent staff trained about mercury spill prevention and management					
20. Do all pertinent staff know where the mercury vacuum cleaners and/or mercury spill kits are located?					
21. Percentage of pertinent staff that know whom to call for clean-up of a mercury spill					
22. Percentage of maintenance staff that know the proper procedure for trap cleaning in areas where mercury is used					
23. Is training documentation kept for all staff educated about the health and environmental concerns of mercury?					
24. Percentage of staff that has been educated about the health and environmental concerns of mercury					
25. Is there a disclosure about mercury content for each of the products or chemicals used by the hospital?					
26. Percentage of disclosures that are on file (see above)					

Appendix F

Wastewater Sampling and Analysis

Measurement of success is vital to determining the effectiveness of a pollution prevention program. In order to measure success a point of reference needs to be established. This is called a baseline (or starting) point. One of the ways a baseline can be measured is through wastewater monitoring. Be sure to consider all the wastewater lines leaving hospital property.

Both analytical concentration of mercury and the volumes of flow need to be measured. This data should be combined to result in a mass loading of mercury to the sewage treatment facility or receiving stream. All sewage treatment facilities measure discharges the same way. By measuring with the same units as these facilities, apples-to-apples can be compared. Sewage treatment plants in the Great Lakes basin measure mercury in the parts-per-trillion (ppt) range. But upstream, at the source of the mercury, parts-per-billion (ppb) testing *may* be sensitive enough. See below for examples of calculations based on these two concentration ranges.

Mass loading calculation:

$$\frac{\text{Mercury in ppb}}{1{,}000} \times \text{Flow in mgd*} \times 8.34^{**} = \text{Mass mercury loading in lbs/day}$$

$$\frac{\text{Mercury in ppt}}{1{,}000{,}000} \times \text{Flow in mgd*} \times 8.34^{**} = \text{Mass mercury loading in lbs/day}$$

This mass loading calculation should be used to calculate your baseline point, to monitor progress, and to help measure program success. This calculation should be done over a period of time. By repeating the flow and analyses, a more accurate status can be determined. Contact a local wastewater testing laboratory to identify options for sample collection and analysis. Clean sampling techniques, as defined by the U.S. Environmental Protection Agency, may be required for very low detection limits. You can monitor your progress by collecting and analyzing samples one to four times per year.

* mgd: million gallons per day

** 8.34 is a set of conversion factors consolidated to one number so that units will work out.

ppb is equivalent to micrograms per liter (μg/L).

ppt is equivalent to nanograms per liter (ng/L).

Appendix G

Mercury Pollution Prevention Cost or Savings Worksheets

1. Reusable Product Replaced by a Reusable Product

Proposed product _____

Current product _____

Hospital _____

Prepared by _____

Date _____

Capital costs of proposed product*

	Description	**$ Cost**
Product		
Materials		
Installation		
Utility connections		
Engineering		
Start-up and training process		
Other capital costs		
	Total capital costs	$

Annual Operating Costs	**$ Current Product Costs**	**$ Proposed Product Costs**
Disposal		
Recycling		
Handling		
Spill clean-up		
Training		
Calibration		
Other		

Annual net operating cost or savings $ _____

Payback period (in years) = $\frac{\text{Total capital costs}}{\text{Annual net operating cost or savings}}$ = _____

*Depreciation should be considered. Consult with your accounting department about this factor.

Mercury Pollution Prevention Cost or Savings Worksheets

2. Disposable Product Replaced by Disposable Product

Proposed product _____
Current product _____
Hospital _____
Prepared by _____
Date _____

Annual cost of proposed product

				$ Annual Cost
Product	$ _____ @ x # purchased annually	_____	=	_____
Disposal	$ _____ @ x # purchased annually	_____	=	_____
Recycling	$ _____ @ x # purchased annually	_____	=	_____
Handling				_____
Spill Clean-up				_____
Training				_____
Calibration				_____
Other	_____			_____

Total annual cost of proposed product $ _____

Annual cost of current product

				$ Annual Cost
Product	$ _____ @ x # purchased annually	_____	=	_____
Disposal	$ _____ @ x # purchased annually	_____	=	_____
Recycling	$ _____ @ x # purchased annually	_____	=	_____
Handling				_____
Spill Clean-up				_____
Training				_____
Calibration				_____
Other	_____			_____

Total annual cost of current product $ _____

Total annual cost of current product $ _____
Total annual cost of proposed product - $ _____
Annual net cost of savings of proposed product = $ _____

Mercury Pollution Prevention Cost or Savings Worksheets

3. Disposable Product Replaced by a Reusable Product

Proposed product _____

Current product _____

Hospital _____

Prepared by _____ Date _____

Capital costs of proposed product*	**Description**	**$ Cost**
Product		
Materials		
Installation		
Utility connections		
Engineering		
Start-up and training process		
Other capital costs		
	Total capital costs	$

Expected lifetime of product _____ years

$$\frac{\text{Total capital costs}}{\text{Expected lifetime of product}} = \text{Annualized capital cost} = \$\_\_\_\_\_$$

Annual cost of current product	**$ Annual Cost**
Product $ _____ @ x # purchased annually _____ =	

Annual Operating Costs	**$ Current Product Costs**	**$ Proposed Product Costs**
Annualized capital cost of proposed product		
Annual capital cost of current product		
Disposal		
Recycling		
Handling		
Spill clean-up		
Training		
Calibration		
Other _____		
Total annual cost of current product	$	
Total annual cost of proposed product	$	
Net cost of savings of proposed product	$	

*Depreciation should be considered. Consult with your accounting department about this factor.

Appendix H

Sample Letter Requesting Certificate of Analysis and Sample Certificate of Analysis

(Adapted from sample prepared by Western Lake Superior Sanitary District)

University Memorial Medical Center

January 2, 1997

Mary Smith
Director of Sales
Mercury Laboratory Products
40 Third Street
Duluth, MN 55805

Subject: Certificate of Analysis

Dear Ms. Smith:

As you are aware, mercury is ever increasingly becoming a concern as an environmental pollutant. Mercury released from air and water sources is transformed into methylmercury in lakes or rivers. The methylmercury bioaccumulates in the aquatic food chain making consumption of fish hazardous to those organisms high on the food chain. As a result, regulations on the discharge of mercury to the solid and wastewater stream are becoming increasingly stringent.

Because of this knowledge, and our concern for the environment, our institution has instituted a mercury reduction policy. This policy requires the elimination or minimization of mercury in all our purchases. Low level concentrations of mercury in products (less than 10,000 ppm or one percent) are not required to be listed on Material Safety Data Sheets. The contribution from the sum of these low concentration sources accounts for a large fraction of the mercury in the wastewater stream. In order for our purchasing department to be able to make an informed choice on mercury concentration within the products that it buys, we are requesting that all vendors supply us with a certificate of analysis and/or a notarized affidavit which describes product mercury concentration and the detection method used in the analysis. This information will be used along with other criteria in the selection process of our vendors.

Please submit the aforementioned information on all products that you intend to supply our institution. Thank you for your understanding and assistance in this matter.

Sincerely

Jane Doe
Purchasing

Sample Certificate of Analysis

(Adapted from sample prepared by Western Lake Superior Sanitary District)

Anderson's Acids
98 Molarity Drive
Marathon, Ontario
H2S O4 CANADA

Customer : Acme Manufacturing, Inc.

Attn: John Jefferson
Fax : 1-800-555-5555

Product Grade : SULFURIC ACID 93% Shipment Date : 09/03/96

B/L Number : 00008650 Quantity (as is): 100.400 T

Customer P/O No.: C125062

Routing : ONR-HEARST-AC-SSTMA-WC-SUPER-BN-CLOQ-DNE

Tank Car/Tank Truck No. :
UTLX125021

The analysis below is representative of the quality of product loaded into the above shipment.

Parameter	Analysis	Specification
Strength (% H2S04)	93.67	93.19 Min
Color (HU)	11	40 MAX
Iron (ppm Fe)	9	50 MAX
Sulfur Dioxide (ppm S02)	10	50 MAX
Appearance (%T)	100	
Oxides of Nitrogen (ppm NO3)	1	10 MAX
POM (ml 0.02N KMnO4)	1.00	5.00 MAX
Mercury (ppb)	60	

Detection method for mercury analysis _____

ANALYST :

Appendix I

Vendor Product Mercury-Content Disclosure

Hospital name _____

Name of Hospital Purchasing Agent _____

Address _____

_____

Telephone _____ Fax _____

The above-named Hospital has the policy of minimizing the use of mercury in products purchased for the Hospital. Such products may include:

- Barometers
- Batteries
- Cleansers and soaps
- Electrical relays
- Gastrointestinal tubes
- Laboratory chemicals
- Laboratory manometers
- Lamps
- Pharmaceutical products
- Sphygmomanometers
- Switches
- Thermometers
- Thermostat probes
- Thermostats

Vendor name _____

Name of vendor's agent _____

Address _____

_____

Telephone _____ Fax _____

The above-named vendor agrees to:

- Assist _____ Hospital in obtaining manufacturers' disclosures about the mercury content of their products.
- Assist _____ Hospital in selecting products that are virtually free of mercury content.

_____ _____

Signature of vendor's agent Date

Appendix J

Educational Resources for a Mercury Pollution Prevention Program

MWRA/MASCO Mercury Work Group Karen Rondeau 617-241-2347	*Mercury Products Database*, computerized listing of 8,000 chemicals in Microsoft Access™ (free)
	Facilities Loadings Subgroup Report (39 pages plus appendices, free)
	Mercury Management Guidebook (30 pages plus appendices, free)
	Pretreatment Guidance Manual (47 pages plus appendices, free)
	Technology Identification Subgroup Report (30 pages plus appendices, free)
	(See also listing for the MASCO Internet site)
Minnesota Office of Environmental Assistance Emily Moore 520 Lafayette Rd. N., 2nd Floor St. Paul, MN 55155-4100 612-215-0201 FAX 612-215-0246	Video (inquire about availability)
National Wildlife Federation **Great Lakes Natural Resource Center** 506 E. Liberty, 2nd Floor Ann Arbor, MI 48104-2210 313-769-3351	*Mercury Pollution Prevention in Healthcare: A Prescription for Success* (42 pages, $6.00)
Terrene Institute 4 Herbert Street Alexandria, VA 22305 703-548-5473 FAX: 703-548-6299 E-Mail: Terrinst@aol.com	*The Case Against Mercury: Rx for Pollution Prevention* (one of two sources for ten-page booklet and poster, free)

U.S. Environmental Protection Agency
Region V
Chris Urban
Attn: WW-16J
77 West Jackson Blvd.
Chicago, IL 60604
312-886-3493

The Case Against Mercury: Rx for Pollution Prevention (one of two sources for ten-page booklet and poster, free)

General outreach materials (free)

Video (inquire about availability)

Western Lake Superior Sanitary District
Jamie Harvie
2626 Courtland St.
Duluth, MN 55806-1894
218-722-3336, ext. 307

MercAlert (pamphlet for consumers, free)

Blueprint for Mercury Elimination: Mercury Reduction Project Guidance for Wastewater Treatment Plants (38-page book of interest beyond wastewater treatment plants, free)

Internet Sites:

(Massachusetts) Medical, Academic and Scientific Community Organization (MASCO)
www.masco.org/mercury

Massachusetts Water Resources Authority
www.mwra.state.ma.us

Michigan Department of Environmental Quality
www.deq.state.mi.us/ead/p2sect/mercury

National Wildlife Federation
www.igc.org/nwf/greatlakes/pp/hosprpt

U.S. Environmental Protection Agency
www.epa.gov/seahome/mercury/src/outmerc

For additional resources, see Appendix L, Mercury Reduction Case Studies, and Appendix R, Bibliography.

Appendix K

Disposal of *Take-Home Household* Mercury Thermometers by Patients

You have been given a mercury thermometer to take home with you at the end of your stay in the hospital. Of course, a mercury thermometer is safe to use as long as the thermometer is intact. However, if the thermometer breaks or is discarded improperly, the mercury may contribute to an environmental problem.

If a mercury thermometer breaks, wear plastic gloves during the clean-up process. The mercury can be gathered using one or two index cards as scoops. Transparent or masking tape can be used to blot up the residue. Double-bag the mercury and cleanup materials in plastic resealable bags and place them into a rigid plastic container.

Dispose of broken and unbroken mercury thermometers at the household hazardous waste facility in the county in which you live.

GLOW (Counties of Genesee, Livingston, Orleans, Wyoming): GLOW conducts household hazardous waste collection days. Call 716-344-4035 or the GLOW recycling hotline at 800-836-1154 to be notified when a collection day will be held and to receive packaging instructions.

Monroe County: Materials containing mercury can be dropped off without an appointment in the Industrial Waste Office foyer of Building 15 at 444 East Henrietta Road in Rochester. The foyer is open from 7:00 a.m. to 4:30 p.m. Monday through Friday. For any other household hazardous waste, call the Household Hazardous Waste Facility at 716-760-7600 to make an appointment.

Ontario County: Ontario County holds a household hazardous waste collection day once a year for County residents. For further information, call the Ontario County Recycling Hotline at 800-836-7678.

Western Finger Lakes Solid Waste Management Authority (Counties of Seneca, Wayne, Yates): Call 800-724-3867 to learn the date of the next household hazardous waste collection.

Appendix L

Mercury Reduction Case Studies

1. Strong Memorial Hospital, Rochester, New York

When the Monroe County Department of Health decided to form a Mercury Pollution Prevention Task Force it contacted and received cooperation from a faculty member of the University of Rochester Medical Center's Environmental Health Science Department. A student in the Master's program for Environmental Studies performed initial fact finding as part of a project for a Master of Science degree.

No University or Strong Memorial Hospital administrator was contacted formally by the County until the initial "kick-off" meeting. Informal communication between a faculty member and the University's Director of Environmental Health and Safety prior to the kick-off meeting was not adequate to outline the project intent or scope. The net result was that it took over a year to work out a Memorandum of Understanding (MOU) that was acceptable to all parties involved. Once top administrative staff were on board the rate of progress and access to the facility improved dramatically. This experience yielded Lesson 1: Identify and involve all appropriate facility management in the process before predetermining a program's scope and desired outcome.

The intern wrote a comprehensive report which detailed the status quo of mercury usage and management at the University of Rochester Strong Memorial Hospital (SMH). In addition, other undergraduate interns, along with members of University/SMH staff, investigated mercury usage and gathered existing policies/protocols (official and unofficial). The findings were as follows:

1. Mercury thermometers were being used in cases of isolation patients and in-patient care units where electronic thermometers were deemed inappropriate. These units included Newborn and the Neonatal Care Units. Six units were identified as using over half the mercury thermometers at SMH. The rest of the Hospital used non-mercury devices. The Director of Medical Engineering stated that over 1.14 million non-mercury temperatures were taken at SMH during 1996 and that the phase-out would continue as more equipment was purchased.

2. Mercury-filled sphygmomanometers were being phased out as the equipment needed replacement. All new construction and renovations included aneroid blood pressure reading devices.

3. Gastrointestinal devices that contained mercury were generally being replaced with tungsten-filled equipment unless there was a medical reason for not doing so.

4. Laboratory reagents, such as histology fixatives and stains, that contained mercury had not been used since 1992. Only those reagents or procedures in which mercury could not be substituted or were not known to contain mercury were still being used in the Clinical Laboratories.

5. Noncontact dental amalgam was being collected for proper disposal.

6. Energy efficient lighting was installed as a part of the USEPA Green Lights Program. High mercury T-12 lamps were replaced by lower mercury T-8 lamps.
7. Fluorescent lamps that failed Toxicity Characteristic Leaching Procedure (TCLP) testing were being collected and disposed of as hazardous waste.

8. Mercury spill protocols were long established (at least since 1983). These were current and the staff trained periodically. A log book of spills was being maintained. In fact, SMH owned a special mercury vacuum cleaner with activated carbon filters for vapor control. An industrial hygienist used a mercury vapor "sniffer" to determine if spill cleanup efforts were successful. The earliest record of a mercury "sniffer" being used at the facility was in the early 1980s. There was also a pre-existing mercury disposal/spill protocol for Nursing Units in existence since 1983 that has been updated periodically.

9. Hazardous waste**,** including mercury, was being collected via a formal program and shipped to off-site facilities for disposal.

10. Battery collection sites were already established throughout the Medical Center to prevent batteries from being incinerated. In addition, a letter was on file stating that the alkaline batteries purchased under the University contract contained no added mercury.

11. Monthly monitoring for mercury vapors was being performed by an industrial hygienist in areas where mercury equipment was being repaired or stored.

Areas of concern included:

- Initial testing of the wastewater effluent showed mercury levels of 0.8 ppb. This would be required to be reduced once the Great Lakes Water Quality Initiative standards were adopted.
- Existing policy was sometimes decentralized. Gathering information was sometimes difficult and the results from questionnaires or other queries could be conflicting. There was no mercury thermometer take-home policy.
- Substitutes for mercury are still to be identified for thermometers in some applications at SMH.
- Mercury as a contaminant needs to be addressed for various lab reagents and cleaning compounds.
- Mercury pollution prevention training needs to be incorporated into as many pre-existing training programs as feasible.
- Contact amalgam (amalgam that has been in the patient's mouth) was being considered regulated medical waste.
- Mercury thermometers from isolation patient care rooms were being considered regulated medical waste.
- Nursing staff surveys indicated that not all staff understood fully what to do with used mercury thermometers or with mercury in the event of a spill, in spite of existing policy and training. Similar knowledge gaps were also discovered in other areas of the institution.

This information led to Lesson 2: In spite of policy or training, there are always items that can fall through the cracks. It pays to compare practice with policy in order to identify and solve a problem.

A Mercury Work Group was established at SMH. It included representatives of:

- Administration
- Clinical Laboratories
- County Health Department
- Dentistry
- Education
- Environmental Health and Safety
- Facilities
- Housekeeping
- Medical Engineering Laboratory
- Nursing Practice
- Procurement
- Quality Assurance
- Stores

The Hospital's mercury pollution prevention program accelerated after the formation of the Work Group in the following areas:

Elimination of mercury

- Non-mercury thermometers were identified and tested in some of the areas where no substitute was previously identified.
- Some nursing units no longer give out take-home thermometers.
- Laboratories were surveyed to verify that mercury was still no longer being used. If discovered, the use and disposal route were determined.
- Mercury sphygmomanometer replacement was tracked more closely and the rate of replacement increased.

Education

- Mercury-specific training was included in the annual required training video. A specific test question about mercury disposal was included. Also a new segment about mercury was added to the Facilities Operations and Maintenance training presentation.
- Educational packets were created for nursing managers and the housekeeping supervisor.
- A mercury survey for nursing personnel was developed that was intended to be used both before and after training. (See survey at the end of this case study.)
- Articles were written and published in SMH/University newspapers that pointed out some of the issues and concerns with mercury.
- Designated containers for mercury thermometer disposal were placed in the "soiled utility rooms." The containers are marked with a specially designed sticker (see end of this case study).
- Specially designed stickers (see end of this case study) were placed on or near red bag containers to discourage the placement of a mercury thermometer there.
- An overview of the mercury pollution prevention program was given to department heads at a meeting. The overview included the reasons for the program and successes that have been achieved so far.
- A pamphlet on "Mercury Management for Nursing Units" was distributed to the nursing personnel (see end of this case study).
- A plan was developed to display educational materials about mercury for the general public in the corridor to the Hospital cafeteria.

Policy

- Nursing Policy was updated to cover mercury thermometers from isolation units (disinfection prior to collection).
- Policies about mercury have been collected from various departments and are being consolidated.

Best management practices

- A disposal container for mercury-containing electrical parts, such as switches, was placed at the location where the replacement equipment is distributed.
- A protocol for the care, use and recycling of dental materials was implemented in the Department of Dentistry and Eastman Dental Center.
- The Hospital entered into an agreement with the Monroe County Department of Environmental Services that establishes best management practices to reduce mercury loading from the Hospital to the County's wastewater treatment system.

For further information, contact Hazardous Waste Manager, Environmental Health and Safety, University of Rochester, 716-275-2056.

Mercury Survey for Nursing Personnel

This survey is part of an upcoming hospital-wide effort to educate personnel about the proper handling and disposal of mercury-containing items.

A. Which of the following items *may* contain mercury?

1. Gastrointestinal tubes
2. Sphygmomanometers
3. Thermometers
4. Batteries

B. What is the proper disposal method for mercury thermometers in patient care units? Choose one.

1. Place in normal trash.
2. Place in red bag.
3. Send home with patient.
4. Place in soiled utility collection area.
5. Place in sharps shelter.
6. Do not know.

C. Do you know why mercury thermometers should be discarded in this manner (see question above)? Choose all that apply.

1. It prevents mercury from getting into the air during incineration.
2. It prevents mercury from causing an explosion.
3. It prevents mercury from reacting with other hospital chemicals.
4. It ensures proper disposal of mercury.
5. It prevents the spread of disease.
6. All of the above.

D. What is the proper disposal method for a mercury thermometer that has been used in an isolation unit? Choose one.

1. Disinfect before removing from the isolation unit and place in normal trash.
2. Place in red bag.
3. Send home with patient.
4. Disinfect before removing from the isolation unit and place in soiled utility collection area.
5. Place in sharps shelter.
6. Do not know.

E. What is the problem with sending mercury thermometers home with new mothers? Choose all that apply.

1. The thermometer can cause a health problem in the baby during normal use.
2. The thermometers are very expensive.
3. The family may be exposed to mercury if the thermometer breaks.
4. The thermometer may not be properly discarded.
5. Do not know.

F. What is the protocol for disposal of gastrointestinal tubes containing mercury? Choose one.

1. Place in a sealed labeled container and place in the soiled utility collection area for pickup by Materials Management personnel.
2. Place in a sealed labeled container and then in the normal trash.
3. Place in a sealed labeled container and call the Hazardous Waste Management Unit for pickup.
4. Do not know.

G. Which of the following health effects is associated with chronic exposure to mercury vapor? Choose one.

1. Cardiac arrest
2. Lung cancer
3. Damage to the nervous system
4. Allergies
5. Do not know

H. Why is it important to keep mercury out of the air and water? Choose all that apply.

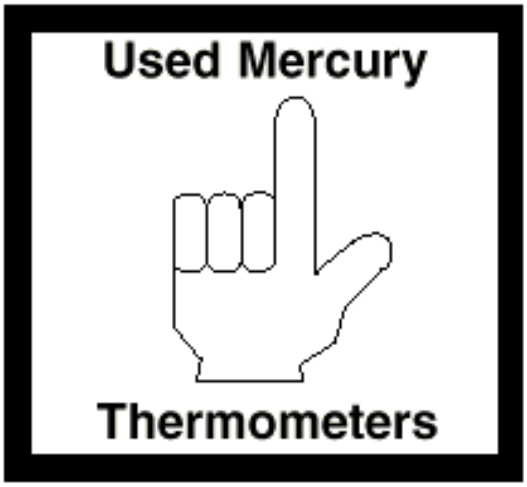
1. It causes human health problems.
2. It bonds easily with other metals.
3. It can damage fish and wildlife.
4. It can be explosive when exposed to sunlight.
5. Its discharge is illegal.
6. Do not know.

I. Who can you always call in the event of an emergency?

_____

What is the telephone number?_____

Mercury Stickers



Steps to Pollution Prevention

AVOID UNNECESSARY USE OF HAZARDOUS MATERIALS.

IF USE IS NECESSARY:

- Use sparingly and carefully.
- Dispose of used and unused products in accordance with facility disposal requirements.
- Clean up spills properly. Follow institutional protocols.

For More Information

CONTACT THE HAZARDOUS WASTE MANAGEMENT UNIT AT:

x 52056

IN AN EMERGENCY CONTACT SECURITY AT:

x 13

STRONG HEALTH

STRONG MEMORIAL HOSPITAL

Mercury Management

FOR

Patient Care Units

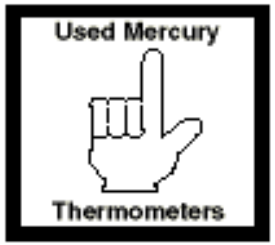
AT

Strong Memorial Hospital

Disposal of mercury for nurses

THERMOMETERS

- Place on soiled utility cart. (If from an "isolation" patient, clean with disinfectant first.)



GASTROINTESTINAL TUBES

- Place on soiled utility cart.

BATTERIES

- Place on soiled utility cart.

SPHYGMOMANOMETERS

- Call Medical Engineering Lab for disposal.

Mercury facts

1. Mercury can cause health problems. High levels of mercury in infants can cause nervous system damage and other problems.
2. Mercury bioaccumulates in the body. Mercury builds up in muscles of humans, fish and other wildlife.
3. Mercury gets into the air during incineration or autoclaving of red bags.
4. Improper disposal of mercury is illegal.

In case of a chemical spill...

- Follow nursing procedures and policy manual guidelines 12.10.
- Contact your supervisor.
- Dispose of properly.

never dispose in:

normal trash, sharp shelters or red bags.

2. F.F. Thompson Hospital, Canandaigua, New York

F.F. Thompson Hospital has not had a *formal* mercury pollution prevention policy, has not had a *formal* educational program, and has not had a mercury pollution prevention "champion." And yet Thompson has eliminated almost all uses of mercury from the facility. Thompson began its informal mercury pollution prevention program in 1990 because of the recognition that mercury products can be hazardous to employees and patients, especially where there is a high potential for breakage. Other incentives were the reduction of mercury disposal costs, the avoidance of mercury spill clean-ups, and the difficulty of complying with OSHA requirements for the use of mercury.

The pollution prevention program began with the phase-out of sphygmomanometers, which was completed in 1993. The Hospital has also:

- Discontinued the use of mercury thermometers, except in isolation units, because the electronic thermometers were considered to be a better technology overall.
- Discontinued the use of mercury stains in order to eliminate discharge of the stains to wastewater.
- Replaced or are replacing mercury gastrointestinal tubes with tungsten tubes.
- Eliminated the use of mercury batteries because newer equipment came with mercury-free batteries.

There are some factors that eased Thompson's transition to mercury-free. Thompson Hospital empowers its associates to make decisions, thus hastening the time to move a project from the idea phase to the implementation phase. Thompson Hospital is a relatively new facility. Therefore, it has been easy to ensure that electrical equipment, such as switches and thermostats, are mercury-free. Thompson's small to medium size may be an advantage over a larger hospital. It is easier to make changes in a smaller hospital because it has a smaller inventory. Also, a smaller hospital may use a smaller variety of materials.

For further information, contact Mike Zanghi, F.F. Thompson Hospital, 716-396-6770.

3. Case Studies of Mercury Pollution Prevention Measures in Michigan Health Care Institutions

The following information is adapted from: Michigan Mercury Pollution Prevention Task Force (1996), *Mercury Pollution Prevention in Michigan: Summary of Current Efforts and Recommendations for Future Activities*.

As part of the compilation of the *Mercury Pollution Prevention in Michigan* report, a health care group was formed to identify the uses of mercury in hospitals and alternatives for those uses. Several hospitals were contacted regarding the topic of mercury pollution prevention measures currently underway in their institutions. While there are measures that must be adhered to under federal and state laws, for example training on spill prevention and management, many of these health care institutions go beyond mere compliance with existing law by educating a broad spectrum of employees in the proper procedures in handling mercury spills and minimization of mercury use. The following are examples of some of the ongoing activities.

Bronson Hospital, Kalamazoo, Michigan

Educating the staff about the proper use of mercury-containing devices and spill clean-up procedures has helped to decrease mercury in water discharge. Bronson Hospital formalized a policy to ban the purchase of mercury-containing items where alternatives exist. In areas undergoing remodeling, sphygmomanometers containing mercury are being replaced with aneroid devices.

Bronson is also working in conjunction with Kalamazoo's wastewater department to meet their mercury discharge limit of 5 parts per billion, and to further decrease their concentration to 3 parts per billion.

Butterworth Hospital, Grand Rapids, Michigan

Butterworth Hospital has made a commitment to reach mercury-free status. They have instituted a purchasing department policy stating that, unless there is no suitable mercury-free alternative, no mercury-containing devices are to be purchased. Administrative approval was given to replace all sphygmomanometers currently in use with aneroid devices. The obstetrics department stopped sending mercury thermometers home with new mothers.

Butterworth Hospital hired a local environmental consultant to devise a mercury spill response and disposal plan that is safe and economical for the entire hospital. The consultant also offered training on spill response, prevention and management. Educational materials about mercury, including the Terrene brochure (see *Appendix J*), were distributed to all hospital departments, administrative personnel and regional facilities.

Butterworth Hospital is introducing mercury pollution prevention in all entities in the Butterworth health system, such as free-standing medical centers, clinics, nursing homes and affiliated rural hospitals.

Corning Clinical Laboratory (now Quest Diagnostics), Wyoming, Michigan

Corning Clinical Laboratory instituted mercury pollution prevention measures to meet the City's strict water guidelines of 0.5 ppb. Corning isolated manufacturer contributions of mercury within its wastewater system by testing its list of reagents for mercury content. Manufacturers might not list mercury on their Material Safety Data Sheets if the amount is less than one percent. Therefore Corning did not know the sources of mercury until test results were finalized. Once the sources were determined, a formal mercury reduction policy was instituted. Corning located vendors that could provide mercury-free reagents or, where possible, changed methodologies to processes that do not involve mercury.

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

- Prostatic specific antigen (Hybertech)
- Cryptococcus antigen wash (Meridian)
- Clostridium difficile wash (Meridian)
- Cesium diluent for lithiums (CMS)
- Wash solution for Hitachi analyzers (BMC)
- FTA antibody test kit (Zeus)
- Lyme antibody test kit (Mardx)
- EBV antibody test kit (Organon)
- Herpes antibody test kit (Biowhittak)

Riverside Osteopathic Hospital, Trenton, Michigan

Riverside Osteopathic Hospital's Mercury Minimization Plan includes identifying sources of mercury, developing a spill management procedure, providing educational material to staff, and developing an action plan that sets up a timetable for implementing mercury pollution prevention measures.

Riverside Hospital identified some mercury sources and found mercury-free alternatives. Riverside informally instituted a policy allowing only mercury-free devices to be used in the Hospital, including thermometers, thermostats and sphygmomanometers. The Hospital discontinued using mercury-containing batteries, and has substituted water-containing esophageal dilator tubes for the mercury-containing tubes. Riverside is investing in T-8 lamps with electronic ballasts that contain less mercury than the lamps previously used. The Hospital has also eliminated caustic drain cleaners and switched to the alternative organic oils and compounds that are not as harmful to the environment. A spill prevention kit was purchased for mercury cleanup.

University of Michigan (UM) Health System, Ann Arbor, Michigan

An informal policy exists in the institution allowing only mercury-free items to be purchased. This includes sphygmomanometers, thermometers and batteries. Sphygmomanometers containing mercury have been replaced with aneroid devices, including those in newly acquired physicians' practices and offsite clinics. The same holds true for mercury thermometers, which are being replaced by their digital counterparts in all areas.

Laboratories within the University Hospitals are investigating whether or not laboratory procedures that contain mercury can be substituted by those that are mercury-free. However, laboratories are hesitant to switch procedures where the same effectiveness is not guaranteed. The pharmacy has successfully discontinued using mercury in any items dispensed. The UM Health System has also implemented a fluorescent tube recycling project.

The Terrene brochure (see *Appendix J*) was distributed to individuals within the UM Health System who are responsible for disposing and dispensing mercury-containing items. UM Hospitals utilize a mercury vacuum as appropriate during spill response activities.

For further information about mercury pollution prevention in the Michigan Hospitals, contact Steve Kratzer, Michigan Department of Environmental Quality, 517-373-0939.

4. Massachusetts Water Resources Authority (MWRA)/Medical, Academic and Scientific Community Organization (MASCO) Mercury Work Group

The Massachusetts Water Resources Authority (MWRA) is a public agency charged with supplying water and sewerage services to municipalities in the Boston metropolitan area. The MWRA/MASCO Mercury Work Group, a public-private partnership of the MWRA and sewer dischargers (including hospitals, universities, and other industries), was established in 1994 to study and implement ways to reduce mercury discharges to the MWRA sewerage system. One institution, the Medical Academic and Scientific Community Organization, Inc. (MASCO) that represents many local Boston hospitals, has worked from the beginning of this effort to help identify the sources and methods of removing mercury from hospital waste streams. Phase II of the Work Group was initiated in 1996 to further examine mercury management techniques and promising mercury pretreatment technologies.

During Phase I, the Work Group addressed sources of mercury, developed a *Mercury Products Database*, considered mercury pretreatment systems, and developed guidelines for source reduction and removal of residual mercury from hospital wastewater piping systems. As a result of this effort, 28 participating hospitals reduced the annual mercury concentration of their wastewater from an overall average of approximately 23 μg/l (ppb) to as low as 6 μg/l (ppb).

The Phase II effort has updated the work of Phase I and has resulted in the development of an enhanced *Mercury Products Database* built on a Microsoft Access™ platform. The Database lists approximately 8,000 chemicals used by hospitals and institutions. For about 800 listed products, the Database includes the results of analytical testing for mercury content. The Phase II effort also resulted in the publication of four reports as follows:

- *Facilities Loadings Subgroup Report* - estimated sewer discharge loadings of mercury from five types of facilities discharging to the MWRA sewerage system.
- *Pretreatment Guidance Manual* - recommended steps for implementing coordinated source reduction, source segregation, and pretreatment including mercury pretreatment.
- *Technology Identification Subgroup Report* - background and results of a bench-scale feasibility testing project involving six different mercury pretreatment technologies.
- *Mercury Management Guidebook* - recommended steps for overall management of mercury to reduce and control the mercury concentration of sewer discharges.

For further information, contact Karen Rondeau, Massachusetts Water Resources Authority, 617-241-2347.

5. Mercury Management at Mayo Clinic

The following case study was written by David H. Senjem, Environmental Safety Coordinator, Mayo Clinic, Rochester, Minnesota.

Mayo's management of mercury in the medical environment has evolved over time. Mercury batteries were first collected for referral to a California-based reprocessing center in 1978. A strong emphasis has existed since the mid-1970s on collecting and commercially disposing of mercury-containing laboratory wastes through Mayo's hazardous waste program. Specialized mercury vacuum cleaners were first purchased in the 1970s to ensure that mercury spills were effectively and safely managed.

In more recent years, institutional interest in mercury management has led to even more aggressive actions. Mercury thermometers have been removed from Mayo's 1,500 outpatient examination rooms and replaced with electronic devices. Mercury-containing sphygmomanometers were replaced with mercury-free devices in all hospital areas. Laboratory test procedures have been re-evaluated for mercury use with an emphasis on substitution, whenever possible, and strict attention to disposal management when not possible. Used mercury-containing fluorescent light bulbs are collected and disposed of through a commercial vendor who recovers and recycles mercury.

Efforts continue to further investigate and reduce the presence of mercury in the Mayo environment. Examples of such efforts include the incorporation of heavy metal analysis in certain product purchases and similar evaluations in certain large components of Mayo's incinerated waste stream. Additionally, there are continuing educational efforts to sensitize staff on avoidance of the use of mercury or mercury-containing materials, whenever possible, and especially when alternative choices are available.

For further information, contact David Senjem, Mayo Clinic, 507-284-7459.

6. St. Mary's Medical Center, Duluth, Minnesota

The following information is from: Western Lake Superior Sanitary District (March 1997), *Blueprint for Mercury Elimination: Mercury Reduction Project Guidance for Wastewater Treatment Plants*, page 18.

St. Mary's Medical Center is a 326-bed hospital located in Duluth, Minnesota. Western Lake Superior Sanitary District (WLSSD) staff began the mercury reduction project by meeting with Hospital management to ensure their interest and commitment. Once support was assured, an existing team of Hospital employees worked with WLSSD staff on the project.

Representatives from maintenance and purchasing departments were particularly important to the team. The maintenance staff is familiar with the inner workings of the Hospital, which is helpful when conducting monitoring. Purchasing department involvement is necessary because toxics reduction projects often involve changes in the types of products purchased and used.

As a first step, the mercury reduction team completed a survey on mercury use provided by WLSSD (see survey at the end of this case study). The survey disclosed that St. Mary's had already replaced some mercury-containing items, such as thermometers and blood pressure cuffs, with alternative electronic devices. In addition, mercuric chloride, a common reagent used in the pathology lab, was being captured and handled as hazardous waste instead of being flushed to the wastewater treatment plant.

A wastewater monitoring plan was then developed to try to pinpoint mercury sources within the Hospital. Older buildings, such as hospitals, often have several discharge points to the sanitary sewer system. Meeting with maintenance staff to review old blueprints was found to be essential before beginning the monitoring program. The use of dye tablets may be needed to verify sewer flow and route connection information, especially in facilities that have undergone expansion. Monitoring results found mercury concentrations varying from 0.3 ppb to 1.2 ppb. The monitoring also identified days on which mercury concentrations were high, and where it came from in the Hospital. In this case, the information was valuable in educating the reduction team. The team felt they had already solved their mercury problem and didn't anticipate additional discharges. Once they saw the numbers, however, a "can do" attitude quickly developed.

In 1997, the remaining mercury in the wastewater appeared to be coming from the Hospital laboratories and laundry services. Reagents and bleach are the suspected sources. These products are being investigated and, where possible, alternatives will be substituted.

Historic sources are also under investigation. Mercury from items such as broken thermometers may have been disposed of down the drain in older buildings. The mercury accumulates in waste traps and discharges in small amounts each time water is used. Traps in nursing stations and in the labs are being cleaned and inventoried as part of the reduction effort.

WLSSD continues to work with St. Mary's on mercury reduction and has initiated similar projects with the other hospitals in Duluth. These following actions are essential first steps for any hospital beginning a mercury reduction project:

1. Discontinue the purchase of mercury-containing equipment such as thermometers, sphygmomanometers and gastrointestinal equipment, and substitute mercury-free alternatives for existing equipment.

2. Discontinue the policy of sending mercury thermometers home with new parents (this practice is illegal in Minnesota).

3. Institute recycling programs for mercury-containing lamps and batteries.

4. Implement a mercury-free purchasing policy and request all vendors to disclose mercury concentration on a Certificate of Analysis. Products with no mercury or low mercury can then be selected for purchase.

For further information, contact Jamie Harvie, Western Lake Superior Sanitary District, 218-722-3336, ext. 307.

WESTERN LAKE SUPERIOR SANITARY DISTRICT
MEDICAL FACILITY MERCURY SURVEY

This checklist is provided as a sample. A checklist can be a useful tool to help medical facility staff identify sources of mercury in their workplace.

Type of Facility (hospital, clinic) _____
Size of Facility (number of beds, number of patient visits) _____
Contact Name _____
Title _____ Phone_____

MERCURY SOURCES

Please indicate the following mercury sources located or used in your facility.

___ Fever thermometers (including home-care visits and those sent home with newborns)
___ Sphygmomanometers
___ Commercial manometer
___ Gastrointestinal diagnostic equipment
___ Feeding tubes

Chemicals
___ Zenker's solution ___ Histological fixatives

Staining solution and preservatives
___ Mercury chloride ___ Mercury (II) oxide ___ Mercury (II) chloride ___ Mercury (II) sulfate
___ Mercury nitrate ___ Mercury iodide ___ Other

Lamps
___ Fluorescent ___ Metal halid ___ High pressure sodium ___ Ultraviolet

Batteries
___ Mercuric oxide ___ Button batteries

___ Thermostats

___ Barometers

___ Switches (relay, tilt, silent)

___ Other possible mercury sources -- please list here any other materials that should be a concern for mercury pollution.

_____

Have you considered mercury-free alternatives for any of the products listed above?___ Yes ___ No

FACILITY PRACTICES

Complete the following section on facility practices. Additional pages may be attached if needed.

Safety Practices

Is staff training provided on the health and environmental concerns of mercury? ___ Yes ___ No

Is staff training provided on mercury spill prevention or management? ___ Yes ___ No
If yes, indicate the departments that have this training and the frequency.

_____

Is there a mercury spill clean-up kit on site? ___ Yes ___ No

Have there been any mercury spills within the last ten years? ___ Yes ___ No
If yes, indicate the source of the spill(s) and the clean-up method.

_____

_____

Purchasing Practices

Does your facility have a policy on purchasing mercury-containing products? ___ Yes ___ No
If yes, please attach policy.

Does your purchasing department currently require a disclosure by your vendors of mercury concentrations in chemicals/reagents? ___ Yes ___ No

Disposal Practices

What is the current procedure for disposal of medical waste?
___ autoclave ___ incineration ___ other

Have your sewer drain traps or catch basins been cleaned to remove mercury? ___ Yes ___ No
If yes, list the area of the facility and dates.

_____

Was mercury discovered? ___ Yes ___ No

Are any mercury products in your facility currently recycled? ___ Yes ___ No

Are there other facility practices that you think should be a concern for mercury pollution? List here:

_____

_____

Appendix M

Prevent Mercury Pollution

Use Best Management Practices for Amalgam Handling and Recycling

John D. Doyle
County Executive

Prepared by the Monroe County Department of Health, in cooperation with
the University of Rochester's Department of Dentistry and Eastman Dental Center and
the Monroe County Department of Environmental Services,
with funding by a grant from the U.S. Environmental Protection Agency

Introduction

This booklet has been developed to enlist your help in a region-wide effort to manage amalgam waste so as to protect the environment from mercury. The amalgam management practices described in this booklet were developed during the past few years by dentists at the University of Rochester's Department of Dentistry and Eastman Dental Center in Rochester, New York, and by dentists in Minnesota, in cooperation with the Western Lake Superior Sanitary District. The methods have been shown to be effective in keeping mercury from amalgam out of the environment.

Share this booklet with your staff. When new employees join your staff, make sure that they read this booklet also. You and your staff together can evaluate your current practices and, where appropriate, adopt new practices to protect the environment from the discharge of mercury from dental amalgam.

How mercury from dental amalgam can get into the environment

There are many ways that mercury from dental amalgam can get into the environment:

- Amalgam particles that are rinsed down drains or that escape poorly maintained chair-side traps and vacuum pump filters travel through the sewer system to the wastewater treatment plant. From there mercury from the amalgam may enter the environment in one of three ways: (1) It may be released directly to a waterway; (2) It may be released to the air if the treatment plant sludge is incinerated and then re-deposited to the ground or a waterway; (3) It may be released to soil if treatment plant sludge is land spread.
- If a dental practice is connected to a septic system, amalgam particles become part of the sludge in the septic tank, which is eventually pumped out and transported to a wastewater treatment plant or land spread. Any mercury from the amalgam that becomes soluble will end up in groundwater.
- Placing an item that contains amalgam particles in a red bag allows mercury from the amalgam to be released into the air if the medical waste is incinerated. The volatilized mercury is then re-deposited to the ground or a waterway.
- If items that contain amalgam particles are discarded with the ordinary trash, there is the potential for mercury from the amalgam to leach into groundwater when the trash is placed in a landfill not designed to handle hazardous waste.
- In an older dental clinic, pure bulk mercury from past practices may have settled in sink traps. The mercury is gradually released into wastewater for many years after the use of bulk mercury has been discontinued.

New federal regulations greatly reduce the amount of mercury that is allowed to be discharged from a municipal wastewater system or an incinerator. By implementing the best management practices described in this booklet, you can reduce the level of mercury in the environment and avoid the need for increased regulations in the years to come.

Amalgam storage and handling

Stock your amalgam materials in a good choice of capsule sizes, in order to better select the right amount of material for a particular restoration. This will minimize waste.

Dental scrap amalgam should be collected and stored in two designated, tightly closed, widemouth plastic containers. One container should be labeled CONTACT AMALGAM (amalgam that has been in the patient's mouth). The other should be labeled NONCONTACT AMALGAM. Neither the New York State Department of Health nor the Occupational Safety and Health Administration (OSHA) requires that contact amalgam be discarded in a medical waste red bag.

Most recyclers prefer that *contact* amalgam be transported for recycling in a disinfectant. The liquid is visual evidence that the contact amalgam has been disinfected. *Noncontact* amalgam in a tightly sealed container can be stored and transported dry.

Amalgam capsule handling

Collect and store the entire contents of broken or unusable capsules with your noncontact scrap amalgam. If empty dental amalgam capsules contain no visible amalgam materials, they may be placed in the trash.

If there is a spill of mercury from a capsule, contain it and clean it up immediately. Keep mercury clean-up materials on hand, and train a staff member in proper spill clean-up. Inexpensive mercury clean-up materials are available from science and safety equipment suppliers. (Some suppliers are listed on page 8.)

Amalgam trap and filter handling

When the fine particles of amalgam come in contact with cleaning agents and chemicals in the suction system and sewers, the mercury may be released. Large particles of amalgam can be prevented from entering the sewer system by the use of chair-side traps and vacuum pump filters. Material captured in the traps and filters can be sent to a recycler. Calculations based on data in scientific literature indicate that, when used properly, chair-side traps and vacuum pump filters can capture about 70% of the amalgam that enters the vacuum system.

- **Never rinse scrap amalgam down the drain.**
- **Never place scrap amalgam in the medical waste red bag.**
- **Never place scrap amalgam in the trash.**

Recommended techniques for collecting amalgam from the chair-side traps are as follows:

1. Change or clean chair-side amalgam traps often. The frequency may vary from daily to weekly depending on how often the chair is used for amalgam placement or removal and the effectiveness of the suction.

2. Flush the vacuum system with disinfecting line solution before changing the chair-side trap. The best method is to flush the line at the end of the day, and then change the trap the first thing the next morning.

3. Use universal precautions (gloves, glasses and mask) when handling the chair-side trap. Choose utility gloves intended for cleaning and handling wastes for this procedure.

4. Do not place gloves, plastic bags or paper towels into the recycling container. These add to the volume of the waste created and cause problems in the recycling equipment.

5. Remove all visible amalgam by tapping the contents into the container labeled CONTACT AMALGAM. Close the cover tightly. If the trap is visually clean, it can be put in the trash. These visually clean traps have been determined to be nonhazardous.* (A heavily contaminated trap should always be recycled. It should be placed in the contact amalgam container.)

Vacuum pump filters are usually located upstream of the central vacuum pump. Recommended techniques for recycling the vacuum pump filters are as follows:

1. Replace or dispose of these filters regularly as recommended by the equipment manufacturer.

2. Use universal precautions.

3. Remove the filter and decant, over a tray, as much liquid as possible without losing visible amalgam.

4. Put the lid on the filter and place the filter in the box in which it was originally shipped. When the box is full, the filters should be recycled.

*Shown by the Toxicity Characteristic Leaching Procedure (TCLP) to be acceptable for landfilling.

Plumbing replacement and repairs

After your office adopts its new amalgam management practices, it may be a good time to replace sink traps. Mercury from past practices often settles at low points such as sink traps and sumps. The slow dissolution of the mercury in a sink trap or sump can release mercury into the wastewater for years after past disposal practices have been corrected. Whenever plumbing parts are moved or cleaned, caution should be taken to avoid spilling the contents in case amalgam or mercury are present. Pour and brush out the sludge and handle it as you would handle contact amalgam. The plumbing parts can be put back in place or discarded in the trash.

Renovations

If you have an older dental office, alert renovators to the possibility of mercury contamination in carpets, in floor cracks, behind moldings and other areas where bulk mercury may have been used, or where amalgam capsules may have been spilled. Call your county health department, district office of the New York State Department of Health, or regional office of the New York State Department of Environmental Conservation if you have questions about disposal of renovation debris. (See page 7 for telephone numbers.)

Keep informed on separator technologies

Systems are available to treat wastewater contaminated with amalgam particles that are too fine to be caught in traps or filters. Most systems employ centrifugation or enhance sedimentation of particles. Some can also capture mercury that is in solution. Some of the new equipment can remove more than 99% of the mercury in the wastewater. It is used in some European countries, where removal rates of at least 95% are required. The systems are being evaluated in dental offices in the U.S. Equipment can be purchased or leased. These systems are expensive now, but may become cheaper in the future. Contact 716-292-3935 for further information.

Recycle bulk elemental mercury stock

In 1994 the American Dental Association recommended that dentists eliminate the use of bulk dental mercury by switching to precapsulated amalgam alloy in their practices. Measurement of the ratio of liquid mercury to amalgam powder is much more exact with the precapsulated technique. There is also less possibility of leakage during trituration. The use of precapsulated amalgam alloy eliminates mercury dispensers and containers as sources of mercury vapor, and eliminates the possibility of spilling a large quantity of mercury.

Recycle bulk mercury. If there is a spill of a large amount of bulk mercury before it is eliminated from your office, call your county health department or district office of the New York State Department of Health for instructions about cleaning it up. (See page 7 for telephone numbers.)

☛ Recycle any bulk elemental mercury that may still be on hand in your office.

Select a recycling method

There are four options for recycling the amalgam from your dental office.

1. **Amalgam containers only**: Mail via U.S. Mail to the Monroe County Household Hazardous Waste Facility in Rochester. It has authorization to collect noncontact amalgam and contact amalgam by mail from other counties, as well as from Monroe County. Make arrangements with the Monroe County Household Hazardous Waste Facility at 716-760-7600 to receive detailed instructions for amalgam recycling. Packaging materials will be provided for your office as long as supplies last.

2. **Amalgam containers, vacuum pump filters and bulk mercury**: Deliver directly to the Monroe County Household Hazardous Waste Facility in Rochester. Materials can be dropped off without an appointment in the Industrial Waste Office foyer of Building 15 at 444 East Henrietta Road, in Rochester. The foyer is open between 7:00 a.m. and 4:30 p.m. Monday through Friday. The Facility has authorization to accept deliveries of these materials from other counties, as well as from Monroe County. Call 716-760-7600 for directions to the Facility and other information.

3. **Amalgam containers and vacuum pump filters**: Ask your infectious or hazardous waste hauler if delivery of amalgam containers and vacuum pump filters to a mercury recycler or the Monroe County Household Hazardous Waste Facility can be arranged.

4. **Amalgam containers, vacuum pump filters and bulk mercury**: Work directly with an amalgam recycling company. There are many questions you will need to ask when choosing a recycler:
   - What can I recycle?
     - Contact amalgam
     - Noncontact amalgam
     - Chair-side traps
     - Vacuum pump filters
     - Bulk mercury
   - What are the costs or profits for recycling each of the above?
   - What are the instructions for disinfection of contact amalgam?
   - What are the packaging requirements for contact amalgam, noncontact amalgam chair-side traps, vacuum pump filters and bulk mercury?

(See page 6 for a partial list of recyclers.)

Recycling Companies

Advanced Environmental Recycling Co.
2591 Mitchell Ave.
Allentown, PA 18103
800-554-AERC

Amalgaway Mail Disposal Service
1002 West Troy Ave.
Indianapolis, IN 46225
800-267-1467

Bethlehem Resource Recovery Division
890 Front St.
P.O. Box Y
Hellertown, PA 18055
610-838-7034

Dental Recycling North America, Inc.
P.O. Box 1069
Hackensack, NJ 07601
800-525-3793

DFG Mercury Corp.
909 Pitner Ave.
Evanston, IL 60202
847-869-7800

Dorell Refinery
533 Atlantic Ave.
Freeport, NY 11520
800-645-2794

Everlights
8500 West 191st Street, Suite 1
Mokena, IL 60448
815-469-0631

Garfield Refining
810 East Cayuga
Philadelphia, PA 19124-3892
800-523-0968 ext. 300

Global Recycling Technologies, Inc.
218 Canton St.
Stoughton, MA 02072
781-341-6080

Maquire & Strickland Refining Co.
1290 81st Ave. NE
Minneapolis, MN 55432
612-786-2858

Mercury Refining Company, Inc.
1218 Central Ave.
Albany, NY 12205
800-833-3505

Mercury Waste Solutions, Inc.
21211 Durand Ave.
Union Grove, WI 53182
414-878-2599

RECYCLIGHTS, Inc.
401 West 86th St.
Minneapolis, MN 55420
800-831-2852

Safety Kleen
P.O. Box 97
Avon, NY 14414
716-226-2411

Note: The above list does not imply an endorsement of any company. Each user is responsible for verifying vendor information. The list is not intended to be all-inclusive, but is provided for informational purposes only.

Contacts for Applicable Regulations

NYSDEC, Region 8 (Counties of Genesee, Livingston, Monroe, Ontario)
Division of Water
6274 East Avon-Lima Road
Avon, NY 14414
716-226-2466

NYSDEC, Region 9 (Counties of Allegany, Wyoming)
Division of Water
270 Michigan Avenue
Buffalo, NY 14203-2999
716-851-7070

Allegany County
Public Health Director
Allegany County Health Department
County Office Building
Belmont, NY 14813
716-268-9254

Genesee County
NYSDEC Region 8; also contact the municipality

Livingston County
Environmental Health Director
Livingston County Health Department
2 Livingston County Campus
Mount Morris, NY 14510-1691
716-243-7280

Monroe County
Industrial Waste Control Section
Monroe County Department of Environmental Services
444 East Henrietta Road
Rochester, NY 14620
716-760-7600

Ontario County
Cornell Cooperative Extension, Ontario County
480 North Main St.
Canandaigua, NY 14424
716-394-4110

Wyoming County
Public wastewater system:
NYSDEC Region 9
Private wastewater system:
Public Health Engineer
Wyoming County Health Department
338 North Main St.
Warsaw, NY 14569
716-237-2666

Providers of mercury spill clean-up products

Bel-Art Products
Pequannock, NJ 07440-1992
201-694-0500

Fisher Scientific
52 Fadem Road
Springfield, NJ 07081
800-766-7000

Lab Safety Supply, Inc.
P.O. Box 1368
Janesville, WI 53547-1368
800-356-0783

Thomas Scientific
99 High Hill Road @ I-295
P.O. Box 99
Swedesboro, NJ 08085
800-345-2100

VWR Scientific Products
5 Marway Circle
Rochester, NY 14624
716-247-0613
800-932-5000

Note: The provision of these names does not imply an endorsement, nor is it intended to be all-inclusive. Each user is responsible for verifying vendor information. The list is provided for informational purposes only.

Contacts for further information

Monroe County Department of
Environmental Services
716-760-7610, Extension 7055

Monroe County Department of Health
716-292-3935

Summary of Recycling and Disposal Options

Waste Type	Source	Option
Amalgam particles - noncontact	Excess mix, broken or unusable capsules	Send to a recycler.
Amalgam particles - contact*	Chair-side traps	1. Change regularly. 2. Send sludge to a recycler. 3. Discard trap in the trash.
Amalgam particles - contact*	Vacuum pump filters	1. Change regularly. 2. Decant some of the liquid. 3. Put on the lid and recycle in the original shipping carton.
Elemental mercury	Past use of bulk elementary mercury	Manage as hazardous waste; send to a recycler.
Empty amalgam capsules		Discard in the trash.

* Amalgam that has been in the patient's mouth

Appendix N

Mercury Waste Recyclers in the Northeast U.S.

The northeastern U.S. mercury waste recyclers listed below are "full service" recyclers. In general, they will accept the full range of mercury waste from a hospital: thermometers, gastrointestinal tubes, laboratory chemicals, batteries, lamps, relays, switches, thermostats, manometers, metallic mercury, and mercury-contaminated material. They also accept dental amalgam from hospitals that have a dental clinic. See the following pages for a list of fluorescent lamp recyclers.

Specific services vary from company to company. Each user is responsible for verifying vendor information. The list below does not imply an endorsement of any company, and it is not intended to be all-inclusive, but is provided for informational purposes only. In addition to contacting the companies listed, you can ask your current hazardous waste hauler to put you in contact with a mercury recycler.

Advanced Environmental Recycling Co.
2591 Mitchell Ave.
Allentown, PA 18103
800-554-AERC
FAX: 610-797-7696

Bethlehem Resource Recovery Division
890 Front St.
P.O. Box Y
Hellertown, PA 18055
610-838-7034

Global Recycling Technologies
218 Canton St.
Stoughton, MA 02072
781-341-6080
FAX: 781-341-6088

Mercury Refining Company, Inc.
1218 Central Ave.
Albany, NY 12205
800-833-3505
FAX: 518-459-2334

Fluorescent Lamp Recyclers in the Northeast

Advanced Environmental Recycling Corporation
2591 Mitchell Avenue
Allentown, PA 18103
(800) 554-AERC

ALR-American Lamp Recycling, LLC
22 Stage Door Road
Fishkill, NY 12524
(800) 315-6262

Bethlehem Resource Recovery Division
890 Front Street
PO Box Y
Hellertown, PA 18055
(610) 838-7034

Dynex Environmental, Inc.
Customer Service
P.O. Box 1323
Fond du Lac, WI 54936-1323
(800) 932-6216

Envirocycle, Inc.
P.O. Box 5367
High Point, NC 27262
(910) 869-8836

Global Recycling Technologies
218 Canton Street
Stoughton, MA 02072
(781) 341-6080

Light Cycle, Inc.
1222 University Avenue
St. Paul, MN 55104
(612) 641-1309

Mercury Refining Company
1218 Central Avenue
Albany, NY 12205
(800) 833-3505

Northeast Lamp Recycling, Inc.
250 Main Street
East Windsor, CT 06088
(860) 292-1992

Recyclights, Inc.
401 W. 86th Street
Bloomington, MN 55420
(612) 948-0626
(800) 831-2852

Recyclights, Inc.
4220 Perimeter Drive
Columbus, OH 43228
(800) 831-2852
(614) 276-3000

USA Lamp and Ballast Recycling, Inc.
5366 Este Avenue
Cincinnati, OH 45232
(800) 778-6645

Specific services vary from company to company. Each user is responsible for verifying vendor information. The list above does not imply an endorsement of any company, and it is not intended to be all-inclusive, but is provided for informational purposes only. In addition to contacting the companies listed, you can ask your current hazardous waste hauler to put you in contact with a fluorescent lamp recycler. For information on the regulations concerning recycling or disposal of fluorescent lamp bulbs or ballasts, contact the New York State Department of Environmental Conservation at (518) 485-8988.

Appendix O
Infrastructure Control Measures

(Information taken from a draft version of the *Mercury Management Guidebook*, now under preparation by the MWRA/MASCO Mercury Work Group, Boston, MA)

[This Appendix cites the current Massachusetts wastewater discharge limit of one part per million which does not apply in New York State. The recommended discharge limit established by the New York State Department of Environmental Conservation for mercury wastewater discharge is: a practical quantifiable limit of 0.8 micrograms per liter (μL) and a method detection limit of 0.2μ/L.]

The MWRA/MASCO Mercury Work Group, a public-private partnership of the Massachusetts Water Resources Authority (MWRA) and sewer dischargers (including hospitals, universities, and other industries), was established in 1994 to study and implement ways to reduce mercury discharges to the MWRA sewerage system. One institution, the Medical Academic and Scientific Community Organization, Inc. (MASCO) that represents many local Boston hospitals, has worked from the beginning of this effort to help identify the sources and methods of removing mercury from hospital waste streams.

One area studied by the MWRA/MASCO Mercury Work Group was the waste piping infrastructure of a facility because elemental mercury waste deposits and mercury-contaminated bacteriological growth (biomass) were identified as possibly significant contributors to chronic mercury contamination in wastewater discharges. Some of the accumulated mercury could be biologically converted to methyl mercury which is both soluble and highly toxic. In addition, research by several hospital institutions found that the biomass within their "Special Waste" plumbing systems would readily absorb and accumulate mercury, with concentrations reaching as high as 1,000 mg/kg (ppm). Fragments of biomass were seen to periodically break off and carry the absorbed, concentrated mercury to the sewer discharge. Because of these concerns, the Work Group developed in its Mercury Management Guidebook a section called Infrastructure Control Measures to assist facilities that experience mercury-contaminated biomass within their waste piping infrastructure.

Infrastructure control measures may include the following steps:

- source reduction
- source segregation, waste piping modifications
- waste trap sampling, cleaning, or replacement
- waste piping cleaning or replacement
- wastewater collection for offsite disposal
- wastewater pretreatment (possibly consisting of solids sedimentation, multistage filtration, or other process steps).

While these steps are listed in a possible chronological order, the actual number and order of steps could be different depending upon the facility and its action plan.

The guidelines and procedures that follow are meant to focus on mercury and biomass removal from piping systems that carry Special Waste (as defined in the Massachusetts State Plumbing Code). However, the guidelines and procedures can be followed by any facility where discharge of mercury-containing materials to waste piping systems has been confirmed or is suspected. The guidelines and procedures are Waste Piping Design Guidelines, Trap Cleaning Procedures, and Power Washing Procedures.

Before any of these guidelines and procedures are considered, however, a facility should learn if elemental mercury or mercury-containing compounds will continue to be disposed to drains within the facility. Continued disposal of any amount of mercury to drains may mean that the waste trap and piping cleaning procedures would be totally ineffective or effective only for a short period after which they would have to be repeated.

In addition, power washing of waste piping systems cannot be recommended without reservation because of the difficulties in reaching all required sections of the system, uncertainties in the ability of power washing to effectively remove all biomass residues thereby exposing new surfaces from which mercury can reach the wastewater, and evidence that power washing may actually lead to new mercury violations. If a facility chooses to engage in power washing, collection and offsite disposal of the affected wastewater or removal of dislodged biomass particles from the wastewater may be needed for some period to avoid further compliance problems.

For its permitted dischargers, the MWRA will require prior notice of intended power washing. In addition, the MWRA is considering additional requirements such as approval of power washing protocols and collection and offsite disposal of the facility wastewater during and after power washing until sampling and analyses show that mercury concentrations in the discharge have returned to the same levels or lower that existed before the power wash procedure. Because dislodged solids could appear at the permitted sampling location for some time after power washing, a temporary or permanent sedimentation and multistage filtration system within the piping system or at the final discharge point could be considered separately or as part of a mercury pretreatment system. The proposed installation of a filtration system must be disclosed to the MWRA, however, since the MWRA will likely consider the filtration system to be a type of pretreatment system.

For reference and clarification, Massachusetts Special Waste is defined below and the concepts of biomass growth and mercury accumulation and concentration are discussed.

Special Waste

According to Massachusetts regulations (248 CMR 2.13, a part of the State Plumbing Code), "Special Waste" includes, but is not limited to, chemicals, nuclear, radioactive, acids, alkalis, perchloric solvents, organisms containing recombinant DNA molecules, and other similar non-domestic wastes from various laboratories and industrial activities. These types of wastes are potentially detrimental to a public sewerage system and often do not comply with limitations established by the local Publicly Owned Treatment Works (POTW) such as the MWRA.

According to the State Plumbing Code, all Special Waste must be conveyed within facilities in a separate, dedicated waste and vent piping system. The design, methods, materials, types of waste neutralization systems, testing, and inspections required for Special Waste piping systems are governed by the Code. Allowed materials and installation methods for Special Waste piping systems are also specified. The Code does not specify, however, the manner by which Special Waste piping systems are to be used after installation or what specific chemicals may be disposed into the system on a daily basis. On the other hand, the Code does prohibit the introduction of solvent-bearing waste[1] and requires the facility owner to submit a notarized letter stating what chemicals will be discharged into the Special Waste system.[2] The letter will be part of the basis of the design of the system by a Registered Professional Engineer. In addition, the Code states that wastewater treatment systems shall be part of the Engineer's design when needed for compliance with regulatory limits.[3]

All proposed Special Waste piping and pretreatment system installations, modifications, revisions and additions must be detailed in engineering drawings and specifications and certified by the Engineer. The drawings and specifications must be submitted to the local Plumbing Inspector for review and approval before construction. The approved documents are then submitted to the responsible jurisdictional authority (e.g., the MWRA or the DEP) with the proper permitting documents and supporting engineering design data for final approval before the Special Wastes can be discharged to the sewerage system.[4]

Biomass Formation and Mercury Accumulation

Biomass growth in Special Waste piping systems is enhanced by the presence of organic matter such as blood products, urea, soaps, chemical reagents, and infectious wastes discharged into the piping system. The combination of these organic substances, temperature, and humidity provides a good environment for biomass growth on the interior surfaces of the waste piping. The organic matter often contains methyl and dimethyl groups that can be combined by certain bacteria with inorganic mercury in the wastewater to create very toxic organic forms of mercury (e.g., methyl mercury). In addition, the mercury accumulates in the biomass and concentrates to significant levels. Because of this phenomenon of "bioconcentration," biomass mercury concentrations of 1,000 mg/kg (ppm) have been reported.

Within a flowing pipe, the biomass growth occurs principally below the liquid level with lesser amounts above. Within a trap at a sink or elsewhere, the growth can be more pronounced because of lower flows that create a continuous liquid "incubator" where there is no oxidation or dehydration of the bacteria. A hardened skeleton of carbon, oxidized soap products containing elements such as calcium and potassium, and dried blood products can be formed that strongly adheres to the piping surface.

When there is wastewater flow, "slugs" of mercury-laden biomass may be carried into the wastewater stream when pieces of the accumulated growth are dislodged from the piping wall. Therefore,

1 Massachusetts regulations 248 CMR 2.13 (8)(e).
2 Massachusetts regulations 248 CMR 2.13 (4).
3 Massachusetts regulations 248 CMR 2.13 (10).
4 For further information, refer to the MWRA/MASCO Mercury Work Group, *Pretreatment Guidance Manual*, December 1997.

large amounts of biomass growth can lead to instances of high mercury concentrations in discharged wastewater. To move toward compliance with mercury discharge limits, therefore, this phenomenon may have to be addressed in facilities that have mercury-contaminated biomass growth. The following guidelines and procedures may help some facilities to properly address the issue.

It should be noted that biomass formation can also occur within wastewater neutralization tanks thereby increasing the potential for further mercury accumulation. As allowed by the Massachusetts State Plumbing Code[5], limestone chips are often used in sumps or tanks (i.e., chip tanks) for neutralization of Special Wastes containing dilute acids and alkalis. Chip tanks cannot be used in facilities discharging significant quantities of organic materials, however, since biomass growth will coat the surfaces of the limestone chips, rendering them useless for neutralization. It is recommended, therefore, that facilities check the condition and efficacy of any chip tanks and replace them with active (adjustable) neutralization systems as appropriate.

WASTE PIPING DESIGN GUIDELINES

Facility Infrastructure Inspection

The first step in dealing with known mercury contamination in the waste piping infrastructure of a facility is to conduct an audit of the existing piping systems. Drawings that reflect details of the actual waste piping, vent piping, and any associated pretreatment system installations should be prepared. Special Waste riser diagrams are important tools and can show regulating authorities that the facility has knowledge and control of all Special Waste discharges. These diagrams should display all isolation valves, glass inspection ports or sections, and sampling/drain valves. The diagrams should also show any current areas lacking control or isolation of Special Waste discharges.

Piping System Design and Modification

After the piping system audit, the facility may determine that modifications are necessary to allow for isolation of waste streams, cleaning, sampling, testing, and monitoring. System designs or modifications should take into account:

- The type of wastes being discharged and the piping material compatibility.
- The future uses of laboratory spaces (*i.e.*, a chemical research laboratory that is to be changed to a blood testing laboratory).
- The need to isolate branch piping from waste and vent stacks to allow pipe cleaning (if needed and selected) without constricting waste flows from other areas or causing overflows to uncontaminated piping systems.
- The investigation of unidentified Special Waste sources and associated piping for biomass and mercury content before combining with previously identified Special Waste piping. Pending the results of investigation of these new sources, additional isolation valving and/or new dedicated risers discharging to the neutralization system may need to be installed.

For trap cleaning and power washing procedures as discussed below, the types of sanitizing and cleaning agents proposed for use must be reviewed in relation to possible interactions with the

[5] Massachusetts regulations 248 CMR 2.13.

chemicals that may be contained in the waste piping system. The potential for incompatible reactions should be considered to ensure that trap cleaning and power washing procedures will not create any unsafe conditions. Reactions that may cause fuming and gas evolution into the working environment, and into the piping system, must be avoided.

Isolation Valves

The facility may determine that isolation valves need to be installed to allow for trap cleaning, removal of noncompliant wastes, sampling of suspect branch piping, and control of potential cross-contamination. The location of isolation valves should consider accessibility and maintenance especially when co-fitted with a sampling port for testing.

The location of valves should not cause an overflow of noncompliant wastes into another area where a spill may occur. As an example, a floor drain would overflow if too much liquid used for pipe cleaning was poured into a counter top sink at a higher elevation. Additionally, the need to provide isolation valves in the venting system must not be overlooked for the same reasons.

Sampling Ports

Sampling ports should be installed in strategic locations for the periodic collection of samples of wastewater for monitoring purposes. Design of the sampling ports can follow that shown in Figure 2, Recommended Sampling Port for Special Wastes, of the *Pretreatment Guidance Manual*.[6]

A sampling port in an isolated branch of piping may not only act as a monitoring point but also as a drain leg for any sanitizing or cleaning agents used. The sampling port nozzle may be replaced with a full-size drain leg for transfer of suspected noncompliant cleaning wastes to containers for off-site disposal.

Special Waste Riser

Vertical Special Waste and vent piping risers may need to be isolated to allow for sequential cleaning, sanitizing, and testing of portions of entire systems in the same manner as has been explained for horizontal runs of piping. During these periods, special consideration must be given to the isolation of vent piping to reduce the possibility of overflow of reagents back through the piping system.

Glass Inspection Ports

Inspection ports or a section of clear borosilicate glass piping should be installed within the main horizontal run of the Special Waste conveyance system employing thermoplastic or other opaque piping materials so that flow conditions can be viewed and the biomass accumulation can be periodically observed. If any branch piping may contain undiluted hydrofluoric acid, however, this piping should be routed separately and connected downstream of the glass fitting and should have its own isolation valve and sampling port assembly.

[6] MWRA/MASCO Mercury Work Group, December 1997.

Discussion

The above design considerations are presented as examples of the various considerations needed for modifications of Special Waste piping systems before cleaning or replacement activities are initiated. But before modifying any portion of its waste piping infrastructure, a facility should make a thorough inspection of any traps and horizontal piping runs (including analyses of biomass samples) to determine if the modification, cleaning, or replacement efforts should be done at all. If trap and biomass contaminations are found, the decision must then be made whether to pursue source reduction, source segregation, infrastructure replacement, infrastructure cleaning, and pretreatment as solutions to noncompliance with mercury sewer discharge limitations.

TRAP CLEANING PROCEDURES

Trap accumulations of elemental mercury and of biomass growth contaminated with mercury has been found to be a significant source of chronic elevated mercury concentrations in wastewater discharges. The trap cleaning procedures outlined below have been found to be of significant value in reducing the levels of mercury in affected wastewater discharges.

Trap Location / Identification

Trap locations are determined by preparing a detailed inventory of all Special Waste sources. Trap identification can be accomplished as part of the facility piping system audit discussed earlier. After all sources are identified, a facility Special Waste piping drawing should be generated with all traps identified by unique numbers. A master inventory of all traps should be generated to record and track all trap cleaning events. Each trap should be tagged or labeled with its unique number, cleaning date, and the name and signature of the person performing the cleaning. Additional information on a Trap Inventory Form could include the type and size of piping material. A typical Trap Inventory Form is included at the end of this section.

Removal of Elemental Mercury

Elemental mercury is sometimes discharged into sinks and floor drains when mercury-containing equipment breaks. Some elemental mercury sources include mercury thermometers, thermostats, electric switches, and blood pressure manometers. When a sink or floor drain trap is removed for the first time, it may contain elemental mercury, identifiable as a pool of heavy silvery liquid separated from the trap wastewater.

Elemental mercury removed from any traps should be collected and disposed as a mercury waste. Disposal of mercury wastes must be done in accordance with federal, state, and local requirements.

Removal of Biomass

Almost every trap will accumulate biomass, identified as a slimy brown film on the internal surface of the plumbing material. The bulk of this growth will occur on the bottom and wetted sections but some biomass will grow along the sides and top of the non-wetted section of the plumbing materials. This capillary action of growth is the most difficult to remove. Biomass growth on non-wetted surfaces can dry out. The dried out biomass develops a strong bond to the plumbing surfaces. Accordingly, some facilities may choose to replace, rather than attempt to clean, contaminated traps.

Trap Removal and Handling Precautions

Where wastewater is elevated in temperature or where chemical reactions producing heat may occur within a piping system, greater amounts of dimethyl mercury may be formed in accumulated biomass. Both elemental mercury and dimethyl mercury may exist in vapor form within the piping systems. Since negative pressures can sometimes exist in laboratory rooms, hazardous elemental or dimethyl mercury vapors can emanate from plumbing traps back into the rooms. Therefore, proper personnel protection should be practiced at all times. In addition, the traps should be of the deep seal type and should continually be filled to afford protection against possible vapor "drawback."

Trap Replacement or Cleaning Procedures

1. Identify traps for replacement or cleaning and discuss the trap removal procedure with the affected facility occupants. Explain to them that the procedure will interrupt their operations and estimate the duration of the interruption.

2. Before any traps are removed, it is important to ask the occupants about the nature of their wastes, identifying all possible health and safety hazards. Before handling traps that are in areas that contain hazardous materials, all traps should be checked by the appropriate administrator for approval (*i.e.*, if a radioactive isotope is being used in a room, have the Radiation Safety Department check out the trap to assure that it is safe for removal and handling).

3. After facility occupants have been made aware of the trap replacement or cleaning program and after it is determined that it is safe to handle traps, actual trap removal, replacement, and cleaning can be started.

4. It is important that personal protective equipment be worn at all times by any personnel doing trap handling. It is recommended that all these procedures be reviewed by an internal Health and Safety Officer.

5. All materials found inside the traps must be handled and disposed of as mercury waste. Disposal of mercury wastes must be done in accordance with federal, state, and local requirements.

6. If the removed trap is to be cleaned, either a rag or flexible brush can be used. A cleaning agent and some type of disinfectant may also be used to help ensure that complete removal of biomass and disinfection is accomplished.

7. After traps are removed, cleaned, and replaced, a tag or label should be wired to the trap (or an existing tag should be updated) with the unique number, date, and the responsible individuals' initials.

8. After trap removal, replacement, or cleaning is completed and the area is returned to its original condition, all access panels and other structural materials should be reinstalled. Before leaving the area, inform the occupants that the procedure has been completed.

9. All trap replacements or cleanings should be logged on the Trap Inventory Form.

10. If mercury-containing materials remain in use, it will be necessary to inspect the affected cleaned traps for recurring contamination of the biomass growth. These inspections could initially be performed quarterly. Once a sufficient level of experience has been obtained, inspection frequencies can either be increased or decreased depending on the levels of contamination and the rates of returning biomass. The inspections should help determine the need for repetition of the entire procedure.

11. Have spare traps available for replacement of corroded or otherwise unusable traps.

TRAP INVENTORY FORM

Institution Name _____

Address _____

_____

_____

Building Name _____

Trap Identification	Room/Dept. Name	Plumbing Material	Trap Type	Type of Waste & Hazard	Cleaning Date

INFRASTRUCTURE POWER WASHING PROCEDURES

Because of the phenomena of bioaccumulation and bioconcentration, the biomass within a Special Waste piping system (that has been used for disposal of mercury-containing materials) may contain concentrations of mercury in the part per million range. Power washing has been used as a mercury control technique for such systems because of its scouring effect on the accumulated mercury-contaminated biomass. Power washing has been identified as a possible lower cost method of biomass control compared to replacement of the facility's waste piping system. However, because of the issues outlined below, power washing of waste piping systems may not be effective at all facilities.

Power washing uses special equipment that produces a high pressure/low volume stream of water. The water flows through a high pressure hose and a power nozzle to produce a high velocity spray that removes accumulated biomass and grease from the inside of waste conveyance piping while flushing the resulting debris down the line. Results of a power washing effort are dependent upon accessibility to the entire waste piping system (*i.e.*, through use of piping isolation valves, cleanouts, access ports, and drains). In addition, there are uncertainties in the ability of power washing to effectively remove all biomass residues thereby possibly exposing new surfaces from which mercury can reach the wastewater, and there is evidence that power washing may actually lead to new mercury violations from continued discharges of dislodged biomass particles.

Because of these issues, the MWRA will require prior notice of intended power washing by permitted dischargers. The MWRA is considering additional requirements including approval of power washing protocols and collection and offsite disposal of the facility wastewater during and after power washing until sampling and analyses show that mercury concentrations in the discharge have returned to the same levels or lower that existed before the power wash procedure. A possible alternate approach would be removal of dislodged biomass particles from the discharge possibly by sedimentation or multistage filtration.

The temporary or permanent particle removal system could be installed within the piping system or at the final discharge point. The particle removal system could be considered separately or as part of a mercury pretreatment system. The proposed installation of the particle removal system must be disclosed to the responsible POTW, however, since the POTW will likely consider the system to be a type of pretreatment system.

Some facilities have considered power washing to be an effective method for reducing mercury concentrations in their sewer discharges. If mercury-containing materials continue to be disposed to the waste piping system, however, the power washing procedure will not be a permanent solution and will likely have to be repeated on a continuing basis. If a facility should choose to engage in power washing, the following discussion should be referred to for precautions, recommended techniques, and possible compliance issues.

Power Washing Precautions

The following are some precautions that should be considered before starting power washing procedures:

- Waste conveyance piping accessibility is essential for successful power washing. Considerable modifications to an existing system may be needed to achieve the needed accessibility.

- Perhaps because of the potential for mercury to form an amalgam with other metals, power washing is not expected to be effective in waste piping systems constructed of metals (*i.e.*, high silicon cast iron or stainless steel). If a metallic waste piping system were mercury-contaminated, total replacement of the system should be considered.

- All substances contained within the waste conveyance piping should be taken as hazardous. Before power washing, the facility's Health and Safety Officer should review the proposed power washing procedure to ensure that proper personal protective equipment will be used.

- Waste conveyance fittings and piping, especially with glass fittings, can be cracked or broken during power washing. Inspect the entire run before power washing, and identify any potential obstructions, so that if a fitting is broken, a replacement fitting can be immediately available for installation.

- If the waste conveyance piping contains large amounts of biomass, dislodged pieces may collect and clog downstream conveyance piping sections. If such clogging occurs, there may be wastewater backups in the plumbing system causing flooding at lower elevation locations.

- Dislodged biomass particles can appear in the sewer discharge for some period after power washing. To avoid compliance problems from the power washing procedure, collection and offsite disposal of the affected wastewater may be needed until testing shows no elevated mercury levels. Alternately, the dislodged biomass particles could be removed from the discharge by a temporary or permanent removal system within the piping system or at the final discharge point. The proposed installation of a particle removal system, however, must be disclosed to the POTW since it likely will be considered a pretreatment system.

- Any proposed sanitizing or cleaning agents should be reviewed to prevent possible chemical interactions with waste constituents that may exist in the piping system. The potential for incompatible reactions should be considered to ensure that trap and pipe cleaning procedures will not create unsafe conditions. Reactions that may cause fuming and result in gas evolution into the working environment, as well as into the piping system, must be avoided.

Power Washing Techniques

The following techniques are easily monitored for effectiveness when performed on glass waste piping systems. The techniques may require some modification when applied to thermoplastic or other waste piping materials.

1. Power washing activities usually require a minimum of two people: one serving as the power wash operator; and the other as an observer of the nozzle and hose as it moves through the waste conveyance piping.

2. The operator begins feeding the 80 to 100 feet of hose with the power washing nozzle attached, while the observer, with a two-way radio in full communication with the operator, watches the hose and nozzle for potential obstructions and other problems. Typical obstructions include: tees, reducers, p-traps, drum traps and valves.

3. Some facilities have determined that successful power washing occurs when cleaning operations begin at the collection or treatment tanks in the lower floors. The operator then works in the waste piping system toward the sources in a reverse flow direction. This technique is preferred because the nozzle is designed with a reverse flow head configuration that literally "pulls" the hose away from the power washer operator and toward the sources while flushing biomass and debris down the line and to the collection point. In addition, most plumbing fittings have smooth swings in the reverse direction and this seems to reduce obstruction interference.

4. Although reverse flow is preferred, the complexities of the piping infrastructure may require some experimentation. For immediate progress, select straight sections observed to contain biomass. In other locations, piping may have to be removed or modified to reach all areas of concern. Power washing on thermoplastic piping will require more experimentation and it may be necessary to remove piping sections to verify cleaning effectiveness. The installation of sight glasses may help to reduce the required amount of pipe removal.

5. At times, it may be difficult or impossible to feed the hose and nozzle in the preferred reverse direction. An alternative method would then be to start at the sources (sink traps or floor drains) and work in the direction of flow. This technique, however, is less desirable because the nozzle head will not be directly flushing debris as it moves along the piping. It may be necessary, then, to apply additional water to aid the flushing process by turning on an adjacent sink tied into the same waste conveyance line.

6. Regardless of the direction that the power wash nozzle is fed into the system, a final wash and high volume rinse in the direction of flow may help to flush residual biomass particles from the system.

Chemical Addition

Bleach

Some power washing units are designed for use with water only and do not allow for addition of chemical solutions. However, it is recommended that a bleach solution be added to the piping at the source, if possible, to accomplish disinfection of the piping system before the power washing and aid in the removal of biomass. The bleach or other disinfecting chemical should be analyzed before use to ensure that it is mercury free or of a "low" mercury content. Unfortunately, some chemicals and reagents, including many disinfecting products that contain bleach, may contain measurable amounts of mercury.

Other Cleaning Solutions

The additions of surfactants, dispersants, caustics and/or wetting agents were investigated during the MWRA/MASCO Mercury Work Group Phase I effort. None of these chemicals were recommended then because of health and safety considerations. In addition, such chemical additions may be costly for waste piping systems at large facilities. However, some power washing companies may offer chemical addition services and facilities may find that chemical addition is quite feasible, safe, and effective.

Power Washing Wastewater Disposal

All power washing wastewater that contains removed biomass should be assumed to contain levels of mercury above the MWRA enforcement limit of 1.0 μg/L (ppb) and, therefore, should be collected for offsite disposal. The collection of the power wash wastewater is difficult, but since power washing will usually occur during non-operating hours, the piping systems can virtually be drained. Once normal flow has stopped, existing neutralization or treatment tanks can be emptied and used as power washing wastewater collection vessels. Additional temporary collection vessels may be needed.

After power washing is completed or the treatment tanks get full, transfer all collected wastewater into storage containers. Other collection and pumping methods can be used on a case-by-case basis. However accomplished, it is very important that this wastewater be collected and not discharged.

In addition, dislodged biomass particles can sometimes appear in the sewer discharge for some period after power washing. To avoid compliance problems, collection and offsite disposal of the affected wastewater or removal of the biomass particles from the discharge may be needed. A temporary or permanent filtration system within the piping system or at the final discharge point should be considered. The proposed installation of a filtration system, however, must be disclosed to the POTW since it will likely be considered a pretreatment system.

All waste disposal activities should be approved by an Environmental, Health and Safety Officer or the person responsible for waste disposal. The MWRA prohibits the disposal of chemicals into the sewerage system except for aqueous solutions of nontoxic and nonhazardous chemicals.[7] In addition, the Massachusetts Department of Environmental Protection (MA-DEP) prohibits the improper disposal of hazardous wastes.[8]

[7] MWRA Sewer Use Regulations: 360 CMR 10.000.

[8] MA-DEP Hazardous Waste Regulations: 310 CMR 30.000.

APPENDIXP

Strong Memorial Hospital (SMH)
Mercury Spill Clean-Up Procedures

Revised November 1996

Broken Thermometers: (There is not enough mercury involved to present a hazard; you do not need to respond with the vacuum.)

1. Using two 3" x 5" cards push mercury into a pile.
2. Draw up into a syringe (no needle) and place in a sealed container or scoop into a specimen container or other sealable container.
3. Disposal:
   Non-patient area: Fill out a hazardous waste tag and call the Hazardous Waste Management Unit for pick up.
   Patient area: Label container (mercury) and place on cart to be returned to Sterile Supply.

Broken Manometers:

SMH patient area: Call should be referred to SMH Housekeeping.
Other area: Contact an Industrial Hygienist for immediate clean-up.

**Note: Any call which sounds unusual (i.e. spilled on patient, on carpet, in toilet, not a thermometer or manometer) should be referred to an Industrial Hygienist.

It is important to respond as soon as possible (within 1 or 2 hours) to clean-up any spill.

1. Make sure everyone is removed from the room (patient(s), visitors, staff). Patient bed should **not** be removed from the room.

2. Gather equipment
   - Mercury vacuum* and attachments (stored in the SMH Housekeeping Office-- If locked have one of the supervisors paged)
   - The mercury vacuum is designed to clean up liquid mercury spills. Regular vacuum cleaners can volatilize the mercury and blow the mercury vapors into the air. An activated carbon filter in this vacuum will absorb and contain the mercury vapors.

- Tool box. The following items should be in the tool box:
  - Flashlight
  - Screwdriver
  - Putty knife
  - Mercury holding jar
  - Respirator (3M 9908 Dust/Mist Respirator)
  - Yellow or pink wash basin (from clean utility room on unit)
  - Heavy plastic bag

3. Before entering room put on protective equipment.
   - Respirator
   - Long sleeve shirt
   - Long pants
   - Disposable gloves
   - Remove all jewelry

4. Assess the extent of the spill. Upon entering the room use flashlight (hold angled at floor level, put head close to floor to see where mercury is located). Also check wall, bed frame and mattress. Do not walk in contaminated areas.

If there is anything unusual about the spill (i.e. on carpet, in a toilet, on patient, etc.) a member of the Industrial Hygiene Unit should be consulted.

5. Set up mercury vacuum using the following steps:
   A. Place plastic dishpan under separator.
   B. Remove red cap off mercury separator and screw jar onto vacuum.
   C. Remove red end cap from hose.
   D. Place required attachment on hose.

6. Begin vacuuming at outer edges of spill and work towards center of spill (usually the wall under the manometer). Set up an organized approach (i.e. begin vacuuming one block and move slowly, in a row to assure that you cover the entire area). Draw vacuum hand-piece slowly towards yourself. Pay special attention to floor moldings. If molding is pulled away from the wall and you suspect that mercury may have gotten behind it, remove the molding using the putty knife and vacuum behind it.

7. Once the area under the manometer has been vacuumed, remove the manometer from the wall bracket by unscrewing the top holding screw. Place the manometer in the wash basin. If the glass tube is not broken on the front of the manometer and there is no visible mercury on the outside of the manometer, put the manometer inside the plastic bag. Seal the bag and place in wash basin. If the tube is broken, empty mercury into the wash basin to be vacuumed. Then put the manometer into plastic bag and seal.

8. Once all the mercury has been vacuumed, take the flashlight and check again for beads of mercury on the floor, wall and bed. Several attempts may be needed to vacuum all of the mercury from a spill.

9. Place wash basin under mercury separator and unscrew jar. Place red cap over bottom of mercury separator and place red end cap on hose. Any mercury that may have fallen on the paper should be dumped into the jar. Place lid on jar and return jar to tool box*.

   If water has been vacuumed, notify Environmental Health and Safety (EH&S) immediately so that the appropriate maintenance can be performed.

   Removal of the jar after each use will extend the life of the activated charcoal filter.

10. Pick up all materials and leave room.

11. Leave manometer (in sealed bag) in the soiled utility room. The unit secretary should be informed to call to have the manometer replaced.

12. Post sign on the door to assure that the room remains browned out and no one enters until EH&S has checked the room.

13. Notify EH&S that the spill has been cleaned up. If the spill occurs during the normal 8-5:30 day, call EH&S immediately after clean up is complete. Please give the secretary the room number and other important details. If the spill occurs after 5:30 or on a weekend, leave a message on phone mail giving the room number and any other details about the spill.

14. EH&S will respond with the mercury vapor sniffer and a flashlight to assure adequate clean up. Mercury vapor levels should be insignificant (<0.02 mg/m^3) at floor level.

15. The patient(s) may be returned to the room after EH&S has approved the room for use.

*Note: If mercury and spill debris reach the fill line on the jar, a Hazardous Waste Tag must be filled out. The tag should be completely filled out and attached to the jar. The Hazardous Waste Management Unit should be called to pick up the mercury.

Mercury Spills
Special Circumstances

Carpeting:

- Following the above directions, vacuum up as much of spill as possible.
- Check using mercury vapor sniffer.
- Re-vacuum.
- If, after vacuuming 3 times, levels remain elevated, the carpeting will need to be removed. Pull carpet up carefully and place into a plastic bag.
- Re-vacuum floor under carpet.
- Check levels using mercury vapor sniffer.
- If the breathing zone level is <0.02 mg/m^3 then the room will be considered clean.

** Note: If it is an area where children will be crawling on the floor, then the mercury vapor level taken at the floor should also be less than .02 mg/m^3.

Appendix Q

Glossary of Terms

Aneroid: Operates by the effect of outside air pressure on a diaphragm forming one wall of an evacuated container. Uses no liquid.

Best management practices: Proven strategies that prevent or reduce the use, release or transport of toxic substances that adversely impact the environment.

Bioaccumulate: To accumulate a substance in the tissues of an organism as a result of uptake from all environmental sources.

Biosphere: The part of the world in which life can exist.

Mercury loading: The amount of mercury that enters a water body per unit of time, such as pounds/year.

Pollution prevention: Use of processes, practices, materials, products or energy that avoid or minimize the creation of pollutants and waste and reduce overall risk to human health and the environment. Includes source reduction, recycling, reuse, reclamation or modification of operating practices.

Source reduction: Waste prevention. Any activity that eliminates or decreases wastes by avoiding their creation.

Toxicity Characteristic Leaching Procedure (TCLP): Test used to determine the ability of a substance, such as mercury, to leach from waste in a landfill.

Appendix R

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