U.S. Army Public Health Command (Provisional)

Technical Guide 333

Mercury Waste Virtual Elimination Model Plan

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USAPHC

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This document was based upon *Reducing Mercury Use in Health Care: Promoting a Healthy Environment*, prepared by the Monroe County Department of Health, in cooperation with Strong Memorial Hospital, Rochester, New York and the Monroe County Department of Environmental Services, under a grant from the U.S. Environmental Protection Agency. This revision was prepared by the American Hospital Association, members of the Hospitals for a Healthy Environment Mercury Virtual Elimination Workgroup and the U.S. Environmental Protection Agency, in cooperation with the Monroe County Department of Health.

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CHAPTER 1
INTRODUCTION

The purpose of this plan is to help hospitals and medical treatment facilities (MTFs) start mercury pollution prevention (P2) programs or accelerate programs that have already begun. The U.S. Environmental Protection Agency (EPA) and the American Hospital Association (AHA) have joined in a voluntary agreement to "virtually" eliminate mercury waste in hospitals and health systems by 2005, and are asking healthcare providers to join in this effort to help reach these environmentally sound goals. Note that the terms hospital and facility are used interchangeably in this plan.

Under Executive Order (EO) 13148, the President has directed the EPA to develop a list of no less than 15 priority chemicals used by the Federal Government that may result in significant harm to human health and the environment, and those that have known, readily available, less harmful substitutes. This list was to be published within 9 months of the date of this EO (i.e., no later than 22 January 2001). One of the goals of EO 13148 is the reduction of use of these 15 priority chemicals by 50% by 31 December 2006. The baseline year for the 50% reduction will be the calendar year immediately following the year in which the EPA established the priority chemical list.

As of March 2003 the list of the 15 priority chemicals has not yet been publicized in its final form. However, the EPA did publish a "proposed" list of priority chemicals in November 2001 and again, an updated list in July 2002. This proposed list identifies mercury as one of the priority chemicals. Specific examples of mercury containing items on this list include temperature and pressure devices as well as switches. Mercury is expected to remain on the list when it becomes finalized.

There are many other reasons why it makes sense for hospitals to reduce their use of mercury. For example, new Federal air and water regulations greatly reduce the amount of mercury that is allowed to be discharged from a municipal wastewater system or an incinerator. In addition, the capability to measure mercury at lower levels makes it easier for regulatory agencies to identify those who are not in compliance. As a result of these developments, regulatory compliance costs are rising. By implementing the best management practices (BMP) described in this manual, levels of mercury in the environment can be reduced as well as the costs associated with hazardous waste (HW) disposal.

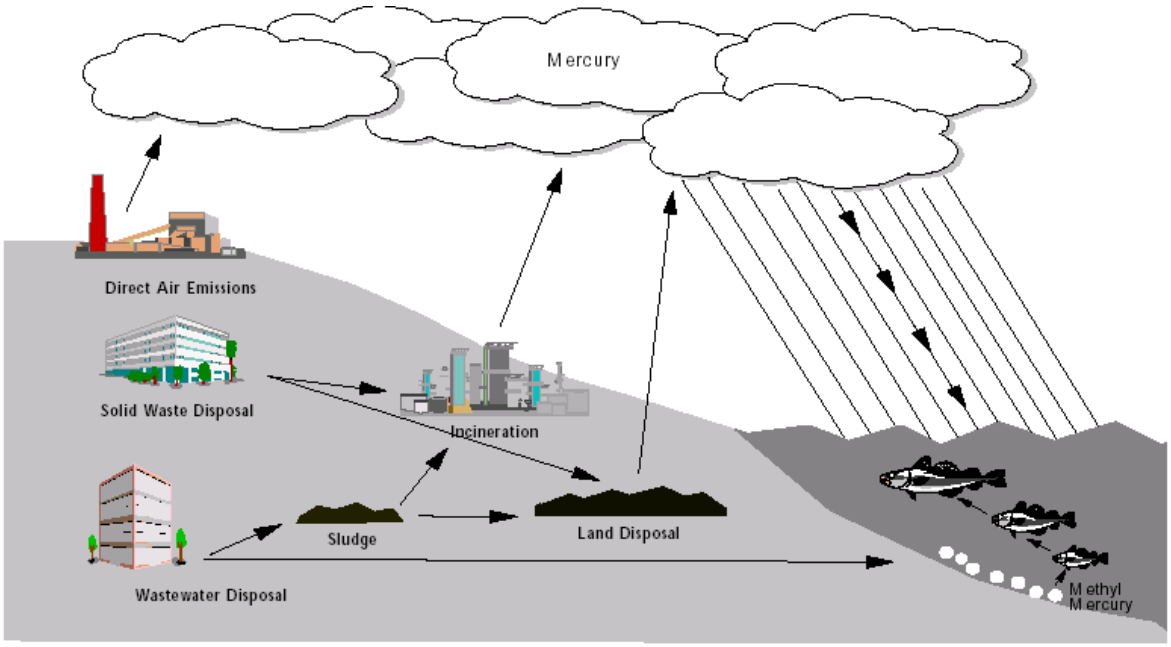
The Army's policy is to follow and implement all applicable Department of Defense (DOD), Federal, State, and local laws. This plan offers general guidance on how to initiate a mercury reduction program and technical guidance to implement the program. It is the facility's or hospital's choice on how many of the recommendations, described in this plan, to implement. *Patient care is always of utmost importance and must not be sacrificed in the decision making process when implementing this program.* This model plan should be coordinated with, and used in concert with, the Pollution Prevention Plan of the supporting military installation.

1.1 Background on Mercury

Mercury is a toxic metal that occurs naturally in the environment. There are both inorganic forms and organic forms of mercury. As shown in **Figure 1** below, 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.

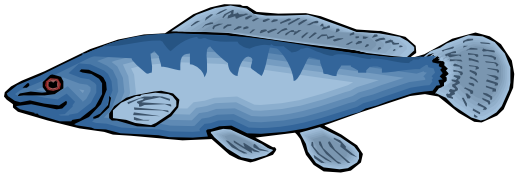
Human activities significantly redistribute mercury and release it into the environment. They allow mercury that was formerly unavailable to the biosphere to be mobilized and carried to new areas via air and water. In the water or soil, microorganisms can convert inorganic mercury into a more toxic organic 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.

Figure 1 - Mercury Transport and Bioaccumulation



1.2 Health Impacts of Mercury Exposure

All forms of mercury are toxic to humans, but the various forms of organic and inorganic mercury have different toxicities. Generally, organic forms are much more toxic than inorganic forms. The organic forms of mercury are primarily neurotoxins. Exposure (even to small amounts of mercury) can damage the brain and nervous system. The developing brain of a fetus or child is especially vulnerable to organic mercury, pregnant women should be especially careful to avoid 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 by dermal contact. The most likely routes of human 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. issue cautionary advisories about eating the fish caught in many of their waterways because of the presence of mercury. These advisories represent conservative measures to protect human health. Because mercury spills in hospitals often occur in small, enclosed spaces, employees should be aware of the proper clean-up procedures and risks of mercury exposure.

1.3 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
- Pharmaceutical preservatives

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 discharge lamps
- Nonelectronic 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.

1.4 Mercury Pollution Prevention

Concerns about the health impacts of mercury are leading to mercury P2 programs at the Federal, State and local levels. The highest priority of any P2 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 available and mercury must be used, it may be possible to recycle it. Recycling is the second priority of mercury P2. 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. Best management practices for the management of mercury within hospitals might involve:

- Developing a plan to purchase mercury-free products whenever possible.
- 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 and pharmaceuticals.
- 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. More detailed information on BMPs is included in Chapter 3.

Benefits of Mercury Pollution Prevention

Mercury P2 in a 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 HW 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.
- Enhancement of the positive public image of the medical facility due to publicity about success stories.

CHAPTER 2
ESTABLISHING MERCURY POLLUTION PREVENTION

2.1 Getting Started

This chapter describes and advocates the teambuilding approach as the best way to approach mercury reduction in most healthcare systems. A lasting P2 program requires cooperation and consensus building. However, it is possible for a single person to make a substantial impact on a hospital's mercury use. For example, there are many instances in which a purchasing manager or facility engineer took the initiative and replaced mercury-containing devices with non-mercury devices throughout a healthcare facility. An empowered employee can follow through on many of this manual's suggestions without involving other people. There is no one-size-fits-all solution for every health care facility. For a diagram of the steps involved in building a mercury P2 team, see Figure 2 in this chapter.

2.1.1 Getting Support From the Top

Support from the hospital's Commander is one critical factor in ensuring the success of a mercury P2 program. A first step should be to communicate with the Commander on the benefits of such a program and to request support. A partial listing of program benefits to use in communicating with the Commander is shown in Appendix C. When communicating with the Commander, it is important to be clear how he or she can help.

2.1.2 Identify and Involve Staff

One or more project leaders should be designated, including:

- A person to be responsible for developing the mercury P2 policy and confirming implementation. This person should be 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 P2 "champion" who will be enthusiastic about the program and will be dedicated to it. This person may be the HW Manager or another qualified individual.

2.1.3 Make it a Team Effort

Because mercury appears in so many different locations in a hospital, it takes a team effort to effectively 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 an initial meeting to introduce the mercury P2 program.

However, it is not 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 P2 program has reached its goal. Additionally, the mercury P2 program could be addressed during routine employee meetings, such as Safety or Infection Control meetings. A committee should be established which would be directly involved with the reduction program and decision-making processes. Suggested committee members could include:

Administrator (i.e., XO)
Safety Officer
Environmental Science Officer
Purchasing Officer
Department of Nursing Representative
Pharmacy Representative
In-service educator/trainer
Laboratory Representative
Maintenance/Facilities Manager
Housekeeping/Environmental Services Manager
Hazardous Waste Manager
Supply Manager/Logistics Manager
Dental Representative

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

2.2 Gather Data

2.2.1 Identify Mercury Sources

The first task of the individual implementing the program, i.e. the Mercury Reduction Manager, 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 (Appendix A) and/or the checklist of categories of possible mercury-containing laboratory chemicals (Appendix B) as guidelines. The department contacts should perform an inventory of all uses and sources of mercury in their departments.

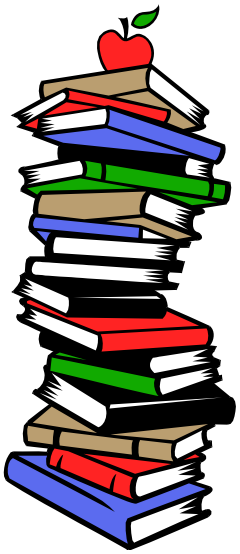
The U.S. Army Public Health Command (Provisional), (USAPHC (Prov)) has conducted a mercury inventory of all major Army MTFs located in the Continental United States

(CONUS). For a copy of your hospital's inventory, contact the Hazardous and Medical Waste Program at DSN 584-3651 or civilian (410) 436-3651. However, it is recommended that this inventory only be used as a template since new mercury containing items may have found their way into the hospital or, mercury items may have already been substituted with non-mercury containing ones.

2.2.2 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.
- Purchasing of alternatives to mercury-containing products.



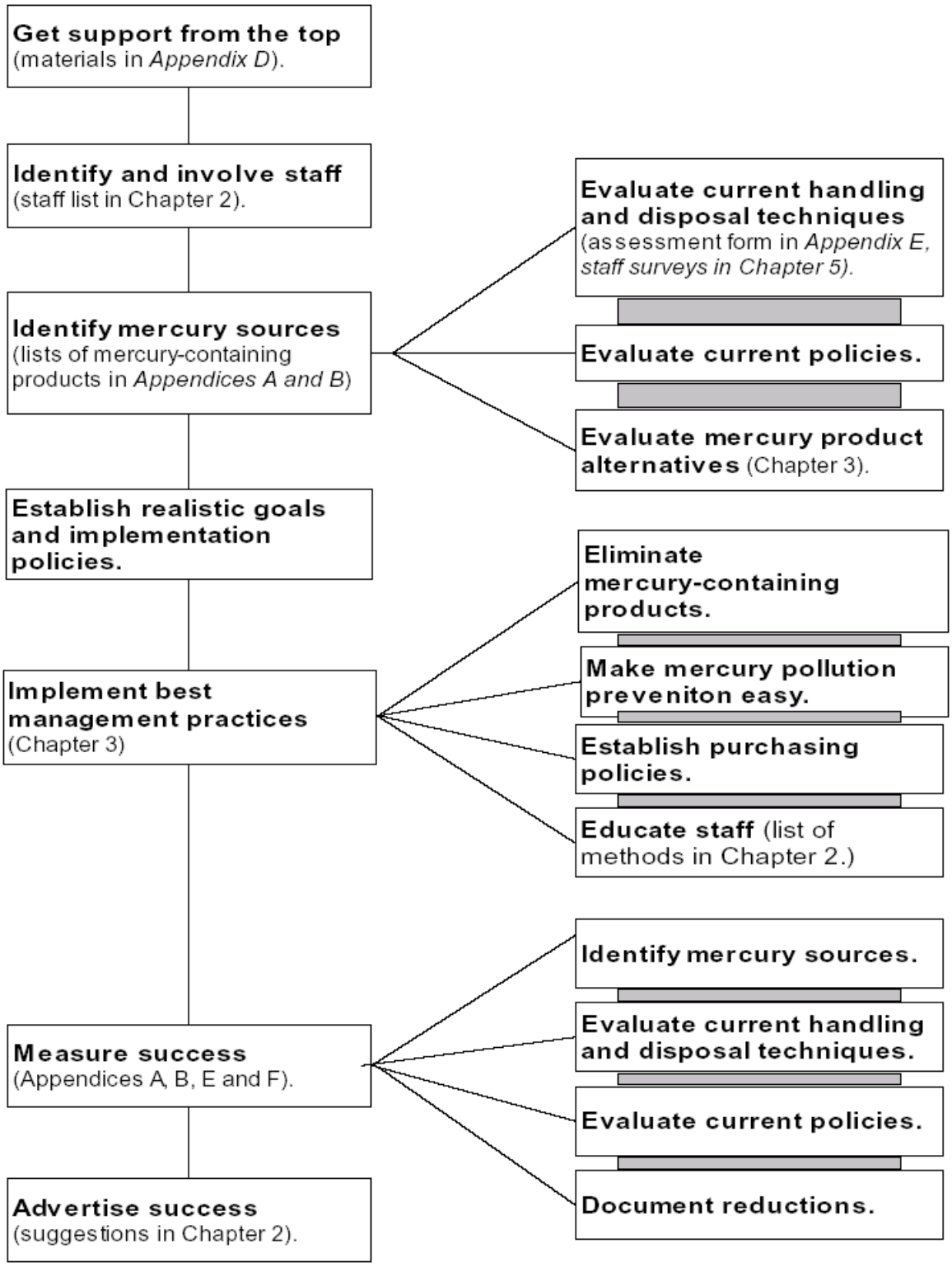
Policies that address hazardous materials management and laboratory chemical management may be pertinent to mercury, even though mercury may not be mentioned specifically. Hospital policies may be collected by either of the two project leaders. The Mercury Reduction Manager should also evaluate if the current policies are being implemented throughout the hospital.

2.2.3 Evaluate Current Handling and Disposal Techniques

The Mercury Reduction Manager, 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 D for a form for recording your hospital's baseline assessment and for yearly updates.)

If possible, wastewater sample results should be included in the baseline assessment. The installation Environmental Office should be contacted for this since more than likely, wastewater sampling is already being conducted. Total discharges of mercury in pounds should be calculated. Total discharges are a better indicator of the hospital's impact on the environment than the concentration of mercury present**.**

Figure 2 - Establishing Mercury P2 in Your Facility



2.2.4 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 Chapter 3.

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.

2.3 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 P2. 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 Commander 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 HW Manager.

- Training and continuing education programs for staff and administrators.

- A process to review progress regularly.

2.3.1 Institute Best Management Practices

Obtain the Commander's approval for all of the BMP that are selected to become part of the hospital's mercury P2 program.

2.3.2 Eliminate Mercury-Containing Products

The highest priority of the P2 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).

2.3.3 Make Mercury Pollution Prevention Easy

Chapter 3 of this plan describes BMP to keep mercury out of the environment. The chapter is organized by products (thermometers, laboratory chemicals, electrical equipment, etc.). The MTF 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. Often, older equipment is considered to be HW and must be properly labeled. In that case, your facility's HW manager should be contacted for specific labeling and storage requirements.

2.3.4 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 Mercury Reduction Manager or other designated official for the purchase of a mercury product. Authorize the Department of Logistics to make "mercury-free" a part of product specifications, to insist on mercury disclosures on all products coming into the hospital and to specify the use of recovered mercury in all products that do not yet have mercury-free alternatives.

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 E for a sample letter requesting mercury information and a sample Certificate of Analysis.

2.4 Educate Staff

Employee education in mercury P2 is an important component of a successful program. 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 P2 into existing training programs such as new employee orientation, safety training, HAZCOM training and department meetings. Training should be continued on an annual basis until mercury-containing products are eliminated from the hospital. Suggested educational materials include:

- Train-the-trainer programs
- Presentations at meetings
- Displays in the cafeteria or other common areas
- Survey about mercury awareness
- Placing articles in the hospital newsletter or other local publications
- Articles from professional journals or newsletters

- Page in the Employee Handbook on the guidelines for handling and disposing of mercury
- 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
- Waste management materials

- Videos/E-Mail
- Verbal instruction from supervisors
- Incentive program to reward workers with good ideas that make mercury P2 easier
- Reports on internal audits

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

2.5 Measure and Document Success

2.5.1 Evaluate the Status of the Mercury Reduction Program

Measurement of success is a vital component of any hospital's P2 program. It allows the hospital to evaluate the effectiveness of the program and communicate this to the staff. Start by repeating the mercury source identification that was done at the beginning of the program (Appendix D), 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, contact the installation Environmental Office and request that new wastewater samples be taken so that the total mercury discharge can be calculated and compared with the baseline assessment.

Document the sources and quantities of mercury that have been eliminated and new policies or changes to former policies instituted since the baseline assessment. Determine if they are related to mercury P2. Compute the costs or savings to the hospital of the substitution of mercury-free products purchased since the baseline assessment (see Chapter 4). Areas where the hospital should see measurable reductions include:

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

Prepare periodic progress reports to communicate your mercury P2 achievements to the hospital staff.

2.6 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 following groups:

- The hospital's Environmental Quality Control Committee (or similar committee) through an annual report that describes accomplishments, upcoming actions and expected outcomes.

- Professional medical associations and groups.

- 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.

- Installation officials, such as the wastewater treatment plant manager and Preventive Medicine, through formal letters.

- The patients and the general public through press releases, stories in local newspapers, and pamphlets or posters available in individual hospital clinics.

CHAPTER 3
BEST MANAGEMENT PRACTICES

3.1 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 BMP now, a MTF can help stay ahead of increasingly stringent regulations on mercury use and disposal. For most mercury-containing products in a hospital, the preferred BMP 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, BMP are effective procedures for handling and either recycling or disposing of the mercury-containing products. Recycling is always the preferred method; HW disposal should always be the last resort.

Mercury-containing products can be found almost anywhere in a hospital. They range from medical instruments and clinical laboratory chemicals to electrical equipment, pharmaceuticals 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 BMP 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 HW Manager will have the ultimate responsibility for its recycling or disposal. All personnel within a hospital who handle mercury-containing products must cooperate with the HW Manager to develop appropriate procedures for the handling of items to be discarded, and their transportation to the designated HW collection point.

A list of recommended best practices generated by the Hospitals for a Healthy Environment Best Management Practices Work Group is provided in Table 1 on the next several pages page for your reference.

Table 1 - Mercury Waste Reduction Best Management Practices Tool

This BMP tool is provided for considering the implementation of various BMP at a healthcare facility. The scoring included with this BMP tool is the opinion of the Hospitals for a Healthy Environment Work Group who gathered and edited this information. It is recommended that each individual utilizing this tool consider all aspects relative to implementation of the practice at a specific facility. Variations in implementation of a practice may cause variations in the results obtained.

Best Management Practices
Rating Definitions and Guidelines

Volume Reduction
1. Increases waste volume significantly
2. Slight increase in waste volume
3. No change
4. Decrease in volume
5. Significantly decreases waste volume

Toxicity Reduction
1. Increases toxicity
2. Slight increase in toxicity
3. No change
4. Decreases toxicity
5. Significantly decreases toxicity

Employee Safety
1. Increases hazard to employee
2. Slight increase in employee hazard
3. No change
4. Improves employee safety
5. Significantly improves employee safety or eliminates hazard

Cost
1. Significant added operating expense or capitalization to implement
2. Minor added operational costs or costs to implement
3. No change
4. Some savings as result of implementation/capital payback in 10 yrs
5. Significant savings from implementation/capital payback in 3 yrs

Ease of Implementation
1. Difficult to implement
2. Some difficulty in implementation
3. No change
4. Easy to implement
5. Greatly favored, very easy implementation

Quality of Patient Care
1. Negative perceptions to patient care
2. Minor decrease perceived to quality of patient care
3. No change
4. Perceived improvement to patient care
5. Significant improvement to patient care

Table 1 - Mercury Waste Best Management Practices Tool

		Volume Reduction	Toxicity Reduction	Employee Safety	Cost	Ease to Implement	Patient Care Quality	Totals
#	Best Management Practice	Ranking	Ranking	Ranking	Ranking	Ranking	Ranking	Ranking
1	Replace cantor tubes/dialators with non-mercury equivalents.	3	5	5	4	2	4	23
2	Institute a purchasing policy that discourages or reduces the purchase of mercury-containing products and equipment.	3	5	5	3	2	3	21
3	Use mercury-free hematoxylin stains.	3	5	5	2	3	3	21
4	Replace mercury blood pressure units with non-mercury equivalents.	3	5	5	2	2	3	20
5	Discontinue practice of sending patients/new mothers home with mercury thermometers.	3	5	3	3	3	3	20
6	Replace gauges with non-mercury equivalents.	3	5	4	2	3	3	20
7	Replace esophageal dialators with non-mercury equivalents.	3	5	4	3	2	3	20
8	Replace mercury thermometers with non-mercury equivalents.	3	5	4	2	3	3	20
9	Use rechargeable batteries for non-critical medical devices.	4	4	3	4	1	3	19
10	Substitute zinc for mercury fixatives.	3	4	4	2	3	3	19
11	Substitute electronic sensing devices for mercury containing devices.	3	5	4	2	2	3	19
12	Substitute mercury thermometers in lab ovens, water baths, paraffin baths, refrigerators and freezers with alcohol or digital ones.	3	5	4	2	2	3	19

Table 1 - Mercury Waste Best Management Practices Tool

		Volume Reduction	Toxicity Reduction	Employee Safety	Cost	Ease to Implement	Patient Care Quality	Totals
#	Best Management Practice	Ranking	Ranking	Ranking	Ranking	Ranking	Ranking	Ranking
13	Develop proper protocol for labeling mercury-containing equipment and protocol for disposal of mercury products.	4	4	4	2	2	3	19
14	Require vendors to disclose mercury concentrations.	3	4	4	3	2	3	19
15	Set up program to manage/recycle mercury oxide batteries	4	4	4	2	2	3	19
16	Replace mercury containing pharmaceutical products with non-mercury containing equivalents.	3	4	4	3	2	3	19
17	Replace lab chemicals with non-mercury equivalents.	3	4	4	3	2	3	19
18	Replace mercury oxide batteries with non-mercury equivalents.	3	4	3	3	3	3	19
19	Replace thermostats with non-mercury equivalents.	3	5	3	2	2	3	18
20	Recycle used batteries.	4	4	3	2	2	3	18
21	Replace equipment switches with non-mercury equivalents.	3	5	3	2	2	3	18
22	Make mercury spill kits readily available.	3	3	5	2	2	3	18
23	Preserve stool samples with alternatives to mercury polyvinyl alcohol.	3	5	3	2	2	3	18
24	Set up program to manage/recycle fluorescent bulbs and mercury-containing lamps.	4	4	3	2	2	3	18

Table 1 - Mercury Waste Best Management Practices Tool

		Volume Reduction	Toxicity Reduction	Employee Safety	Cost	Ease to Implement	Patient Care Quality	Totals
#	Best Management Practice	Ranking	Ranking	Ranking	Ranking	Ranking	Ranking	Ranking
25	Replace dental amalgam with on-mercury equivalents.	3	5	4	2	2	2	18
26	Develop effective mercury spill cleanup procedures.	3	4	4	2	2	3	18
27	Set up program to collect and segregate mercury-containing dental amalgam from waste stream for recycling.	3	5	4	2	2	2	18
28	Conduct mercury training or awareness programs (e.g., thermometer exchange days).	3	3	4	2	2	3	17
29	Analyze/upgrade purity of conditioning chemicals for boilers and cooling towers to eliminate trace content (i.e., mercury content in caustics).	3	4	3	2	2	3	17
30	Check/clean plumbing traps and sumps for mercury from past use.	3	4	3	1	2	3	16

3.2 Fever Thermometers

3.2.1 Alternatives for Mercury-Containing Thermometers

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

3.2.2 Take-Home Thermometers

If some clinics of the hospital send thermometers home with their patients, handing out mercury-free thermometers should be considered. The take-home thermometer might be digital, chemical strips, or a glass thermometer filled with a non-mercury liquid metal alloy (or organic liquid). The use of a mercury-free alternative will prevent the release of mercury into the environment should the family accidentally break or otherwise discard the thermometer.

If an alternative has not yet been evaluated and chosen, and mercury thermometers are to be distributed in the meantime, patients should be educated about how to properly handle and dispose of the mercury after a thermometer has been broken or if one is to be discarded. A list of household HW facilities might be handed out with the thermometers. This information should also be available at the hospital's information desk. Another option might be for the hospital to allow patients to turn-in their old mercury thermometers for proper HW disposal by hospital.

3.2.3 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 must 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.

3.2.4 Recycling/Disposal of Mercury Containing Thermometers

Procedures should be developed for discarding mercury thermometers. Thermometers to be discarded could be placed in an appropriate container at a collection station (i.e. satellite point) that is convenient for staff members. The HW Manager should be consulted for this since there are some labeling and storage requirements that must be met when managing a HW.

Table 2 - Alternatives for Mercury Containing Thermometers

Type of Thermometer	Cost	Accuracy	Time for Reading	Calibration Frequency	Comments
Thermistor w/ digital readout	$225 - $500. Disposable covers: pennies a piece	+/- 0.2F (in 98 – 102F range)	4 – 15 seconds	Every 6 – 12 months.	Curly cord between probe and sensing unit.
Electronic (digital): Tympanic (also called infrared thermometer)	$150 -$300. Covers: pennies a piece	+/- 0.2 F (in 98 – 102F range)	Seconds	Every 6 mo. - 1 year. Some need initial testing only.	Requires batteries. Must use “pull and tug” method to get correct placement.
Glass filled with alloy of gallium, indium, and tin (liquid at room temperature).	Approximately $3	+/- 0.2 F (in 98 – 102F range)	3 minutes	None required	Breakable
Chemical strip (dot matrix)	Approximately $0.04 each	+/- 0.2 F (in 98 – 102F range)	1 – 3 minutes	N/A single use	Not intended to be used for recording temperatures lower than 95F.
Mercury	Approximately $0.40	+/- 0.2 F (in 98 – 102F range)	Oral: 5 min Rectal: 7 min	None required	Breakable, expensive disposal.

3.2.5 Are Non-Mercury Thermometers Adequate Diagnostic Tools?

There has been some controversy regarding the accuracy of non-mercury containing thermometers versus mercury-containing thermometers. The American Medical Association reviewed the benefits and drawbacks of the more readily-available types of fever thermometers and issued the following statement:

- Both glass mercury thermometers and digital thermometers will give you an accurate reading. What's most important is that you choose a thermometer that's easy to use and read.

- Ear thermometers are available that quickly and easily measure temperature inside the ear canal. They are fairly expensive compared with glass and electronic models, and learning how to use them correctly takes some training. But they can be quick and relatively comfortable for children.

- Forehead thermometers are convenient and comfortable to use, but they are not very accurate. They may be handy for quick screenings, but for exact readings use a glass thermometer or a digital one.

- There may be rare instances when a mercury thermometer may be preferred for some types of patients. Patients who are concerned about whether non-mercury thermometers are adequate for a particular circumstance should consult their physicians.

As with all categories, it is very difficult to determine the lifetime cost of the different options of thermometers. Chapter 4 provides more detail on the associated costs, including disposal.

3.3 Sphygmomanometers

3.3.1 Are Mercury-Free Sphygmomanometers as Reliable and Accurate as Mercury Ones?

There has been some recent concern on Gina Kolata's article "The Risk Seen in Move to Replace Gauge of Blood Pressure" (New York Times, Sunday, June 16, 2002). The article raised the point that aneroid sphygmomanometers cannot provide accurate readings unless they are properly calibrated and maintained. This is a good point however, the article neglected to point out that this is true not only for aneroid blood pressure cuffs, but also for the mercury-containing blood pressure devices they are replacing. Furthermore, while the article suggests that the choice of non-mercury diagnostic equipment may harm public health, it fails to mention the occupational, patient and greater public health risk of mercury-containing devices.

The article as well as more information on non-mercury containing blood pressure devices may be found at Healthcare Without Harm's web site at www.noharm.org,

Both mercury and aneroid blood pressure cuffs have been in use for about 100 years, and when working properly, either gives accurate results. Both devices are required to meet voluntary standards for accuracy set by the Association for the Advancement of Medical Instrumentation. The American Heart Association recommends that both aneroid and mercury sphygmomanometers must be checked regularly for measurement accuracy in order to avoid errors in blood pressure measurement.

In 2001, the National Heart, Lung and Blood Institute of the National Institutes of Health selected an electronic blood pressure monitor for use in a 10,000-patient study designed to reduce the risk of heart attack and stroke. A peer-reviewed study of the Mayo Clinic aneroid replacement program found that, "a carefully maintained aneroid sphygmomanometer is an accurate and clinically useful means of indirect blood pressure measurement," (Archives of Internal Medicine, March 12, 2001). Historical concerns about the inaccuracy of mercury-free alternatives are not born out by the experiences of the National Institutes of Health Clinical Center and leading hospitals that have eliminated their use of mercury blood pressure cuffs.

In 1995, Louise O'Donnell, a RN and Clinical Nurse Specialist, researched sphygmomanometers in a literature review and concluded the following:

- For bedside use, there is no obvious accuracy benefit to using the mercury sphygmomanometer routinely.

- In light of the health risk (and associated patient/staff safety as well as spill cleanup & waste management costs) associated with use of mercury in the clinical areas, it appears that it is most appropriate to use non-mercury systems on a broad scale.

It is highly recommended (no matter whether mercury, aneroid, or electronic BP devices are used) that:

- Appropriate size, placement, & snugness of cuff placement are ensured.

- Integrity of all system components is ensured (via routine preventative maintenance).

- Accurate calibration of the device is ensured (via routine preventative maintenance).

- Appropriate technique for inflation, deflation, and auscultation is ensured.

- The users are aware of, and efforts are made to counteract, common error points prone to cause inaccurate blood pressure determinations.

-- 12/16/95 Louise O'Donnell RN, MS
Neuroscience Clinical Nurse Specialist

3.3.2 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 the manufacturer's instructions and Occupational Safety and Health Administration (OSHA) standards.

The protocol might include the following instructions:

1. If the sphygmomanometer is mounted on the wall, the entire apparatus must be removed and taken to a safe workspace to refill. **Do not attempt to remove the mercury** until you have removed the sphygmomanometers from the wall and taken it to a safe workspace.

2. Place the sphygmomanometer to be refilled in a clear plastic bag and seal the bag. Do not use a red bag or biohazard bag.

3. Mark the bag: "CONTAINS MERCURY."

4. Place the bag in a plastic basin to contain spills while transporting to the area where the sphygmomanometer is to be refilled.

5. Wear appropriate protective clothing and work within a hood to provide ventilation.

6. Make sure the sphygmomanometer is resting on its side when you remove the mercury containing tube inside. Pressing the lever on older sphygmomanometers will cause the glass mercury tube to be released from the bottom of the apparatus. The glass tube is fragile!

7. Handle over a tray to contain any spills. Never handle mercury over a sink or floor drain.

8. If the sphygmomanometer is an older wall mounted Baum model, make sure that the sphygmomanometer has a safety clip installed to ensure that the mercury containing tube is not accidentally released. Safety clips for older sphygmomanometer may be obtained for free from W. A. Baum by calling 631-226-3940. Replacement tubes made of shatterproof mylar-coated glass can also be purchased from the manufacturer.

9. 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.)

Table 3 - Alternatives for Mercury-Containing Sphygmomanometers

Type of Sphygmomanometers	Mercury Content (Ounces)	Cost	Comments
Aneroid			
Portable	Mercury–free	$54 - $152	Needs calibration. Accuracy comparable to mercury.
Mobile with stand	Mercury–free	$225 - $242	See above
Wall-mounted	Mercury–free	$130 - $146	See above
Electronic	Mercury-free	Approximately $2,000	Common where long-term continuous monitoring is needed, such as intensive care
Mercury			
Desktop	3 – 4	$124 - $150	Requires annual refilling and calibration. Easily broken. Disposal is expensive. Not recommended for carpeted areas.
Mobile with stand	3.3 – 4.4	$225 - $282	See above
Wall mounted	3 – 4	$115 - $133	See above

3.3.3 Recycling/Disposal of Mercury-Containing Sphygmomanometers

Develop a protocol for the preparation of mercury sphygmomanometers for recycling or disposal that is consistent with EPA, State and local regulations, and other pertinent standards. Check with the manufacturer to see if a buy-back program is available for older equipment. Contact your HW Manager for details about packaging, labeling and

transporting that are specific to your facility. A suggested protocol might include the following instructions:

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

Note that when sphygmomanometers are disposed of, the sphygmomanometer maintenance kits (which also contain mercury) should also be disposed of as well.

3.4 Gastrointestinal Tubes

3.4.1 Recycling/Disposal of Mercury-Containing Gastrointestinal Tubes

Gastrointestinal tubes typically have expiration dates, after which their use must be discontinued. The hospital should have a protocol for the handling and recycling or disposal of mercury-containing tubes that is consistent with EPA, State and local regulations, and other pertinent standards. Clinics should contact the HW Manager for details about packaging, labeling and transporting that are specific to the facility. Prior to disposal, a designated person should check with the manufacturer to see if there is a buy-back program in place for older equipment. A suggested protocol for disposal of gastrointestinal tubes might include the following instructions:

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

Table 4 - Alternatives for Mercury Containing Gastrointestinal Tubes

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

3.5 Dental Amalgam and Mercury

Although dental clinics fall under a separate command, many hospitals have a dental clinic within the facility. 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 H. The mercury P2 best management practices described in the booklet were developed simultaneously with those described in this manual.

3.6 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. To phase out all nonessential uses of mercury in laboratories, hospitals may:

- 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; and

- Clear laboratories and storage areas of unnecessary mercury compounds.

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

3.6.1 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 Table 5. In the table, the shaded boxes indicate mercury-containing products followed by their mercury-free counterparts in the unshaded boxes.

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 proprietary information. Material Safety Data Sheets might not list mercury in a product if the formula is proprietary information 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.

Table 5 - Alternatives for Mercury-Containing Laboratory Chemicals

Compound	Mercury Content	Cost	Comments
Histological fixatives (such as B5 and Zenker's Solution) with mercury (II) chloride as a tissue preservative	3.7 – 4.5 g/L		
Zinc Formalin	Mercury-free	Approximately $.068/oz	Other products are available that are both mercury-free and formaldehyde-free.
Hematoxylin with mercury (I) chloride as an oxidizer	Approximately 2.5 g/L		
Gill's hematoxylin	Mercury-free	$0.50 - $1.50/oz	
Hematoxylin with sodium iodate as an oxidizer	Mercury-free	$0.51 - $1.20/oz	
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 Merrthiolate)		$3 - $7/g	
Methyl paraben, propyl paraben	Mercury-free		
Mercurochrome	24% - 27%	$0.75 - $0.90/g	
Neosporin	Mercury-fee		
Mycin	Mercury-free		

The laboratory's purchasing agent should contact the suppliers and request that mercury-free reagents be supplied. If the usual supplier cannot provide mercury-free reagents, it is often possible to locate one that can. Request that all vendors disclose mercury concentration by requiring them to supply 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 E.)

Wherever possible, change methodologies to processes that do not involve mercury. 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; care should be*

taken in this case when choosing an alterative product. The Environment Science Officer and/or Industrial Hygienist may be of assistance in this process.

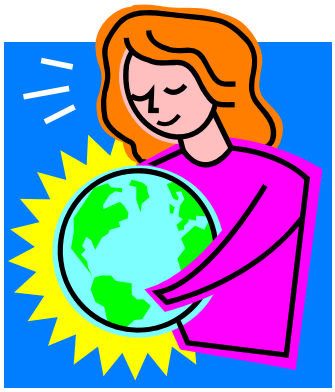
3.6.2 Recycling/Disposal of Mercury-Containing Laboratory Chemicals

Laboratory staff must be trained on the proper use, handling and disposal of hazardous materials, and the importance of keeping mercury out of wastewater. Staff must also be aware of laboratory products that are known to contain mercury. To minimize the amount of HW generated, laboratory chemicals collected for recycling should be kept separate from chemicals destined for disposal. Chemicals must never be mixed!

Depending on its concentration, mercury-contaminated waste may have to be collected and disposed of as HW. The HW Manager and the wastewater treatment plant should be contacted for information about the proper disposal of mercury-contaminated rinse water.

For plumbing in lab areas and dentist offices, filtration devices are available that can be attached to the plumbing. These devices separate and collect in-solution mercury from wastewater and can save time and money.

Check for unused, nonessential mercury-containing chemicals in storage areas and, depending on concentration, dispose of them as HW. Contact the hospital's HW Manager for proper instructions. Protective clothing, carpeting or debris that is contaminated with a mercury compound should be managed in accordance with EPA and State regulations.



3.7 Pharmaceutical Products

Mercury may 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.

Table 6 - 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).
Diuretic	Mersalyl and salts are still manufactured. Extent of use is unknown.

3.7.1 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. Vendor should be asked to assist the hospital in selecting mercury-free products for the pharmacy.

3.8 Cleaners and Degreasers

3.8.1 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 F, Educational Resources for a Mercury P2 Program) This information is provided to illustrate the widespread presence of mercury.

3.8.2 Alternatives for Mercury-Containing Cleaners and Degreasers

To learn the mercury content of the cleaners and degreasers used by a hospital, a Certificate of Analysis may be requested from all suppliers when purchasing materials. Mercury-free products should be chosen, 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. An MSDS is **not** equivalent to a Certificate of Analysis. (See Appendix E for a sample letter requesting a Certificate of Analysis and a sample Certificate of Analysis.)

Table 7 - Mercury Content of Selected Cleaning Products

Information from MWRA/MASCO Mercury Work Group

Products	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.	

3.9 Batteries

3.9.1 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. 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.

Table 8 - Batteries That May Contain Added Mercury and Replacement Alternatives

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 laws allows up to 25 mg mercury	Consumer	Multiples of 1.5 v	Silver oxide (last 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

In the 1990s, manufacturers stopped designing equipment requiring 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 learn of a variety of devices in which mercury-containing batteries have been used.

3.9.2 Alternatives to Mercury-Containing Batteries

The alternative to 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. Only one manufacturer has been successful in eliminating mercury from these batteries (hearing aid batteries only). 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.

3.9.3 Recycling/Disposal of Batteries

Many used batteries are a HW because of their mercury content and must be properly collected and disposed off. Convenient collection points for the batteries should be provided 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 HW Manager could post written guidance at the collection locations.

2. Collect all batteries. The HW Manager could take the responsibility for sorting the batteries. Under Federal law, batteries having a Toxicity Characteristic Leaching Procedure (TCLP) concentration of 0.2 parts per million (ppm) of mercury or greater are considered to be a HW. The manager should determine which types of used batteries are HW, which types can be recycled, and which types can be thrown away as trash.

3.10 Lamps

3.10.1 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 energy-efficient than incandescent lamps.

The mercury content of fluorescent and HID lamps should be investigated. Only those lamps with low mercury content should be purchased. Under Federal law, lamps having a TCLP of 0.2 ppm of mercury or greater are considered to be a HW. 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.

3.10.2 Recycling/Disposal of Mercury-Containing Lamps

Throughout the hospital, the Facilities Engineering branch generally replaces spent lamps. A conveniently located collection point should be established within the branch for the spent lamps. The HW Manager can assist in establishing the collection point because there are specific labeling and accumulation procedures that must be met. Lamps may also be taken directly to the HW Manager who will collect them at the hospital's designated HW collection point. The lamps can be sorted for recycling or disposal at either collection point. The preferred management method for the spent lamps is to send them to a recycler. Lamps should never be broken or crushed, as this will release hazardous mercury vapors. Intentional crushing of the lamps may also be considered treatment according to some State regulatory agencies. Consult with the installation Environmental Office for more information on this. If a lamp is accidentally broken, properly clean up the spill residue and store all of the debris in a sealed plastic container. Turn in all spill residues to the hospital HW Manager.

The exact procedures for sorting, storage, packing, and recycling or disposal will partly depend on State and local requirements. It is important to know the facility's HW generator status for this. Some the questions the HW Manager should ask of the installation Environmental Office are:

- Which lamps can and cannot be recycled?
- Which lamps must be considered as HW?
- How should lamps for recycling be packed for transporting?
- How should broken lamps be packaged?

3.11 Electrical Equipment

3.11.1 Alternatives for Mercury-Containing Electrical Equipment

Mercury can be found in many types of electrical equipment (see Table 9) 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.

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.

3.11.2 Recycling/Disposal of Mercury-Containing Electrical Equipment

If the hospital is preparing used electrical equipment for recycling or disposal through the Defense Reutilization and Marketing Office (DRMO) and there is a question about the mercury content, obtain this information from the manufacturers. Because DRMO has the option of reselling serviceable electrical equipment, the installation Environmental Office and/or DRMO should be contacted for instructions on whether or not to remove the mercury from any electrical equipment.

If the facility is directed to extract the mercury-containing parts from the equipment, only do so if it can be done in a safe manner. Store the parts in a tightly covered, labeled container. 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 closed, labeled container should be turned in to the HW Manager.

Table 9 - 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 devices Laptop computer screen shutoff Lids of clothes washers and chest freezers Silent light switches Space heater Thermostats Curling irons Security systems Cell phones	Mechanical switch
Float switch	Bilge pumps Septic tank Sump pump Irrigation systems	Magnetic dry reed switch Optic sensor Mechanical switch
Thermostat	Temperature control device may have a mercury tilt switch	Electronic thermostat
Reed delay	Low voltage, high precision analytical equipment such as electron microscope	Solid state relay, Electro-optical relay, dry reed delay
Plunger or displacement relay	High currents high voltage applications such as lighting, resistance heating, power supply switching	Mechanical switch
Thermostat probe	Electric stoves, hot water heaters	Non-mercury probe

3.13 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.

3.13.1 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

3.13.2 Recycling/Disposal of Mercury-Containing Thermostat Probes in Gas Appliances

If the hospital is preparing used appliances for recycling or disposal through the DRMO and there is a question about the mercury content, obtain this information from the manufacturer. Because DRMO has the option of reselling serviceable appliances, the installation Environmental Office and/or DRMO should be contacted for instructions on whether or not to remove the mercury from any appliances.

If the facility is directed to extract the mercury-containing parts from the appliances, only do so if it can be done in a safe manner. 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 and turn in to the HW Manager.

3.14 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.

3.14.1 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 HW collection point in a tightly closed container and in a manner that will prevent breakage of the thermometers. Contact the HW Manager for detailed instructions.

Table 10 - 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.

3.15 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 mercury-containing devices that measure pressure is aneroid devices.

Table 11 - Type of Manometer Cost Comments

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)	Prices 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	Prices 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.

3.15.1 Recycling/Disposal of Mercury from Mercury Containing Gauges

Store mercury waste from servicing manometers and other mercury-containing gauges in a covered, airtight plastic container. Contact the HW Manager on proper labeling procedures for the container. Small amounts of mercury can be stored in vials placed in a larger covered, airtight container, such as a five-gallon plastic pail.

3.16 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 release of the mercury accumulation in a pipe, sump, or sink trap is enough to cause violations of wastewater discharge standards even after BMPs 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 HW unless it is demonstrated, through the TCLP or verifiable user knowledge, that it is not hazardous. The installation Environmental Office should be contacted in case mercury is suspected in the sumps or sink traps.

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

3.17 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 cleanup challenge.

3.17.1 Mercury Spill Prevention

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

- Work under a well-ventilated hood to ensure minimal exposure to mercury vapors.
- Clean or refill instruments over a tray to contain any spills. Never handle mercury over a sink. 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 that are not smooth and easily cleaned. Mercury devices should not be used in units with beds that have high structures or projections off the beds that can smash wall-mounted sphygmomanometers, or in areas where patients cannot be moved.

3.17.3 Mercury Spill Response Preparation

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 any 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.

Specially trained staff members must perform the cleanup of mercury spills. Simulated spills and cleanup should be included as part of regular training. A formal mercury spill policy for the hospital must be established (see Appendix I for a sample spill plan). The following factors should be considered 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 must be evacuated from the area before cleanup.
- How to determine when a room is "clean enough" to reoccupy.
- 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.
- Posting of "Who to Call" signs in case of a spill in areas where mercury is used and near mercury recycling/HW receptacles.

3.17.4 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 may 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 HW coordinator. After the removal

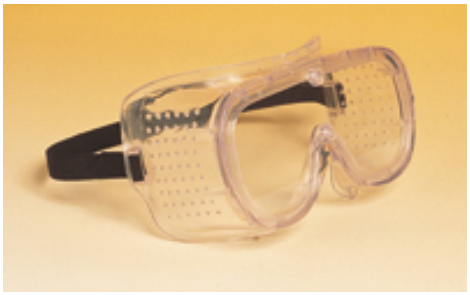
of the mercury-containing products the areas may need to be checked with the mercury vapor sniffer.

3.17.5 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 the Safety Officer prior to doing such work to ensure that the correct procedures are followed 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

Periodic training should be conducted for all employees who may come into contact with mercury-containing products. New and temporary employees, employees at offsite locations, and contractors should be included in the training. (See also the section on Spills.)



CHAPTER 4
COSTS AND BENEFITS OF ALTERNATIVES

4.1 Introduction

As part of the effort to provide information on the "virtual" elimination of mercury, the AHA, the EPA, and the hospitals involved in the Hospitals for a Healthy Environment (H2E) project recognized the need to develop relative cost information on mercury free products to assist facilities with the decision of reducing and eliminating mercury use. The goals of this effort were:

- To gather specific information on the costs of mercury-containing products and their mercury-free alternatives, and then to compare the two groups (presented in chapter 3).

- To provide information on often hidden or unaccounted for costs (internal and societal) associated with the use of mercury containing equipment and products in health care facilities.

- To provide hospitals with tools that enable a better understanding of the relative costs associated with the use of mercury containing equipment and products.

The information available on this subject shows that hospitals will likely save money by phasing-out the use of mercury-containing products and related mercury handling and disposal requirements. This chapter discusses both the internal and societal costs associated with mercury-containing products. Internal costs include purchase price; money and staff time spent on HW training, mercury spill clean-up, and waste storage and disposal; potential costs of non-compliance with environmental laws (e.g., fines, staff time and expenses for sampling and cleaning traps and drains, damages to hospital's image); and potential health risks to staff, patients, and visitors. Societal costs include damage to the environmental and public health.

In terms of initial purchase price, mercury containing and mercury-free diagnostic equipment were found to be competitive in some cases, while in other cases the mercury-free equipment was more expensive. However, when a more complete range of costs are considered, the mercury free equipment was found to be more cost effective and the preferred option in the long term.

Because of the specific patient care needs, hospitals must consider factors other than purchase price in their decisions. In fact, cost is often applied secondarily, after a specific product is identified. Some of these factors are: safety (patient & staff), ease of use, efficacy, warranty, timesavings, and preferences of medical staff. This chapter is not meant to indicate that costs should be paramount in purchasing decisions. However, nearly all of the diagnostic products and the majority of chemicals have a mercury-free alternative that has been used successfully. Therefore, this chapter was put together with the realization that cost can be a significant factor in choosing between products.

Prices for many mercury-containing lab and pharmaceutical chemicals are not included in this plan. However, often there is a mercury alternative that can be substituted and the price could be more or less dependent on the hospital's contract with its supplier (Pollution Probe 1996). The most effective way to replace mercury-containing pharmaceuticals and lab chemicals is to replace them over time by adopting a mercury free purchasing policy. This type of policy directs suppliers and vendors that all such products should be mercury-free chemicals whenever possible, and to alert you when new mercury- free substitutes become available.

Identifying the total cost of a product to a facility or to the hospital can be a very effective way to identify opportunities for cost-effective toxics reduction. Mercury thermometers are an excellent example. The purchase cost of a mercury thermometer is very low. However, the safest disposal for elemental mercury is triple distillation recycling, which is very expensive and requires that thermometers be collected, transported, and delivered intact to a hazardous materials recycling facility for processing. It requires the tracking of paperwork and other regulatory requirements on an ongoing basis. This can triple the total cost from the point of sale to ultimate disposal.

There are many reasons why hospitals are reducing and eliminating mercury-containing products from their facilities. These include: reducing the risk of accidental spills or discharges; not wanting to contribute to environmental degradation; obtaining savings through waste reduction; demonstrating leadership in the community; complying with requirements of present and future regulations and with international environmental agreements; responding to a perceived ethical obligation; and, of course, to work with the AHA to "virtually" eliminate mercury by 2005.

The missions of hospitals are moving toward broader definitions of disease prevention, patient health care and community well being. The use of mercury in hospitals and the resulting emissions to air and discharges to water contribute to environmental and health problems for people and wildlife. Civilian sector hospitals as well as Army medical treatment facilities recognize this inconsistency and as community health care leaders play an important role in achieving the goal of mercury elimination and reduction.

4.2 Limitations

A major limitation faced in this type of analysis is the variability of costs between hospitals and between suppliers. Prices of goods purchased and costs of disposal vary according to purchasing power and waste quantities generated. Costs stated in this report are generally quotes on a single item from one or two suppliers and therefore do not represent average prices from all suppliers or prices for bulk purchases. Price and cost information obtained by individual hospitals will undoubtedly vary. The tables in Chapter 3 are meant to illustrate purchase prices of comparable products as a basis for cost comparison.

The costs of a program to an individual facility needs to be determined on a site specific basis by working through purchasing and a facility's vendors. There are "costs or savings" worksheets in Section 4.5 of this chapter to assist with determining the total costs and benefits of mercury-containing products and their alternatives.

The cost information in this report is meant to cover the sources of mercury that are most commonly found in a hospital setting but is not meant to be inclusive of every potential mercury source. Mercury is found in many different chemicals and in many different uses. The cost information presented in chapter 3 and in this chapter is mainly for equipment and products. Other chemicals may be used, in labs, for example, which are not included in this plan.

For a more thorough list of chemicals, please refer to the Massachusetts Water Resources Authority and the Massachusetts Academic and Scientific Community Organization (MASCO) website, which can be found at www.masco.org. MASCO has developed a database of 5,500 mercury products and chemicals database.

Accurate estimates of the costs and risks of pollution directly linked to mercury in the environment and risks to human health can be difficult to quantify. Exposure to many persistent toxic substances and other health risks make it difficult to isolate the effects of mercury on humans and wildlife, except in cases of gross exposure. Ironically, the more widespread the toxic substance, the more difficult it is to isolate chronic exposure because traditional methods of study depend on exposure differences.

4.3 Hospital Costs (Internal)

4.3.1 Purchase Price (Mercury Containing Products and Alternatives)

Relative pricing information on mercury containing products and mercury free-alternatives is presented in Chapter 3; it is assumed that the military pays competitive prices for products purchased. In many cases, the cost of mercury spills is not tracked back to purchase of the mercury containing equipment. Often those types of costs are lumped into general overhead costs rather than traced back to the responsible products and decision-makers. When accounting practices are adjusted, it is possible to recognize

the origins of these downstream costs and make improved long term purchasing decisions. Because of the significant cost that can be incurred from clean-ups, handling, training, etc., the true total costs of mercury containing equipment is not only greater than the purchase price but in many cases also more costly than the total cost associated with the mercury-free alternative.

4.3.2 Spill Clean-Up Costs

Since mercury is highly toxic, spill clean-up costs can be significant for facilities that use mercury-containing equipment. Most hospitals seem to have some type of spill recovery procedure, but spills themselves are not consistently recorded and reported. It is therefore not surprising that the number of breakages and mercury spills occurring in a hospital tend to be underestimated by hospital staff (Smith, 1996a). Better recording of spills and their costs would likely prove helpful to those who want to include estimates of spill costs in purchasing decision-making.

While actual costs of cleaning up mercury spills are not well documented, certain documented cases show that mercury spills can be very expensive to clean up. For example, Hartford Hospital in Hartford, Connecticut gathered information on mercury spills from mercury sphygmomanometers and used the clean-up costs information as part of its justification to replace all of the mercury-containing sphygmomanometers with mercury-free equivalents. Mercury spills at Hartford Hospital cost the hospital over $60,000 in 1998. Replacement of all of the blood pressure equipment at the hospital in 1999 cost approximately $80,000.

Using mercury not only involves potentially high clean up costs, but also administrative costs to keep procedures up to date and staff trained. In areas where major spills occur, more stringent measures must be taken, including evacuating the area, using respiratory gear, and posting warnings.

Clean up costs vary depending on the number of spills, amount of time that it takes to clean up the spill, wage rate, cost of mercury spill kits, and management time. The average wage rate of spill team members was estimated to be $11 - $15/hr. It is estimated that a mercury spill clean up can take anywhere from 15 minutes to 12 hours to clean depending on the size and location of the spill, as well as the availability of knowledgeable people to clean up the spill (O ’Grady, 1996; Smith,1996a; Smith 1996b).

Table 12 - Mercury Cleanup Costs

Product	Purchase Price	Comments
Mercon Cleanup Kits	$102 - $288	Contain surface and air decontaminants, solidifier, identifier, aspirator, disposal bags, instructions, etc.
Mercury recovery vacuum (w/ a 6 gal tank)	$1,854 - $3,000	
PPE	$200 – 500/person	
Disposal of mercury and mercury-contaminated objects	$50 - $1,500 depending on amount to be disposed	
Spill Response Team	$20 - $25/hr	
Employee training	$15/hr/person	Does not include cost of mercury cleanup kit and training materials.

4.2.3 Training

As per OSHA regulations, the use of mercury and other hazardous substances requires that employees be properly trained on how to identify, use, and clean up the substances. Training can be expensive especially because mercury is used throughout the hospital. A typical spill clean-up training course takes 5 hours and costs $15/hour per employee plus the cost of materials. There are also administrative costs associated with training. These costs include keeping procedures update, tracking who has been trained, and who still needs to be trained.

4.3.4 Storage and Disposal

Mercury is required to be disposed of as a HW through DRMO. Most clinics or laboratories store waste mercury with other HWs at Satellite Accumulation Points until the quantity is large enough (55 gal) to warrant a turn-in to the HW Manager. The HW manager will in turn store the HW at the hospital's 90-day HW storage location until final turn-in through DRMO. Separating the disposal cost of mercury itself can be difficult because DRMO contracts with waste disposal companies generally do not call for the isolation of specific products.

According to a 1996 study, the average cost to a hospital for the proper disposal of hazardous waste is $250 per pick up of a "Labpack", a 45 gallon drum that contains a mixture of different hazardous materials (Santostefano, 1996; O'Grady, 1996). Depending on the size and the functions of each hospital, the number of pickups will vary. Assuming the average number of pickups to be 10 per year (based on Laidlaw's estimate for a large hospital), the hospital would pay $850 annually for disposal. Assuming further that 1/4 of an average Labpack is mercury and mercury contaminated

waste (Santostefano, 1996), the cost for proper disposal of mercury would have been $463 a year.

4.3.5 Ensuring Compliance

As a result of mercury's toxicity and well-documented adverse human health and environmental effects, Federal, State, and municipal governments have instituted laws and agreements to minimize the amount of mercury that is released into the environment.

The International Joint Commission identifies mercury as one of eleven Critical Pollutants that should be targeted for reduction. The North American Free Trade Agreement includes mercury in its group of four substances to be banned or phased out by Canada, the United States and Mexico. The other three substances have already been banned in Canada and the US. The Binational Toxics Strategy between Canada and the US also designates mercury as a level one substance with the challenge of 50% reduction of releases by 2006.

Part of the cost of using hazardous substances such as mercury is ensuring compliance with all current applicable regulations. Unfortunately, costs for hospitals to comply with current regulations are not well documented. For planning purposes each hospital needs to have staff that are familiar with and regularly verify and update all applicable environmental, health, and safety regulations. It suffices to say that any costs imposed by regulation will only make storing, treating, and disposing of waste more expensive. Pollution prevention is increasingly cost-effective because it can provide savings, improve efficiency, and reduce the environmental liabilities of an organization.

4.3.6 Potential Non-Compliance

On the other hand, there are also potential costs associated with non-compliance with regulations, including the remediation and fines, and staff time and expenses for sampling, monitoring and cleaning of drains and traps. Under the Resource, Conservation and Recovery Act (RCRA), fines may be as much as $27,500/day for each incident of noncompliance.

In Minnesota, the inability to comply with water discharge regulations for mercury has meant that hospitals have had to look closely at their operations. Mercury used in the past often settles at low points in sumps and traps. This means that discharge violations for mercury can occur years after mercury is poured down the drain. Hospitals in Minnesota, which are not in compliance with mercury discharge to the sewer, have been required to undertake regular sampling. The only way to avoid the leaching off of mercury from the system is through costly cleaning of drains and traps.

In Minnesota, many hospitals have avoided potential fines by partnering with the wastewater treatment plant to develop mutually beneficial solutions. One key to this strategy has been eliminating all mercury disposal to drains and in many cases creating hospital wide plans to eliminate mercury.

4.3.7 Human Health Risks

The risk to human health is very difficult to quantify in terms of cost. However, the risk is very real. OSHA standards require that maximum exposure to mercury vapor be no more than 0.1mg/m^3 on an 8-hour time-weighted average. The American Conference of Governmental Industrial Hygienists recommends mercury exposure levels below 0.025 mg/m^3. Any mercury spill, even as little as mercury thermometers contain, could pose potential risk to workers and needs to be cleaned up properly. Mercury vaporizes relatively quickly, and although the mercury spill itself is unlikely to hurt anyone, the mercury vapor in the room where the spill occurred presents a hazard to employees. A spill within a confined area could also require respiratory protection under the OHSA regulations, further increasing the cost. Those most at risk from mercury exposure are pregnant women, as fetuses are very susceptible to small amounts of mercury.

4.4 Environmental and Health Costs (Societal Costs)

Identifying and quantifying the costs to society and the economy from the use of toxic substances is a rigorous and complex task. Yet, it is possible to begin to consider the nature of these costs and some specific environmental consequences of mercury releases to the environment. Specific costs related to mercury use and consequent environmental effects are very difficult to quantify. For instance, in terms of human health and the environment, how much is it worth to decrease the amount of mercury in air, water, or soil from human activities by 1 ppm? Alternatively, how much is it worth to recreation and fishing enthusiasts to know that they can eat all the fish they can catch without fear of harming their health?

While these costs are difficult to estimate, it is important to recognize that mercury has these detrimental effects and the overall detrimental effect should be a consideration in the decision making process. The next three sections address more specific environmental and societal effects that need to be considered in a facility's decision to adopt the goal of virtual elimination of mercury.

4.4.1 Cost of Polluted Lakes

Beneficial use impairments (e.g., reductions in availability of edible fish or drinkable water) resulting from mercury can be found in lakes in most every State in the country. The pollution is of particular concern in the Great Lakes ecosystem. These impairments include: restrictions on fish consumption by humans, restrictions on dredging activities, and impairment of water and sediment quality. Mercury concentrations in shoreline samples of water, sediment, sport fish and biota of the Great Lakes often exceed the Great Lakes Water Quality Agreement. Similarly, forty-one States and three eastern Canadian provinces have issued fish consumption advisories recommending limits on the consumption of potentially contaminated fish.

Mercury is a problem in the Great Lakes basin and many of the smaller lakes in which millions of people live and enjoy recreational activities. The environmental impacts of mercury affect both commercial and sport fishing industries. Loss of commercial fisheries is one of most easily identifiable losses of economic value. Cleaner waters would likely increase both the commercial and sport fishing industries and create spin-off benefits for other sectors such as tourism and related activities.

Mercury is so toxic, persistent, and bioaccumulative that it is the most frequent basis for fish advisories. Mercury is the significant pollutant in 60 percent of all water bodies with advisories. Forty-one states have advisories for mercury in one or more water bodies, and eleven states have issued statewide mercury advisories.

If sport fishing were to increase by 10% in the Great Lakes due to decreased pollution and decreased fish advisories, estimates of the economic impact show an increase of revenues of approximately $300 million each year. If the fishery is managed in a sustainable manner, this economic impact can be replicated each year for an indefinite period of time (National Wildlife Federation, 1993). Dangerously high levels of mercury in fish also threaten subsistence fishers and wildlife. For example, several species of wildlife have shown reproductive problems attributable to chemical pollutants in the Great Lakes. These fish catching species include eight birds, one reptile, and two mammals. (Environment Canada et.al., 1991).

4.4.2 Health Effects

Heavy metals such as mercury can impair human health and have medical costs. The most important benefit to society of reducing pollution is the decreased risk of illness and premature death. These risks occur because a large number of substances are emitted to the natural environment that cause negative health effects upon exposure to humans. For instance, low concentrations of substances such as mercury, PCB, and dioxin in drinking water supplies can be associated with increased incidence of serious chronic illnesses including certain forms of cancer and adverse effects on neurological, immunological, and reproductive systems (Flint and Vena 1991).

Benefits of reducing pollution can be difficult to evaluate in economic terms for a number of epidemiological reasons including: uncertainty surrounding the dose-response relationship for many toxic substances; the latency periods associated with some diseases; extent to which responses can be reduced by "defensive actions", and the compounding effects of exposure to multiple substances. It is also difficult to estimate and assign dollar values to avoided cancer, asthma, eye irritation, and the pain and suffering that accompany these illnesses. However, it is important to recognize that there are serious health effects associated both with consumption of fish contaminated from mercury and with direct exposure to high concentrations of mercury.

4.4.3 Societal Costs and Pollution Prevention

Costs to the environment and society are not generally included in the purchase price of products or equipment containing persistent toxics such as mercury. Environmental liabilities of current and past practices are usually ignored and not accounted for on financial statements. Pollution prevention is generally a much more cost-effective way of reducing environmental impacts than using pollution controls. For example in Minnesota, it is estimated that it costs approximately $2,500 to $3,500 to remove one pound (.4538 kg) of mercury from a municipal waste incinerator's air emissions (Michigan Mercury Pollution Prevention Task Force, 1996). It is easier and cheaper to prevent pollution than to try to control the release after it has already occurred.

4.5 Mercury Cost Savings Worksheets

The following worksheets were put together to assist hospitals in determining the costs or savings of eliminating mercury in their facilities. For the first worksheet, a sample is provided for reference, followed by a blank worksheet for your personal use. The sample worksheet compares the costs of a mercury and a non-mercury mobile sphygmomanometer. The analysis shows that, although the initial purchase price of the mercury sphygmomanometer might be the same or slightly higher, when clean-up estimates and low disposal cost estimates are included, the non-mercury sphygmomanometer becomes the more cost effective option. Note: costs quoted are only examples and may vary for individual facilities.

For Calculations on the Sample Worksheet use the Following Methodology:

Spill clean up includes the cost of the clean-up kit plus the time required to train staff. If an external contractor is required to clean up a spill, costs increase by 4 or 5 times the cost of using internal staff.

Annual operating costs of mercury sphygmomanometer, assuming 1 spill per year:

Initial capital cost of mercury sphygmomanometer = $115

Spill cleanup kit = $75

Personal protective equipment (PPE) for staff = $200 * 3 employees = $600

Initial training for spill cleanup = $25/hr for trainer * 3 hours = $75
$10/hr for employees * 3 employees * 3 hours= $90

Hazardous waste disposal of PPE and cleanup materials = $150 per spill

Staff time for cleanup = $10/hr per employee * using 2 employees * 2 hours = $40

Total annual operating cost of mercury sphygmomanometer: $1,145 per spill

Total capital costs for aneroid sphygmomanometer = $225

*Note, no mercury spill clean-up kit, mercury spill training, or disposal costs required for aneroid sphygmomanometer

SAMPLE

Proposed product	Aneroid Mobile Sphygmomanometers
Current product	Mercury Mobile Sphygmomanometers
Hospital	Your Hospital
Prepared by	

Date _____ Number of Replacements 30

Capital costs of proposed product*

	Description	**$ Cost**
Product	30 sphygmomanometers ($225 each)	6750
Material	_____	_____
Installation	floor model	N/A
Utility connections	_____	N/A
Engineering	_____	N/A
Start-up and training process	you will need to determine	
Other capital costs	Disposal of old sphygmomanometers	2000
	Total capital costs	$8750

Annual operating costs, assuming 1 spill/year	**$ Current Product Costs**	**$ Proposed Product Costs**
Disposal	150	0
Recycling	unknown	unknown
Spill clean-up (at 1 spill/year/2 employees)	715	0
Spill Training	165*	0
Calibration	unknown	unknown
Other (replace broken unit)	115	225

Annual net operating cost or savings = (current – proposed) product operating costs

= ($1,145/yr - $225/yr) = $920 annual savings w/ mercury free sphyg.

Payback period (in years) = $\frac{\text{Total capital costs}}{\text{Annual net operating cost or savings}}$ = 9.5 years

*Depreciation should be considered because only annual refresher training is needed after initial training expense

Reusable Product Replaced by a Reusable Product

Proposed product _____

Current product _____

Facility _____

Prepared by _____

Date _____

Capital costs of proposed product*

	Description	$Cost
Product	_____	_____
Materials	_____	_____
Installation	_____	_____
Utility connections	_____	_____
Engineering	_____	_____
Start-up 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) = $\frac{\text{Total capital costs}}{\text{Annual net operating costs or savings}}$ =

*Depreciation should be considered

Disposable Product Replaced by Disposable Product

Proposed product_____

Current product _____

Facility _____

Prepared by _____

Date _____

Annual cost of proposed product

			Annual Cost
Product	$_____ @ *	# purchased annually _____	=_____
Disposal	$_____ @ *	# purchased annually _____	=_____
Recycling	$_____ @ *	# purchased annually _____	=_____
Handling			_____
Spill clean-up			_____
Training			_____
Calibration			_____
Other	_____		_____
		Total annual cost of product	_____

Annual cost of current product

			Annual Cost
Product	$_____ @ *	# purchased annually _____	=_____
Disposal	$_____ @ *	# purchased annually _____	=_____
Recycling	$_____ @ *	# purchased annually _____	=_____
Handling			_____
Spill clean-up			_____
Training			_____
Calibration			_____
Other	_____		_____
		Total annual cost of product	_____

Total annual cost of current product _____

Total annual cost of proposed product - _____

Annual net cost of savings of proposed product = _____

Disposable Product Replaced by a Reusable Product

Proposed product_____

Current product _____

Facility _____

Prepared by _____ Date_____

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

Expected lifetime of product _____ years

Total capital costs / Expected lifetime of product = Annualized capital cost = _____

Annual costs of current product	**Annual Cost**
Product $_____ @ * # 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	_____	

4.6 Summary of Results

Mercury free alternatives exist for most mercury-bearing products. Truly effective purchasing decisions need to be based on more than the purchase price. When total costs of mercury products are considered, cost does not appear to be a significant barrier to the replacement of mercury products with mercury free alternatives. On the basis of purchase price alone, the cost of mercury free equipment is in some cases competitive and in some cases more expensive than mercury-based products. However, there are several additional internal and societal costs that need to be considered with mercury products. Hospitals' internal costs include:

- Purchase price.
- Money and staff time spent on hazardous waste training.
- Mercury spill clean-up, waste storage and disposal.
- Potential costs of non-compliance with environmental laws (e.g., fines, staff time and expenses for sampling and cleaning traps and drains, damages to hospital's image).
- Potential health risks to staff, patients, and visitors.

Societal costs include damage to the environmental and public health for which the hospital is not held responsible. Even when only the internal costs were considered, it was shown that the use of mercury-free equipment can save facilities money. The key is in identifying all of the costs associated with the usage of mercury equipment and attributing those costs to the equipment itself rather than letting those costs get lost in overhead accounts.

Costs for lab chemicals and pharmaceuticals are difficult to compare directly since these chemicals are not used in isolation but as part of a protocol or procedure. Several hospitals that have replaced their lab chemicals found that costs for using mercury free alternatives were approximately the same (Pollution Probe 1996). For lab chemicals and pharmaceuticals, purchase price is not considered to be the most significant issue when exploring alternatives, but rather assuring that the mercury-free alternative is right for the application and educating hospital staff on its use.

It is important to note that product cost is not the most important factor when patient care decisions are being made. Hospitals' primary considerations in their purchasing specifications include: quality of patient care, safety, ease of use, efficacy, warranty, time savings, and preferences of medical staff. However, as noted above, in most cases mercury free products have been developed that meet hospitals' specifications. These products are being used successfully by hospitals around the country. Purchasing decisions benefit from the evaluation of true costs and the consideration of the environmental benefits of being mercury-free.

APPENDICES

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
  - Lead analyzer electrode (ESA model 3010B)
  - Vibration meters

Sample 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 halide ___ 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 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

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 E 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
Benefits of a Mercury Pollution Prevention Program in your Hospital

Addresses Human Health Concerns About Mercury in the Environment

- Hospital medical equipment contains a much larger amount of mercury than home medical equipment, and thus presents a larger potential hazard. For example, while a home fever thermometer contains about 1.59 grams of mercury, a desk-mounted sphygmomanometer contains about 83.7 grams of mercury.
- There are human health impacts due to eating mercury-contaminated fish and fish consumption advisories due to mercury
- Worker and patient exposure to mercury from broken thermometers and other mercury-containing devices could be avoided by using mercury-free equipment
- 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), several states have adopted stricter water quality standards for 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.

Additional Benefits to Mercury Pollution Prevention

- Avoids disruption of services due to spills.
- Avoids high disposal costs of mercury.
- Avoids need to train staff for handling mercury.
- Avoids 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 an environmental leader in the local medical community.

Appendix D
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.

	Baseline	**Year 1**	**Year 2**	**Year 3**	**Year 4**
Are mercury thermometers still in use? In which departments?					
Number of mercury thermometers purchased.					
Number of mercury thermometers sent home with patients.					
Are mercury sphygmomanometers still in use? In which departments?					
Number of mercury sphygmomanometers purchased.					
Are mercury gastrointestinal tubes still in use?					
Number of mercury gastrointestinal tubes purchased.					
Is phase-out of mercury laboratory chemicals underway or completed?					
Is phase-out of mercury pharmaceutical products underway or completed?					
Is phase-out of mercury batteries underway or completed?					
Number of mercury batteries purchased.					
Is phase-out of mercury in electrical equipment underway or completed?					
Quantity of mercury waste disposed as hazardous waste.					
Quantity of mercury waste recycled.					
Costs for the recycling and/or disposal of mercury waste.					
Number of mercury spills.					
Estimated total quantity of mercury involved for all mercury spills.					
Is documentation kept to track					

that all pertinent staff are educated about mercury spill prevention and management?					
Percentage of pertinent staff trained about mercury spill prevention and management.					
Do all pertinent staff know where the mercury vacuum cleaners and/or mercury spill kits are located?					
Percentage of pertinent staff that know whom to call for clean-up of a mercury spill.					
Percentage of maintenance staff that know the proper procedure for trap cleaning in areas where mercury is used.					
Is training documentation kept for all staff educated about the health and environmental concerns of mercury?					
Percentage of staff that has been educated about the health and environmental concerns of mercury.					
Is there a disclosure about mercury content for each of the products or chemicals used by the hospital?					
Percentage of disclosures that are on file (see above).					

Appendix E
Sample Letter Requesting Certificate of Analysis and Sample Certificate of Analysis

January 2, 2003

Jane Doe
Director of Sales
Mercury Laboratory Products
40 Third Street
Duluth, MN 12345

Subject: Certificate of Analysis

Dear Ms. Doe:

Our hospital 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 products.

Please submit the aforementioned information on all products listed on the enclosure to this letter. Thank you for your understanding and assistance in this matter.

Sincerely

James Smith
Title

Encl.

Sample Certificate of Analysis

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 F
Resources for a Mercury Pollution Prevention Program

MWRA/MASCO Mercury Work Group
David Eppstein **deppstein@masco.harvard.edu**, or 617-632-2860.

Online Mercury Management Guidebook
http://www.masco.org/mercury/phase2/index.html

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
Michael Bland Attn: MI-10J
77 West Jackson Blvd.
Chicago, IL 60604
Phone: (312) 353-9196

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
Mercury Specialist
2626 Courtland St.
Duluth, MN 55806-1894
218-722-3336, ext. 307

Merc Alert (pamphlet for consumers, free)
Blueprint for Mercury Elimination: for Wastewater Treatment Plants (42-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

Sustainable Hospitals Project
www.uml.edu/centers/LCSP/hospitals/

For additional resources, see the State Contacts in Appendix G and Appendix R, Bibliography.

Appendix G
National Listing of State Hospital Waste Reduction / Pollution Prevention Contacts
(Compiled in September 2000)

ALABAMA

Alabama Department of Environmental Management
Pollution Prevention Unit
PO Box 301463
Montgomery, AL 36130

Mr. Gary Ellis
Telephone: (334) 213-4303
General Number: (334) 271-7700
Fax: (334) 271-7950
Email: Oeomail@adem.state.al.us
Website: http://www.adem.state.al.us/EnviroProtect/P2/P2.htm

ALASKA

Alaska Department of Environmental Conservation
Environmental Health Coordinator
554 Cordova Street
Anchorage, AZ 99500

Ms. Kristin Ryan
Telephone: (907) 269-7630
General Number: (907) 269-7630
Fax: (907) 269-7678
Email: kryan@envirocon.state.ak.us
Website: http://www.state.ak.us/local/akpages/env.conserv/dsps/compasst/cao_home.htm

Alaska Department of Environmental Conservation
Pollution Prevention
555 Cordova Street
Anchorage, AZ 99501

Ms. Tee Little
Telephone: (907) 269-7586
General Number: (907) 465-5350
Fax: (907) 269-7678
Email: tlittle@envirocon.state.ak.us
Website: http://www.state.ak.us/local/akpages/ENV.CONSERV/dsps/compasst/cao_home.htm

ARIZONA

Arizona Department of Environmental Quality
Pollution Prevention
3033 N. Central Avenue
Phoenix, AZ 85012

Ms. Sandra Eberhardt
Telephone: (602) 207-4210
General Number: (800) 234-5677 ext. 4333.
Fax: (602) 207-4538
Email: eberhardt.sandra@deq.state.az.us
Website: http://www.adeq.state.az.us/environ/compliance/index.html

ARIZONA, Nationwide Links

Earth's 911
Reduce, Reuse and Recycle Sites
5110 N. 44th Street, Suite L120
Phoenix, AZ

Ms. Anne Reichman
Telephone: 6022245444
General Number: (602) 224-5444
Fax: (602) 553-8782
Email: areichman@cleanup.org
Website: http://www.1800cleanup.org/states/default.asp

ARKANSAS

Arkansas Department of Pollution Control and Ecology
Customer Service Division/Pollution Prevention
P.O. Box 8913
Little Rock, AR 72219-8913

Mr. James Gilson
Telephone: (501) 682-0821
General Number: (501) 682-0744
Fax: (501) 682-0798
Email: gilson@adeq.state.ar.us
Website: http://www.adeq.state.ar.us/custsvs/businessasst.htm#Pollution Prevention

CALIFORNIA

California Environmental Protection Agency/Department of Toxic Substances Control
Office of Pollution Prevention and Technology Development
P.O. Box 806
Sacramento, CA 95812-0806

Ms. Mary Pride
Telephone: (916) 324-1088
General Number: (916) 322-3670
Fax: (916) 327-4494
Email: mpride@dtsc.ca.gov
Website: http://www.westp2net.org/Sector/healthcare.htm

COLORADO

Colorado Health and Hospital Association
Pollution Prevention
7335 East Orchard Rd., Suite 100
Englewood, CO 80111

Ms. Particia McClearn
Telephone: (720) 489-1630
General Number: (720) 489-1630
Fax: (720) 489-9400
Email: pat.mclearn@chhn.com
Website: http://www.coloradop2.org/

CONNECTICUT

Connecticut Department of Environmental Pollution/Bureau of Waste Management
Department of Pollution Prevention
79 Elm Street
Hartford, CT 06106-5127

Ms. Kim Trella
Telephone: (860) 424-3234
General Number: (860) 424-3297
Fax: (860) 424-4081
Email: kim.trella@po.state.ct.us
Website: http://www.dep.state.ct.us/whatshap/press/1999/ls0111.htm

DELAWARE

Delaware Department of Natural Resources and Environmental Control
Pollution Prevention Program
89 Kings Highway
Dover, DE 19901

Ms. Andrea Kreiner
Telephone: (302) 739-3822
General Number: (302) 739-4403
Fax: (302) 739-6242
Email: akreiner@dnrec.state.de.us
Website: http://www.dnrec.state.de.us/DNREC2000/P2/p2home.htm

FLORIDA

Florida Department of Environmental Protection
Pollution Prevention
2600 Blair Stone Rd., MS 4750
Tallahassee, FL 32399-2400

Ms. Laurie Tenace
Telephone: (850) 488-1865
General Number: (850) 488-1865
Fax: (850) 921-8061
Email: laurie.tenace@dep.state.fl.us
Website: http://www.dep.state.fl.us

Florida Pollution Prevention Roundtable
Website: http://www.flppr.org/

GEORGIA

Georgia Department of Natural Resources
Pollution Prevention Assistance Division
7 Martin Luther King, Jr. Drive, Suite 450
Atlanta, GA 30334-9004

Ms. Stephanie Busch
Telephone: (404) 651-5120
General Number: (800) 685-2443
Fax: (404) 651-5130
Email: p2ad@ix.netcom.com
Website: http://www.ganet.org/dnr/p2ad/

HAWAII

Department of Health/Environmental Health
Hazardous Waste Branch/Waste Minimization
919 Ala Moana Boulevard #212
Honolulu, HI 96814

Ms. Marlin
Telephone: (808) 586-4226
General Number: (808) 586-4226
Fax: (808) 0586-7509
Email: maguilar@eha.health.state.hi.us
Website: http://www.hawaii.gov/health/eh/index.html

IDAHO

Division of Environmental Quality
Air Toxics Regulatory Analyst
1410 North Hilton
Boise, ID 83706

Mr. Tim Teater
Telephone: (208) 373-0457
General Number: (208) 373-0502
Fax: (208) 373-0417
Email: tteater@deq.state.id.us
Website: http://www2.state.id.us/deq/ptwo/p2_1.htm

ILLINOIS

Illinois Environmental Protection Agency/Pollution Prevention Office
Mercury Reduction Project for Hospitals
1021 North Grand Avenue East
Springfield, IL 62794-9276

Mr. Kevin Greene
Telephone: (217) 785-0833
General Number: (217) 782-8700
Fax: (217) 557-2125
Email: epa8603@epa.state.il.us
Website: http://www.epa.state.il.us/p2/mercury-reduction-for-hospitals.html

INDIANA

Indiana Department of Environmental Management
Voluntary Compliance
105 West Market Street, Suite 703
Indianapolis, IN 46204

Mr. Dave Wintz
Telephone: (317) 233-1194
General Number: (800) 988-7901
Fax: (317) 233-5627
Email: dwintz@dem.state.in.us
Website: http://www.state.in.us/idem/ctap/hospitals/index.html

IOWA

Iowa Department of Natural Resources
Pollution Prevention and Business Assistance
502 E. 9th Street, Wallace State Office Building
Des Moines, IA 50319-0034

Mr. Brian Tormey
Telephone: (515) 281-8927
General Number: (515) 281-4367
Fax: Fax: (515) 281-8895
Email: brian.tormey@dnr.state.ia.us
Website: http://www.state.ia.us/dnr/organiza/wmad/inside/staff.htm

KANSAS

Department of Health and Environment/Division of Environment
Pollution Prevention
Forbes Field, Bldg. 283
Topeka, Kansas 66612

Ms. Janet Neff
Telephone: (785) 296-0669
General Number: (800) 357-6087
Fax: (785) 291-3266
Email: jneff@kdhe.state.ks.us
Website: http://www.kdhe.state.ks.us/opp/index.html

KENTUCKY

Kentucky Pollution Prevention Center
P2 For Healthcare Organizations
420 Lutz Hall
Louisville, Kentucky 40292

Ms. Penny Williams
Telephone: (502) 852-0965
General Number: (502) 852-0965
Fax: (502) 852-0964
Email: info@kppc.org
Website: http://www.kppc.org/about/P2/links/healthcare.cfm

KENTUCKY

Kentucky Department of Environmental Protection
Resource Conservation and Local Assistance
14 Reilly Road
Frankfort, KY 40601

Ms. Melinda Meredith
Telephone: (502) 564-6716
General Number: (502) 564-6716
Email: Melinda.Meredith@mail.state.ky.us
Website: http://www.nr.state.ky.us/nrepc/dep/waste/programs/p2/recycle.htm

LOUISIANA

Louisiana Department of Environmental Quality
Small Business/Pollution Prevention
P.O. Box 82135
Baton Rouge, La. 70884-2135

Mr. Patrick Devillier
Telephone: (225) 765-0912
General Number: (225) 765-0219
Fax: (225) 765-0222
Email: assist@deq.state.la.us
Website: http://www.deq.state.la.us/assistance/index.htm

MAINE

Maine Department of Environmental Protection/Bureau of Management Services
Pollution Prevention
Augusta, ME 04333
State House Station 17

Ms. Chris Rushton
Telephone: (207) 287-7100
General Number: (207) 287-7100
Fax: (207) 287-2814
Email: chris.rushton@state.me.us
Website: http://janus.state.me.us/dep/oia/p2home.htm

MARYLAND

Maryland Department of the Environment
Waste Management Administration
2500 Broening Highway
Baltimore, MD 21224

Mr. Nick Kauffman
Telephone: (410) 631-4119
General Number: (800) 633-6101 x4119
Email: mdeprf@olg.com
Website: http://www.mde.state.md.us/permit/p2prog.html

MASSACHUSETTS

Massachusetts Office of Technical Assistance
Pollution Prevention
100 Cambridge St. Room 2109
Boston, MA 02202

Mr. Scott Fortier
Telephone: (617) 727-3260
General Number: (617) 723-4920
Fax: (617) 626-1095
Email: scott.fortier@state.ma.us
Website: http://sbir.gsfc.nasa.gov/SBIR/states/matm.htm

MASSACHUSETTS

Massachusetts Executive Office of Environmental Protection
Bureau of Waste Prevention
One Winter Street, 7th Floor
Boston, MA 02108

Ms. Judy Shope
Telephone: (617) 292-5597
General Number: (617) 292-5849
Fax: (617) 292-5778
Website: http://www.state.ma.us/dep/bwp/contacts.htm

MICHIGAN

Michigan Department of Environmental Quality
Environmental Assistance Division
PO Box 30473
Lansing, MI 48909

Ms. Marcia Horan
Telephone: (517) 373-9122
General Number: (517) 373-9122
Fax: (517) 335-4729
Email: horanm@state.mi.us
Website: http://www.deq.state.mi.us/

MINNESOTA

Minnesota Pollution Control Agency
Pollution Prevention
520 Lafayette Rd.
St. Paul, MN 55155-2100

Mr. Ed Swain
Telephone: (651) 296-7800
General Number: (651) 296-7800
Email: ed.swain@pca.state.mn.us
Website: http://www.moea.state.mn.us/

MINNESOTA

Minnesota Office of Environmental Assistance
Pollution Prevention
520 Lafayette Rd.
St. Paul, MN 55155-2100

Mr. John Gilkeson
Telephone: (651) 215-0199
General Number: (651) 215-0199
Email: john.gikeson@moea.state.mn.us
Website: http://www.pca.state.mn.us/about/index.html

MISSISSIPPI

Mississippi Department of Environmental Quality
Waste Reduction/Waste Minimization Program
101 W. Capitol Street
Jackson, MS 39201

Mr. David Peacock
Telephone: (601) 961-5220
General Number: (601) 961-5171
Fax: (601) 961-5742
Email: david_peacock@deq.state.ms.us
Website: http://www.deq.state.mi.us/

MISSOURI

Missouri Department of Natural Resources
Technical Assistance Program
P. O. Box 176
Jefferson City, MO 65102

Mr. David Goggins
Telephone: (573) 526-6627
General Number: (800) 361-4827
Fax: (573) 526-5808
Email: nrgoggd@mail.dnr.state.mo.us
Website: http://www.dnr.state.mo.us/deq/tap/polprev.htm

MONTANA

Montana Department of Environmental Quality
Pollution Prevention Bureau
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Helena, MT 59620-0901
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Appendix H
Best Management Practices for Amalgam Handling and Recycling

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

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 text has been edited to meet specific military management requirements. 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 (HW).

- 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 designated, tightly closed, wide mouth plastic containers. The containers should be labeled "Used Amalgam". The Defense Reutilization and Marketing Office (DRMO) that the amalgam is collected "dry". Do not suspend the amalgam in a liquid solution.

Amalgam capsule handling

Collect and store the entire contents of broken or unusable capsules with your scrap amalgam. If empty dental amalgam capsules contain no visible amalgam materials, they maybe 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.

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 or sharps container.**
- **Never place scrap amalgam in the trash.**

Many chair side traps are serviced by a local contract. For dental clinics that do not have a service contract in place, 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 "Used Amalgam". Close the cover tightly. If the trap is visually clean, it can be put in the trash. A heavily contaminated trap should always be recycled. It should be placed in the Used Amalgam container.

6. Turn-in the Used Amalgam container to your HW manager for recycling.

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

- Replace or dispose of these filters regularly as recommended by the equipment manufacturer.
- Use universal precautions.
- Remove the filter and decant, over a tray, as much liquid as possible without losing visible amalgam.
- 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 through your HW manager.

Plumbing replacement and repairs

After your clinic 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 is present. Pour and brush out the sludge and handle it as you would handle contact amalgam.

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 Installation Environmental Office if you have questions about disposal of renovation debris.

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.

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 clinic, call your HW manager or Installation Environmental Office about cleaning it up.

TRAP INVENTORY FORM

Facility Name _____

Address _____
_____
_____

Building Name _____

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

Appendix I
Mercury Spill Clean-Up Procedures

Broken Thermometers:

There is not enough mercury involved to present a hazard. If the following steps are taken, you do not need to respond with the mercury vacuum*. **Never use a regular vacuum to clean up a mercury spill.**

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:

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

**Note: Any call that 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:

- Specialized mercury vacuum* and attachments (stored in the 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.

Toolbox: The following items should be in the toolbox:

- 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 washbasin. 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 washbasin. If the tube is broken, empty mercury into the washbasin 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 washbasin 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 toolbox*. 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 8:00-5:30 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 <0.02 mg/m^3.

This is a sample spill plan and only a suggestion. You may wish to incorporate these suggestions into your hospital's mercury spill plan.

SAMPLE SPILL PLAN

Everything used during the cleanup procedure must be managed as a hazardous waste unless it is known for certain that an item did not come into contact with mercury.

Evacuate the spill area: Before people leave, verify that their shoes, clothing, and other articles have not been splashed with mercury. Secure the scene (use barrier tape if necessary) and restrict admission to only those persons necessary to clean up the spill.

Lower the room temperature by turning down the thermostat. The cooler the temperature, the less mercury vapors that will be released into the air. Remember that mercury vapors are odorless and colorless.

Close interior doors leading to other inside areas and open exterior doors and windows.

Contact the Environmental Office (or, IAW local procedures, the Fire Department).

Contain the spill: Surround or block off the mercury to keep it from spreading onto sloped or porous surfaces. Divert all mercury away from floor drains, cracks, or crevices that may impact groundwater, surface water, and soils.

Ventilate the room to the outdoors by using fans to force air circulation for a minimum of one hour after clean up. If possible, increase the air exchange rate for one day. The danger of mercury exposure is greatest in small, confined, poorly ventilated areas**.** Avoid breathing any dust, vapors, mist, or gas. Avoid contact with eyes, skin, and clothing.

Assemble clean up supplies or obtain a mercury spill kit. Mercury spill kits are commercially available and convenient, but not absolutely necessary to clean up a small mercury spill. The following are some common household articles that could be used to construct a mercury cleanup kit:

eye dropper	flashlight
goggles	napkins
paper towel	plastic bags with zipper seal
plastic container with lid	plastic dust pan
plastic sheeting	powdered sulfur[2]
powdered zinc[1]	rubber gloves
rubber squeegee	syringe without needle
tape; wide, duct, or masking	trash bags
tray or box	wide mouth container

[1] Amalgamates (bonds with) mercury.
[2] Visualizes mercury by turning from yellow to brown and forms mercuric sulfide. Dusting the area

with this powder also reduces mercury vapors.

Note: Used items are to be double-bagged and disposed of in accordance with state and local requirements.

Dress appropriately: Remove all jewelry from hands and wrists so the mercury does not combine (amalgamate) with the precious metals. Change into PPE that can be safely discarded should it become contaminated. Put on rubber gloves and goggles or safety glasses.

Never use a household vacuum cleaner or shop vacuum to clean up mercury! These devices are not adequately filtered and will spread mercury vapors. Never use a broom on a mercury spill because it will only scatter the mercury droplets, making them harder to find and pick up.

Pick up all visible mercury droplets: Inspect the spill zone with a bright light to help illuminate any hidden droplets. Clean up any metallic beads of mercury by using a plastic squeegee or index card and plastic dustpan. With the index or plastic card, sweep the mercury toward the center of the spilled area away from any carpet, fabric, or porous surfaces. Carefully combine and consolidate the mercury droplets. Next, slide droplets onto a sheet of rigid paper like an index card.

Transfer mercury into an unbreakable plastic container like a 35mm film canister with a locking or air tight lid (avoid using glass). If necessary, suction off the droplets using an eyedropper or syringe. Adhesive tape strips may also be used to clean up any tiny remaining mercury droplets. Place the plastic container inside a second plastic container to provide additional containment protection. Tighten each lid securely so that liquid and vapors will be contained.

Place the mercury waste container into a zip top plastic bag: This should ensure that in the event of any leakage, all mercury will be safely contained within the packaging. Label the package in accordance with hospital procedures. Contact the HW Manager for turn-in instructions.

Never pour liquid mercury or mercury compounds down the drain. Since mercury is heavier than water, it will accumulate in the S-trap of your drain and may continue to emit harmful vapors.

Remove and properly dispose of contaminated carpeting or other articles that have directly contacted mercury**.** It may be necessary to remove contaminated carpet from the room where the spill incident occurred. Double or triple wrap these remnants in plastic trash bags and contact the HW Manager for proper disposal.

Sprinkle fine powder sulfur or zinc on the spill site to bind any remaining mercury. This may be supplied in mercury spill kits as mercury vapor absorbent or purchased separately from garden supply stores or chemical supply houses. Apply over hard to

reach areas such as cracks and crevices to minimize the release of mercury vapors. In instances where furniture has been exposed to mercury, wash fabric thoroughly and allow all items to air out completely. Mercury may lodge in porous areas like carpet backing or cracks and crevices.

Check carefully for missed mercury: To aid in detection, a high intensity lamp may be used to better illuminate the spill area. The presence of scattered mercury droplets may also be detected by a sodium sulfide solution, which can be obtained from most chemical supply houses. This solution may also be sprayed on an affected person (but NOT the eyes, mucous membranes, or the mouth). Any mercury present will show up as dark, reddish brown stains. Residual mercury may then be uplifted using a variety of techniques including vinegar wash followed by hydrogen peroxide. To combat any hydrogen sulfide odors generated from mixing the two chemicals, an alternate method would be to wipe the area with a vinegar-soaked swab, followed by a peroxide wipe.

Do not place mercury-contaminated articles in the trash unless otherwise instructed to do so by proper authorities. This is especially important if your trash goes to an incinerator (municipal waste combustor). Contact the HW Manager or installation Environmental Office for proper disposa1 suggestions.

Monitor spill zone for mercury vapors: Even if the impacted area appears clean, there may still be hidden residual quantities of mercury present that emit vapors. For larger-sized spills, it may be necessary to monitor (test) mercury vapor levels in the immediate area. Industrial Hygiene should be contacted for this. If mercury is detected, re-clean the impacted area using previously mentioned procedures and repeat testing until levels fall to within safe parameters

Decontaminate personnel exposed to mercury using an alkaline soap (i.e., Lava soap) and a paste of water and flowers of sulfur. Flowers of sulfur can be found in most garden supply shops and will turn the mercury into an insoluble sulfide. Afterwards, the remaining residue should be thoroughly rinsed. All wash water containing mercury should be collected and kept out of the sanitary sewer system.

Replace Broken Device with a Mercury-Free Alternative.

Appendix J
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 K
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