A GUIDE TO MERCURY REDUCTION IN INDUSTRIAL AND COMMERCIAL SETTINGS

A Joint Effort By:

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I. Introduction

In 1998, Bethlehem Steel Burns Harbor Division, Ispat Inland Indiana Harbor Works, United States Steel Gary Works, the United States Environmental Protection Agency, the Indiana Department of Environmental Management, and the Lake Michigan Forum – a stakeholders group providing input into the Lakewide Management Plan for Lake Michigan – signed a voluntary agreement known as the Mercury Pollution Prevention Initiative. (See Appendix A) The agreement called for the three participating companies to inventory mercury in storage, mercury-containing equipment and materials, significant waste streams and revert outputs. ("Revert" refers to materials that are internally recycled within the facilities.) It also called for the companies to identify, where possible, alternatives to mercury containing equipment and materials and prepare reduction plans that include reduction goals, planned actions to reach the goals, and an implementation schedule.

The purpose of this report is to share the results of this mercury reduction initiative and provide guidance to suppliers and other industrial facilities to assist in their mercury reduction efforts. It begins with background information on mercury—why it is important to reduce its use and release to the environment and why a voluntary approach is the most effective way to accomplish that. Next, a case study of the mercury reduction initiative at the three northwest Indiana steel mills is presented, including inventory findings and reduction schedule. Finally, a guide to developing a mercury reduction program, based on the experiences of the three mills, is presented in order to assist others.

Mercury is a pollutant of concern due to its toxic and bioaccumulative properties. Large industrial complexes often use devices such as gauges, relays, switches, manometers, and thermometers that contain mercury. Liquid elemental mercury may also be kept in labs or storerooms. These devices can leak or break, and when they do, the resulting uncontrolled mercury spills may pose dangers to human health and the environment and impact the facility's ability to meet discharge permit limits. In addition, properly cleaning up a mercury spill in order to meet current safety standards is extremely expensive.

The good news is that most uses of mercury are unnecessary. Alternatives exist for most, if not all, mercury containing devices. However, identifying and replacing these devices can be daunting for a large facility. This report presents a pollution prevention approach to mercury in devices and products and steps for constructing a mercury elimination program. It features a case study from three Northwest Indiana steel mills and step-by-step measures for achieving significant mercury reductions at industrial complexes, manufacturing facilities and related operations since many of their mercury uses and scales of operations are probably similar.

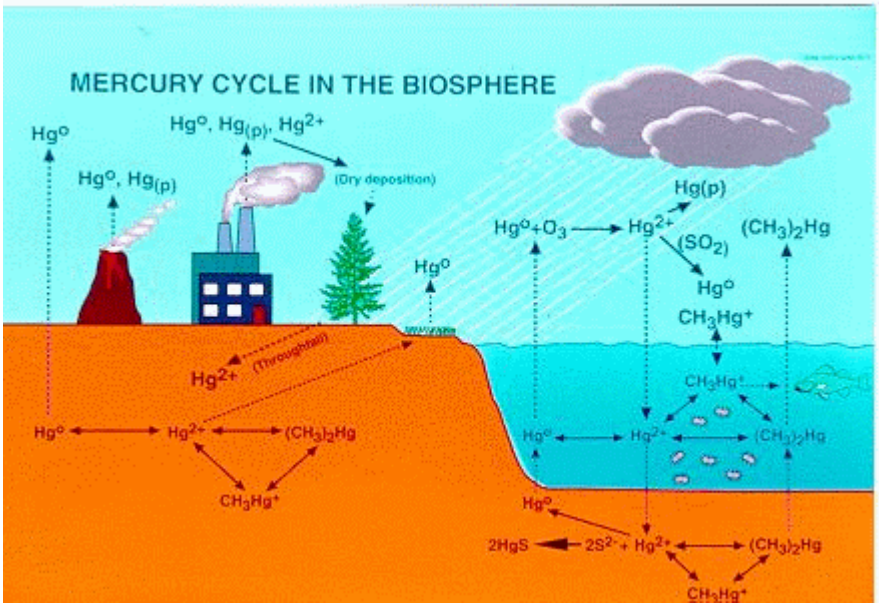
Why Focus on Mercury?

Mercury is released to the environment from many sources. It is used in household and commercial products, as well as industrial processes. Manufacturing facilities, hospitals, dental

practices, schools and even some motor vehicles have all been found to contain quantities of elemental mercury that can cause releases to the environment if recognition and proper precautions are not instituted. Most of these sources, individually, may release relatively small amounts of mercury. However, the problem arises from the propensity for mercury to build up, rather than break down, in the environment and the potential for minute concentrations to cause health and environmental impacts. For example, bioaccumulation —the process of chemical magnification up the food chain—can result, over time, in a level of mercury in the topmost consumer up to 10,000,000 times greater than the original amount in surrounding waters.[1]

Adding to the complexity of mercury build-up is the fact that gaseous mercury can be transported long distances in the atmosphere and can persist there for a long time before being deposited, creating a global reservoir of mercury. The amount of mercury falling on any water body is potentially comprised of contributions from this global atmospheric reservoir, regional sources and local sources. Figure 1 illustrates the different pathways that mercury can take in the environment.

Figure 1
The Mercury Cycle



(Source: Dr. Steven Lindberg, Oak Ridge National Laboratory)

Mercury can be dangerous to aquatic and human life. When mercury is deposited in lakes or streams, natural bacteria action converts it to methylmercury, which makes the mercury available to concentrate in the tissue of fish, wildlife and people who eat the fish. Due to high mercury levels in fish and the potential health impacts for people, most states issue advisories each year cautioning people to limit their consumption of certain species and sizes of fish from certain water bodies.

Human exposure to mercury can result in long-lasting health effects, especially on fetal development during pregnancy. In addition, mercury poisoning has been linked to nervous

system disorders, kidney and liver damage and impaired childhood development. Nervous system disorders include impaired vision, speech, hearing and coordination.[2]

Mercury has many applications in industry due to its unique properties, such as its fluidity, uniform volume expansion over the entire liquid temperature range, high surface tension, electrical conductivity and its ability to alloy with other metals. A wide variety of industries including electrical, medical, chemical and mining utilize mercury. Such commercial uses of mercury include barometers, thermometers, switches, fluorescent lamps, and mercury arc lamps.

Mercury has been identified as a "critical pollutant" under the Great Lakes Water Quality Agreement (GLWQA) due to its (1) presence in open lake waters, (2) ability to cause or contribute to failure to meet Agreement objectives, and (3) potential to bioaccumulate. Under the GLWQA, Canada and the United States agreed to develop, in consultation with state and provincial governments, Lakewide Management Plans (LaMPs) to address the critical toxic pollutants that contribute to ecological impairments in each Great Lake. Each LaMP focuses on substances such as mercury that persist at levels that are causing or are likely to cause impairments.

In recent years, there has been a focus on reducing the use of mercury in products and reducing air emissions that are greater than what is necessary to protect public health. In 1997, the United States and Canada signed the Binational Toxics Strategy Agreement, which seeks to achieve, by 2006, a 50% reduction in the deliberate use of mercury in the United States as well as a 50% reduction in releases of mercury to the atmosphere.[3] Mercury is identified as a "Tier 1" pollutant in this agreement, making it a top priority for coordinated efforts between the two countries to reduce its use and release.

<u>Voluntary Approach to Mercury Reduction</u>

Starting in 1998, Bethlehem Steel Burns Harbor, Ispat Inland Inc. Indiana Harbor Works, and U.S. Steel Gary Works, all Northwest Indiana integrated steel mills, have been participants in a Mercury Pollution Prevention Initiative. The key objectives of this initiative are:

- Identify mercury uses and quantities within each facility;
- Identify mercury in the waste stream; and
- Determine and implement mercury pollution prevention options including on-going management of mercury, recycling, and substitutions.

The expected results of this effort include elimination of mercury use to the extent practicable, consolidation and better management of mercury, replacement of equipment containing mercury, establishment of purchasing policies, and development of educational initiatives for facility employees.

The recognition by state and federal environmental agencies that mercury is a priority chemical of concern affecting both the health of people and the degradation of the environment results in the need to phase out the use and release of mercury to the greatest extent possible. All parties

agree that an effective way to achieve further mercury reductions is through voluntary partnerships involving sources of mercury.

By definition, voluntary efforts are those that go beyond existing legal requirements. Voluntary agreements, such as the Mercury Pollution Prevention Initiative, challenge potential sources of a pollutant(s) to design and carry out their own tailored, cost-effective prevention and/or reduction programs. Rather than requiring formal, complicated contracts with government agencies, these voluntary agreements can be simple and flexible.

Benefits of voluntary pollution prevention efforts to companies include:

- Voluntary participation can provide the best opportunity for cost-effective reductions.
- Participation can be beneficial to a company's image in the community and with environmental regulators.
- Lack of participation may increase the chances of mandatory reductions being required in the future through other regulatory programs.
- Avoiding the costs associated with the use of mercury, such as disposal or recycling, collection and storage prior to disposal, paper work for tracking hazardous waste disposal and liability for environmental problems or worker exposure, can be economically beneficial.
- Reducing or eliminating mercury can minimize mercury spills, their attendant clean-up costs and worker exposure.
- Participation in pollution prevention efforts that both protect the environment and improve worker safety can raise employee awareness and improve morale.

The concept of using voluntary agreements to work toward reducing use or releases of pollutants has been applied in a variety of source sectors, including printing, automobile manufacturing and metal finishing among others. For example:

- The chlor-alkili industry has committed to a 50% reduction in mercury use over 1990-1995 average levels by 2005.
- The American Hospital Association has agreed to virtually eliminate use and release of mercury from member facilities also by 2005.
- The three largest U.S. thermostat manufacturers have developed a mercury thermostat take-back program through a reverse distribution system involving HVAC contractors and wholesalers.
- Automobile manufacturers have committed to phasing out use of mercury switches for convenience lighting and antilock braking systems.

In addition, outreach programs are targeting proper management and recycling of dental amalgam and elimination of mercury use in schools. Table 1 provides a list of current, voluntary mercury reduction efforts taking place in the Great Lakes basin and beyond.

Table 1

Voluntary Mercury Reduction Efforts in the Great Lakes Basin

(Adapted from: The Great Lakes Binational Strategy: Draft Progress Report—November 16, 2000)

Northwest Indiana Steel Mill Agreement
Health Care Memorandum of Understanding (Canada)
Hospitals for a Healthy Environment (U.S.)
Wisconsin Communities Mercury Reduction Program
Western Lake Superior Sanitary District Mercury Zero Discharge Project
Michigan Mercury Pollution Prevention Task Force
Detroit Water and Sewerage Department Mercury Minimization Program
Dairy Manometer Replacement Programs (Wisconsin and Michigan)
Thermostat Recycling Corporation Initiative
Automobile Pollution Prevention Project
Electric Utility Mercury P2 Initiatives (Consumers Energy Company, Detroit Edison and Wisconsin Electric)
Great Lakes Dental Mercury Reduction Project
Chlor-Alkali Industry Mercury Reduction Initiative

Many non-essential uses of mercury have been discontinued. Many mercury source sectors are currently implementing voluntary mercury reduction programs. The time is right for all significant users of mercury to evaluate alternatives and phase out mercury use consistent with voluntary, cost effective business practices.

II. Guide for Supplier Mercury Reduction Initiatives

The underlying principles and general approaches for implementing a mercury reduction effort at an industrial facility are basically the same as for any pollution prevention initiative. The challenge is to tailor these principles and approaches to your facility and your current mercury usage.

Utilize an initial "common sense" pollution prevention approach to your mercury reduction efforts and you are half way there. Best management practices for reducing mercury use and release at industrial facilities include:

- Substitution of non-mercury alternatives for products that contain mercury;
- Avoid purchasing mercury-containing items.
- Recycling of mercury-containing products when they can no longer be used;
- Correct handling and disposal of mercury and mercury-containing equipment;
- Proper mercury spill prevention and cleanup of spills; and
- Facility policies that support these best management practices.

Your mercury reduction team should be composed of personnel from all affected areas or departments. Electrical, systems, environmental and analytical personnel usually have some knowledge of mercury use and should be included. The leader of the team should be someone with enough clout to ensure that the project gets done. Each affected department or group should be included so that everyone feels invested in its outcome.

Here is a brief, step-by-step approach to a mercury reduction program for your facility. Following this is more detailed information on the mercury inventory and resources to assist your mercury reduction efforts.

Mercury Reduction Step-by-Step

Secure management buy-in and commitment. In some companies, upper management may dictate a mercury reduction initiative. In others, lower level managers or employees may be the driving force. If your mercury reduction efforts start from the bottom up, request support from top management and from all managers who will be directly affected. All mercury reduction efforts, whether bottom-up or top-down, also need to seek support of all employees that will be involved with the project. Once the mercury reduction initiative was explained to employees at the three plants, there was a lot of enthusiasm about it.

A mercury policy statement issued by the procurement department, plant manager or CEO may enhance legitimacy and staff support. For example, at Ispat Inland, a written procedure (ENV-20) has been put in place called the "Mercury Reduction and Waste Management Program" that clearly spells out the goals of the mercury reduction initiative at the plant. This procedure is

part of a larger environmental management system (EMS) at the plant, and is currently being incorporated into the facilities" ISO 14001 plan. (See Appendix B)Management should also consider connecting the mercury reduction effort with state and/or federal environmental agency pollution reduction initiatives. Such collaboration may provide opportunities for technical assistance, positive formal recognition and enhancement of relationships with these agencies.

Figure 2 provides a sample "Mercury Pledge Form" which may be useful in formalizing your company's mercury reduction commitment and communicating it to both suppliers and clients.

Figure 2

MERCURY PLEDGE

We pledge to continue to seek out opportunities to reduce or eliminate mercury in raw materials, equipment and products. As a participant in this pledge program, we will:

- **Identify mercury in our facilities and in the products we make.**
- **Evaluate nonmercury alternatives and phase in as many as possible as soon as possible.**
- **Develop and implement a mercury reduction plan and report on our results.**
- **Establish purchasing policies relating to mercury.**
- **Inform and educate staff, suppliers and clients about mercury issues and nonmercury alternatives.**

Company Name _____

Address _____

Contact Person _____

Telephone, Fax and Email _____

Signed by:

_____

Company President or Facility Manager

_____

Date

Start reducing mercury right away. It isn't necessary to complete an inventory before you start eliminating mercury from your facility. There are probably some obvious, nonessential uses or sources of mercury that can be addressed immediately while you are evaluating overall mercury use. Do you have any mercury that is just "laying around"—bulk mercury that has been stored and added to over the years and no one knows why or mercury sitting in an old or abandoned laboratory? Check those basements and storage rooms for retired equipment containing mercury that was never disposed of or old mercury compounds that have been sitting on a shelf for decades. Picking off such "low hanging fruit" can get your mercury reduction program off to a fast start.

Identify mercury sources. Consider conducting a two-stage inventory—an initial, screening inventory to let you generally know what and how much you have and then later implement a more detailed inventory which eventually addresses every piece of equipment, waste stream and all mercury in storage.

Develop an initial screening inventory of potential uses and sources of mercury in all buildings and departments. It isn't necessary to determine where every drop of mercury is, particularly for the initial screening inventory. General knowledge, e.g. what types and brands of equipment contain mercury, can initially substitute for knowing where each ounce of mercury is in each piece of equipment

How much actual sampling and analysis—of raw materials, processes, products and waste streams—to characterize the disposition of mercury in your facility is needed prior to the majority of your mercury reduction efforts? How sensitive must your analytical procedures be (i.e. what is the appropriate detection level)? What level of mercury in a sample is significant and what isn't?

The answers to these questions will depend on the goals and assumptions you set for your mercury reduction program. In some cases, you may have to strike a balance between ideal information and the sampling, time, and laboratory expense needed to reach that ideal. Taking the time to clearly describe your assumptions and calculations so that they are transparent and easily understood may in some cases be more cost effective than additional sampling or use of more sensitive testing protocols. The experience and knowledge of your mercury reduction team members will also go a long way toward helping to decide on the necessary quality and quantity of data.

A comment on the use of a mass balance analysis—it's not for everyone. A mass balance calculation is based on the concept that the total mass of a system remains unchanged. Applied to an industrial facility, this concept can be expressed as: the amount of a chemical entering the facility should equal the amount of chemical leaving via products and waste streams plus the amount recycling in the plant. Your mercury reduction team should evaluate the appropriateness of a mercury mass balance analysis for your facility--determine its potential value to your

mercury reduction efforts, estimate potential costs in terms of extra staff time and delays, and then weigh these benefits and costs to decide if a mass balance approach is worthwhile. Keep in mind that a mass balance is only as accurate as the analytical data used to construct the balance model.

Remember—it is important to be both systematic, and pragmatic. Mercury may be found in raw materials, equipment, storage areas and waste streams and you need to evaluate each of these logically and comprehensively. Regardless how extensive and detailed your inventory is, it is critical to keep good, consistent records across your facility and incorporate them into a database that works for you.

Evaluate nonmercury alternatives. Use information from this report and elsewhere to learn more about mercury-free substitutes for the mercury-containing equipment and materials identified in your inventory. 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:

- Can a process or procedural change be implemented to eliminate the mercury source?
- 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, calibration, maintenance and disposal?
- Is added cost offset by lower handling, disposal and liability costs?
- Does the substitute introduce new problems for maintenance, handling or disposal?
- What is the risk relating to leaving the mercury device in place—can it leak or spill and, if so, will it be released to the environment?

Make sure that an appropriate economic analysis—one that addresses life cycle costs and impacts—is used to evaluate alternative products and equipment. For example, it is usually advantageous to replace standard fluorescent lamps with low-mercury fluorescent lamps due to avoidance of hazardous waste disposal costs and ease of handling (in most states, nonhazardous lamps can go into the regular garbage and need not be segregated).

Establish realistic goals and implementation plans. The long-term goal of your company may be to virtually eliminate the use of mercury. However, it may be easier and more satisfying to achieve interim success by developing short-term goals, e.g. recycling obviously nonessential mercury within three months or eliminating all mercury switches within two years. The mercury reduction team should get the support of the plant manager or CEO for the mercury reduction goals and create a plan that clearly describes how to achieve these goals. Key components of the plan may include:

- Establishing a mercury reduction team;
- A process for more detailed inventory of mercury-containing products and equipment and identification of nonmercury alternatives;
- Prioritizing risks relating to various mercury uses;

- Evaluation and implementation of mercury recycling options;
- New or revised policies for various departments, including process design, purchasing, maintenance and waste management;
- Staff training programs;
- Prioritization of mercury sources for removal with schedules;
- Regular progress reviews; and
- Communication of results.

The plan should identify specific action steps and determine time lines for implementation. Time frames should be realistic and must account for time spent researching the availability of alternative products and equipment and training personnel in their installation and/or use

Undertake a pilot project. Sometimes, it just isn't feasible to implement a whole facility approach right away. Instead, a department-by-department or building-by-building approach may fit better into your budgeting and priorities. Consider an initial pilot project that is doable, has support for its implementation, and one that indicates a high potential to succeed. The success and lessons learned from this initial pilot project can bolster support for your next mercury reduction project. Taking on the whole project from the start may result in failure, causing people to give up on the whole program.

Use the information from the pilot project to choose a new project or expand the first one. If you switched one building or process line over to mercury-free equipment, decide which should be switched over next. If you specified mercury-free equipment in your last purchase order, consider creating a mercury-free policy for all future purchase requests.
For example, one of the mills involved here began with an edict from the purchasing department that only low mercury nonhazardous fluorescent light bulbs can be purchased.

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 plant manager or CEO for the purchase of any mercury-containing product.

Authorize the purchasing department to make "mercury-free" a part of product specifications and to require mercury disclosures on all products coming into your facility. Policies such as this will eventually make it a competitive issue for vendors to ensure that they can provide mercury-free alternatives. Ask your vendors to verify in writing that their products are mercury-free or that they will assist you in selecting mercury-free products. For laboratory and process chemicals, a Certificate of Analysis can be requested. (See Figure 3)

Inform and educate staff. Employee education in mercury pollution prevention can be an important component of a successful program. Communicate the mercury reduction program process and goals to employees and solicit employee input. Determine which groups within your facility need information and/or training and identify the most important topics for each

group. Try to incorporate mercury pollution prevention into existing information and training programs such as new employee orientation, safety training, right-to-know training and department meetings. Other outreach techniques include:

- Displays in cafeteria or other common areas
- Employee survey about mercury awareness
- Articles in internal newsletter
- Employee handbook page on guidelines for handling and disposing of mercury
- Posters and fliers
- Labels on equipment that contain mercury
- Incentive program to reward good ideas that make mercury reduction easier

Implement, review and adjust. When all is ready, implement your overall mercury reduction program. The plan should identify specific action steps and determine time lines for implementation and be subject to periodic review and revision. It should also address new or revised policies relating to:

- Maintenance and handling of mercury-containing products and equipment;
- Mercury spill prevention and management;
- Recycling or disposal of mercury-containing products;
- Purchasing of mercury-containing products; and
- Phase out during retrofitting or new facility construction.

The mercury reduction team should meet throughout the project to evaluate any problems and adjust course, as needed. Involve staff in a climate that encourages input and feedback regarding inventory and reduction methods, new products or equipment. Make sure the team weighs the feedback during the evaluation process. Don't be surprised if things get behind schedule--sometimes it may take longer than expected to find a new product or arrange for training.

Celebrate success. As you accomplish each goal, celebrate success! Find a way to communicate your initial success and future plans to the entire facility or company. Track how much mercury you have recycled and publicize your results. Make sure the public relations department gets information it can share with the community. Place information about your mercury reduction program prominently on your company web site. Also, consider sharing your accomplishments with other facilities in your corporation, community and trade association.

<u>Finding It—The Mercury Inventory</u>

This section provides some more detailed information for mercury inventories of purchased materials and equipment. Table 2 provides the mercury inventory instructions issued by one of the participating steel mills. Table 3 is a blank form for inventorying mercury devices and liquid mercury and Table 4 is a similar blank form for mercury containing materials. These guides may be helpful when you customize inventory materials to fit with your business, inventory strategy, targets and goals.

Table 2

MERCURY INVENTORY - LIQUID, DEVICES & MATERIALS

INVENTORY SCOPE

Objective: Identify, quantify and document existence of all mercury containing devices, liquid mercury and Lab type supplies that contain mercury at all USS Gary locations.

- Light bulbs, batteries and thermostats will not be inventoried; we have recycling in place for these items.
- Conduct inventory any way you feel most efficient for your Business Unit.
- Inventory 'Data Collection' forms are attached. Electronic copy on Microsoft Word file will be supplied upon request via E-Mail.
- Inventory must be submitted, complete, to the plant coordinator by end of business - 2/24/99.
- A majority of items in the plant are likely to be related to Electrical, Systems Control, or Utilities.
- Business Unit inventory should reflect items which fall under the respective department normally responsible no matter if the department is headquartered within the operating unit or at a remote site.
- Group all like items on one line for each:
    - Operating Unit
    - Maintenance Area
    - Storage facility

  (Listing each individual piece in not required)
- Part Number and Manufacture may be valuable information to record in the description as reference to assist in making contacts regarding volume & weight information. Use comments section to record additional information that you want readily available or which may have future value.
- Plant Mercury Reduction Coordinator will pass along additional pertinent or potentially helpful information as it is discovered.

Note! If you have a problem finding quantification information etc. for an item and have depleted all of your resources, contact the plant coordinator as soon as possible. We may be able to locate other resources to assist in obtaining the information we require.

Table 3

MERCURY INVENTORY:

Mercury Containing Devices and Liquid Mercury

(In Use or Storage**)**

Business Unit: **Date: / /**

Item (Description)	Data/Info Source	Devices				Location	Comments
		Quantity	Weight Each	Est. Tot. Hg (lbs)	Est. Tot. Hg (gm)	Operating Unit/ Storage location	

Table 4
MERCURY INVENTORY:

Mercury Containing Materials
(In Use or Storage**)**

Date: / /

Item (Description)	Data/Info Source	Materials				Location Operating Unit/ Storage location	Comments
		Quantity	Hg Conc. (PPM)	Est. Tot. Hg (lbs)	Est. Tot. Hg (gm)		

Mercury in Purchased Materials

Widely used industrial chemicals such as caustic soda (sodium hydroxide) and sulfuric acid may contain mercury below the 10,000 parts per million (1%) listing requirement for Material Safety Data Sheets but in concentrations high enough to affect the environment or exceed wastewater regulatory requirements. The mercury content of caustic soda and sulfuric acid is dependent upon the manufacturing process. Caustic soda can be produced by the electrolysis of salt brine using the porous-diaphragm process, ion-exchange membrane process or the mercury-cell process. Most caustic soda is produced using the diaphragm process, however the mercury-cell process produces 13 % of all caustic soda available in the market place.

The mercury cell process uses mercury as a cathode and caustic soda produced by this process can contain mercury in the hundreds of parts per billion range. Eleven chemical plants in the United States use the mercury-cell process. Mercury grade caustic soda is high quality (low salt) and is more expensive than diaphragm-grade caustic. Typically, mercury grade caustic soda and membrane grade caustic soda (also high quality) are used for water conditioning for boilers, ion-exchange regeneration and other processes requiring low-salt caustic soda.

Other chemicals manufactured by the mercury-cell process include potassium hydroxide, chlorine, and muriatic acid. In addition, sulfuric acid produced as a secondary product of lead and copper smelting can contain mercury up to 10,000 parts per billion range. Table 5 contains a list of additional industrial chemicals that may contain mercury.

Table 5
MERCURY-CONTAINING CHEMICALS
IN THE INDUSTRIAL SETTING
(Source: A Business Guide to Conducting a Mercury Audit, P3ERIE)

♦ Catalysts for Urethane and Vinyl Production

♦ Electroplating Solutions and Processes: Zinc-mercury plating, steel coloring, mercuric chloride, mercuric sulfate, mercuric nitrate, mercuric cyanide, mercuric oxide and mercuric dichromate have been used in the metal finishing industry.
♦ Caustic soda
♦ Sulfuric acid
♦ Potassium hydroxide
♦ Muriatic acid
♦ Ferric chloride.
♦ Laboratory Chemicals: mercury chloride, mercury (II) chloride, mercury iodide, mercury nitrate, mercury (II) oxide, mercury (II) sulfate, nessler reagent, zenker's solution and dozens of other less commonly used laboratory chemicals.

Although the mercury concentrations in these industrial chemicals may be relatively low, the total mass of mercury in your facility's waste streams can be large. The mercury may be discharged in wastewater effluent and/or released into the air during the wastewater treatment process or if wastewater sludge is land spread or incinerated.

Industrial users of caustic soda can review and amend their specifications to ensure that low mercury caustic soda is used. Mercury levels in raw materials can vary significantly depending upon the source. Industries can specify low-mercury chemicals and request certificates of analysis from all chemical suppliers when purchasing materials. Similarly, facilities should evaluate their uses and sources of other industrial chemicals that may contain mercury. Figure 3 provides an example of a letter requesting a certificate of analysis and Figure 4 provides an example of such a certificate.

Figure 3
Sample Letter to Supplier Requesting Certificate of Analysis

(Source: Western Lake Superior Sanitary District)

Mary Smith
Director of Sales
Mercury Equipment Products
123 Quicksilver Lane
Mercury City, USA 55805

Subject: Certificate of Analysis

Dear Ms. Smith:

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

Because of this knowledge, and our concern for the environment, our company has instituted a mercury reduction policy that requires the elimination or minimization in all our purchases. Low-level concentrations of mercury in products (less then 10,000 ppm) are not required to be listed on Material Data Safety Sheets. The contribution from the sum of these low concentration sources can account 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 that describes product mercury concentration and the detection method used in the analysis. This information will be used along with other criteria in the selection process of our vendors.

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

Sincerely,

Jane Doe
Purchasing

Figure 4
Sample Certificate of Analysis
(Source: Western Lake Superior Sanitary District)

Anderson's Acid
98 Molarity Drive
Marathon, Ontario
H2S 04 CANADA

Customer : Acme Manufacturing, Inc.

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

Product Grade : SULFURIC ACID 93%
B/L number : 00008650
Shipment Date : 09/03/96
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 (% H2SO4)	93.67	93.19 Min
Color (HU)	11	40 MAX
Iron (ppm Fe)	9	50 MAX
Sulfur Dioxide (ppm SO2)	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 (ppm Hg)	**0.060**	

ANALYST : C. MORIN

Mercury in Equipment

Many types of industrial equipment contain mercury, including electrical equipment, measurement and control instruments, batteries and lamps. Consumer and medical use of mercury-bearing equipment is decreasing, however industrial use remains high. The total installed base of mercury bearing equipment in U.S. industry has been estimated at more than 3,000 metric tons, including roughly 300 metric tons in measuring and control instruments and 2,700 metric tons in electrical equipment.[4] Mercury recycling efforts currently remove 70-140 tons per year while new mercury use in equipment adds 250-300 tons per year.[5]

Why be concerned about mercury use in industrial equipment? The answer to this question is best described in "life cycle" terms. Mercury production and processing results in an estimated ½ ton of mercury emissions per year in the U.S. Manufacturing of mercury bearing equipment results in another estimated ½ ton of mercury emissions per year in the U.S.[6] Use of this equipment results in additional mercury emissions via volatilization due to leakage and spills and, finally, improper disposal and scrapping can result in additional emissions. Although ½ ton of emissions does not seem like a lot compared to emissions of other pollutants, it is indeed significant due to the human and environmental health effects that can be caused by very small amounts of mercury.

In addition to potential environmental impacts, mercury spills can result in employee health concerns, high clean-up costs, poor public perceptions and increased insurance costs. Scrap metal from disposal of mercury bearing equipment can result in significant contamination of metal scrap that, in turn, results in mercury emissions from facilities using that scrap as raw material. For example, recent tests indicate that some electric arc steel furnaces release significant amounts of mercury, depending on the sources and percentage of scrap used in their operations. The same may be true for secondary aluminum production as well.

Table 6 contains a list of mercury-bearing equipment that may be found in the industrial setting. If your facility has a medical station, also check for mercury-containing equipment there, including thermometers and blood pressure devices.

Table 6
MERCURY-CONTAINING EQUIPMENT
IN THE INDUSTRIAL SETTING

(Source: A Business Guide to Conducting a Mercury Audit, P3ERIE)

- Accustats
- Barometers
- Batteries: mercuric oxide, mercury-zinc and mercury-cadmium
- Catalysts for Urethane and Vinyl Production
- Counterweights
- DC Watt-Hour Meters
- Displacement/Plunger Relays
- Elemental Mercury for refilling mercury-containing equipment.
- Flame Sensors: sometimes found in the pilot light and burner assembly on gas-fired furnaces, boilers, unit heaters, space heaters, industrial ovens and in central air conditioning systems.
- Flow Meters
- Gas Extraction Apparatus
- Gas Regulators
- Gyroscopes
- Hydrometers with thermometers
- Hydronic and Warm Air Controls with tilt switches such as aquastats, pressurestats, firestats, fan limit controls and pressure/flow controls on air handling units.
- Lamps: florescent, high-pressure sodium, mercury arc, metal halide, ultraviolet and neon (except red, orange and pink).
- Level and Rotation Sensors
- Manometers and Vacuum Gauges
- Mercury Displacement Relays: sometimes found in street lighting, resistance heating, plastics molding equipment and motors.
- Mercury-Sealed Pistons
- Microwave Relays/Transmitters
- Permeters
- Pressure-trols
- Pyrometers
- Rectifiers
- Ring Balances
- Semiconductors, Solar Cells, Thin Film Transistors, Infrared Detectors and Ultrasonic Amplifiers: may contain mercury-cadmium-telluride, mercury-selenide or mercury-telluride that can contaminate electroplating baths.
- Shunt Trips
- Stokes Gauges
- Switches and Relays: fire alarm box switches, mercoid Control Switches, pressure control switches (mounted on bourdon tube or diaphragm), silent light switches, relay switches, mercury wetted relays, switches in pneumatic tube and conveyor belt message systems, phase splitters, sump pump, bilge pump and other float controls, tilt switches, etc.
- Thermometers: including industrial dial face thermometers with capillary tubes.
- Thermostats and Thermoregulators
- Transmitters
- Wastewater Treatment Plant Pivot Arm Bearings

Table 7 provides information on the mercury content of some of the commonly used equipment at the three mills.

Table 7
MERCURY CONTENT OF EQUIPMENT/CONTROLS

Type of Material	Mercury Content (grams)	Vendor/Source Data	Purpose of Equipment/Controls	Comments
Barometers	395	215 Princo Instruments Southampton, PA 515-355-1500	unknown	
Manometers	85		various pressure measurements	
Thermometers	5.56 (1" bulb); 19.78 (2" bulb)		various temperature measurements	
Switches	3.5	Honeywell, Inc.;	various electrical functions	
	56.6	Dwyer Instruments Michigan City, IN 219-874-8000		This information was in an e-mail from Dave Blomberg - USS
Thermostats	3 – 18	AERCMG Mercury Recycling;	various temperature control functions	

It appears that mercury in use in "traditional" equipment is substantial, widespread, and provides a significant opportunity to control the fate of a major portion of all mercury present at many facilities. In order to begin the process of identifying non-mercury equipment that may be available to replace mercury-containing equipment, a detailed survey of this equipment should be initiated. Specifically, each and every type of mercury containing equipment should be identified, including its model number and plant purchase order identification number. Only in this way can the appropriate vendors be contacted to determine what substitutes exist. Table 8-- Inventory of Mercury and Mercury-Containing Devices, Departmental Summary-- provides the results for one department at one of the three steel mills. It uses a similar form to that provided in Table 3. For more information on mercury switches and relays, their non-mercury alternatives and vendors, see Appendix C.

TABLE 8

ISPAT INLAND INC.
INDIANA HARBOR WORKS

INVENTORY OF MERCURY AND MERCURY-CONTAINING EQUIPMENT/DEVICES

DEPARTMENTAL SUMMARY:
#7 Blast Furnace

Description of Item	Item Location and/or Function	Manufacturer / Supplier	Manufacturer's Part and/or Model Number	Ispat IPN Number	Mercury Content Per Item	Total Number of Items	Total Mercury (Pounds)
LAMPS: (Fluorescent)	Various	GE / Graybar	F40LW/RS/WM	15053	30mg	2,047	0.13
LAMPS: (High Pressure Sodium)	Various	GE / Graybar	LU150/55	15470	12mg	903	0.02
			LU250	34955	15mg	25	0.001
			LU1000	3224	25mg	122	0.007
			LU70	206346	9mg	30	0.001
			LU400	14045	23mg	29	0.001
			LU150/MED	321810	12mg	45	0.001
			LU100	203099	10mg	3	0.00007
LAMPS: (Mercury Vapor)	Various	GE / Graybar	HR175DX39	15056	30mg	7	0.0005
LAMPS: (Metal Halide)	Various	GE / Graybar	MVR250/U	541765	26mg	11	0.0006
			MVR400/U	405572	62mg	8	0.001
			MVR1000/U	569939	100mg	16	0.002
SWITCHES: (Pressure)	J-2 Stand Air	Mercoid	PGW-153-R-P1	42967	unknown	1	---
SWITCHES: (Float)	Sump&Casthouse Hydraulics	Magnetrol	A-153-F	41940	unknown	2	---
SWITCHES: (Level)	Stoves	Magnetrol	89-7401-006	31991	unknown	1	---
SWITCHES: (Tilt)	R/M Chutes	Ramsey Engineering	20-39-25	31990	unknown	24	---
THERMOSTATS: (60-100)	R/M Mechanical Stores	Honeywell	T42M1023	276421	unknown	1	---
THERMOSTATS: (3-Stage)	R/M Mechanical Stores	Honeywell	T605A1016	711	unknown	1	---

Resources to Assist Your Mercury Reduction Efforts

The good news is that you don't have to start from scratch in terms of your mercury reduction efforts. Others have done it and are doing it and there is no need to relearn what they have learned. Certainly, no two facilities are the same, and you will have to tailor your efforts to your operations and your mercury usage, however there are probably similarities between your facility and your mercury usage and those of others that can help to inform your mercury reduction efforts.

This report can provide guidance for finding and inventorying the mercury at your facility. Also, most states have pollution prevention technical assistance providers available to assist your efforts at little or no cost. For example, in Indiana, home of the three steel mills that participated in the Mercury Pollution Prevention Initiative, the Indiana Department of Environmental Management maintains an Office of Pollution Prevention and Technical Assistance. In other states, such as Illinois and Wisconsin, pollution prevention technical assistance is provided separate from the environmental regulatory agency (at the Illinois Waste Management and Research Center and University of Wisconsin Solid and Hazardous Waste Education Center, respectively).

For information on removing the mercury from equipment, vendors and waste contractors may be able to provide assistance. For recycling, disposal and transportation of mercury, waste contractors, mercury recyclers, state environmental agencies and local or regional solid waste management agencies can help. For information on alternatives to mercury-containing products and equipment, this report, vendors and technical assistance providers can be sources of useful information.

Keep in mind that the "Universal Waste Rule" (40 CFR Part 273) which relaxes RCRA requirements relating to storage and transportation of certain hazardous wastes in order to promote recycling, may apply to some of the mercury products and equipment that you are trying to dispose or recycle. The list of universal wastes varies from state to state but may include fluorescent lamps, thermostats, switches and other mercury-bearing equipment.

Universal wastes are certain commonly generated hazardous wastes that are subject to somewhat less stringent Federal and State regulations in terms of handling and storage times (you can store them onsite longer than other hazardous wastes). The regulations are designed to encourage the proper collection and recycling of these widely used materials. They include:

- Batteries
- Certain pesticides
- Mercury thermostats
- Mercury lamps (such as fluorescent tubes)

At Ispat Inland, Policy and Procedure P-019 specifically outlines the required method for collecting and disposing/recycling these wastes. Essentially, a plant coordinator has been

assigned responsibility for picking up all Universal wastes, and a Universal waste storage area has been established in the plant. Operating personnel are directed as to how the materials are to be packaged prior to calling for pickup. Once collected, they are stored onsite until a large enough number exists to warrant a truck shipment offsite to a recycler or to disposal.

An excellent fact sheet on Universal Waste can be found on the Internet at www.afcee.brooks.af.mil/pro-act/fact/jun00.asp.

III. Results of The Steel Mill Voluntary Mercury Reduction Effort

The purpose of this section is to share the experiences and results of the three Northwest Indiana steel mills relating to inventorying mercury at their facilities. Not all the mercury sources found at these mills will also be found in other steel mills or other industrial facilities, however, many of these mercury sources may be common to other facilities and the following information should be useful to others in designing their mercury inventories.

Significant amounts of mercury are in use at all three participating steel mills, and the mills were interested in responding to the growing concern about mercury in the environment. The mills developed a pollution prevention initiative to inventory, recycle, and substitute mercury at their facilities to the greatest extent practicable. The majority of mercury at these three mills can be found in:

- Mercury in purchased materials;
- Mercury in equipment (including mercury in storage from obsolete or broken equipment or held for equipment maintenance); and
- Mercury in waste streams and revert materials

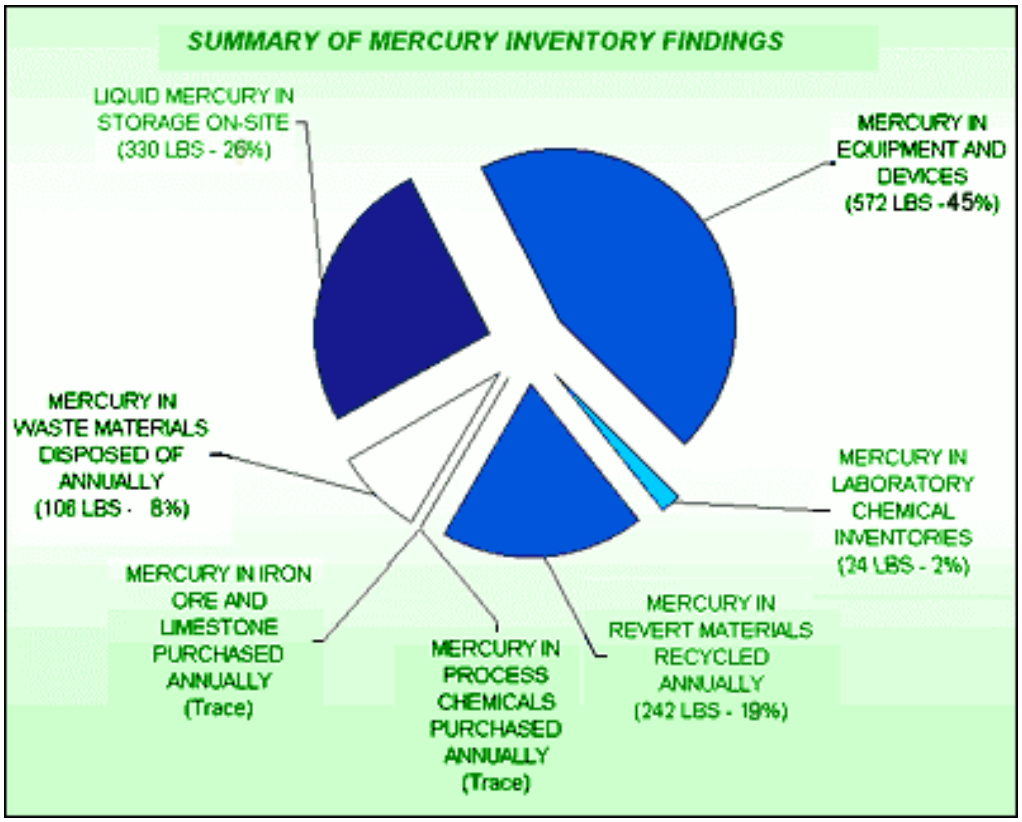
One of the first activities of the Mercury Pollution Prevention Initiative was to try to identify other steel mills or industrial facilities that had conducted mercury inventories. This was unsuccessful. There is, it turns out, little data available from suppliers about the mercury content of many materials and supplies. This experience argues for the necessity of effective information sharing among facilities and sectors. Others need not duplicate the time and resources that have gone into this project. The three steel companies participating in the initiative hope that other steel making facilities, as well as other industrial facilities, can utilize the technical information they generated, such as the availability and effectiveness of substitutions for mercury-containing equipment.

The Mercury Pollution Prevention Initiative also illustrates the need for greater awareness of the importance of reducing chemicals of concern, such as mercury, throughout the supply chain. Large industries will only be effective in this effort to the extent that suppliers are equally committed to providing cost effective and reliable mercury-free products and equipment.

Overall Mercury Inventory Results

Mercury was found in a variety of materials at the three mills. Figure 5-- Summary of Mercury Inventory Findings--summarizes the results of an initial inventory of mercury sources, and illustrates that almost half of all mercury present in the three plants (572 pounds) is contained in equipment.

Figure 5



There was an additional 330 pounds of mercury in temporary storage at the time of the inventory, including mercury that had been removed from obsolete equipment. Approximately 24 pounds was in laboratory chemical inventories, and another 242 pounds was estimated to be in revert (recycled) materials that circulate in the process and never leave the three plants. Mercury content of purchased chemicals, iron ore and limestone was found to exist in trace amounts only.

Mercury in Purchased Materials

The mills conducted an initial survey of the mercury content of purchased materials based on a thorough review of Material Safety Data Sheets (MSDS), literature review and discussions with vendors. They concluded that the MSDS does not typically provide the detail and detection limit required by this inventory, i.e. if mercury is present at less than 1 percent the MSDS may not indicate it's presence.

This left discussions with vendors and use of generally available industry data as key sources of information. Typically, vendors could not provide specific mercury content and could only provide ranges. As interest in reducing mercury use in industrial processes increases, it will be necessary for manufacturers and suppliers to provide more accurate mercury content information.

The three mills used a contractor to collect mercury content information for the chemicals and raw materials that they use. Sources of information consulted included: vendor lists supplied by the three steel companies; input from USEPA, U.S. Geological Survey and state agency staff; internet web sites, technical data bases, and other sources.

Testing of certain raw materials purchased in large quantities (i.e. iron ore and limestone) was also performed. Considerable time was spent discussing coal but it was ultimately eliminated from the inventory because the thorough analysis that coal combustion is receiving at the national level by the EPA will provide more useful information on mercury in coal than could be provided by the three companies.

Generally, it was found that purchased process materials did not contain significant quantities of mercury. For example, recent data provided by the Minnesota Pollution Control Agency indicates mercury content of fired taconite pellets (the main input to these mills) to be between 0.00000029 ppm and 0.0000022 ppm.[6] At these concentrations, all the taconite ore used by the three companies would yield less than 0.1 pounds of mercury annually. These concentration levels are below the detection levels set for this study, and are considered "trace". (The participating companies agreed upon Detection limits of 0.01 ppm for solids and 0.0002 mg/l for liquids.) Table 9 provides a summary of estimated mercury amounts in chemical products purchased by the three companies.

Table 9
ESTIMATED AMOUNT OF MERCURY IN CHEMICAL PRODUCTS PURCHASED ANNUALLY

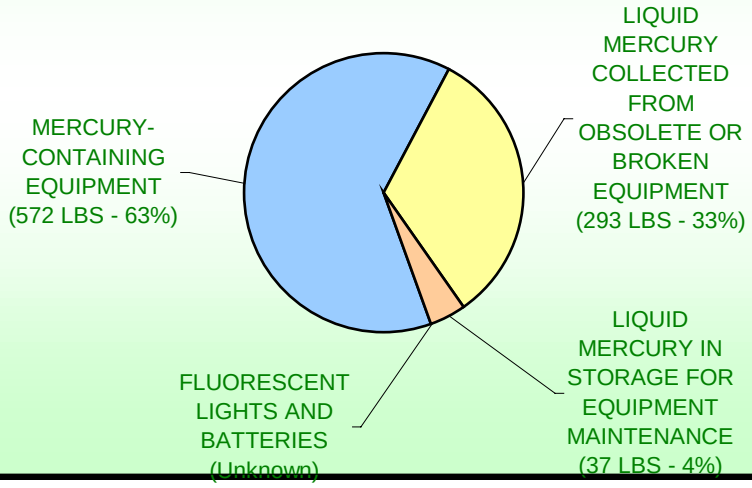
MERCURY SOURCE	TOTAL MERCURY ESTIMATE (POUNDS)
MERCURY IN WASTEWATER TREATMENT CHEMICALS	Trace
MERCURY IN PROCESS CHEMICALS AND SOLUTIONS	Trace
MERCURY IN LABORATORY CHEMICALS AND ANALYTICAL SOLUTIONS	24
MERCURY IN IRON ORE AND LIMESTONE	Trace

Mercury in Equipment

The substantial size of these three mills (each several square miles in size with multiple facilities) presented a major impediment to a thorough and complete inventory of mercury containing devices such as manometers and other equipment. However, the general locations and uses of these devices are well documented in the mills, which greatly aided the inventory process. Given this location and use knowledge, initial estimates of total quantities in various equipment at each mill were calculated. Figure 6 summarizes the volumes of mercury in the

various mercury containing devices used at the three facilities, including amounts of liquid mercury in storage.

FIGURE 6
ESTIMATED AMOUNT OF LIQUID MERCURY IN STORAGE
ON-SITE AND CONTAINED IN EQUIPMENT AND DEVICES



What USEPA categorizes as Universal Wastes (fluorescent lights, batteries and thermostats that contain mercury) were not individually inventoried by the three steel mills for two reasons--they are simply too numerous in these facilities and all three mills have well established Universal Waste programs that ensure proper disposal and recycling of these devices as they come out of service.

For example, mercury containing pressure switches are in common usage in the mills, and number in the thousands (see Figure 7 - Mercury Pressure Sensing Devices). There are many different types, each with its own specific, non-mercury replacement device. In general, the mills have identified a non-mercury replacement pressure switch that utilizes a pressure-sensing diaphragm. For more information on switches, see Appendix C.

FIGURE 7 -MERCURY PRESSURE SENSING DEVICE

Ignitrons are another good example of mercury-containing devices in use in older facilities in these mills. An ignitron is a rectifier that is used to change alternating current (AC) into direct current (DC). Many motors use DC current, which allows them to run at variable speeds. Figure 8 – Ignitron Rectifiers provides a picture of four such ignitrons in use at one of the mills' steel cold rolling facilities. These units were recently replaced with solid-state rectifiers that do not contain mercury. Approximately 10 pounds of mercury was safely removed from service through this replacement.

FIGURE 8 - IGNITRON RECTIFIERS

The detailed, exhaustive inventory for mercury devices and their non-mercury replacements has turned out to be a much more time consuming, lengthy process than was originally estimated. Many thousands of these devices exist in the plants and it is taking hundreds of worker hours to locate and inventory these devices. However, this approach is the only way to systematically identify and track all of the mercury devices in these plants. Completion of the survey at the three facilities is expected by June 2001. The fact that the inventory is not complete has not, however, delayed work on replacement of mercury-containing devices. All three mills are currently working with operating personnel to determine the most high risk and high quantity mercury-containing devices in an effort to prioritize equipment replacement.

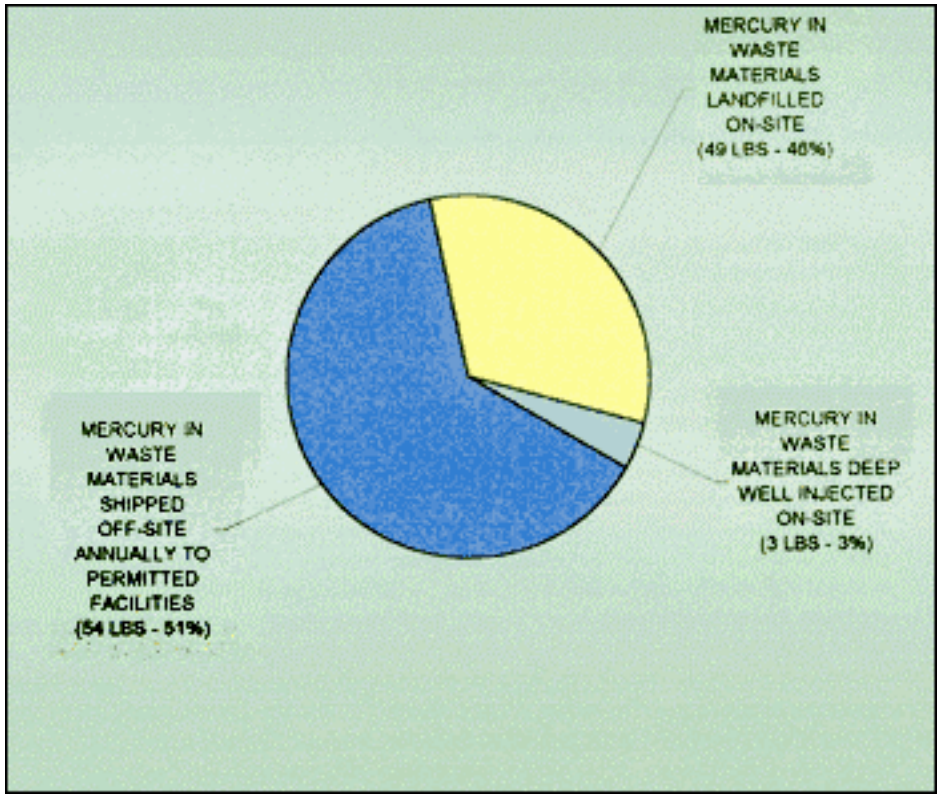
Mercury in Waste Streams and Non-Product (Revert) Outputs

This third category of the mercury inventory required the largest amount of sampling in the three facilities--40+ revert and waste streams had to be evaluated. These revert and waste streams are generated mostly from air and water pollution control devices, and screening equipment used to size the reverts. Most are reused back into the iron and steel making process, usually in the sinter plant, which makes solid chunks out of waste dusts and sludges for reuse in the blast furnaces. Those dusts and sludges that have been historically reused in the process, for

example blast furnace flue dust, blast furnace scrubber sludge, and mill scale are referred to as "revert" materials. Essentially, contaminants such as mercury that may be present in these reverts circulate in the process--sinter is sent to the blast furnace; iron from the blast furnace is sent to the basic oxygen furnace shops for further refining, and waste dusts and sludges from the blast furnaces and some from the basic oxygen furnace shops are sent back to the sinter plant for reuse.

Waste streams generated from the coke, iron and steel making processes were sampled and analyzed. Mercury concentrations in waste materials ranged from less than 0.01 mg/kg (parts per million) in some blast furnace and steel making shop pollution control dusts and sludges to 6.074 mg/kg in some sinter plant pollution control residues. The total annual quantity of mercury present in these wastes is approximately 348 pounds. However, many of these materials are reused (such as materials recycled to the sinter plant as described above), resulting in a total of 106 pounds per year of mercury present in materials which are disposed of either onsite or offsite in permitted landfills. The results for mercury in waste streams are summarized in Figure 9. Not shown (because they are never disposed of) are 242 pounds contained in the constantly recycled revert materials.

Figure 9
Estimated Mercury in Waste Streams



Mercury Reduction Plan

During the course of the initial inventory at the three steel mills, it became apparent that mercury exists in varying quantities in thousands of devices currently in operation. Some of these devices, such as fluorescent lights, hold minuscule quantities of mercury, while others, such as large ignitrons, can hold many pounds each. The mercury reduction team concluded that it would be physically and economically prohibitive to embark on an immediate replacement program for all mercury containing devices currently in operation. In addition, by their design and nature, mercury-containing devices are often very reliable, operating for years without failure. For example, some ignitron tubes installed at the mills in the 1930s remain totally functional and reliable today.

However, the team identified and began a program to remove mercury from sensitive areas, such as next to waterways. This effort, in conjunction with replacement of failed or out-of-service devices, will lead to continued significant mercury removal. Some devices on older units that reside at locations of little environmental risk will remain in service as long as they remain functional. For this reason it will take many years to completely eliminate mercury usage. During this period of time, these facilities will continue to track the location of each of these devices in the plants and keep an up-to-date inventory to prevent improper disposal. This inventory, in tandem with the prioritized removal and replacement program, will serve to minimize potential releases of mercury while the plants move to mercury-free devices. In addition, all three of the mills employ a vendor who specializes in mercury cleanup. This vendor, on call 24 hours, has the proper equipment to respond to almost any kind of mercury spill

All three mills are working with operating personnel to determine the most high risk and high quantity mercury-containing devices in an effort to prioritize equipment replacement. This prioritization is a matter of replacing the devices in phases, as follows:

Phase 1: Devices that have immediate potential harm to the environment if damaged

Phase 2: Devices with potential harm, but controllable in their current setting

Phase 3: Devices that pose no threat if inventoried and properly disposed when removed.

Based on the inventory work conducted at these facilities, an effective reduction program and schedule has been prepared. Based on an estimate of approximately 1,000 pounds of mercury on site at the beginning of the inventory, the three mills committed to a one-third reduction of mercury in storage and used in devices by the end of calendar year 2000, i.e. 330 pounds. Within the next four years, or by the end of calendar year 2004, it is anticipated that an additional third, or a total of 660 pounds can be removed. For reasons previously discussed, the elimination of the final third of mercury present in the plants becomes a more difficult issue. None-the-less, these facilities committed to a 90% + reduction in mercury in use by the end of calendar year 2008, compared to the 1998 base year (the beginning point of the mercury

reduction effort). The three companies intend to annually report on progress in meeting these goals at regional, national or international conferences to update all interested parties.

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Appendices

A. NW Indiana Steel Mills Mercury Pollution Prevention Initiative Agreement
B. Inland Ispat Inc. Procedure ENV-20: Mercury Reduction and Waste Management Program
C. Mercury Switches and Relays and Their Non-Mercury Alternatives

Appendix A

Mercury Pollution Prevention Initiative

Voluntary Agreement

Between

The Lake Michigan Forum, Indiana Department of Environmental Management, U.S. Environmental Protection Agency *And* Bethlehem Steel Burns Harbor, Ispat Inland Inc. Indiana Harbor Works, and U.S. Steel Gary Works

This memorandum outlines a voluntary agreement to implement a Mercury Pollution Prevention Initiative at Bethlehem Steel Burns Harbor, Ispat Inland Inc. Indiana Harbor Works, and U.S. Steel Gary Works in Northwest Indiana.

I. Background

Bethlehem Steel Burns Harbor, Ispat Inland Inc. Indiana Harbor Works, and U.S. Steel Gary Works, each integrated steel mills operating in Northwest Indiana, are participants in the Lake Michigan Primary Metals Project (the Project). The objective of the Project is to work with members of the primary metals industry in the Lake Michigan basin to identify opportunities for pollution prevention for a range of pollutants that are of concern according to the Lakewide Management Plan for Lake Michigan. In the course of the Project, the companies have been identifying where the Lake Michigan pollutants are found and released in their industrial processes and how they are managed. The companies are also discussing opportunities for reductions of these contaminants and barriers to contaminant reduction.

The Project was initiated by the Lake Michigan Forum, a stakeholders group providing input to the U.S. Environmental Protection Agency (U.S. EPA) and federal and state agencies regarding revisions to the Lake Michigan Lakewide Management Plan. This effort has been coordinated by the Delta Institute, a nonprofit organization, through funding provided by the Joyce Foundation, a private philanthropic foundation headquartered in Chicago, Illinois.

Mercury is a pollutant of concern in Lake Michigan. While mercury releases are generally well below reporting thresholds for the Toxic Release Inventory, mercury is in use at the participating mills, and the mills are interested in responding to the growing concern about mercury in the environment. The mills intend to develop a clean sweep/pollution prevention initiative to inventory, recycle, and substitute to the greatest extent practicable mercury at their facilities.

The Mercury Pollution Prevention Initiative is fully supportive of the goals of the Lakewide Management Plan for Lake Michigan which seeks to find effective ways to reduce toxic contamination in the Lake Michigan basin. The initiative also supports the goals of the Great Lakes Binational Toxics Strategy, a joint U.S. and Canadian initiative that seeks to virtually eliminate from the Great Lakes basin persistent toxic substances resulting from human activity, particularly those which bioaccumulate. Mercury is one of the contaminants being addressed by the Binational Toxics Strategy. The initiative also supports Indiana's Mercury Program, launched by the Indiana Department of Environmental Management (IDEM).

This initiative will be managed by the individual participating companies. Periodic reports will be provided by the companies and technical support will be provided by agency

participants as needed.

II. Objectives

The key objectives of the project are as follows:

- Identify mercury uses and quantities within the facility;
- Identify potential mercury pollution sources;
- Identify mercury in the waste stream; and
- Determine mercury pollution prevention options including on-going management of mercury, recycling, and substitutions.

This effort is expected to result in the elimination of mercury use to the extent practicable, consolidation and better management of mercury, replacement of equipment containing mercury, the establishment of purchasing criteria, and development of educational initiatives for facility employees.

III. Activities To Be Conducted

A. Kickoff Meeting

Participating companies will meet with IDEM and U.S. EPA to identify potential sources of mercury that would be examined during the inventory. IDEM and EPA will provide a generic list of typical mercury sources to augment a list of sources particular to integrated steel mills.

B. Inventory

Participating companies will conduct an inventory of:

1) Current and on-going purchases of mercury and mercury containing equipment and material;
2) Mercury in use at the facilities in equipment and materials, and liquid mercury in storage.
3) The presence of mercury in waste streams such as blast furnace sludge, sinter plant pollution control dust or sludge, and coke oven by-product plant wastes.

A summary report of the inventory will be prepared and submitted to the Lake Michigan Forum, IDEM, and U.S. EPA.

C. Identify Alternatives

After the inventory is completed, the participants will identify alternatives to mercury-containing equipment and materials. To identify alternatives, the participants will evaluate information provided by the Mercury Work Group of the Binational Toxics Strategy, IDEM's Office of Pollution Prevention and Technical Assistance, and other experts.

D. Identify Recycling Options

Participating companies will work together to provide a list of recycling options. IDEM and U.S. EPA will provide input into the list.

E. Reduction Plan

Based on the inventory and research into alternatives to mercury use and recycling options, participants will prepare reduction plans that will indicate reduction goals, actions to be taken to reach goals, and an implementation and reporting schedule. The reduction plans will be provided to the Lake Michigan Forum, IDEM's Office of Pollution Prevention and Technical

Assistance, and U.S. EPA's Great Lakes National Program Office.

IV. Milestones and Schedule

The following milestones and schedule are set forth for this initiative.

Milestone	Completion Date
A. Kickoff Meeting	October 1, 1998
B. Inventory	
C. Inventory Report Submission	April 1, 1999
D. Mercury Use Alternatives	
E. Collection and Recycling Alternatives	
F. Reduction Plan Report Submission	December 1, 1999

V. Roles

Participating Companies

Bethlehem Steel Burns Harbor, Ispat Inland Inc. Indiana Harbor Works, and U.S. Steel Gary Works will implement the activities outlined in Section III and meet the milestones outlined in Section IV.

IDEM

IDEM will provide information on mercury sources, alternatives for mercury use, and recycling options as outlined in Section III. IDEM will receive and review progress reports listed in Section IV. Reports will be made available to the public.

U.S. EPA

U.S. EPA will provide information on mercury sources, alternatives for mercury use, and recycling options as outlined in Section III. U.S. EPA's Great Lakes National Program Office will solicit input from the Mercury Work Group of the Binational Toxics Strategy as requested by the participating companies. U.S. EPA will receive and review progress reports listed in Section IV. Reports will be made available to the public.

Lake Michigan Forum

The Lake Michigan Forum will receive and review reports as outlined in Section IV. The Lake Michigan Forum will promote the initiative and progress made under it to Lake Michigan stakeholders (e.g., state and tribal agencies, industry, environmental organizations, recreation, local government, academia, etc.) Reports will be made available to the public.

VI. Special Terms and Conditions

A. The parties shall attempt to secure reasonable funding to allow for the successful completion of the activities described in this agreement. However, nothing in this agreement or elsewhere shall be construed as obligating the parties to provide money, goods, or services of any kind. This agreement does not, by itself, provide any party with a basis for a claim of legal action.

B. Any of the parties may unilaterally withdraw at any time from this agreement by transmitting a signed written document to that effect to the other signatories.

C. The parties understand that this agreement does not diminish their obligations to comply with local, state, and federal environmental statutes and regulations.

D. Nothing in this agreement prohibits any of the parties from entering into similar agreements with other entities.

E. The participation of the parties in this agreement does not imply or express an endorsement of any policy or position advocated by the other parties nor of any good or service offered by the other parties.

VI. Signatures

_____ _____

Janet Vail Date
Co-Chair
Lake Michigan Forum

_____ _____

John Hamilton Date
Commissioner
Indiana Department of Environmental Management

_____ _____

David A. Ullrich Date
Acting Regional Administrator
U.S. Environmental Protection Agency, Region V

_____ _____

Walter N. Bargeron Date
President
Bethlehem Steel Burns Harbor

_____ _____

John M. Hanak Date
Vice President and General Counsel
Ispat Inland Inc. Indiana Harbor Works

_____ _____

Charles G. Carson Date
Vice President of Environmental Affairs
U.S. Steel Group

Appendix B

ISPAT INLAND INC. QUALITY MANAGEMENT SYSTEM

Affected Area: **Indiana Harbor Works**

Title: **Mercury Reduction and Waste Management Program**

Procedure No. **ENV-P-020**

I. PURPOSE

This procedure establishes the responsibilities and practices necessary to implement a mercury reduction/management program in accordance with the provisions of the voluntary mercury reduction and pollution prevention agreement with the U.S. Environmental Protection Agency (USEPA), the Indiana Department of Environmental Management (IDEM) and the Lake Michigan Forum.

II. SCOPE

This procedure applies to all departments that use, store, or otherwise handle mercury, mercury-containing chemicals, or mercury-containing devices other than those regulated as universal wastes (See Environmental Procedure ENV-P-019).

III. REFERENCES

- The voluntary "Mercury Pollution Prevention Initiative" agreement with the U.S.EPA, IDEM and the Lake Michigan Forum signed on September 25, 1998.
- Environmental Procedure ENV-P-019, "Universal Waste Management Program"
- Environmental Procedure ENV-P-015, "Cleanup and Disposal of Spilled and Contaminated Material"
- Environmental Procedure ENV-P-016, "Spill Response and Notification Procedure Immediate Actions"
- Environmental Policy ENV-002, "Unauthorized Waste Disposal"
- Environmental Bulletin ENV-B-001, "Release Reporting"
- Departmental Spill Prevention Control and Countermeasure (SPCC) Plans

IV. EXAMPLES OF MERCURY-CONTAINING MATERIALS AND DEVICES

The following are examples of mercury-containing materials and devices that may be found at the Indiana Harbor Works. Not included are the mercury-containing devices (lamps, batteries, and thermostats) that are regulated as universal wastes (See Environmental Procedure ENV-P-019, "Universal Waste Management Program").

- > Elemental (Liquid) Mercury
- > Barometers
- > Hydrometers
- > Manometers
- > Pyrometers
- > Light Switches
- > Tilt (Motion) Switches
- > Various Industrial Switches
- > Laboratory Chemicals and Solutions
- > Thermocouples
- > Thermometers
- > Rectifiers
- > Relays
- > Ignitron Tubes
- > Various Other Gauges and Devices

V. RESPONSIBILITIES

A. Department Heads

1. Contact the By-Product Materials Section of Logistics at extension 3687 for assistance in establishing a comprehensive departmental program for managing mercury-containing wastes to ensure that the department fulfills all applicable requirements of this procedure.
2. Establish departmental procedures and assign responsibility for compiling and maintaining a departmental inventory of known or suspected mercury-containing materials and devices. Contact Environmental Affairs at extension 6296 for guidance and assistance regarding the initial inventorying of mercury-containing materials and devices.
3. Assign responsibility for the proper management of mercury-containing wastes and the development of specific mercury reduction plans through equipment substitutions and purchasing practices.
4. Review the provisions of this procedure with supervisors and outside contractors working under your jurisdiction so that the requirements for managing mercury and mercury containing wastes are understood by all.

    1. Ensure that mercury-containing wastes are properly segregated from nonhazardous, universal and other hazardous wastes, and accumulated in a secure area that is readily accessible to personnel and mobile equipment for emergency response and/or disposal purposes.

    2. Instruct all personnel involved in the handling/management of mercury-containing materials/wastes of the proper procedures emphasizing the consequences of improper management (See Section VI, D of this procedure). Record training in the CESA System.

    3. Departmental personnel shall contact the By-Product Materials Section of Logistics at extension 3687 or Environmental Affairs at extension 6296 if there are any questions regarding the handling/management of mercury-containing wastes not mentioned in this procedure and/or in Environmental Procedure ENV-P-019, "Universal Waste Management Program".

    4. Report unauthorized disposal or attempted disposal on-site of any material that is known or suspected of being toxic or hazardous to By-Product Materials at extension 3687.

Logistics Department, By-Product Materials Section

1. Provide overall coordination of the waste mercury management and disposition program.

2. Designate properly qualified personnel to direct waste shipment and disposition activities to ensure compliance with this procedure, and assist other departments in matters relating to on-site management.

3. Generate and distribute as required, all Ispat Inland Inc. and regulatory agency mandated waste tracking documents.

4. Ensure that all mercury waste tracking and record keeping requirements are complied with and that any violation of established procedures are reported immediately to the By-Product Materials Section Manager. All required records and documents must be available for inspection upon request by representatives of the U.S. EPA and/or the state.

5. Compile and store data required to generate mandated federal and state reports regarding the quantity and final disposition of mercury-containing wastes.

6. Immediately alert the Environmental Affairs Department to any reports of unauthorized mercury waste disposal activities or attempted improper management and/or disposal on-site of any other toxic or hazardous wastes.

C. Internal Logistics

Ensure that all equipment operators involved in the moving/handling of mercury and mercury-containing wastes are informed of the requirements of this procedure and other applicable procedures and regulations concerning the transportation of contaminated materials.

D. Construction Engineering

1. Ensure that outside contractors working under department direction are fully informed as to the requirements of this procedure and other applicable procedures and regulations.

2. Report any violations to By-Product Materials (3687) and Environmental Affairs (6296).

E. Purchasing and Materials Control Department or Equivalent Function

1. Actively seek feasible alternatives for all mercury-containing commodities utilizing input from operating department personnel.

2. Ensure that all contractors and vendors are fully informed as to the provisions of this procedure regarding their involvement in mercury reduction and waste handling/management activities.

3. Ensure that all contractors and vendors are fully aware of the violation provisions of Section VI of this procedure and that the reporting requirements etc. are included in the purchase order.

4. Coordinate the off-site disposition of all mercury-containing wastes with the By-Product Materials Section of Logistics.

5. Forward purchase orders for all mercury-containing commodities to the Environmental Affairs Department.

F. Environmental Affairs Department

1. Disseminate to affected departments all applicable federal, state and local mercury waste management regulations, standards and guidelines.

2. Make necessary changes to this procedure pursuant to changing government regulations.

3. Make necessary reports to the appropriate regulatory agency in a timely manner.

4. Immediately investigate all reports of improper or unauthorized waste disposal practices.

G. Engineering

Ensure that all construction inquiries and requisitions for capital projects include the provisions of this procedure as applicable.

H. Contractors

1. Ensure that the general provisions of this procedure are followed regarding the management and final disposition of mercury-containing wastes.

2. Obtain approval, where applicable, from both By-Product Materials (3687) and Environmental Affairs (6296) for the proper disposition of wastes outside of the plant.

3. Ensure that mercury-containing wastes generated outside of Ispat Inland Inc. are not brought into the plant.

WASTE HANDLING PROCEDURES

A. Mercury-containing wastes must be accumulated and stored in a manner that minimizes the potential for releases of mercury to the environment.

B. If a release of mercury should occur during the handling of mercury-containing materials or wastes, follow the release reporting and response procedures specified in Environmental Bulletin ENV-B-001, Environmental Procedure ENV-P-015, Environmental Procedure ENV-P-016, and the Departmental Spill Prevention Control and Countermeasures (SPCC) Plan(s).

- **NEVER** handle mercury or mercury-containing wastes without the proper personal protection equipment.
- **NEVER** pour mercury or mercury-containing wastes down a drain or allow mercury or mercury-containing wastes to go down a sewer.
- **NEVER** throw mercury or mercury-containing wastes into trash or general refuse containers.

- **NEVER** use an ordinary vacuum or shop vacuum to clean up mercury. The vacuum will put mercury vapor into the air and increase the likelihood of human exposure. The vacuum cleaner will be contaminated and will have to be disposed of properly with the spilled mercury.

- **NEVER** use a broom or a paint brush to clean up mercury. It will break the mercury into smaller beads and spread them around.

- **NEVER** use industrial/commercial cleaners containing ammonia or chlorine to clean up a mercury spill. They can react violently with mercury, releasing toxic gases.

- **NEVER** place contaminated garments in a washing machine or clothes dryer or combine with other clothing. Instead, place contaminated garments in a plastic bag and seal the bag before ensuring proper disposal.

Unauthorized disposal or attempted disposal on-site of any material or waste that is known or suspected of being toxic or hazardous, shall be reported immediately by operating supervisors to appropriate By-Product Materials personnel, who in turn, will report to the Environmental Affairs Department. Environmental Affairs will initiate an investigation. Upon determination of the facts surrounding violation of this procedure and/or appropriate regulations, the manager of the department involved will be informed of the nature and seriousness of the violation. Violations of this procedure are of a serious nature and must be avoided (Refer to Environmental Policy ENV-002, "Unauthorized Waste Disposal").

Appendix C

Mercury Switches and Relays and Their Non-Mercury Alternatives

(Sources: Identifying Research and Development Priorities to Reduce Mercury Use and Environmental Release in the United States (draft) from the U.S. Environmental Protection Agency and the draft Wisconsin Mercury Sourcebook from the Wisconsin Department of Natural Resources)

Switches and relays that use mercury include mercury switches, reed switches, reed relays, and mercury displacement relays. A small switch may contain 3 grams of mercury, while some industrial switches may contain as much as eight pounds. Mercury switches are typically used to detect motion, such as tilt, tip-over or vibration, and are used in products like thermostats and silent switches.

Mercury tilt switches have been used for more than 50 years. They may be used in: “man down” alarms, “silent” wall switches (believed to be totally discontinued in 1991), airflow/fan limit controls, building security systems, fluid level controls (mounted on float, lever arm, diaphragm or plunger), pneumatic tube communication systems, pressure controls, safety shut off switches for machinery and temperature controls.

Mercury-wetted reed switches are often used for applications where electronic noise and interference from switch “bounce” are a concern. A relay is an electromagnetic switch where the variation of current in one circuit controls the current in another circuit. Reed relays contain reed switches as the contact. Relays may be used in: security system applications, oscillators, magnetically activated proximity sensors and rectifiers.

Mercury displacement relays were developed for high load current applications and contain about 130 grams of mercury, far more than the 0.5 to 3.0 grams typically found in mercury tilt switches and reed switches. Mercury displacement relays may be used in: industrial process controllers, high current/voltage lighting, power supply switching, resistance heating, tungsten lighting and welding.

An estimated 230 tons of mercury are contained in thermostats in use in the United States; assuming a 20-year average lifespan, 7-10 tons of mercury from used thermostats is disposed each year. An estimated 630 tons of mercury are contained in other switches and relays in the United States; assuming a 10-50-year average lifespan, 36-63 tons of mercury from used switches and relays are disposed each year.

Switches, Relays and Thermostats—
Non-Mercury Substitution Options

- Steel ball switches
- Nontoxic liquid metal alloys
- Open contact magnetic snap switches
- Sealed magnetic snap switches
- Digital Thermostats
- Hybrid thermostats
- Light sensing heat thermostats
- Hard contact switches
- Photoelectric sensors
- Non-mercury mechanical relays
- Solid state relays

For more information on switches, relays, other industrial devices and their non-mercury alternatives, consult the following web sites.

Description of different relay types:
http://www.fda.gov/ora/inspect_ref/itg/itg51.html

Industrial temperature measurement and control, plus a link to the Wilkerson Instrument catalogue:
http://www.wici.com/technote/tmcover.htm

Temperature and power control technologies and Watlow mercury and non-mercury switches and relays:
http://www.watlow.com

Comus International mercury and non-mercury switches and relays:
http://www.comus-intl.com