

How to Add Mercury Switch & Sensor Removal to a Municipal White Goods Program

AMRC Manual



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1.0 ABOUT THIS MANUAL

This manual has been produced to assist municipal staff with adding mercury switch and sensor removal to their white goods programs. Much of the practical information in the manual is based on the results of a nine month pilot carried out in the Regional Municipality of Niagara. A full report on the pilot is available from the AMRC office.

There is also a video that goes with the manual and provides step by step guidance on removing mercury devices from the two most commonly received appliances: chest freezers and gas ranges.

The AMRC gratefully acknowledges the assistance of the Regional Municipality of Niagara for undertaking the pilot, and the funding support received from Environment Canada, Ontario Region. As well, there were several state and county resources in the US that were very helpful - in particular, the State of Vermont's Department of Environmental Conservation who graciously allowed us to use photos of appliances that we didn't receive in our pilot.

In addition to this manual and video, there is a wealth of information available on the internet pertaining to municipal mercury initiatives, one of the best can be found at the *Binational Toxics Strategy Reducing Mercury Page*, www.epa.gov/region5/air/mercury/reducing.html.

2.0 INTRODUCTION

Mercury occurs naturally in soil, vegetation and the atmosphere. It has also been widely used in certain consumer products, such as thermometers, thermostats, electrical switches, sensors, fluorescent tubes and in amalgam for dental fillings. It can be released to the environment, usually through disposal at the end of a product's useful life.

Recently there has been increased awareness of the problems with the improper use and management of mercury, and in many cases alternative technologies have been developed. Significant reductions in the use of mercury in consumer items have already occurred in Canada.

Mercury is a toxic metal that slowly evaporates, and when spilled or improperly stored, it can continuously contaminate the surrounding environment. It can also accumulate in the natural environment and pollute the air and water. Children and pregnant women are particularly sensitive to mercury poisoning and are more likely to suffer serious effects from exposure. Mercury poisoning can affect the brain, spinal cord, kidneys and liver, and may impair motor function and/or lead to paranoia.

Mercury can be released into the atmosphere by allowing a mercury spill to evaporate, by incinerating mercury-containing products, or by putting mercury-containing products into landfills.

In lakes and rivers, bacteria can convert elemental mercury into methyl mercury which can work its way up the food chain into fish. In the Great Lakes area in particular, there are special advisories warning people to limit their consumption of certain species and length of fish because of concerns about bioaccumulated mercury.

Mercury is one of a group of persistent and bioaccumulative substances that have been targeted for virtual elimination.

2.1 Mercury in Consumer Items

There are numerous every day products that contain mercury. They may not pose a health risk until they have reached the end of their useful life and need to be disposed.

The following products may contain mercury:

- Thermometers (fever, cooking, ambient temperature),
- Thermostats and thermostat probes,
- Fluorescent lamps,
- Old button batteries (the use of mercury in batteries has been discontinued),
- Certain components of electronic products such as the LCD back-lights, and
- Switches, sensors or relays in chest freezers, old (pre-1972) washing machines, gas ranges, space heaters, bilge and sump pumps, commercial gas hot water heaters, and other gas fired appliances, and automobiles.

2.2 Use of Mercury in Appliances

Because of the unique properties of mercury (it is a conductive metal that can be either a liquid or vapour over normal temperature ranges), it has been used for decades in appliances in one of three ways:

- 1) as a component of switches found in such appliances as chest freezers and washing machines,
- 2) as part of the safety gas shut off system in gas fired appliances with pilot lights, and
- 3) in the fluorescent lights that back-light the control panels on some stoves and washing machines.

The use of mercury in domestic appliances manufactured in Canada has been phased out as of 1999/2000. However, old appliances containing mercury will continue to be seen in the domestic waste stream for decades to come.

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When used in switches, mercury is part of the mechanism that turns a light, motor or pump on or off by creating an electrical connection inside a sealed ampoule that usually has two wires attached to it. Thus, when a freezer lid is opened, or a space heater is tipped over, the mercury is used to detect a change in position and either turn on the freezer light or shut off the space heater.

When it is used in flame sensor assemblies in gas fired appliances, the property of mercury to expand when heated and contract when cooled is used to regulate gas flow. The mercury is contained in a bulb capillary bellows assembly. The bulb is located in the pilot flame that heats the mercury and causes it to expand, causing a diaphragm to open and allowing the gas valve to supply gas to the pilot light. If the pilot light goes out, or if a spark ignition pilot fails to light, the safety device will shut off the gas supply. Although there have been mercury free safety assemblies available for some time, they cannot be used in gas ranges that lack standard domestic voltage electrical power. This means that recreational vehicle gas stoves, and gas appliances that are used at cottages or camps without electricity will have mercury safety devices.



Mercury containing pilot flame sensor removed from gas range

The mercury found in intact switches and sensors poses no threat to anyone handling these devices. With a few simple precautions during disassembly, it is very unlikely that one would come into contact with it. The mercury is contained in a hard plastic casing, or a stainless steel or a glass ampoule, and these can be removed intact.

On the other hand, once the appliances leave the municipal disposal/handling facility and are shredded for recycling and smelting, the mercury may leak from the switches and sensors and be released into the environment, either in the shredder fluff or through the smelting process. So, just like the removal of refrigerant from old freezers and refrigerators, removing mercury switches and sensors from appliances at the collection point before they are compacted and shredded is the most efficient and cost-effective way to keep mercury out of the environment.

2.3 Municipal Mercury Collection Initiatives

Niagara Pilot

In order to assess the feasibility of removing mercury containing devices from discarded appliances, the Regional Municipality of Niagara undertook a nine month pilot in 2001 at two of its waste handling sites. Appliances suspected of containing mercury were segregated and examined. Mercury switches and sensors were removed if found. Of the 1,314 appliances received, 120 were found to contain mercury switches. Of these, 117 were chest freezers. The other three mercury-containing appliances were gas

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ranges.

Time and cost assessments were also carried out. The average time to remove the switches from freezers was under two minutes. Segregation and space concerns were minimal as the freezers had to be segregated for CFC removal anyway. At the end of nine months, there was still not a full lab pack ready for pick up by the Region's HHW contractor.

Owen Sound

The City of Owen Sound added mercury switch removal to its white goods program in 2001. Removal of the switches is being done by the city's white goods contractor at no additional cost.

US Programs

A number of US states have targeted and/or mandated the removal of mercury switches and sensors from old appliances. In particular, the state of Vermont (which now requires that all consumer items containing mercury be labeled) has two solid waste districts that remove mercury containing devices prior to recycling. California has mandated the removal of mercury from appliances, and numerous Midwestern states have done extensive research and pilot programs in this area. Indeed, the research and pilot programs in these states have been very helpful in the work carried out in Niagara Region.

2.4 Mercury in Appliances

The following is a list of appliances that have been found to contain mercury switches and sensors.

- Chest freezers with lights in the lid (and no visible manual switch),
- Gas pilot light ranges,
- Washing machines (per-1972),
- Gas dryers, pool heaters, air conditioners and HVAC systems,
- Commercial Gas hot water heaters (100 gallons+),
- Some space heaters
- Sump Pumps, and
- Bilge pumps.

Niagara Pilot

Key findings

- The majority of mercury devices were found in chest freezers,
- The average number of chest freezers received per month was 14,
- The age of the freezers was estimated to range from 10 to 30+ years,
- There were over 30 different makes/models of chest freezers processed,
- The average time to remove switches from the freezers was 1-2 minutes, and
- Mercury sensors were found in three gas ranges.

3.0 ESTABLISHING A MERCURY SWITCH/SENSOR REMOVAL PROGRAM—KEY STEPS

Recognizing that the operation of white goods programs varies between municipalities, the following is a list of generic steps, some of which may not apply to your program.

1. *Review your current white goods program with staff and/or contractor.* They should be able to provide you with a description of the range of appliance types received. From this, you can estimate the proportion of those that contain mercury (based on the appliances listed on page 4.) You can also check CFC removal records to get an estimate of the number of chest freezers received annually.
2. *Review current white goods program costs and revenues.* How is the program cost assessed by contractor? By the tonne or unit? If you have a contractor for CFC removal, how is cost assessed? Would the CFC contractor be able to do mercury switch/sensor removal? Do you receive revenues for the metal recycled? Do residents currently pay a fee for collection or drop off of appliances? Can you add \$1-2 to this fee?
3. *Determine Site logistics:* Can you use the area currently allocated for CFC removal to set aside additional appliances (e.g., gas ranges, old washing machines, etc. for inspection and mercury device removal if required? In the Niagara pilot (April through December), all of the work was done outside. During the winter months, it may be preferable to have an indoor work area for removing the more time consuming sensors in e.g., gas ranges, or to store these appliances until the weather is better. Do you have space for this?
4. *Review the certificate of approval and hazardous waste generator documentation for your site to ensure that you are covered for mercury containing items.* When you contact your regional MOE representative, ensure that you can provide details on the operation of the program, and storage/transportation logistics.
5. Contact your hazardous waste contractor (or AMRC for a current list) to ensure that they can pick up from your site and provide a cost estimate.
6. *Prepare program cost estimates.* These will vary depending on your site, and whether it is municipal staff or your contractor who will be doing the work. Tools, personal protective equipment (PPE) and a

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mercury spill kit may already be on site, and therefore it may not be necessary to factor in these costs. You can use the following worksheet to calculate program costs.

3.1 Estimating Program Costs—Worksheet

Item/Activity	Estimated Purchase costs	Estimated Operating cost	Calculation	Estimated one year costs
Tools (see Appendix 3 for list)	\$50.00-100.00			
Personal protective equipment: safety glasses, latex gloves, work gloves	\$25.00-\$75.00			
Mercury Spill Kit	\$100.00-\$200.00			
Pail with securable lid	\$20.00			
Lab pack container	Usually provided by HHW contractor			
Staff time		Cost per hour	X 2 minutes per chest freezer X # of chest freezers per year	
		Cost per hour	X 10 minutes per other appliance X # of these appliances per year	
		Training on mercury spill procedure	1 hour X # of staff + cost of training	
Disposal		\$65—120 per lab pack		
Total one year costs	_____	+	_____ =	_____

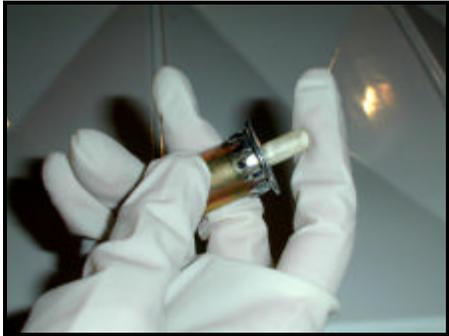
Niagara Pilot: Key findings

- The total number of appliances received over the nine month pilot was 1,314,
- The majority of mercury devices were found in chest freezers,
- The average number of chest freezers received per month was 14,
- The average time to remove switches from the freezers was 1-2 minutes, and
- Mercury sensors were found in three gas ranges.

4.0 HOW TO REMOVE MERCURY SWITCHES AND SENSORS

4.1 Chest Freezers

Some chest freezers manufactured with an internal lid light have a mercury switch incorporated into the light socket so that the light goes on when the lid is opened. If there is no light in the freezer (many small chest freezers do not have lights), or the freezer is an upright model, there is no mercury switch. Some chest freezers have a manual light switch such as the one illustrated in figure 1 - this does not contain mercury.



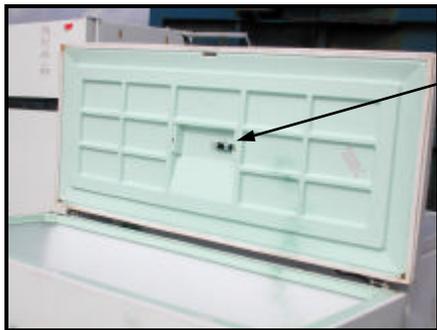
There are two general types of switches that may be found in chest freezers—the ones found in the Niagara pilot were located in the light socket, which are a hard black plastic or a black and white rubber casing. When shaken, the mercury can be heard inside the sockets. The second, less common type is a glass ampoule switch that is inline of the wiring of the freezer's light and is located inside the cover, in the insulation. As with any glass ampoule type switch, care such be taken in removing the switch.

Figure 1—Manual light switch—no mercury

The average amount of mercury in the switch is approximately one to two grams.

4.1.1 Removing Mercury Switches from Chest Freezers

1. Open the freezer lid and inspect for a light in the freezer. If there is no light, or if you find a manual switch like the one illustrated in Figure 1, there is no mercury, so set the appliance aside for CFC removal. If you don't find a manual switch, proceed to step 2.
2. Locate the light socket on the underside of the lid. In some models, it may be necessary to remove the plastic light cover, and the plastic insulation cover in the lid.



Light socket in freezer lid

3. Remove the light bulb.
4. Carefully pull the light socket out of its mounting bracket. Note that the glass ampoule type of mercury switch is typically located inline of the wiring and can be concealed in the insulation of the freezer lid.



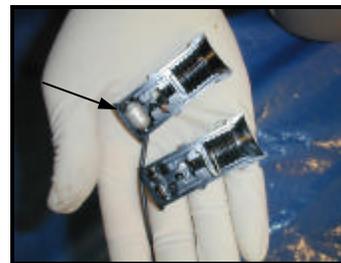
5. Cut or remove the attached wires.



6. The mercury is in the light socket which should be placed in a container with a securable lid.



Mercury containing switches removed from chest freezers



Mercury containing bulb in dismantled switch

Average removal time: 2 minutes

4.2 Gas Ranges

Gas stoves are ignited using either an electronic ignition system or a pilot light. Gas ranges that use a pilot light require a safety device to detect whether the pilot light is on and shut off the gas in case the light goes out. They can contain a number of temperature probes and switches.

The probes and switches that contain mercury are usually made of ferrous metals like iron or steel, while copper assemblies use oil - so a good magnet is an essential tool. As well, any temperature capillary tubes and bulbs that are right inside the oven or below the upper burners are usually copper.

In mercury flame sensors, the mercury is contained in a probe and thin steel capillary that is connected to the gas control valve, which is part of the gas burner assembly.

4.2.1 Removing Mercury Flame Sensors from Gas Ranges

1. The oven should be placed on a spill proof surface such as a plastic tarp. Remove the broiler pan drawer to get to the gas burner assembly. If you find a small ferrous capillary tube like the one in the illustration at right, then you have a mercury flame sensor, and you'll need to remove the burner assembly, valve and all attached gas fittings.



Capillary tube (ferrous) identified

2. Remove the key—note that this could be a screw or pressure fit, depending on the stove—holding the burner assembly in.



3. Now that the burner assembly is loose, disconnect the gas feed line by loosening the fitting (using a crescent wrench) or cutting the gas line.



4. Disconnect the pilot gas feed line by loosening or cutting. Note that there can sometimes be two gas feed lines.





5. Remove the two screws holding the gas safety valve control in place



6. Remove the burner assembly and valve control



7. Remove the screw holding the gas safety valve control and gas safety valve capillary tube and bulb to the oven pilot assembly.



8. Carefully pull the gas safety capillary tube and safety valve sensor bulb back through the bracket.

9. The entire gas safety valve control, gas safety capillary tube and safety valve sensor bulb should be placed in a container with a securable lid.

Average removal time: 10 minutes



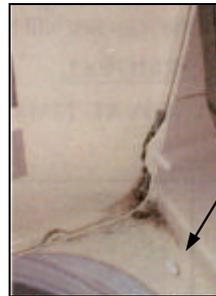
Check the gas range for fluorescent backlighting, and remove the tube for proper disposal if present.

4.3 Washing Machines

Mercury switches were used in some washing machines manufactured before 1972 to either shut off the machine when the lid was opened or when the machine was severely out of balance.

4.3.1 Removing Mercury Switches from Washing Machines

1. Open the washing machine lid and inspect the rim for a mechanical switch—this can be similar to the push button types found in some chest freezers. A mechanical switch will also make an audible click when the lid is opened and closed. If you find a mechanical switch, there is no mercury device.

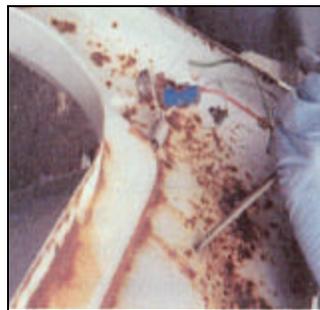


Mechanical switch

2. If you don't find a mechanical switch, remove the top section from the washing machine (note this includes lid and top). This can be done with a sledge hammer, or by removing the sheet metal screws holding it in place.



3. Turn the top section over, cutting away any wires as necessary. The mercury switch is located on the underside of the lid and attached to the lid mounting rod.



4. Remove the switch from the bracket



5. Cut or remove any attached wires.



6. Place the entire washing machine mercury switch into a securable container.



Average Removal Time: 5-10 minutes

4.3.2 Out of Balance Switch Removal

Some models of washing machines used mercury switches in the dynamic stabilizing system to shut off the machine in severe out of balance conditions.

1. Locate the dynamic stabilizing switch on the back of the machine.



2. Remove the fastening bolts.



3. Disconnect the attached wires and inspect the switch. If it is a mercury switch, the mercury should be clearly visible.



4. Place mercury switch in a securable container.

Pictures reproduced, with permission, from the *Household Appliance Mercury Switch Removal Manual*, Vermont Dept. of Environmental Conservation

4.4 Other Appliances/Equipment that May Contain Mercury Switches and Sensors

There are a number of other appliances and items that may contain mercury switches or sensors and that you may occasionally receive as part of your white goods program. These include: gas-fired dryers, pool heaters, air conditioners and HVAC systems, and electric space heaters, sump pumps and bilge pumps.

None of these items were received during the Niagara pilot, but the illustrations below can assist with identification:

Sump Pumps



Sump pump float that contains mercury



Example of a mechanical sump pump which is mercury-free. A metal guide has been used instead of a wire—this is a good indication of a non-mercury containing sump pump.

Bilge Pumps



Example of a mercury containing bilge pump. Older bilge pumps use mercury to complete an electrical circuit, thus turning on the pump. Newer pumps use a steel ball. Shaking the unit can determine whether it contains a steel ball or mercury.

Note that some stoves and washing machines use fluorescent lamps to back-light the control panels. The fluorescent tubes should be removed and disposed as mercury containing waste. Refer to page 10.

APPENDIX 1 GENERAL SAFETY PRECAUTIONS

Handling, Storage and Disposal

Most mercury switches are contained in rigid plastic assemblies that can be safely removed and contained. In some cases, however, the mercury is contained in glass ampoules or in metal capillary tubes that must be carefully handled to prevent breakage.

For this reason, mercury containing devices should only be removed from appliances that have been placed on a surface that will trap and contain an accidental spill.

Safety glasses and gloves should be worn at all times when working on the appliances. Chest freezer lids commonly contain insulation that should not come into contact with skin, and the general state of old appliances can sometimes result in loose parts or assemblies.

Latex gloves should be worn when handling the mercury containing switches or sensors to prevent any accidental skin contact.

Mercury switches and sensors should be placed in securable containers as soon as they are removed. This may be an lab pack labeled according to your HHW contractor's instructions.

Lab pack containers and instructions on how to properly pack them for transport should be obtained from your HHW contractor.

APPENDIX 2 MERCURY LEAKS OR SPILLS

Before initiating any mercury switch or sensor removal, you must ensure that you have mercury spill equipment on site, and that staff are trained in how to manage an accidental spill. Mercury spill kits are commercially available, and if your household hazardous waste depot is located at the same site as your white goods disposal site, you likely already have one.

The following items are the minimum requirements to handle a small mercury spill:

Rubber squeegee	Zinc or copper flakes	Latex gloves
Sulfur powder	Reasealable plastic bags	Safety glasses
Flash light	Paper towels	Respirator with mercury vapour cartridges
Tape	Plastic garbage bags	

Mercury Spill Clean up Procedure

Note for small spills only

1. Wear latex gloves and safety glasses at all times. Ensure that the area is well ventilated, or, if you are working in a confined space, wear a respirator equipped with mercury vapour cartridges. Before handling anything at the spill area, have two garbage bags ready (one inside the other) and opened so that they do not have to be handled before you place plastic bags or containers in them.
2. Remove any pieces of broken glass and wrap them in paper towel, placing the paper towel in a sealable plastic bag or plastic container with lid.
3. Sprinkle mercury powder on the spill area to reduce mercury vapours. Working from the outside of the spill area, push the smaller mercury beads together to form larger beads using a squeegee or stiff card or paper. Scoop the droplets onto the card and place in a plastic bag or sealable plastic container.
4. Use the sticky side wide masking or duct tape to pick up any remaining glass shards or mercury beads.
5. Use a flashlight to check the spill area—the light will reflect off any remaining mercury beads.
6. Sprinkle sulfur powder on the spill area. If it changes colour from yellow to brown, there is still mercury present and more clean-up is required.
7. Sprinkle zinc or copper flakes to consolidate any small mercury beads that remain, and place in sealable plastic bag or container.
8. Place all sealed plastic bags or containers in the doubled garbage bags that you prepared in step one.
9. Remove one latex glove and use it to loosen and remove the second so that your hand does not come into contact with any part of the glove that handled the mercury. Drop the gloves into a sealable plastic bag or container and place in the doubled garbage bag. Carefully secure the garbage bag and dispose of it through your HHW contractor.
10. Thoroughly wash your hands and body.

11. Mercury can lodge in fibres so if any part of your clothing came into contact with the spill area, it should be disposed. NEVER WASH CONTAMINATED CLOTHING IN A WASHING MACHINE.
12. DO NOT ATTEMPT TO VACUUM THE SPILL AREA—THIS WILL SPREAD MERCURY OVER A WIDE AREA.

APPENDIX 3 TOOLS

The following is list of the tools used for switch and sensor removal. In the Niagara pilot, the only tool that was not already available on-site was a magnet.

1. Pry bar/Flat bar
2. Sledge Hammer
3. Vise Grips
4. Large Flathead Screwdriver
5. Small Flathead Screwdriver
6. Phillips head Screwdriver
7. Wire Cutters
8. Tin Snips
9. Hammer
10. Adjustable wrench / Crescent wrench set
11. Magnet