

Getting Mercury Out of Schools

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Why Should Schools Get Rid of Mercury?

- Spills are a common occurrence, and can be costly to clean up.
- Children are more vulnerable to toxic effects.
- NYS Mercury-Added Consumer Products Law bars sale to, and use of, elemental mercury in schools.
- Mercury elimination manageable project in long-term chemical management work
- Educational responsibility

What Do
You Know
About
Mercury?



Mercury is an Amazing Element

- Very dense
- Liquid at room temperature
- Conducts electricity
- Expands and contracts uniformly with temperature
- Bonds readily with other metals
- Element
- Bioaccumulates



Mercury Has 3 Forms

- Elemental, or liquid
- Inorganic
- Organic

Elemental Mercury

- Most common form
- Shiny liquid metal
- Found in mercury-containing equipment
- Easily inhaled
- Easily crosses blood/brain and placental barriers and enters breast milk (80% goes to brain)
- Impacts central nervous system



Elemental Mercury Effects

- Neurological Effects: tremors, mood swings, irritability, excessive shyness, insomnia, loss of coordination, slurred speech, “pins and needles sensation”
- Very high exposures can cause kidney effects, respiratory failure, and death



Inorganic Mercury

- Usually white, except cinnabar (red)
- Can enter body through mouth and skin from products such as disinfectants and fungicides
- Kidney is the target organ; very little crosses the blood brain barrier
- Inorganic mercury compounds frequently found in school science labs: mercuric nitrate, mercuric oxide, etc.

Inorganic Mercury Effects

- Least toxic of 3 forms
- Damages GI tract, kidneys and nervous system;
- High exposures can lead to skin rashes, dermatitis, mood swings, memory loss, mental disturbance, muscle weakness



Photo courtesy: Cuoco and Cormier

Organic Mercury

- Common form in environment methyl mercury
- Converted by bacteria
- Bioaccumulates in the environment
- Form found in fish
- Crosses blood brain and placental barriers
- Damages central nervous system; causes birth defects, neurological problems and developmental delays



Methyl Mercury Effects

- Impacts developing brain—Fish studies on Arctic, island populations show impact on children: cognitive thinking, memory, attention, language, motor skills
- Fetuses most vulnerable: chord blood levels twice maternal blood level
- Chronic exposure: impairment in vision, speech, walking, hearing; lack of coordination, “pins and needles” sensation
- Extreme exposures lead to death, Minimata Syndrome



Biological Mercury Limits

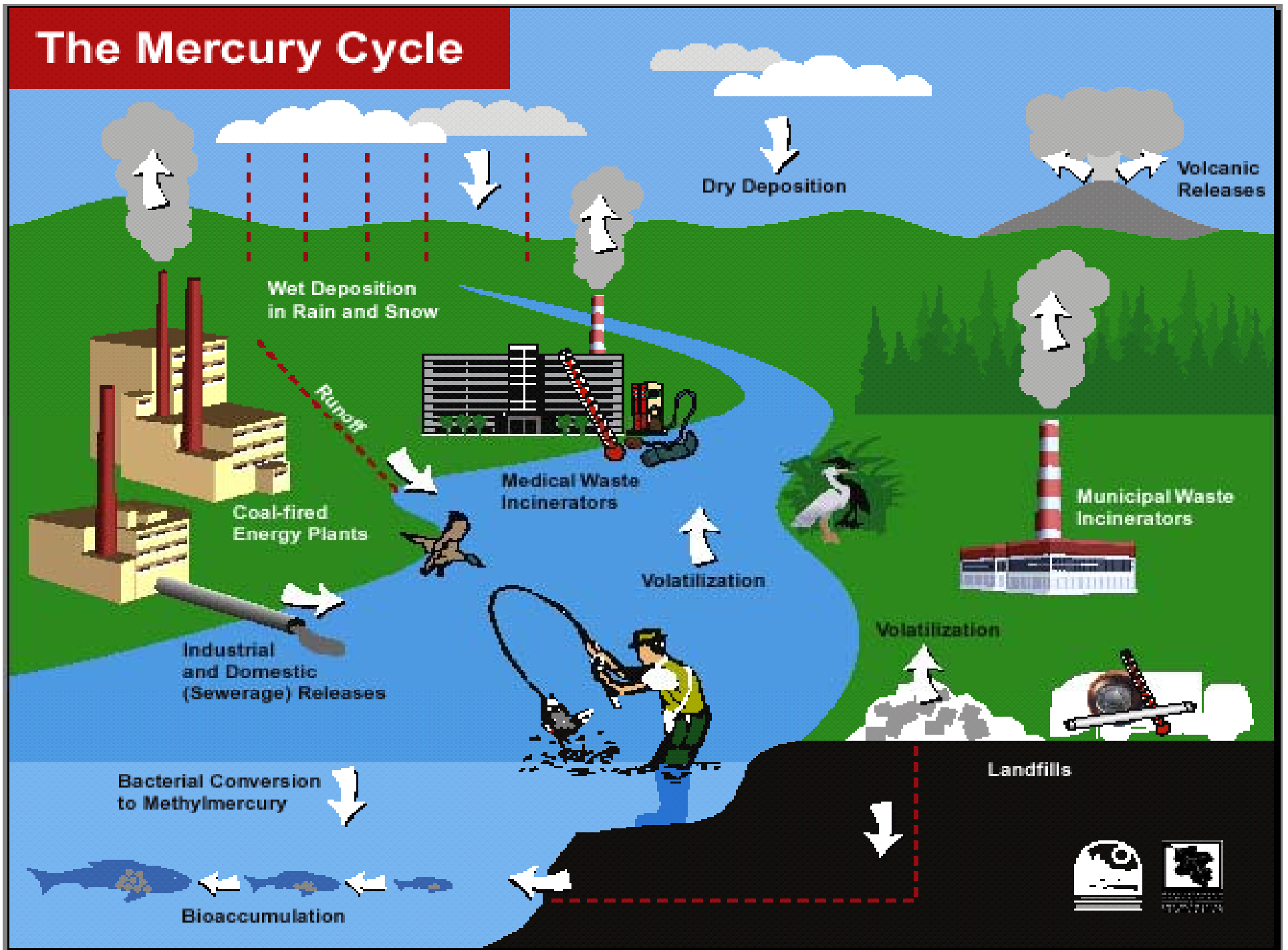
- **Blood is best measure of organic mercury exposure** EPA “safe” limit $< 5.8 \text{ ug/L}$
Threshold for toxic effects seen at $> 2 \text{ ug/L}$
- **Urine measures inorganic, metallic mercury exposure.** Normal is $< 20 \text{ ug/L}$
- **Hair and toenails are also good indicators of organic mercury exposure.** 1 ppm is exposure limit

Mercury

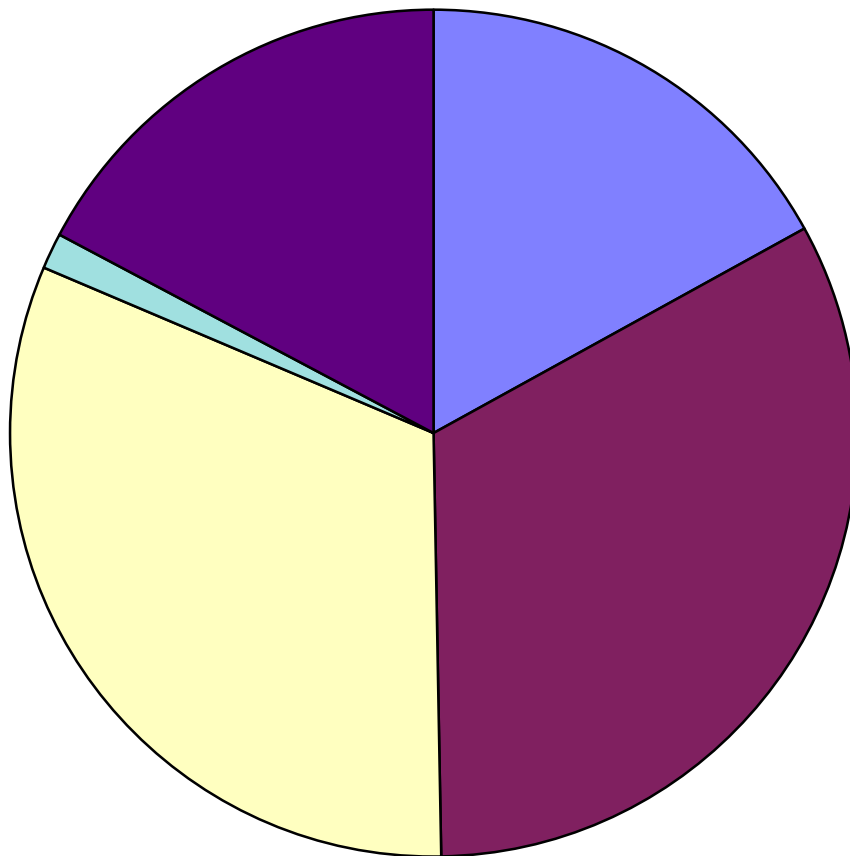
Routes of Exposure

- Oral ingestion of fish is the most common
- Inhalation of vapors
Spilled mercury, dental amalgam
- Dermal – handling pesticides, elemental form

The Mercury Cycle



Mercury Releases to the Environment in New York State 2002

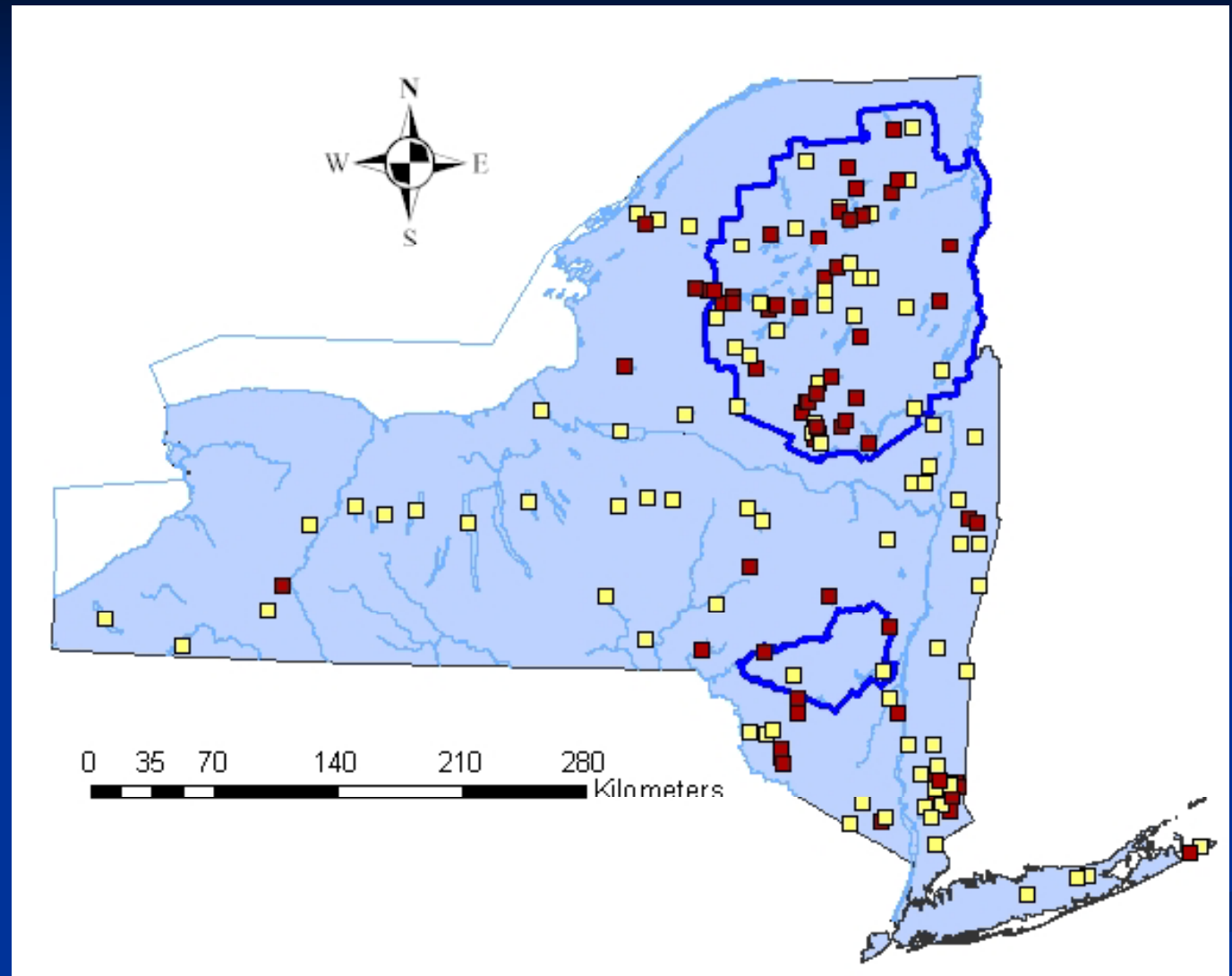


- Manufacturing, 17%
- Coal-fired Utilities, 33%
- Mun. Solid Waste, 32%
- Medical Waste, 1%
- Sewage Sludge, 17%

Fish Warnings FDA and NY DOH

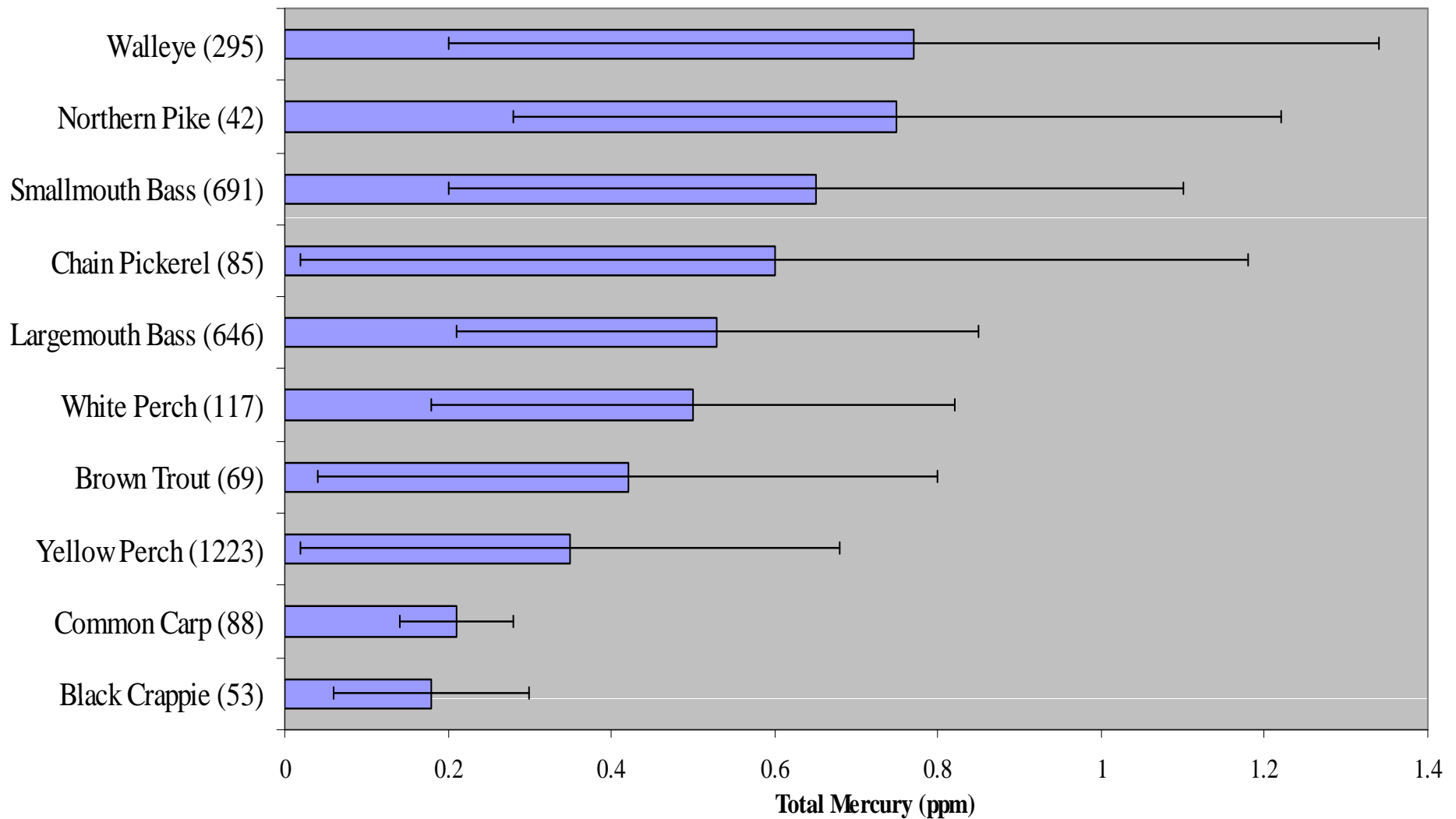


148 Lakes, Reservoirs, and Ponds Tested Since 2001



- 85 lakes without consumption advice
- 63 lakes now under advisory (43%)

Mean Mercury Concentrations Ten Most Sampled Fish Species (Since 2001)



Mercury Impact on Wildlife

- Mercury poisoning widespread, beyond fish
- Fish-eating birds (i.e. eagles, loons)
- Otters, minks, muskrats
- Even animals from forest ecosystems, song birds and bats, that feed on insects



Where is mercury in schools?

- Science Classrooms and Labs
- Medical Office
- Boiler Rooms and Maintenance Areas
- Vocational Schools
 - HVAC laboratories
 - Plumbing laboratories
- Home Economics
- Hidden Sources

What Can You Find in a Typical School?

- In 72 Massachusetts high schools, median amount = 8.7 lbs
- Range of < 1 pound up to 54 pounds*
- Most commonly collected items are lab thermometers, fever thermometers, barometers, blood pressure devices, bulk elemental

*excludes one school with 278 pounds

Science Classrooms

- Bulk elemental mercury
- Mercury barometers
- Mercury laboratory thermometers
- Molecular motion devices with liquid mercury
- Mercury spectral tubes
- Mercury psychrometers, hygrometers, hydrometers
- Mercury sphygmomanometers
- Used mercury spill clean up kits

Elemental Mercury



Lab Thermometers

3 grams Hg



Barometer

500 grams HG



Barometers Come in all Shapes and Sizes



Manometer

60-500 grams

Photo courtesy: Cuoco and Cormier

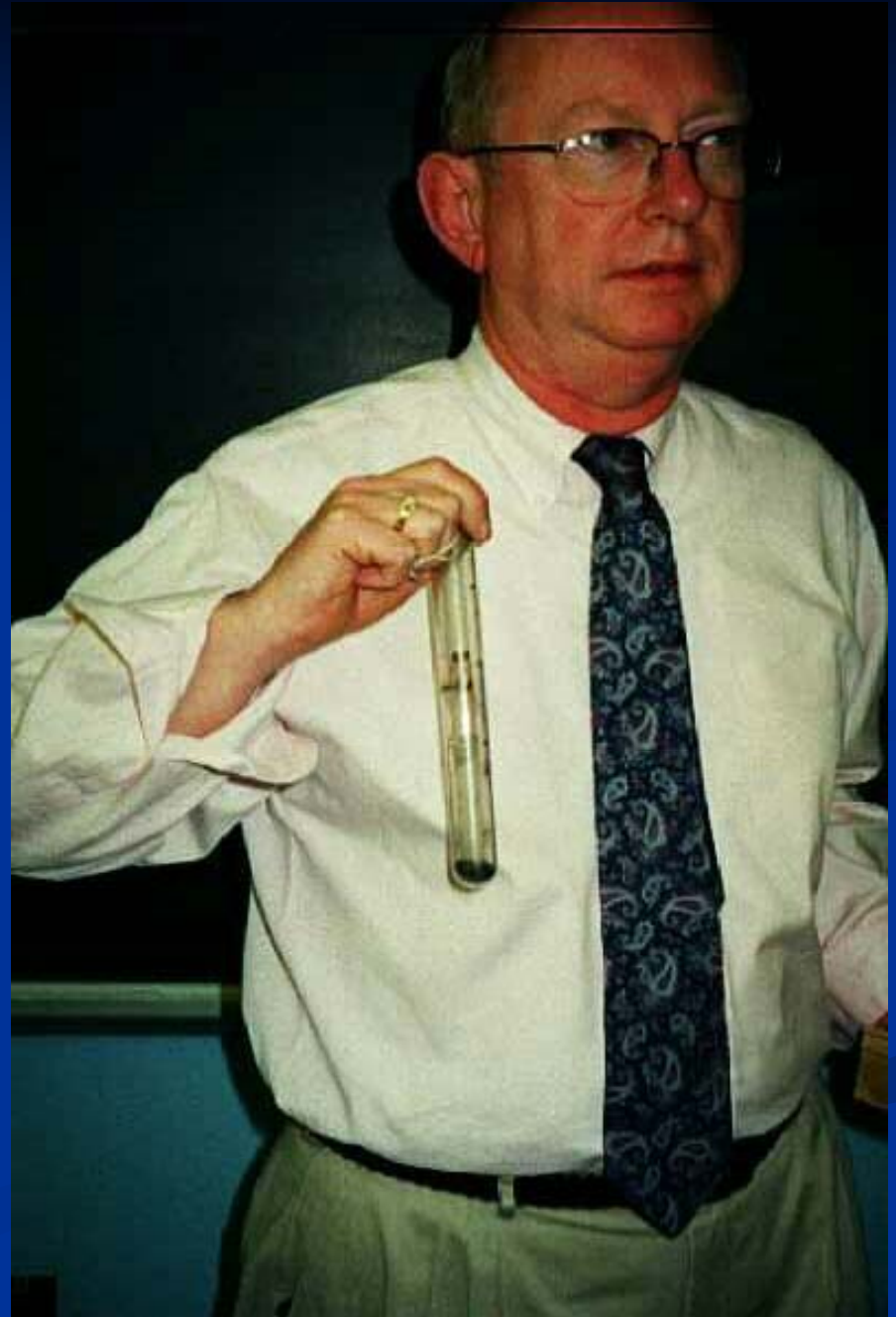


Homemade Equipment



**Molecular
Motion
Devices**

100-200 grams Hg



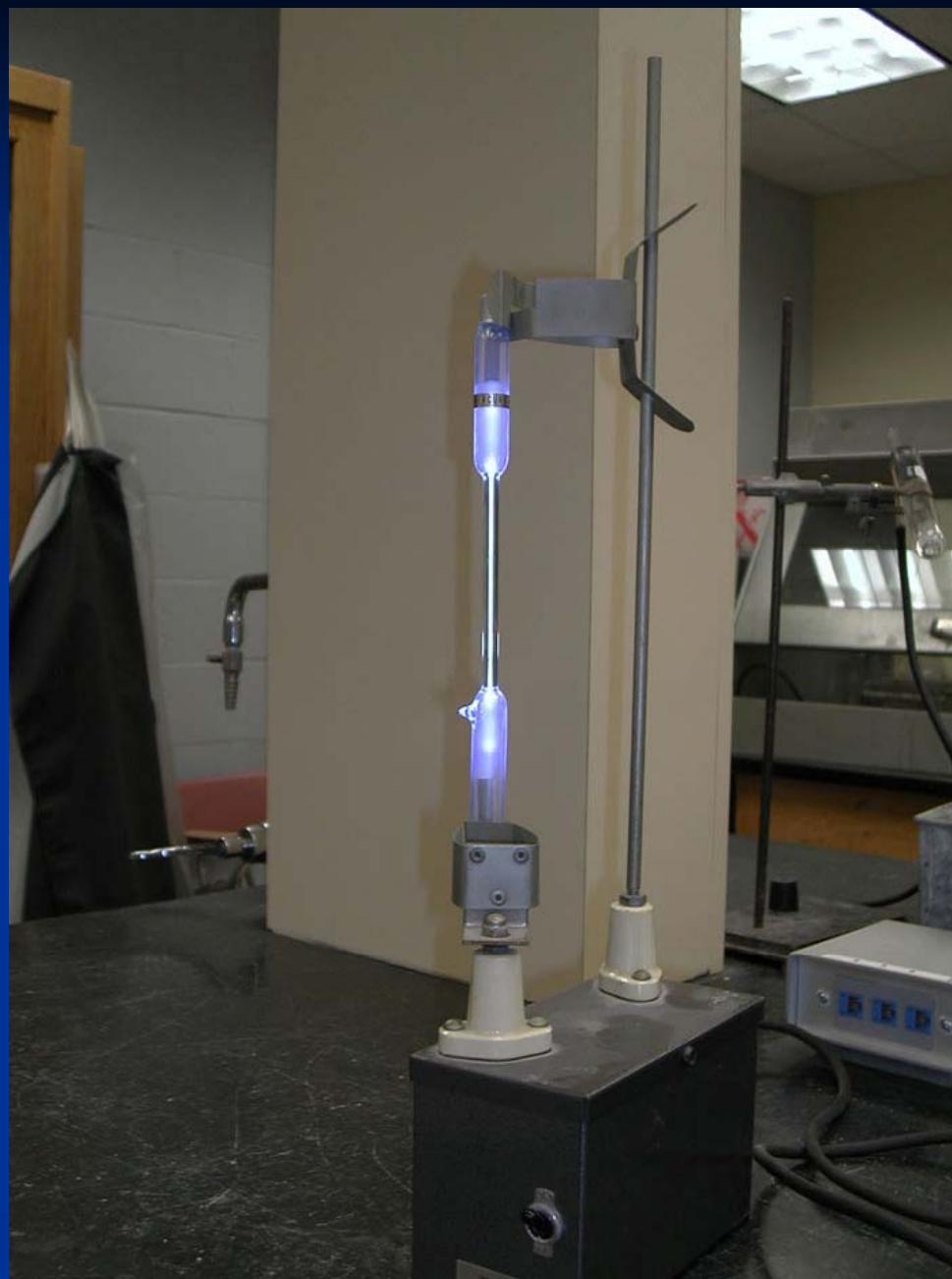
Mercury Spectral Tubes

0.5 grams Hg



Mercury Spectral Tube

Photo courtesy: Cuoco & Cormier



Sling
Psychrometer

6 grams Hg



Hydrometer



DOD Cylinders

Each cylinder
contains 50-75
lbs mercury

270 lbs total Hg



Medical Office

- Mercury fever thermometers
- Mercury blood pressure devices
- Topical disinfectants – mercurochrome

Mercury fever
thermometers

1 gram Hg

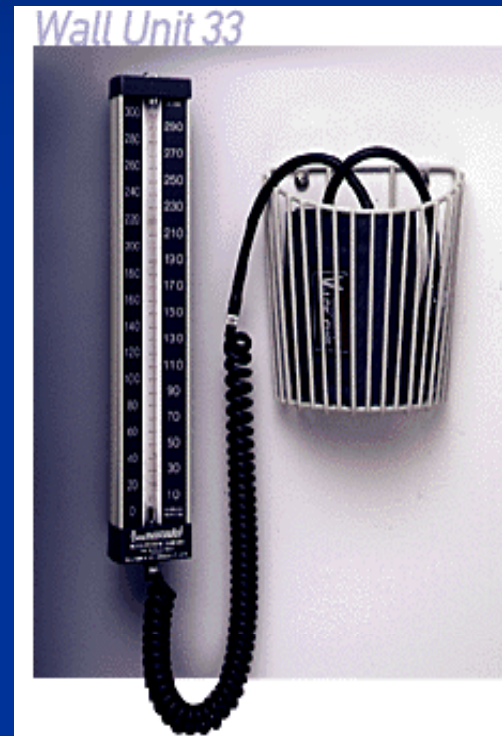


Mercury Blood Pressure Device

110-200 grams Hg



Wall-mounted and mobile blood pressure devices



School Buildings

- Fluorescent lamps
- High intensity discharge lamps
- Mercury thermostats
- Mercury switches (e.g., fire alarm)
- Mercury thermostat probes
- Plumbing
- Mercury in flooring

Fluorescent Lamps

- There are **NO** non-mercury fluorescents!
- Newer “low mercury” fluorescents (3-4 mg mercury)
- Mercury amount decreasing in fluorescents: 40 mg average in 1990, 10 mg average now.
- All fluorescents must be recycled



High Intensity Discharge Lamps



HID lamps are commonly used in security and outdoor lighting.

Outdoor and Security Lighting

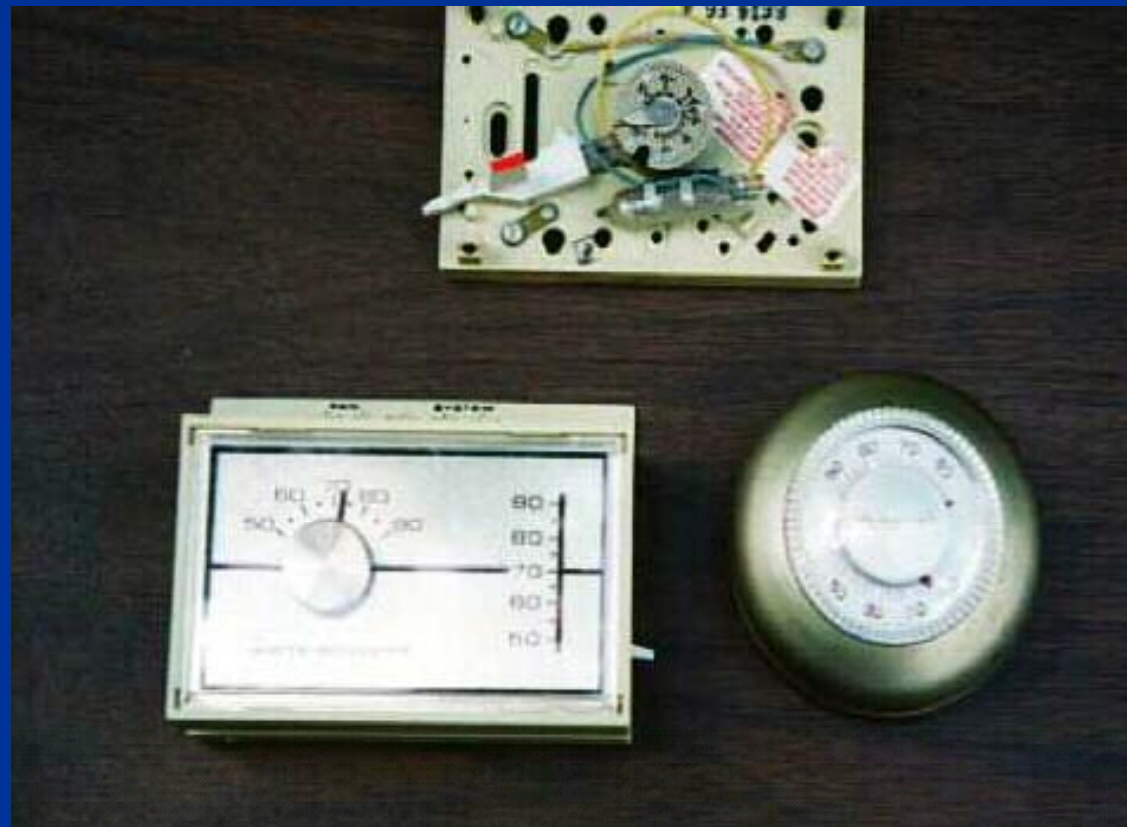


Photo courtesy: Cuoco and Cormier

Mercury Switch



Mercury-switch Thermostats



Pressure gauge



Photo courtesy: Cuoco and Courmier

Switch in fire alarm



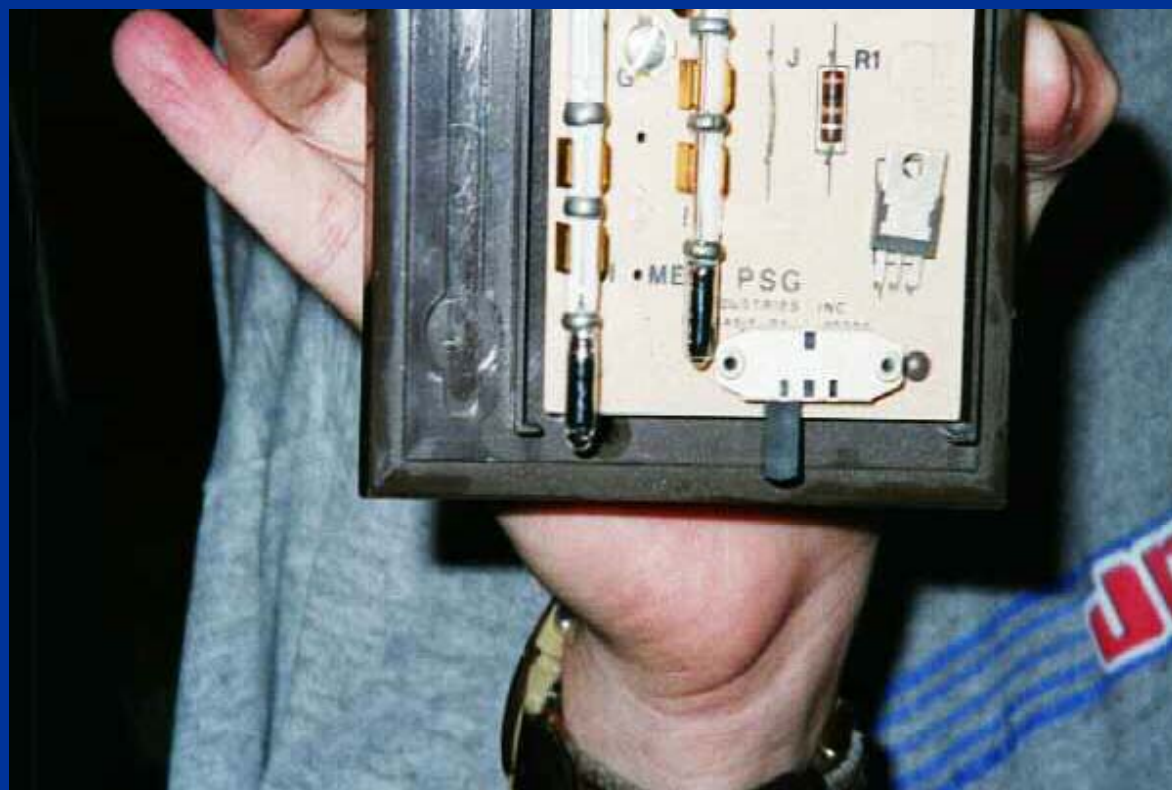
Photo courtesy: Cuoco and Cormier

Vocational Laboratories

In one
HVAC
laboratory,
found 80
Mercury-
switch
thermostats



Accustat Thermostat



Mercury in Drain



Candy Thermometers



3 grams Hg

Approximate Mercury Amounts in School Equipment

- Lab thermometer --- 3 grams
- Fever thermometer --- 1 gram
- Sling psychrometer --- 6 grams
- Barometer --- 500 grams
- Sphygmomanometer --- 110-200 grams
- Manometer --- 60-500 grams
- Switch/thermostat --- 3-5 grams
- Spectrum tube --- 0.5 grams
- Molecular motion device --- 100-200 grams

BREAK

Collecting and Storing Mercury Equipment



Collecting and Storing Mercury Equipment

- **NYS Universal Waste Rule**

*mercury-containing equipment
intact fluorescent lamps, thermostats (batteries and
pesticides)*

- **NYS Hazardous Waste Regulations**

*bulk elemental mercury, mercury spill clean up materials,
mercury compounds, crushed lamps*

Universal Waste Rule

An Alternative Hazardous Waste Regulation

Created To:

- Manage common hazardous wastes
- Reduce the amount of hazardous waste that is incorrectly included in the solid waste stream.
- Encourage recycling and proper disposal.
- Ease the regulatory burden on generators.

Universal Waste Rule

- Federal: Universal Waste Rule
40 CFR Part 273
- New York State:
Standards for Universal Wastes
6 NYCRR Subpart 374-3

Handlers

- Universal Waste Handler - Anyone who generates, manages, receives, accumulates, or sends Universal Wastes (UW) to another UW Handler or to a destination facility.
- Small Quantity Handler (SQH) - Accumulates less than 5,000 kg (11,000 lb) of total UW on-site at any time.
- Large Quantity Handler (LQH) - Accumulates 5,000 kg (11,000 lb) or more of total UW on-site at any time.

Small Quantity Handler (SQH)

Must manage UW in a way that prevents releases to the environment

- Contain any UW in structurally sound containers adequate to prevent leaks, spills or damage, and compatible with contents.
- Immediately contain all releases of UW and other residues and determine whether any material resulting from the release is hazardous. If the material is hazardous, it must be managed accordingly.

Small Quantity Handler (SQH)

- Must inform employees who handle or manage the waste of the proper handling and emergency procedures.
- May accumulate UW for up to one year from generation. Label each waste or container as “Waste Mercury Containing Equipment” etc. and with the date it became waste.
- Must send UW to another Universal Waste Handler or destination facility.

Small Quantity Handler (SQH)

- May self transport UW without a part 364 hazardous waste haulers' permit if less than 500 lbs of Universal Waste is on the same vehicle.
- Recordkeeping is not required but is strongly recommended.

Large Quantity Handler (LQH)

Must meet all requirements for SQH's and:

- Notify EPA in writing and receive an EPA identification number.
- Keep a record of all Universal Waste shipments received or sent off-site, must retain those records for at least 3 years from date of receipt or shipment.

Major Advantages of Using the Universal Waste Rule

- Universal wastes are not counted toward generator status.
- Less paperwork (manifests and annual reports are not required).
- May self-transport or use a common carrier.
- Can consolidate Universal Wastes for shipment from one location.

Lamp Crushers

Crushed lamps may **NOT** be managed as a
Universal Waste

EPA Study showed drum-top crusher operators
potentially exposed to significant mercury levels

<http://www.epa.gov/epaoswer/hazwaste/id/univwast/drumtop/drum-top.htm>

Mercury Containing Equipment (MCE)

- MCE is a device or part of a device that contains elemental mercury integral to its function.
- Mercury in a device accidentally, or if contaminated by some external source, is **NOT** eligible to be managed as Universal Waste.

Handling Ampules and Housings

- Removing ampules from equipment is allowed but not recommended. Handlers who want to remove ampules must follow procedures as required by 40 CFR 273.
- Housings (containers that are open at one end) must have an airtight seal and be packaged in a manner that prevents releases when managed and transported.

**Management of
Non-Universal
Hazardous Wastes**

Non-Universal Waste Mercury

- Elemental mercury not contained in equipment or devices; mercury compounds; spill cleanup materials are NOT Universal Waste.
- Elemental mercury being sent for reclamation can be considered as an “unused commercial product” if it only needs distillation to be brought to product status.

Non-Universal Hazardous Wastes

Regulatory requirements based on generator status:

- CESQG – generates no more than 100 kilograms (220 lbs) of hazardous wastes in a month (and stores no more than 1,000 kilograms).
- SQG – generates more than 100 kg but less than 1,000 kg of hazardous waste in a month (and stores less than 6,000 kg)
- LQG – generates at least 1,000 kg of hazardous wastes in a month, or at least 1 kg of acute hazardous waste (P-listed or F-02X listed).

CESQG – Overview

- Can send waste to consolidation points (e.g. household hazardous waste facility)
- Can self-transport up to 100 kilograms of hazardous wastes in one calendar month (otherwise, must use a permitted transporter)
- No manifests, no EPA ID#, no required paperwork (recordkeeping is recommended)
- Hazardous wastes must be counted toward generator status
- Must conform to DOT requirements.

SQG - Overview

- Obtain and use EPA ID
- Adhere to same basic training, spill clean up, container requirements of the Universal Waste Rule
- Label containers “Hazardous Waste– elemental mercury or mercury compounds” and date accumulation began
- Arrange for proper disposal or recycling within 180 days; must use authorized destination facility

For more information see:

Small Quantity Generator Compliance Guide

Recycling and Disposal Options

- Make arrangements through your municipality --- household hazardous waste collection event or at a permanent facility*
- Coordinate with another municipality to save on transportation, labor costs
- Hire a hazardous waste contractor. Use one of the state's Filed Price Agreements, NYS Office of General Services, 518-473-5721 for more information
<http://www.ogs.state.ny.us/purchase/fpa/fpa.asp>

*Small quantity generators of hazardous waste may not use this option.

NYS Hazardous Waste Regulations

New York State Department of Environmental
Conservation

Division of Solid and Hazardous Materials

John Miccoli, jdmiccol@gw.dec.state.ny.us

(518) 402-8629

Compliance Guide for Small Quantity Generators

<http://www.dec.state.ny.us/website/ppu/p2pub.html#small>

Regional Contact

For more information contact DEC Region 5-
Warrensberg sub-office:

Guy Carayannis, PE, Environmental Engineer II
Division of Solid and Hazardous Materials
(518) 623-1200
gjcarayi@gw.dec.state.ny.us

Replacement Equipment

Almost all mercury-containing equipment found in schools can be replaced by non-mercury substitutes of equal functionality!

Vendors

Two main vendors for scientific equipment:

- Sargent Welch, 800-727-4368
<http://sargentwelch.com>
- Flinn Scientific, 800-452-1261
<http://www.flinnsci.com>

Discounts often available if purchasing in bulk.

Replacement Thermometers

- Thermometers are the most common mercury-containing equipment in schools
- Enviro-safe (green liquid) are the most accurate of the non-mercury thermometers – but they need to be stored upright
- For high temperatures (above 260° C), digital thermometers are required

Non-mercury Replacement Products

LABWARE & SUPPLIES 1260 Thermometers



Partial Immersion Thermometers

Choosing the Right Thermometer

It's easy to select the right thermometer for the task at hand. Start with the requirement that is most important to you and look for the recommendations under that category.

Accuracy: Calibrated Thermometers—Fractional Degree
Mercury Thermometers, Total Immersion
Enviro-Safe® Thermometers

Low Cost: BASIX Spirit-filled Thermometers

Safety: Enviro-Safe Thermometers
Teflon-coated Mercury Thermometers

Durability: 6" (165 mm) Enviro-Safe Thermometers
8" (203 mm) Spirit-filled Thermometers
Teflon-coated Thermometers (Spirit-filled)

Partial or Total Immersion?

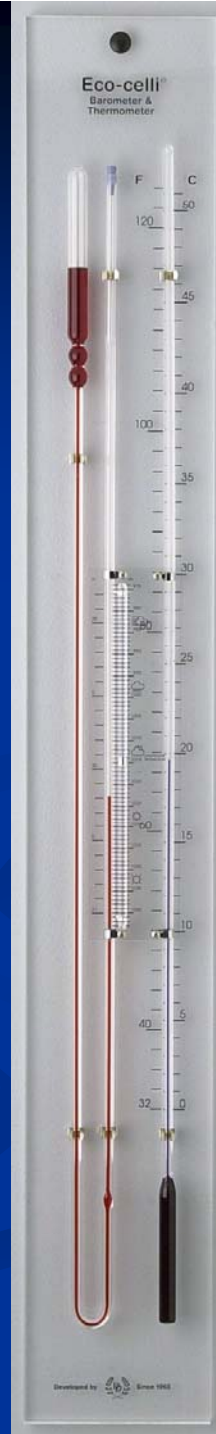
The two types of thermometers are not interchangeable.

For general use we recommend a partial immersion thermometer. The thermometer should be immersed in the test solution up to the line printed on the thermometer.

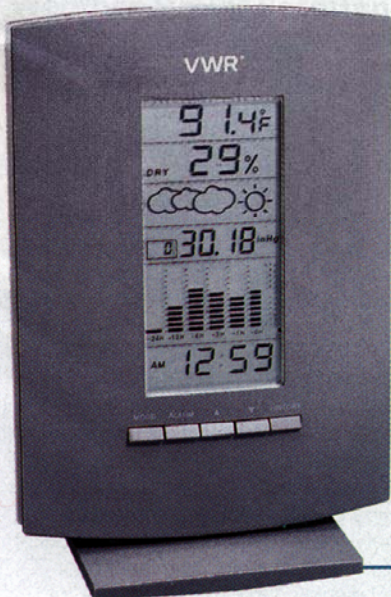
For highest accuracy we recommend a total immersion thermometer. The entire thermometer column needs to be immersed in the liquid to be measured. This gives the highest accuracy, but using a total immersion thermometer improperly will result in errors.

Replacement Barometers

- Eco-celli liquid-gas silicon barometers have same teaching value as mercury barometers because they enable students to visualize concepts.
- Available through Allivan Marketing, 978-649-8547, sales@allivanmktg.com



Non-mercury Replacement Products



The image shows a VWR Electronic Digital Barometer, a dark grey rectangular device with a digital display. The display shows a temperature of 91.4°F, a humidity of 29% with a 'DRY' indicator and a sun/cloud icon, a barometric pressure of 30.18 inHg, and a time of 12:59 AM. A bar chart below the pressure display shows a trend over 24 hours. The device has a small stand at the bottom and a row of buttons.


EARTH/SPACE SCIENCE
Meteorology **441**

Electronic Digital Barometer

The combination unit provides barometric pressure, temperature, humidity and time. It's ideal for weather stations and as a substitute for mercury barometers. Barometer comes with stand and batteries. Unit measures 5-1/2" x 7-1/4" x 1". Memory display to show the past 24 readings plus a trend display for the previous 1, 3, 6, 12 and 24 hours.

Barometric Pressure Display — 23.45 - 31.01 in Hg, resolution 0.03 in Hg, 790 - 1050 millibars, resolution 1 mbar, accuracy ± 5 mbar
Altitude compensated -0/ — 3500 meters, adjustable
Temperature Display — -5 to 55° C, resolution 0.5 C, accuracy $\pm 1^\circ$ C 23 - 131 F, resolution 0.9° F
Humidity Display — 10 - 98% Relative Humidity, accuracy ± 5 % RH
Time of Day Display — Date and time

WLS-4521 \$149.00



A vertical mercury barometer with a wooden frame and a glass tube containing a column of mercury.

Replacement Sphygmomanometers

- Medical office blood pressure units need high quality replacements, e.g. Welch Allyn Tycos or Baum aneroid sphygmomanometers
- Aneroid problems: require more frequent calibration, units are more easily damaged
- Benefits: easier to read and maintain, no mercury!



Economy Pocket Aneroid Sphygmomanometer

Economical, easy to use sphygmomanometer features no pin stop gauge, Velcro® cuff, chrome air valve and latex inflation system. With zippered vinyl pouch and instructions. Just add a stethoscope to measure your blood pressure.

WLS-5596-05 \$36.80



Blood Pressure Experiment Kit

Teach your students the important aspects of blood pressure through hands-on experience. Kit includes pocket aneroid sphygmomanometer with Velcro® cuff and vinyl pouch, a Bowles stethoscope and manual, "Experiments in Blood Pressure". Topics for discussion include physiological theory and medical conditions, hypertension and effects of exercise, caffeine, pain and standing on blood pressure.

WLS-5606 \$68.95



Student Blood Pressure Gauge

Get high quality without the cost. Set includes our no-pin aneroid sphygmomanometer and a self-adjusting cuff with gauge holder, all in a convenient, vinyl storage case. Includes an illustrated step-by-step instruction manual and recording charts.

WLS-5603 \$26.40



Mercury Sphygmomanometer

Compact desk top design is enclosed in heavy metal case and frame to withstand classroom use. Mercury column records blood pressure changes up to 300 mm Hg. Built-in mercury column lock eliminates spillage and air brakes. Includes Velcro® cuff and case. Case measures: 2" H x 3-1/2" W x 13-1/2" D.

WLS-5591 \$114.00

Digital Blood Pressure/ Pulse Monitor

Accurately obtain blood pressure and pulse rate measurements on your own and without a stethoscope! Battery powered sphygmomanometer has built-in device to obtain error-free readings. Features automatic deflation mechanism, large digital LCD and graphic icons for easy use. Uses four "AA" batteries WLS-30841-10 (not included). Complete with vinyl case, recording charts and instructions.

WLS-5593-15 \$68.40



Replacement Fever Thermometers

- Geratherm makes high quality, inexpensive digital fever thermometers and liquid gallium-indium-tin thermometers
- Available through RG Medical Diagnostics, Jon Nelson, 888-596-9498 X 202



Replacement Fever Thermometers

- The SURE-TEMP electronic thermometer is high quality and gives very rapid temperature readings.



Replacement Thermostats

- Electronic, programmable thermostats can provide significant energy savings by automatically shutting off the heat/AC when not needed
- Used as teaching devices in vocational classrooms
- Some wholesalers will collect for recycling



Replacement Switches

- Switches can be found in many locations – sump pumps, fire alarms, boiler pressure gauges, HVAC systems, silent light switches, safety valves
- Make sure this equipment is clearly marked as containing mercury
- When purchasing new equipment, specify non-mercury components

Mercury Spill Clean Up



When Can a Spill or Release Lead to Health Problems?

- Fever thermometer break (1 gram) can cause symptoms if not cleaned up properly
- Sphygmomanometer spills (100-200 grams) sig. more potential to cause harm
- Most severe cases of mercury poisoning result from extended exposure, esp. through play and when spills occur on porous materials; amounts less than 1 lb can cause acute poisoning.
- Mercury spills involving heat result in greater exposures

Mercury Spill Clean Up

- Evacuate room immediately
- Evaluate the spill. Do you need outside help? Is the spill more than 2 Tbsp?
- Contain the spill – tape works well
- Open exterior windows; shut down interior ventilation; lower room temperature
- Keep potentially contaminated individuals in a separate area until they can clean up and change clothes and **shoes** – treat contaminated items as hazardous waste

Mercury Spill Clean Up “Don’ts”

DO NOT use a broom,
mop or vacuum cleaner

DO NOT put mercury
down the drain



Mercury Spill Clean Up “Dos”

- DO clean up with two pieces of stiff paper, eye dropper, or rolled up duct tape
- Do use zinc powder or flowers of sulfate to ensure you get all the mercury
- DO put all mercury and contaminated material into double containment and label it
- DO dispose of as hazardous waste

Who you can contact

- **DEC's Spill Hotline:**

1-800-457-7362

...if the spill is more than 2 tablespoons

- Visit EPA's mercury website:

www.epa.gov/mercury

Broken Fluorescent Lamp Clean Up

- Wear gloves
- Use a damp cloth to sweep up broken shards and pilled powder
- Place all spill clean up materials in a puncture-resistant, sealed plastic container or bag
- Recycle broken lamp and clean up materials; do not place in trash
- Do not vacuum