United States Environmental Protection Agency

Office of Pollution Prevention and Toxics, Washington, DC 20460

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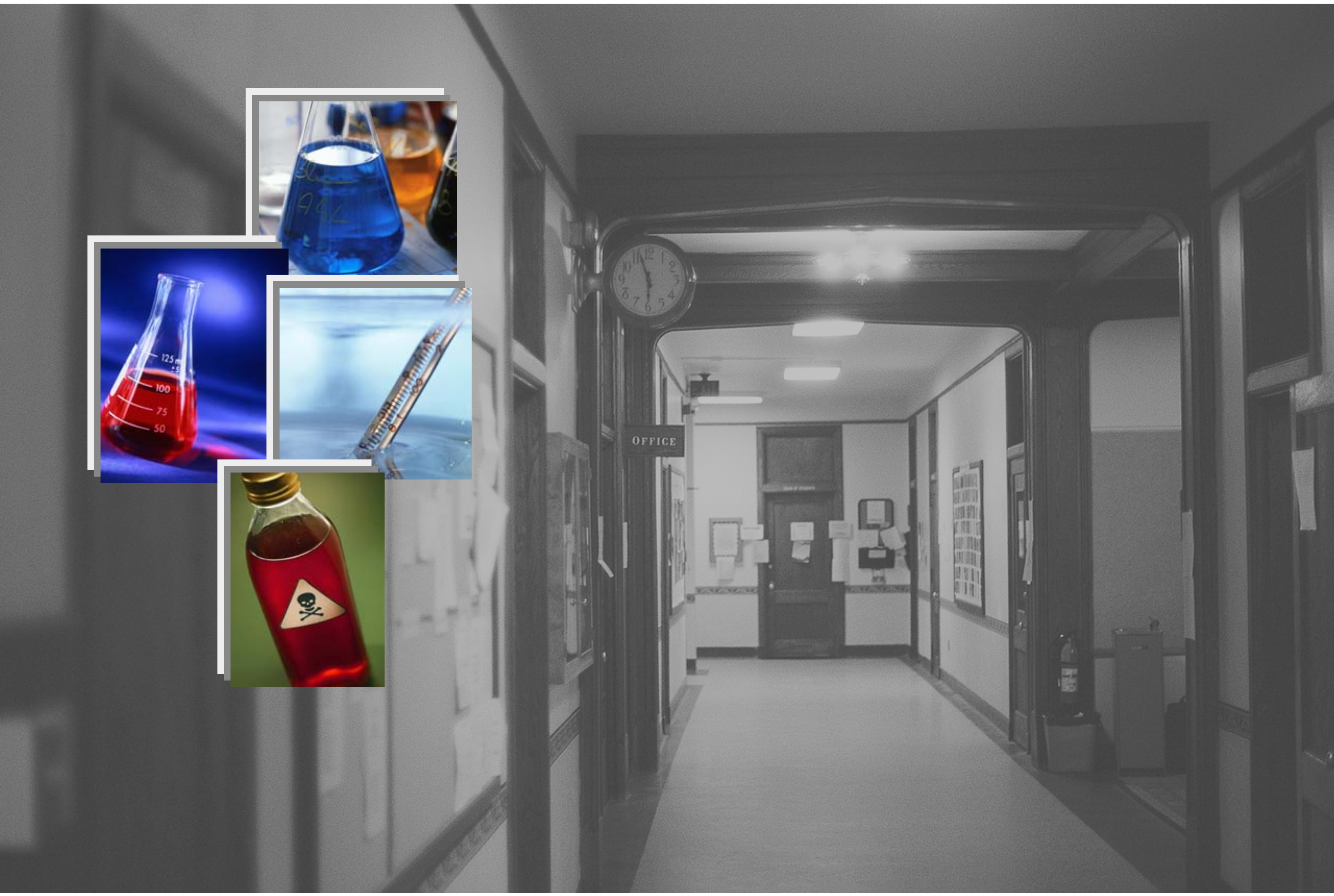
April 2008

# Mercury and Chemical Management in Schools:

## An Instructor's Guide for Trainers in Schools in Southeast Asia

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# Acknowledgements and Disclaimer


## Acknowledgements

The time and effort that many individuals contributed to the review and development of this document is gratefully acknowledged by the United States Environmental Protection Agency (U.S. EPA). We especially acknowledge the assistance of Ms. Pornpimon Chareonsong of the Thailand Pollution Control Department. This document was prepared by Battelle Memorial Institute under contract EP-W-04-021 at the direction of Mr. Clarence Lewis of the EPA Office of Pollution Prevention and Toxics.


## Disclaimer



Section

# I

# Introduction for Instructors

This instructor's guide is a tool to help instructors promote the concepts of safe mercury and chemical management in schools. The guide is accompanied by the "Mercury and Chemical Management in Schools: A Participant's Manual for School Administrators and Teachers in Southeast Asia" (Participant's Manual), which will be distributed to training participants. This instructor's guide contains three types of materials:

1. Guidance for the instructor/facilitator on conducting the training course (Section I)[1]
2. A copy of all presentations with talking points as appropriate (Section II)
3. Instructions for participant activities (Section III).

Sections II and III are both arranged according to the four training session topics: (1) Importance of Mercury and Chemical Management for School Administrators and Teachers, (2) Hazardous Chemicals and Equipment in Schools, (3) Policies and Actions for School Administrators and Teachers, and (4) Be Smart About Mercury. The presentation slides (overheads) corresponding with Section II are contained on a CD included with this guide. The instructor is encouraged to rearrange, add, or delete slides as appropriate to his or her approach, the audience, and the time available for training. The facilitator should also review the more detailed information in the Participant's Manual.

Instructors are encouraged to duplicate any portion of this guide and the Participant's Manual as needed to conduct training or to implement a mercury and chemical safety program. Any and all parts of these documents may be reproduced or translated as necessary, but credit should be given to this original document.

## I.A. Training Objective and Approach

The participants in this training are university and high school administrators, teachers, and school district personnel. After the training, each participant should be able to:

1. Understand the need for and basic principles of responsible chemical and mercury management in schools.
2. Develop or revise school policies to incorporate basic steps to prevent and minimize the incidence of chemical spills, exposures, and emergency scenarios in schools.
3. Support broader district-level efforts to raise awareness of chemical and mercury safety in schools, promote alternatives, and engage in proper waste management.

1 Much of Section I is adapted from United States Environmental Protection Agency, Principles of Pollution Prevention and Cleaner Production, An International Training Course, Facilitators Manual, prepared by Battelle Memorial Institute, December 15, 2000.

This training course is to be taught by an instructor (facilitator) using an interactive or "facilitated training" approach. The goal of facilitated training is to enable class participants to solve problems through participation and involvement, rather than simply by listening to a lecturer. This mercury and chemical safety training course is designed to foster maximum participation, including activities and opportunities for group discussion.

It is essential that participants bring their own ideas and experiences with mercury and chemical safety into the training. Facilitators offer specialized knowledge, but participants have the experience to develop practical solutions out of the information provided. Facilitators guide participants through an interactive process. This facilitated method is a model for training that you can adapt to meet your own training needs. The most important idea is to **be creative and have fun** with the training course.

## Adult Learning Concepts

Adults are excellent learners because they are often highly motivated and bring so many of their own experiences to the educational setting. In instructing adults about mercury and chemical safety, keep the following in mind:

- Design learning activities to engage and enable participants to develop technical knowledge in mercury and chemical safety, including effective planning, problem solving, analyzing the root causes of problems, and communication.
- Emphasize how participants can apply mercury and chemical safety concepts to develop specific policies and programs for their schools.
- Demonstrate how the material you are presenting is relevant and useful. Participants are less likely to remember and use information if it is not clear how this information applies to their schools. Course material must be linked directly to their experience in a way they can understand.

## The Role of a Facilitator

The responsibilities of the instructor/facilitator include:

- Presenting information in several forms (verbal, written) to ensure understanding, especially since participants may not be familiar with specific terminology and, in some cases, may not be native speakers of the language of instruction
- Asking questions to stimulate discussion, demonstrating the relevance of key comments, keeping the discussion on track
- Providing instructions for small group activities and checking in with each group periodically to keep the groups on track
- Restating conclusions at the end of a discussion and preparing the group for the next session.

An effective facilitator expands the group's thinking on important details by asking appropriate questions. A facilitator should avoid making participants feel singled out of as if they are being tested, but rather should ask questions in a participatory manner. The questions a facilitator may ask can be organized into the following categories:

- *Exploratory questions*: What are the facts? What went wrong? What can be done?
- *Challenging or testing questions*: Are these solutions to the problem? Are others possible? Where might these solutions go wrong?
- *Contextual and relational questions*: What kinds of solutions do you have? How is this solution like that solution? How is it different?

- *Questions of priority*: Which is the best solution? Why?
- *Questions of concept and conclusion*: What have you learned? What are the principles involved in the choices you have made? How do they relate to choices you have made in previous sessions?

Table 1 answers some frequently asked questions about facilitated training.

### Table 1. Frequently Asked Questions Asked About Facilitated Training[2]

| | |
|---|---|
| How do I promote learning? | Before the course or at the beginning of the course, assess each participant's knowledge of mercury and chemical safety. Start your instruction at a level appropriate to the participant's understanding. Seek feedback and use it to judge whether participants are learning. Learn the difference between effective and ineffective instruction. |
| How do I gain confidence and overcome stage fright? | Stop thinking about yourself. Focus on the message you will convey. Practice calming techniques, such as deep breathing, to control involuntary reflexes. Prepare for the course by reading the instructor's guide and participant's manual, and making notes in the margins or highlighting important points. Practice in front of your friends or co-workers. |
| What are some technical tips for working with visual aids? | Set up the equipment well in advance. Make sure you are not standing between your audience and the visual aids. Face the audience as you speak. Keep the group's attention focused by pointing at the specific items to which you are referring, using a pointer if available (even a pencil will work). Have backup materials for any electronic presentations. |
| What if the group asks a question I cannot answer? | Refer the question back to the audience. Ask them their opinions or ask if anyone else knows the answer. Alternatively, guide participants in how and where they can find the answer themselves. |
| How can I handle discussion that strays from the training topic? | It is up to the facilitator to determine if pursuing such a topic will benefit the group. If so, feel free to record the group's responses on a blank flipchart. If not, then interrupt and bring the discussion back on track with an appropriate question or transition to the next subject. |
| What are the characteristics of a good style of delivery? | Project your voice so that everyone can hear. Time your remarks so that the pace is neither too slow nor fast. Maintain eye contact with the group by looking at different people. Smile. Use examples. |

## I.B The Design of This Training

### Emphasis and Audience

While covering the basics of mercury and chemical safety, the emphasis of this training is on the **policies and programs** that schools and schools districts need to adopt to protect students, staff, and the surrounding community. Schools and school districts need solid, useful, specific recommendations and information on responsible mercury and chemical management to facilitate the establishment of sound policies and programs. The goal is to prevent and minimize the incidence of chemical spills, exposures, and emergency scenarios in schools.

This training is designed to be understood by university and high school administrators and teachers, without a requirement for an advanced chemistry or other scientific background. Certain technical terms may not be understood by all participants, but the overall message of the need for sound policies and programs should be clear to all participants. In addition to school staff, this training may be useful to other stakeholders such as government, industry, and non-profit organizations who have a role in safe mercury and chemical management. For example, government officials may have a role in regulating or overseeing mercury and chemical management, chemical and equipment

[2] From United States Environmental Protection Agency, Principles of Pollution Prevention and Cleaner Production, An International Training Course, Facilitators Manual, prepared by Battelle Memorial Institute, December 15, 2000.

companies may develop new products or conduct outreach to customers, and non-profit organizations may raise awareness of mercury and chemical safety in schools.

A small class size of 20-30 people promotes discussion and active participation in activities. At the beginning of the training, the instructor should invite each participant to briefly introduce him/herself. This will not only create a participatory atmosphere, but will also foster the establishments of informal networks outside of the training to collectively address mercury and chemical management in schools, and share lessons learned.

## Preparing for Training

You should take several important steps before the training course begins:

**Step 1.** First, determine the amount of time available for the training. An abbreviated version of this training with very limited activities could be given in two hours (or two 1-hour sessions), but an ideal amount of time is about 8 hours. If time allows, arrange for a site visit to a school or well-run laboratory before the training begins (in addition to the 8 hours), to get participants actively engaged in identifying and solving mercury and chemical safety issues. Develop an agenda based on the sample agendas at the end of this section.

**Step 2.** Second, determine whether you will be the only instructor, or whether you will have a co-instructor. For trainings of four hours or longer, it is recommended to have two instructors. Co-instructors can be useful for keeping participants' interest and maintaining the instructors' energy levels. As necessary, coordinate with the other instructor, and tailor each of your presentations to follow a logical order and fit within the allotted time.

**Step 3.** Next, take care of logistics, such as ensuring that:

- Invitations have been sent well in advance
- A good training room with appropriate temperature setting has been reserved
- Training room containing the needed audio-visual equipment
- Your presentation (and a separate backup copy) are ready
- Participants' manuals have been copied (and translated, if necessary)
- Materials for the activities have been gathered
- The laboratory tour has been arranged (if included).

Pay careful attention to the room setup, especially the arrangement of participants' desks. Ideally, participants' desks and chairs should be configured in a "U" shape with the participants around the U facing inward with the facilitators and flipchart stands at the front of the room in the open part of the U. A room large enough to hold the participants in a U format with tables and additional break-out space is the best setting. If separate break-out spaces are not available, arrange tables so people are seated in groups throughout the class. This arrangement works well since it is most comfortable for group work. No matter what the room arrangement, rearrange the membership of the small groups from activity to activity. This way the participants meet and work with all the people in the room.

**Step 4.** Finally, practice delivering the training course. Carefully review the Participant's Manual, the slides and talking points in Section II of this guide, and the activity instructions in Section III of this guide. The importance of practicing, and coordinating with other instructors, as appropriate, cannot be emphasized enough.

## Timing and Flow

Because the needs of your audience may vary widely, this guide provides material sufficient to allow the instructor to tailor the information to the level of the group. Shorter courses may be appropriate for staff peripherally involved in mercury and chemical safety. A full 8-hour course is recommended for school administrators and teachers who will be responsible for developing and implementing mercury and chemical safety policies and programs in schools.

Each of the four session topics should begin with a discussion of the session goals and activities, so that the participants understand how it fits into the whole course. At the end of each session, facilitators should highlight key points of the session and leave open time for discussion to clarify points and answer participant questions. At the end of the training course, provide certificates of course completion, and end the training on a positive note.

## Sample Agendas

Although there is a lot to know about mercury and chemical safety in schools, keep the design of the training course simple. Identify core materials and do not sacrifice quality if short on time. It is better to reduce the amount of material covered than to try to fit too much information into a limited time. The following agendas are guidelines; adapt them according to your style, the participants' needs, and the time available.

## Sample Full Day Agenda with Two Instructors

| | | |
|---|---|---|
| 8:30 a.m. | Welcome, Overview of Day, Round-the Room Introductions (Both Instructors) | |
| 9:00 a.m. | Part 1: Importance of Mercury and Chemical Management for School Administrators and Teachers (Instructor #1) | Presentation (30 minutes) |
| **Activity 1:** | **Interactive Analysis of School Chemical Accident Case Studies** | 45 minutes |
| 10:15 a.m. | Break (provide drink and snack) | |
| 10:30 a.m. | Part 2: Hazardous Chemicals and Equipment in Schools (Instructor #2) | Presentation (45 minutes) |
| **Activity 2:** | **Identifying Chemical Hazards** | 45 minutes |
| 12:00 p.m. | Break for Lunch | |
| 1:00 p.m. | Part 3: Policies and Actions for School Administrators and Teachers (Instructor #1) | Presentation (45 minutes) |
| **Activity 3:** | **Brainstorming on School Policies and Actions** | 30 minutes |
| 2:15 p.m. | Break (provide drink and snack) | |
| 2:30 p.m. | Part 4: Be Smart About Mercury (Instructor #2) | Presentation (45 minutes) |
| **Activity 4:** | **Mercury Spill Role-Playing** | 45 minutes |
| 4:00 p.m. | Question and Answer Session (Both Instructors) Facilitate discussion with participants. Consider asking participants to name the "Top 10" things they learned, and create and distribute a poster based on this list. | |
| 4:30 p.m. | End of Training | |

## Sample Half Day Agenda with One Instructor

NOTE: Presentation times have been shortened in this agenda. The instructor should present only the most important slides, and refer participants to their manual for additional information.

| | | |
|---|---|---|
| 8:30 a.m. | Welcome, Overview of Day, Round-the Room Introductions | |
| 9:00 a.m. | Part 1: Importance of Mercury and Chemical Management for School Administrators and Teachers | Presentation (30 minutes) |
| 90:30 a.m. | Part 2: Hazardous Chemicals and Equipment in Schools | Presentation (30 minutes) |
| 10:00 a.m. | Activity 2: Identifying Chemical Hazards | 30 minutes |
| 10:30 a.m. | Break (provide drink and snack) | |
| 10:45 a.m. | Part 3: Policies and Actions for School Administrators and Teachers | Presentation (30 minutes) |
| 11:15 a.m. | Part 4: Be Smart About Mercury | Presentation (30 minutes) |
| 11:45 a.m. | Closing Discussion (Activity 3): Brainstorming on School Policies and Actions | 30 minutes |
| 12:15 p.m. | End of Training | |

## Sample 2-Hour Agenda (Over Lunch) with One Instructor

NOTE: Presentation times have been shortened in this agenda. The instructor should present only the most important slides, and refer participants to their manual for additional information.

| | | |
|---|---|---|
| 11:00 a.m. | Part 1: Importance of Mercury and Chemical Management for School Administrators and Teachers | Presentation (30 minutes) |
| 11:30 a.m. | Part 2: Hazardous Chemicals and Equipment in Schools | Presentation (20 minutes) |
| 11:50 p.m. | Break (provide lunch for participants to take back to their seats) | |
| 12:00 p.m. | Part 3: Policies and Actions for School Administrators and Teachers | |
| Presentations (30 minutes) | | |
| 12:30 p.m. | Part 4: Be Smart About Mercury | Presentations (30 minutes) |
| 1:00 p.m. | (Optional) Closing Discussion (Activity 3): Brainstorming on School Policies and Actions | 30 minutes |

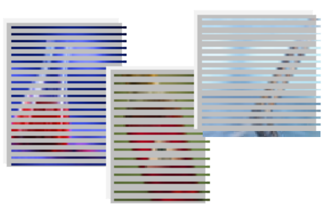
Section

II

# Presentations With Notes

## II.A Session 1: Importance of Mercury and Chemical Management for School Administrators and Teachers

**Part 1:** Importance of Mercury and Chemical Management for School Administrators & Teachers



Mercury in Our World
April 22-24, 2008
Bangkok, Thailand

Clarence Lewis
Senior Policy Advisor
National Program Chemicals Division
U.S. Environmental Protection Agency

# Why You Should Care….

1. Expense to school
2. Health risks
3. Community trust
4. Potential for school closure
5. Harm to the environment



2

**1. The expenses incurred from disposal, spills, and other incidents, including potential liabilities/lawsuits, can be considerable.** The costs of responding to chemical incidents can reach hundreds of thousands of U.S. dollars (or several million Thai Baht) or more at a single school. In addition to response costs, improper chemical waste management can result in fines and increased insurance premiums in some countries.

**2. Improper mercury and chemical management poses health and safety risks to students and school employees.** Students' bodily systems are still developing: they eat more, drink more, and breathe more in proportion to their body size, and their behavior can expose them more to chemicals than adults.

**3. It only takes one chemical incident, such as a spill, explosion, or chemical exposure, to break the trust with the community.** School incidents can lead to increased parental and community concern, negative publicity, and embarrassment to the school and school district.

**4. Improper chemical management may result in school closures that result in a loss of valuable education time.** Schools can be closed for days, weeks, or even months as a result of an improperly cleaned-up chemical incident, such as the breakage of a mercury thermometer, especially when spilled chemicals are accidentally spread throughout the school.

**5. Improper chemical management can lead to unintended chemical discharges and spills, which inflict damage upon the environment where students, teachers, staff, and parents live and work.** Improper chemical discharges into sanitary sewer lines or on-site waste treatment systems (including septic tanks) can have adverse effects on rivers, streams, and groundwater. Improper waste segregation and management can result in direct exposure of communities to toxic chemicals, whether through fumes from trash burning, direct contact to waste pickers, or contamination of nearby soils and water.

## 1. Expense to School

- Costs of responding to a chemical incident can be up to:
  - Several million Thai Baht
  - Hundreds of thousands of US$

- Compare:
  - US $300 (9,500 Baht) for a school mercury cleanout (prevention)
  - US $3,000 (95,000 Baht) to clean up a mercury spill (reactive)

3

In a joint “Rehab the Lab” program, *81 schools* collected their liquid mercury and mercury thermometers, and packed and transported them for hazardous waste disposal at a per school cost of US $300 (about 9,500 Baht).

A small amount of mercury was spilled at *one school* on a carpet, causing bad publicity, potential exposure, and extensive clean-up and disposal costs of about US $3,000 (about 95,000 Baht).

## 2. Health Risks

- Children and adolescents are NOT little adults:
  - Their body systems are still developing.
  - They eat, drink, and breathe relatively more than adults (in proportion to their body size).
  - Their behavior is more likely to cause accidents.
- Poor chemical and mercury management can harm students and impair their learning.

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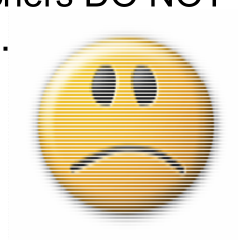
Students’ bodily systems are still developing; they eat more, drink more, and breathe more in proportion to their body size; and their behavior can expose them more to chemicals than adults.

## 3. Community Trust

- It only takes one mercury or chemical incident to break trust with the community.
- School officials and teachers DO NOT want to be embarrassed.



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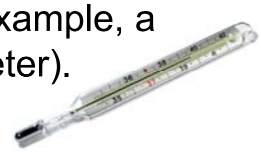
School incidents can lead to increased parental and community concern, negative publicity, and embarrassment to the school and school district.

## 4. Potential for School Closure

- Schools can be closed for days, weeks, or months if a chemical incident is not properly cleaned up (for example, a broken mercury thermometer).



- In Washington D.C., Ballou High School was closed for 35 days as a result of mercury contamination.

7

Schools can be closed for days, weeks, or even months as a result of an improperly cleaned-up chemical incident, such as the breakage of a mercury thermometer, especially when spilled chemicals are accidentally spread throughout the school.

At Ballou High School in 2003, a student had taken 250 milliliters of elemental mercury from a school science laboratory and sold some of it to other students, which caused the spillage.

## 5. Harm to the Environment

- Improper disposal damages the environment where students/teachers live.
- Dumping chemicals "down the drain" impacts rivers, streams, and groundwater.

- Sending a mercury thermometer to a garbage dump endangers waste pickers/ recyclers. Burning one can be even worse!

8

Improper chemical management can lead to unintended chemical discharges and spills, which inflict damage upon the environment where students, teachers, staff, and parents live and work. Improper chemical discharges into sanitary sewer lines or on-site waste treatment systems (including septic tanks) can have adverse effects on rivers, streams, and groundwater. Improper waste segregation and management can result in direct exposure of communities to toxic chemicals, whether through fumes from trash burning, direct contact to waste pickers, or contamination of nearby soils and water.

## Examples: How Things Go Wrong

*St. Andrew's School, Manila, Philippines, 2006*

- First hint of mercury exposure was a result of student call to National Poison Center.

- 203 students had to be tested for exposure
- 10 students were hospitalized
- Joint Philippine and U.S. clean-up team
- School was closed for about 3 months.

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In this incident, mercury was spilled during a chemistry experiment. However, no measures were taken to clean up the spill at the time which allowed the mercury to be tracked all over the school. Students were found playing with mercury beads which resulted in much of the harm to health from this event.

## Examples: How Things Go Wrong

*Somers High School, New York, 2008*

- Student dropped a bottle of bromine (corrosive liquid that can harm respiratory system if inhaled).
- Fumes spread quickly.
- School was evacuated and closed for the day.
- 11 students treated at hospital.

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This is an example of why students should not be handling dangerous chemicals, especially in large quantities.

## Examples: How Things Go Wrong

*Ballou High School, Washington, DC, 2003*

- Student took 250 mL of mercury from a science lab, then sold it to other students.
- Contaminated classrooms, gymnasium, cafeteria, city buses, homes.
- Over 200 homes were tested for mercury contamination.
- School was closed for 35 days.

11

A student had taken 250 milliliters of elemental mercury from a school science laboratory and sold some of it to other students, which caused the spillage.

Mercury was found in classrooms, gymnasium, and cafeteria. In addition, students unknowingly carried mercury through the streets, onto city and school buses, and into their homes, broadening the potential area of mercury contamination. As a result of the spill, Ballou High School was closed for 35 days and over 200 homes were tested for mercury contamination.

## Examples: How Things Go Wrong

*St. Joseph's Catholic School, Idaho, 2008*

- 6 ounce (≈30ml) jar of mercury was dropped and broke.
- School was closed.
- Vehicles and houses of three contaminated students were tested.
- Trained response team followed proper clean-up and decontamination procedures.

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## Role of School Administrators and Teachers

- ✓Raise awareness (through trainings such as this one).
- ✓Make the case for an adequate budget.
- ✓Remove all mercury from schools.
- ✓Explore safer alternatives (alcohol thermometers, less hazardous chemicals).
- ✓Develop and implement school policies for safe chemical management and disposal.

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The need for awareness and education on mercury and chemical safety and management was identified as a major need by high school teachers in Thailand.

An adequate budget includes both funding for chemical inventory, storage, and disposal, and also allocation of staff time dedicated to developing and overseeing chemical management.

Safer alternatives can include options such as pollution prevention and green chemistry. In many cases a commercially available product is less concentrated and therefore less hazardous than their laboratory chemical equivalents.

Schools should not contain elemental mercury, mercury salts, or any mercury-containing products with the exception of fluorescent lighting.

Most importantly, put in place mechanisms such as policies and procedures that give high priority to safe chemical management and define the roles, responsibilities, and steps to achieve this goal.

(more on this in Part 3 of this training)

# **Part 2:** Hazardous Chemicals and Equipment in Schools

Erica Zell
Environmental Engineer
Battelle Memorial Institute

## Chemicals Are Important

- Chemicals are used to:
  - Teach scientific principles
  - Keep the school clean
  - Reduce disease vectors (e.g., insects)
  - Monitor student health (e.g., thermometers)

However…

Teachers and school administrators must recognize and minimize chemical hazards.

2

## Where Chemicals Are in Schools

- Some places are obvious:
  - Science laboratories
  - Nurse's office
- Some places are NOT obvious:
  - Janitor maintenance/cleaning supply closets
  - Grounds maintenance
  - Technical education (e.g., auto repair)
  - Art classrooms

3

Chemicals are used both in the maintenance of a school and in the curriculum taught.

For example, nurse's offices often contain mercury-thermometers and manometers (blood pressure measuring devices).

For example, in art classes:

Solvents (used in paints, inks, paint thinners, adhesives, lacquers, primers, and other products) can contain toluene and mineral spirits.

Pottery clear coating glaze can contain lead and other heavy metals.

Pigments for paints and coatings can contain: cadmium, manganese, and chromium.

Dry clay for ceramics and jewelry can contain silica.

## Chemicals in Science Labs

| Product Type | Hazardous Ingredient Examples |
|---|---|
| Concentrated Acids (undiluted) | Hydrochloric acid<br>Nitric acid |
| Concentrated Bases (undiluted) | Sodium hydroxide |
| Solvents | Methanol<br>Methylene chloride |
| Oxidizers | Lead nitrate |
| Compressed gases | Oxygen |
| Toxins | Mercury<br>Cyanides<br>Chromates (VI)<br>Lead salts<br>Mercury salts |
| Mercury Thermometers, Barometers, Molecular Motion Demonstration Devices | Mercury |

4

For example:

Igniting methanol is a common lab demonstration. It's also used as a solvent for inks, resins, dyes, and also found in paint and varnish removers.

Methanol occurs as a flammable, mobile, colorless liquid that is miscible with water.

The problem with methanol, a volatile liquid, is that it gives off vapors at a low temperature, around 50 F (10 C). It has a "wide flammability range" which means that there doesn't have to be a thick concentration of vapors for a fire to ignite.

Acute exposure of humans to methanol by inhalation or ingestion may result in visual disturbances, such as blurred or dimness of vision, leading to blindness. Neurological damage, specifically permanent motor dysfunction, may also result.

Contact of skin with methanol can produce mild dermatitis in humans.

Example: mercury sulfide (mercury salt)

Symptoms noted after acute oral exposure to inorganic mercury compounds include a metallic taste in the mouth, nausea, vomiting, and severe abdominal pain in humans.

The primary effect from chronic exposure to inorganic mercury is kidney damage.

Acrodynia (pain in the hands and feet) may also occur from exposure to inorganic mercury compounds.

## Chemicals in Janitor Closets

| Product Type | Hazardous Ingredient Examples |
|---|---|
| Cleaning supplies/detergents | 2-Butoxyethanol<br>Trisodium phosphate |
| Drain cleaners (alkaline)<br>Drain cleaners (acidic) | Potassium hydroxide<br>Sulfuric acid |
| Pesticides (including disinfectants/sterilizers) | Permethrin<br>Sodium hypochlorite |
| Paint thinners | Toluene |
| Solvents (used in paints, paint thinners, adhesives, lacquers, primers, and other products) | Xylene |
| Water treatment chemicals for swimming pools | Chlorine tablets |

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For example: Potassium hydroxide (white or yellow) in alkaline drain cleaners. Very dangerous! Corrosive. Water-Reactive. Harmful if swallowed. Causes severe eye and skin burns. Causes severe digestive and respiratory tract burns. Something to keep away from students!

## Chemicals in Tech Education*

| Product Type | Hazardous Ingredient Examples |
|---|---|
| Solvents (used in paints, paint thinners, adhesives, lacquers, primers, and other products) | Petroleum naphtha<br>Turpentine |
| Cleaning supplies/detergents | Phosphoric acid<br>Sodium silicate |
| Compressed gases | Acetylene<br>Nitrogen |
| Fuels, transmission, and brake fluids | Gasoline |

* for example, Auto Repair, Machine Shops

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Acetylene is used in oxy-acetylene welding, commonly referred to as gas welding, a process that relies on combustion of oxygen and acetylene. Acetylene has been used in steel welding and other heat treatment processes for more than a century.

It is an extremely flammable gas and differs from other fuel gases due to its very unstable nature.

Under certain conditions acetylene may decompose explosively into carbon and hydrogen, this decomposition is usually triggered by heat if the cylinder is involved in a fire or scorched by the flame of a torch. This decomposition can also be triggered where the cylinder has been subject to shock such as when carelessly handled, dropped, being knocked over or struck by an object.

## Risks from Chemical Exposure

Risk is dependent upon:

- Route of exposure (e.g., inhalation, skin absorption, consumption)
- Duration of the exposure
- Underlying health problems
- **Chemical's hazard level** (e.g., degree of flammability, toxicity)

7

Therefore, it is important to understand chemical hazards and labeling.

# UN Classification of Chemicals

| | | | |
|---|---|---|---|
|  | Flammable |  | Poison |
|  | Explosive |  | Low-level hazard |
|  | Corrosive |  | Severe chronic hazard |
|  | Oxidizer |  | Environmental hazard |

8

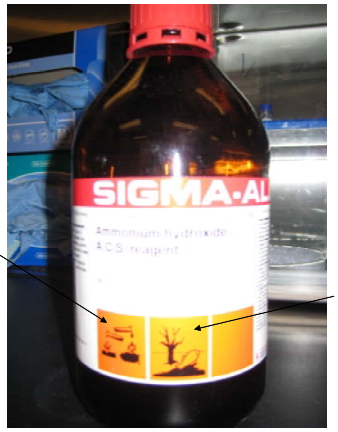
# Identify the Hazards: Hydrogen Peroxide and Peroxyacetic Acid


9

Hydrogen peroxide is often used in low concentrations to "bleach" hair or as a disinfectant. However, in larger concentrations (such as those used for laboratory experiments) it becomes corrosive. Over time it breaks down into water and oxygen gas, and therefore must be placed in containers suited to expanding gas to prevent leaks or even explosions of the containers.

## Identify the Hazards: Ammonium Hydroxide

Corrosive




Environmental Hazard

10

Ammonium hydroxide is a mixture of water and ammonia.  It is the same mixture as household and industrial "ammonia" cleaning products, although many different concentrations exist.  It can be found in a laboratory or with cleaning supplies. It should never be mixed or stored nearby anything with chlorine bleach as it will form a poisonous gas if mixed.  High concentrations ammonium hydroxide can cause severe burns and can be fatal if ingested even in small amounts.  Additionally it has similar harmful effects on other organisms and therefore is an environmental hazard.

## Identify the Hazards: Carbon Dioxide


Compressed non-flammable gas

- Suffocation hazard if inhaled (need ventilated room)

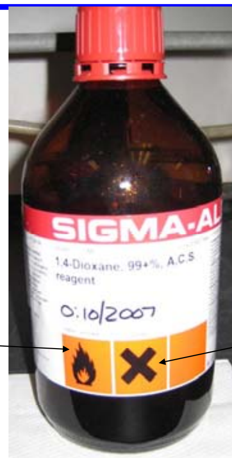
- Explosion hazard if knocked over (safety straps)

11

Compressed gases are used for many purposes.  You may find them in laboratories, in a nurse's office (oxygen), or they may be used with high-powered cleaning equipment.  Carbon dioxide, like many other gases, can cause suffocation if too much is released in an enclosed area.  Also, all compressed gases run the risk of exploding if the bottle is knocked over or damaged.  Therefore it is important to use mechanisms to prevent such accidents from occurring.

## Identify the Hazards: 1,4-Dioxane

Highly Flammable



Harmful

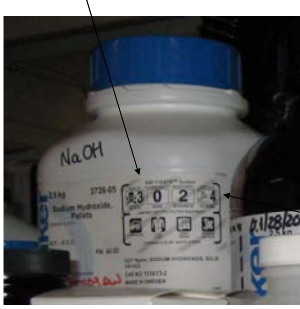
12

1,4-Dioxane is a solvent generally used in the manufacturing industry but also has some laboratory applications. It can form explosive peroxides if allowed to mix with too much oxygen. Additionally, it burns very readily and is a probable carcinogen and irritant.

(Click once for each hazard to appear, two hazards total)

## Identify the Hazards: Sodium Hydroxide

Health/Poison




Corrosive

13

Sodium hydroxide is a base that is very commonly used in laboratory experiments. In its pure form it is a solid (such as inside the container pictured) but is often mixed with water prior to use. It can cause severe burns and reacts with acids to generate substantial amounts of heat. Sodium hydroxide is also commonly known as lye or caustic soda.

(Click once for each hazard to appear, two hazards total)

## Identify the Hazards: Unidentified Compressed Gas


Flammable

14

In addition to the concerns with all compressed gases, flammable gases add another issue. The gas held within the container is itself also flammable, meaning that if something were to ignite the gas as it comes out, it would burn. A few examples include propane and natural gas. However, it is also extremely important to make sure that flame sources are far away from the containers themselves because of the risk of the container exploding.

## Identify the Hazards: Ammonium Nitrate


Oxidizer

Low Level Hazard

Explosive

15

Ammonium Nitrate is commonly used as a fertilizer. It can also be used (generally in very small quantities) in laboratory experiments. When exposed to heat and shock forces, ammonium nitrate can explode, and has in some instances been intentionally used as an explosive. When it contacts certain other materials it may heat up rapidly and a fire can result. Additionally, it can cause skin and eye irritation. Ammonium Nitrate should be handled very carefully according to the instructions given by the manufacturer. Be careful not to expose yourself to it or to place it somewhere where it may be subjected to intense heat or shock.

(Click once for each hazard to appear, three hazards total)

## Identify the Hazards: Carbon Tetrachloride

Poison / Toxic

Environmental Hazard

16

Carbon Tetrachloride is a chemical that was once in widespread use but has dramatically declined. It was used to create many refrigerants which are now banned and was once used for dry cleaning, in fire extinguishers, and many other places. Exposure can cause harm and even death in larger quantities. It also has effects on the environment by depleting the ozone layer.

## Identify the Hazards: Hydrochloric Acid


Corrosive

Poison / Toxic

17

Hydrochloric acid is frequently used in school chemistry labs as it is very useful as a strong acid. It can severely burn skin and eyes, ruin clothing, and in large concentrations burn through other materials. It can be fatal if swallowed or inhaled. One interesting fact is that hydrochloric acid is the main component of stomach acid.

(Click once for each hazard to appear, two hazards total)

## Identify the Hazards: Mercury


Severe Chronic Hazard

Poison

18

Mercury presents many hazards. In it's elemental form, it is very difficult to clean up and can cause health issues of several kinds. This is especially true for children as mercury causes developmental problems. Sources of mercury include certain thermometers, components of electronics, fluorescent lighting, and others. It is important to try to prevent mercury contamination and if contamination occurs to follow the procedures very carefully.

## Identify the Hazards: Two Kinds of Thermometers

19

The one on the left is a mercury thermometer. The one on the right contains alcohol instead of mercury.

## II.C. Session 3: Policies and Actions for School Administrators and Teachers

**Part 3:** Policies and Actions for School Administrators and Teachers

Clarence Lewis
Senior Policy Advisor
National Program Chemicals Division
U.S. Environmental Protection Agency

Erica Zell
Environmental Engineer
Battelle Memorial Institute

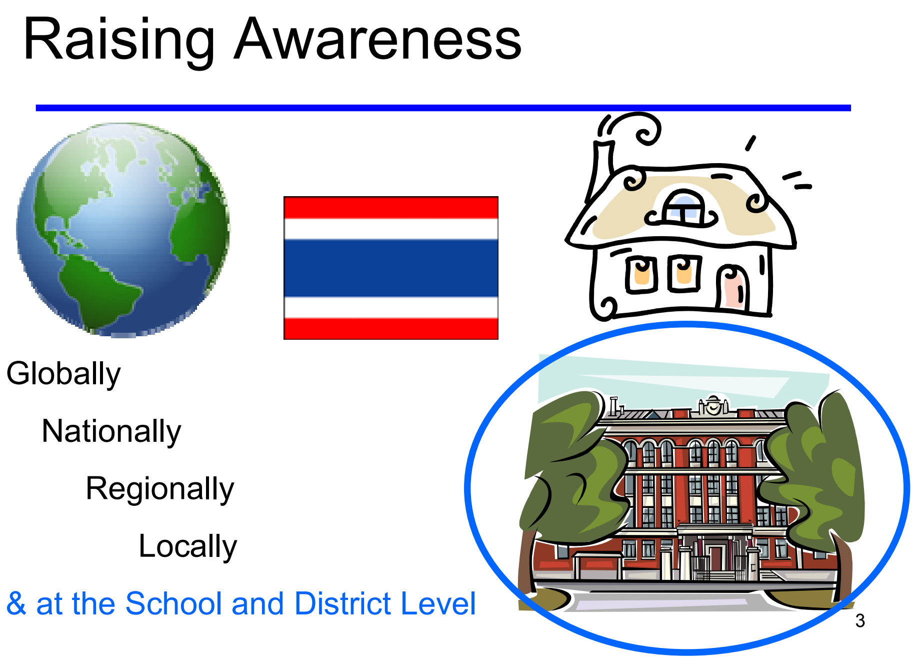
Role of School Administrators and Teachers

- ✓ Raise awareness (through trainings such as this one).
- ✓ Make the case for an adequate budget.
- ✓ Remove all mercury from schools.*
- ✓ Explore safer alternatives (alcohol thermometers, less hazardous chemicals).
- ✓ Develop and implement school policies for safe chemical management and disposal.

*Except fluorescent lights

2

We already showed this slide in Part 1, and promised to provide more information on each of these roles. This presentation does just that.




Raising awareness on Mercury and chemical safety is critical to promoting a safer environment for everyone.

(CLICK ONCE) This training focuses on raising awareness at the school and school district level

These actions will be most effective when complemented by broader scale efforts.

For example, the Thailand Pollution Control Department is engaged on this issue, and is acting as a co-organizer of this conference.

Also, Merck Thailand conducts a "Let's Care Safety Camp" for final-year chemistry and chemical engineering university students."

Finally, non-governmental organizations (NGOs) such as the Thailand Environment Institute are participating in this conference.

## Raising Awareness

- Two key elements:
  - Budget / funding: Should cover chemical and safety equipment purchasing, proper training, storage, handling, and disposal.
  - Dedicated staff: Each school should have a chemical hygiene officer (qualified and trained) and a dedicated team focused on chemical management.

4

## Raising Awareness

With adequate budget/funding and staff resources, you can develop….

a Chemical Management Program

and

a Chemical Hygiene Plan

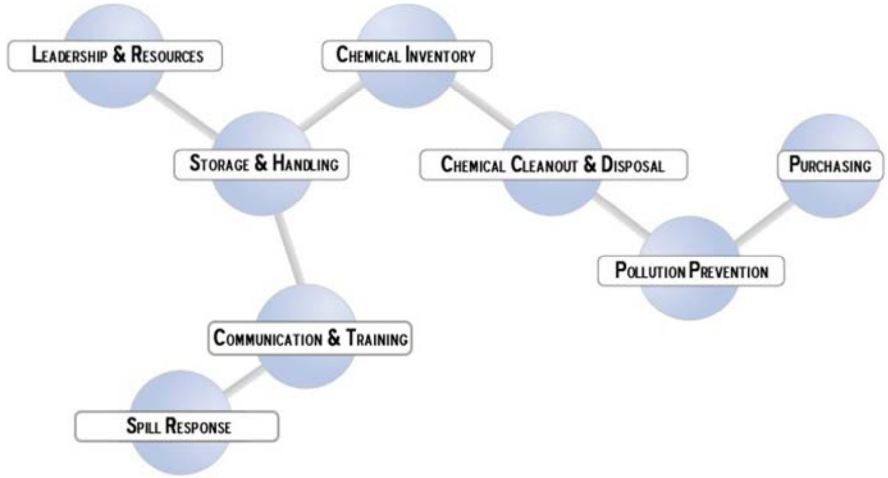
5

We will distinguish between these two:

A chemical management program is an entire set of policies, budget allocation, leadership, and actions at the school or school district level.

A chemical hygiene plan is a document that describes specific procedures and practices for laboratory settings (a chemical hygiene plan is PART of a chemical management program).

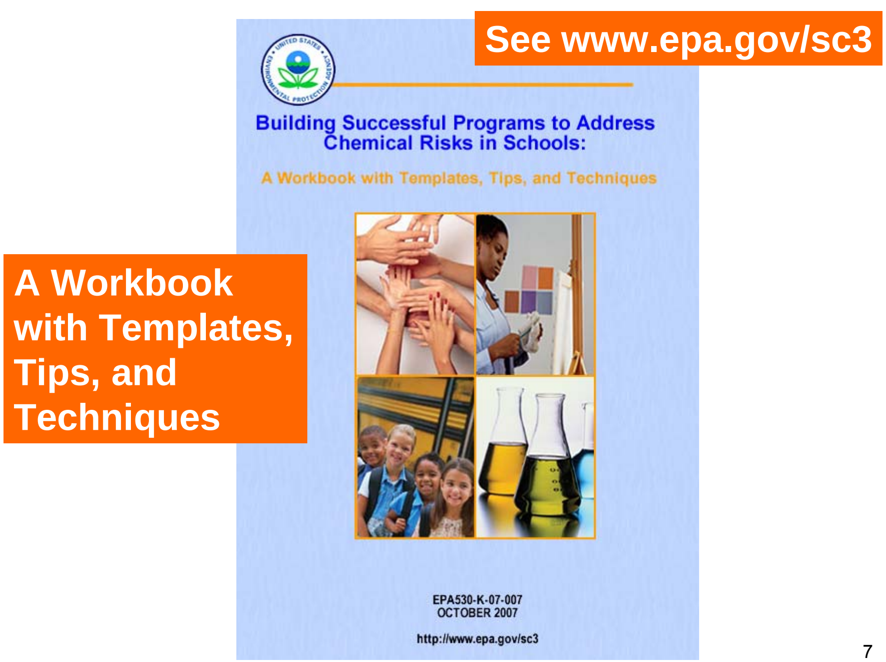
## Chemical Management Program




Source: EPA, Building Successful Programs to Address Chemical Risks at Schools: A Workbook with Templates, Tips, and Techniques, October 2007
See www.epa.gov/sc3

6

We're going to talk about each of these in this presentation.




7

## Chemical Hygiene Plan

- Document that describes procedures and practices for the protection of students and school employees from chemical hazards in the laboratory.
  - Roles and responsibilities
  - Training
  - Hazard classifications
  - Operating procedures
  - Spills and hazard controls
  - Labeling, storage and recordkeeping
  - Disposal

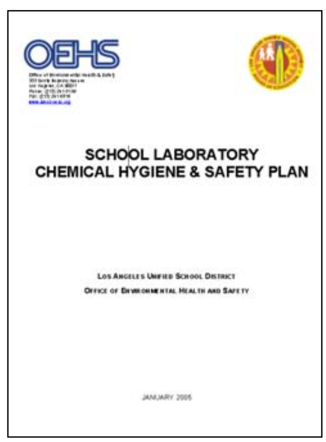
8

## Example Chemical Hygiene Plans

Chemical Hygiene Plan, Northshore School District, Washington
http://schoolcenter.nsd.org/education/components/scrapbook/
(click on Health and Safety)

Lake Havasu Unified School District, Arizona District Chemical Hygiene Plan, http://www.havasu.k12.az.us/support/warehouse/chempolicy.html

LAUSD, School Laboratory Chemical Hygiene and Safety Plan, http://www.lausd-oehs.org/docs/CSC/Chemical%20Hygiene%20Plan.pdf


OEHS

SCHOOL LABORATORY
CHEMICAL HYGIENE & SAFETY PLAN

LOS ANGELES UNIFIED SCHOOL DISTRICT
OFFICE OF ENVIRONMENTAL HEALTH AND SAFETY

JANUARY 2005

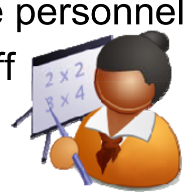
These vary from a few pages to more than 60 pages. Schools may wish to use one of these as a starting point.

## Training is Essential

*A plan is only as good as the training provided on how to follow it.*

Trainees should include:

- School management
- Custodial & maintenance personnel
- Appropriate teaching staff




10

This training program should address how school employees and students are to be properly trained to handle certain chemicals and products and how to respond to a chemical spill or lease, to understand the hazards of these materials, and to understand the types of liability associated with accidents involving chemical usage in schools. The training program should include a review of the chemical management policy and approved product listing. Training sessions should be documented in a log for each employee and repeated periodically (annually).

## Explore Safer Alternatives

1. Pollution Prevention: preventing or reducing pollution at the source

2. Green Chemistry: using fewer and less toxic chemicals in experiments

3. Mercury alternatives: replacing mercury-containing products with alternatives, such as alcohol thermometer

11

Safer alternatives can include options such as pollution prevention and green chemistry.

In many cases a commercially available product is less concentrated and therefore less hazardous than their laboratory chemical equivalents.

Schools should not contain elemental mercury, mercury salts, or any mercury-containing products.

# 1. Pollution Prevention (P2)

P2 Program: focus on scaling down chemical use, less hazardous substitutions, and waste reduction goals.

Examples:

- Minimize the use of pesticides (balance with benefits of pesticides)
- Use less hazardous cleaning products (e.g., products made from baking soda, vinegar, lemon, salt, and water)

12

For general cleaning of countertops, floors, walls, and upholstery, try one of the following:

Dissolve 4 tablespoons baking soda in 1 quart warm water; or

Use a mixture of 1/2 cup vinegar and 1 cup to 1 quart of warm water; or

Mix vinegar and salt together for a good surface cleaner

# Laboratory Pollution Prevention Checklist - see Appendix C

- Material Substitution
  - e.g., switch to less toxic solvents
- Purchasing/Inventory Control
  - e.g., find a supplier who will accept returns of expired chemicals
- Process Efficiency
  - Create an incentive program for waste reduction
- Recovery/Reuse/Recycling
  - Filter spent solvent for reuse on site
- Innovation
  - Move to microscale chemistry

13

## 2. Green Chemistry

Saves the school money by reducing the amount of chemicals needed for experiments.

- Small-scale chemistry (microchemistry)
- Substitute less hazardous chemicals
  - Appendix D: Green Chemistry Experiment

Unsuitable for schools: strong oxidizers, corrosive, toxics, carcinogens, and mutagens.

- see Appendix E
- Survey of Thai high schools identified several unsuitable chemicals in classrooms, e.g., benzene (C6H6) and magnesium powder (Mg)

14

Appendix D contains two examples of green chemistry experiments dealing with the principles of acid-base chemistry, deriving a pH indicator from red cabbage.

Appendix E contains a list of chemicals for which the educational utility is eclipsed by the hazards it poses to human health and environment.  This list is from the US Consumer Product Safety Commission, School Chemistry Laboratory Safety Guide.

## 2. Green Chemistry (cont.)

| Chemical | Formula | Commercial Equivalent | Local Source |
|---|---|---|---|
| acetic acid | $CH_3COOH$ | vinegar ( 5% solution) | grocery store |
| acetone | $CH_3COCH_3$ | nail polish remover | grocery or drug store |
| carbonic acid | $H_2CO_3$ | seltzer water | grocery store |
| citric acid | $C_6H_8O_7$ | lemons, limes, oranges | grocery store |
| hypochlorous acid | HClO | laundry bleach | grocery store |
| magnesium sulfate heptahydrate | $MgSO_4 \cdot 7H_2O$ | Epsom salts | drug store |

15

## Mercury Product Alternatives

**Remove all mercury from schools!**

Alternatives are (almost always*) available:

- Electronic digital gauges instead of mercury barometers
- Alcohol or mineral spirit-filled thermometers instead of mercury thermometers
- Substitute reagents for mercury salts

*Continue to use fluorescent lights.

16

Alcohol or mineral spirits filled thermometers generally provide suitable accuracy for most laboratory temperature measurement applications. Fluorescent lights should continue to be used because there is no suitable indoor lighting alternative that is as energy-efficient.  Energy-efficiency means reduced generation of electricity, which means reduced generation of associated pollutants such as mercury from fossil fuel burning.

## Safe Management of Chemicals

- Purchasing
- Inventory
- Storage
- Handling
- Spill cleanup
- Disposal

Appendix G.: Sample Monthly Chemical Management Checklist

17

Even with the practice of pollution prevention and green chemistry, some chemicals will inevitably remain on school grounds.  Responsible chemical management is critical to controlling a variety of environmental, health, and safety issues within any school.  Knowing what materials are present in your school and how they are used, stored, and discarded will enable you to understand the issues associated with these substances.  Properly recognizing and controlling the hazards inherent to these materials, wherever they are found in your schools, will enhance your ability to create a safe school with minimal environmental liabilities and lawsuits.  Appendix G. provides an example of a monthly chemical management checklist for school may wish to adopt.

## Check Local Online Resources

For example, the Thailand Pollution Control Department (PCD) has online resources:

- Chemical Use Safety
- Hazardous Waste Handling
- Fluorescent Lamp Recycling

กรมควบคุมมลพิษ
POLLUTION CONTROL DEPARTMENT

See http://www.pcd.go.th/info_serv/en_hazadous.html

18

Note these resources are in Thai

## Purchasing

Establish a district-level chemical purchasing policy:

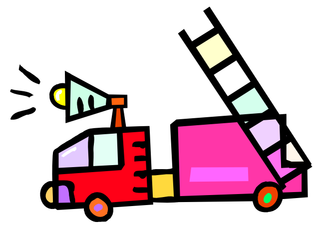
- Screen for environmental, health, and safety hazards before purchase
- Establish an approved chemicals list
- Limit the quantity of chemicals purchased to annual needs
- Consider disposal cost as part of purchase price

Disposal cost for expired materials can be 20 to 50 times the original purchase price.

19

# Inventory

- Should include:
  - Chemical name and quantity
  - Physical location
  - Potential hazard
- Serves as a reference for school and emergency personnel.
- Saves school money by eliminating duplicate, unnecessary purchases.



20

# Inventory (cont.)

- Must be conducted by technically qualified individual.
- Conduct when students are NOT in school.
- Work in pairs (not alone).
- Wear personal protective equipment.
- Have a spill response plan in place.
- DO NOT move very old chemicals - get professional help!
- Update at least annually, and conduct periodic cleanouts.


Appendix H: Conducting a School Inventory

21

## School Chemical Cleanout Campaign

- Remove outdated, unknown, excessive, or unnecessarily hazardous chemicals from U.S. secondary schools;
- Prevent future stockpiles and reduce accidents by establishing prevention activities such as good purchasing and management practices;
- Obtain Material Safety Data Sheets (MSDS) for remaining chemicals;
- Raise awareness of the problem.

See www.epa.gov/sc3

22

School leadership should recognize that cleanout and accident prevention programs are good investments for schools. Cleaning up after a chemical incident is costly (can cost over a million dollars (US$), cause closure of schools, and relocation of students). School cleanout programs are a relative bargain (average cost of US$5,000 per school).

## Storage

- Establish a chemical storage policy:
  - Proper storage
  - Labeling
  - Secure location
- Store chemicals by group: inorganic shelves, organic shelves, flammable storage cabinet, corrosive acid cabinet, corrosive base cabinet (see Appendix I for Storage Guidelines)
- Conduct regular inspections of classrooms, storage closets, etc.

23

## Poor chemical storage practices

AVOID the following:

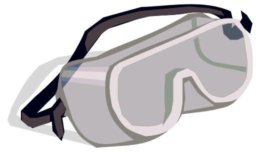
- Water reactive chemicals stored near or under a sink.
- Heavy containers stored on high shelves.
- Corrosive chemicals stored on metal shelves (especially if corroded).
- Flammable chemicals stored on wood shelves.
- Chemicals stored alphabetically by name.
- Unlabeled or ”mystery” content chemicals.
- Chemicals stored next to food, or in old food containers.

24

## Poor Chemical Storage!!!


25

## Safe Handling



- Follow appropriate safety measures (safety glasses, long-sleeved shirts, pants, close-toed shoes, gloves) - check MSDS
- Inspect and test emergency equipment at least annually (eyewash, exhaust fans)
- Create a written emergency response plan for spills or releases.

26

**Create a written emergency response plan** for all chemicals and products. This plan should describe what to do and whom to contact in the event of a spill or release, as well as the location of spill management supplies and equipment (e.g., spill kits, fire extinguishers) within the school. The clean-up and response plan should include a process for communicating with students, parents, teachers, and other staff about the incident, as well as methods for preventing accidents and exposures.

## Spill Cleanup


Spill clean-up materials should be available and labeled. 27

Citric acid may be used to neutralize base spills, sodium bicarbonate may be used to neutralize acid spills, and an absorbent material may be used for organic spills

# Disposal

## Develop an adequate budget for chemical disposal.

| Initial (one-time) Costs | Annual (ongoing) Costs |
|---|---|
| -Hiring a chemical expert as a consultant<br>-Disposing of accumulated chemicals and products through hazardous waste disposal service | -Staff time to develop and maintain disposal procedures<br>-Possible contract with hazardous waste disposal service<br>-Disposal supplies/equipment<br>-Staff training |

28

The annual (ongoing) costs will be greatly reduced if the school can avoid or minimize bringing hazardous chemicals on school grounds in the first place.

# Disposal (cont.)

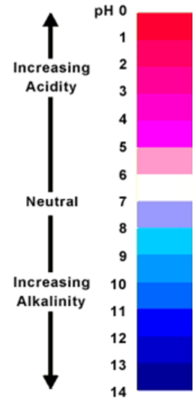
- Chemical disposal "on the cheap" *(e.g., pouring untreated waste down the drain)* is generally a bad idea!

  - Metals such as mercury end up in rivers and lakes, then cycle back through fish to humans.
  - Concentrated, highly acidic or basic waste can corrode pipes, kill fish, damage sewage treatment equipment, and degrade water quality.

29

## Disposal (cont.)

- Simple treatment methods can make certain wastes safe for drain disposal, but check with local authorities first.
  - – Neutralization of acids and bases is common in schools to reduce corrosivity (by adjusting pH to between 6 and 9)
- Other options: separation, fixation, oxidation, precipitation, ion exchange




30

## Conclusion: Role of School Administrators and Teachers

✓ Raise awareness (through trainings such as this one).

✓ Make the case for an adequate budget.

✓ Remove all mercury from schools.

✓ Explore safer alternatives (alcohol thermometers, less hazardous chemicals).

✓ Develop and implement school policies for safe chemical management and disposal.

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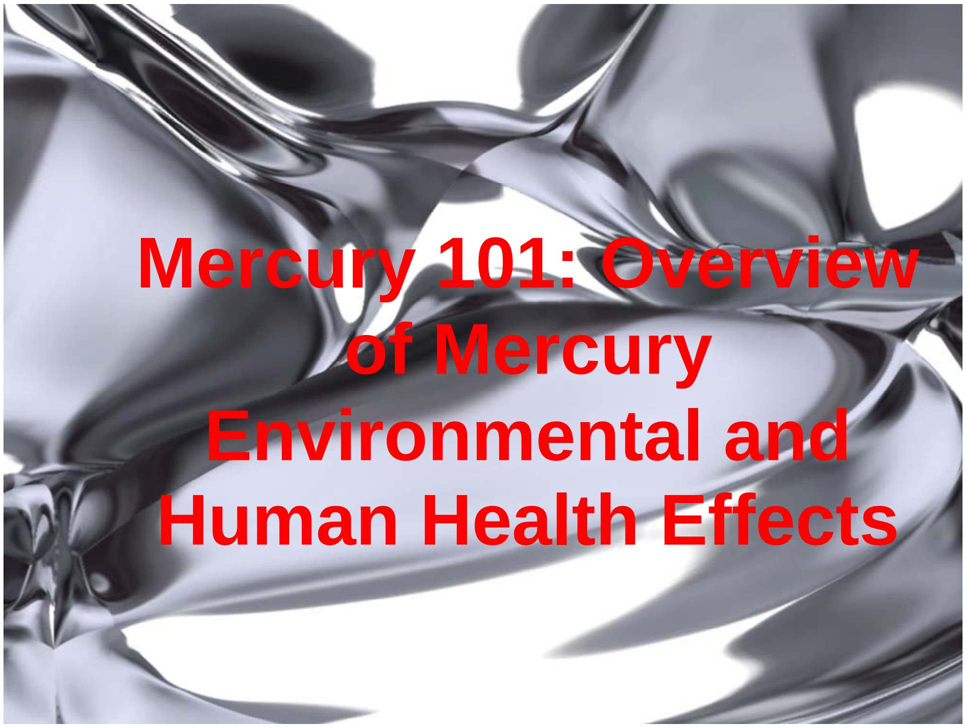
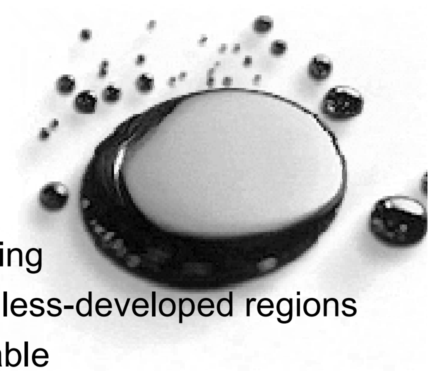
## II.D. Session 4: Be Smart About Mercury




### IMPORTANCE



**Mercury…**

- circulates globally
- is used widely
- Exposure is hazardous
- Has an impact on global fishing
- generate health problems in less-developed regions
- Interventions can be achievable

# DEFINITION

**One element;** 3 species

- Elemental
- Inorganic
- Organic

**Mercury's characteristics:**

Mercury is a heavy metal, an element, and therefore cannot be created or destroyed.



Image from Wikipedia

# ELEMENTAL MERCURY

## Sources of Exposure

- Environmental Exposure:

  Volcanic explosions, rock weathering, degassing

- Anthropogenic Exposure:

  Combustion fossil fuels (coal), waste incineration
  Dental amalgams, ritual and folk-medicine use

- Industrial Exposure:

  Gold/silver mining, chloralkali plants, batteries, switches, fluorescent lights, thermometers, sphyngomanometers

# ELEMENTAL MERCURY

Routes of exposure:

- Inhalation (volatile at room temp): 75-85% absorption
- Ingestion and skin: almost no absorption

Elimination:

- Urine and Feces

Toxicity:

- Lungs, eyes, gingival, skin
- Also: Central nervous system, kidneys, immune system

# INORGANIC MERCURY

## Sources of Exposure

- **Environmental**
  - **None**
- **Industrial products:**
  - **Vapor lamps, embalming,**
  - **Photography**
  - **Latex paint (pre 1990s)**
  - **Disinfectants, antimicrobials**
  - **Alternative medicines, cosmetics**

## INORGANIC MERCURY

### Routes of Exposure

- Ingestion - 10% absorbed
- Skin - can be high and deadly

### Elimination

- Renal

### Toxicity

- Primary: kidneys, gastrointestinal tract
- Secondary: Central nervous system

## ORGANIC MERCURY

### The major three compounds

- Methyl-mercury
- Ethyl-mercury
- Phenyl-mercury.

Methyl-mercury is the most toxic, formed by microorganisms from ele mental mercury found in the environment via human or natural sources (Goldman & Shannon, 2001).

### Sources of Exposure

- Environmental conversion:
  - Fish and shellfish (methyl-mercury)
  - Industrial production:
    - Fungicides, bactericides (phenyl-mercury)
    - Vaccine preservatives (thimerosal)

# ORGANIC MERCURY

## Routes of Exposure

- Gastrointestinal - rapid & complete absorption
- Parenteral - 100% absorbed
- Transplacental – Bioconcentrated

## Elimination

- Feces- $T_{1/2}$ 45 to70 days in adults

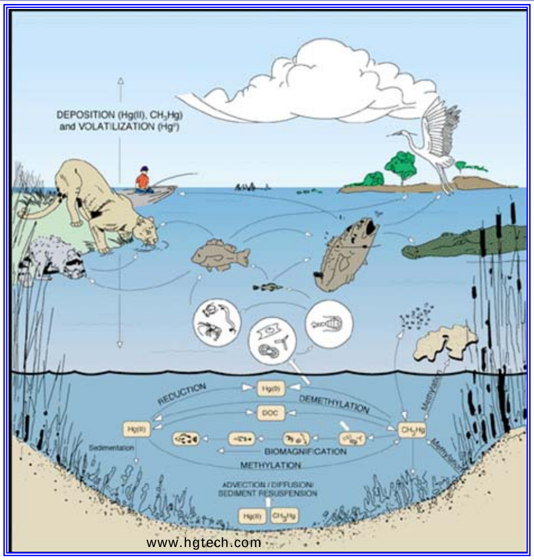
## Toxicity

- Primary: Central nervous system
- Secondary: Cardiovascular

# OVERALL SOURCES OF MERCURY

| Mercury and Children's Environmental Health | | | | |
|---|---|---|---|---|
| **Mercury** | **Sources** | **Routes of exposure** | **Elimination** | **Toxicity** |
| **Elemental (metallic)** | **Volcanoes<br>Combustion<br>Waste incineration<br>Thermometers<br>Amalgams<br>Folk remedies** | **Inhalation** | **Urine and faeces** | **CNS<br>Kidney<br>Lungs<br>Skin (Acrodynia in children)** |
| **Inorganic (mercuric chloride)** | **Lamps<br>Photography<br>Disinfectants<br>Cosmetics<br>Folk medicine** | **Ingestion<br>Dermal** | **Urine** | **CNS<br>Kidney<br>GI tract<br>Skin (Acrodynia in children)** |
| **Organic (methyl; ethyl)** | **Fish<br>Fungicides<br>Preservatives** | **Ingestion<br>Parenteral<br>Transplacental** | **Faeces** | **CNS<br>Cardiovascular** |

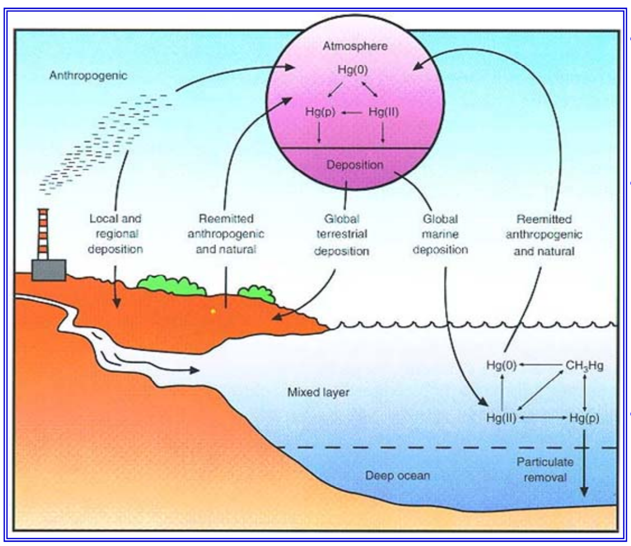
# CIRCULATION




**Emission types :**

- Anthropogenic
- Natural
- Re-emitted

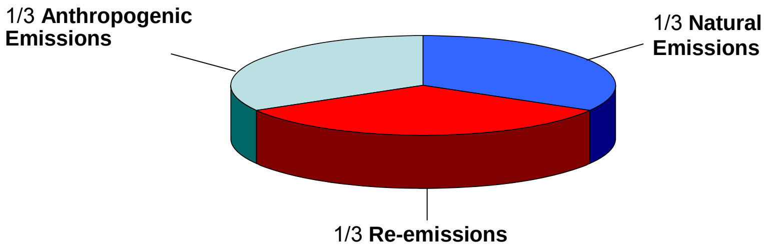
# CIRCULATION




- $Hg_{(II)}$ and $Hg_{(p)}$ have short atmospheric lifetimes and deposit locally and regionally.
- $Hg^0$ has a long atmospheric lifetime; can be transported globally; and becomes part of a global background; >90% in air is $Hg^o$
- Deposition within the US comes from domestic sources and from the global pool

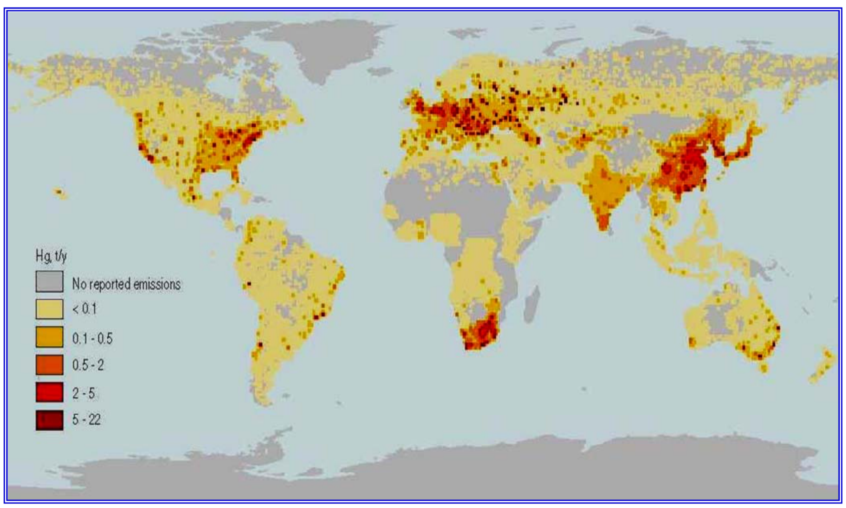
## ENVIRONMENTAL SOURCES OF EXPOSURE

Contributions to background include worldwide anthropogenic, natural and re-emitted (recycled) emissions




Total Estimated Global Emissions ~4,400 - 7,500 metric tons/yr

## WHERE ARE ANTHROPOGENIC MERCURY EMISSIONS ORIGINATING?

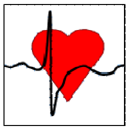



Metric tons per year.
Source: UNEP Global Mercury Assessment, 2002, using J. Pacyna 1995 data, as presented by AMAP (1998).

# TOXIC EFFECTS

## Toxic Effects

- Neurotoxicity
- Nephrotoxicity
- Teratogenicity: MeHg is a teratogen (Minamata disease)
- CVS: elevated risk of heart attack
- Hypertension
- Carcinogenicity: MeHg is a possible human carcinogen
- Mutagenesis: Hg seems not to be mutagen
- Reproduction: no clear evidence of effect



# EXAMPLE OF "MINAMATA DISEASE"

- **Minamata is a neurological syndrome caused by severe mercury poisoning.**
- **Symptoms**
  - Ataxia, numbness in the hands and feet
  - General muscle weakness
  - narrowing of the field of vision
  - damage to hearing and speech.
  - In extreme cases, insanity, paralysis, coma and death follow within weeks of the onset of symptoms.
  - As of March 2001, 2,265 victims had been officially recognized (1,784 of whom had died)

**Minamata disease was first discovered in Minamata city in Kumamoto prefecture, Japan in 1956. It was caused by the release of methyl mercury in the industrial wastewater from the Chisso Corporation's chemical factory**

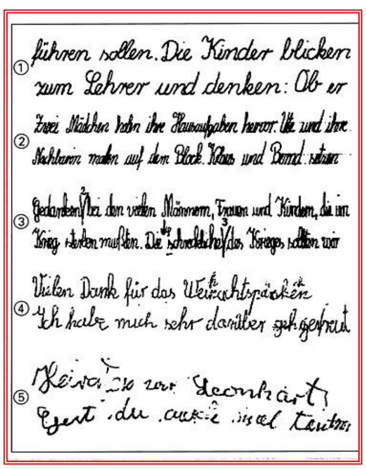
## EXAMPLES OF “ARCRODYNIA”

Uncommon Syndrome

“Pink disease”

- Pain in the extremities
- Pinkish discoloration and desquamation
- Hypertension
- Sweating
- Insomnia, irritability, apathy
- Considered a sidiosyncratic reaction

## EXAMPLE OF “TREMOR MERCURIALIS”




Hand-writing of a 9 year old girl in monthly intervals after an accidental intake of mercury containing seed preservatives.

# FOCUS ON ASIA

| Continent | Stationary Combustion | Pig iron & steel production | Cement production | Waste disposal | Nonferrous metal production | Artisana gold mining | Sum quantified sources |
|---|---|---|---|---|---|---|---|
| **Europe** | **186** | **0** | **26** | **12** | **15** | | **250** |
| **Africa** | **197** | **0.5** | **5.2** | | **7.9** | | **210** |
| **Asia** | **860** | **12** | **82** | **33** | **87** | | **1075** |
| **North America** | **105** | **4.6** | **16** | **66** | **25** | | **210** |
| **South America** | **27** | **1.7** | **5.5** | | **25** | | **60** |
| **Australia &Oceania** | **100** | **0.3** | **0.8** | **0.1** | **4.4** | | **105** |
| **Sum, quantified sources 1995** | **1470** | **30** | **130** | **110** | **170** | | **1900** |
| **Worldwide** | | | | | | **300-100** | |

Drasch , Wiley VHC, Verlag, 2004, all data in metric tons

# FOCUS ON CHILDREN

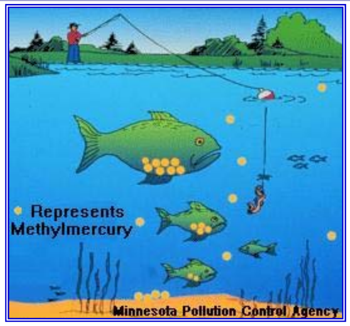
**Children are highly exposed in developing countries**.

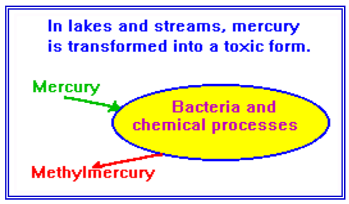
- "Occupational" exposures from gold/silver mining
- Regional cultural uses
- Eating contaminated fish
- High exposure may cause overt symptoms

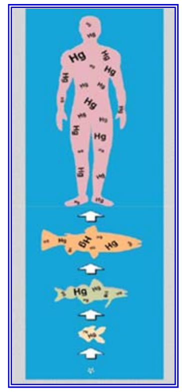
## FISH CONSUMPTION

Metabolic conversion and bio-accumulation through "food-chain"

- Hg in sediments converts into methyl-mercury (Me Hg)
- MeHg enters the aquatic food chain: fish, marine and freshwater
- MeHg uptake by humans through fish consumption



## FISH CONSUMPTION

### Pediatric Exposure-Fish

- Major source of mercury burden for children in most countries
- Fish may contain methyl-m ercury
- Children exposed
  - ✓ By eating fish
  - ✓ Transplacentally
  - ✓ Via breast milk

Rice field in the Philippines, Irrigated with Tailing sediments containing mercury

## SOLUTIONS

**Secondary Prevention**

- Fish consumption advice

**Primary Prevention**

- Mercury free office and hospital
- Mercury free communities
  - ✓ Hazardous waste education
  - ✓ Thermometer exchange
  - ✓ Change high-risk behaviors: Folk medicines, cottage indus tries,…
- Get politically active
  - ✓ Request emission controls on power plants, incinerators
  - ✓ Prevent childhood exposure to artisanal mining

NOAA Photo Gallery, Tuna

## SOLUTIONS

- ❖ Diagnose and treat
- ❖ Publish, do research
  - Sentinel cases
  - community-based interventions
- ❖ Educate
  - Patients and families
  - Colleagues and students
- ❖ Advocate
- ❖ Role model

# CONCLUSION

- Health and environment professionals have a critical role to play and a big responsibility in protect both: our environment and health from mercury effects.

- Our political and personal lives to support sustainable development, should include practices for ways to en hance the environmental health of our patients.

- All of us can do something to detect and avoid the effects of mercury in the environment.

Section

# III

# Activity Instructions

## III.A Activity 1: Interactive Analysis of School Chemical Accident Case Studies

**Purpose:** To get participants thinking about the causes of mercury and chemical accidents at schools, how quickly contamination can spread, ways to prevent accidents, and proper ways to respond.

**Time required:** 30-45 minutes

**Materials required:** Participant's Manual that contains Case Studies (in Section 1.3)

**Instructions:** Start by asking participants to break into groups of 5 persons each. Next, explain the purpose of the activity as written above. Assign one case study to each group. If there are more groups than case studies, assign some groups the same case study.

Ask the participants to discuss their assigned case study for 15 minutes. They should analyze the event from a safety perspective. One participant from each group should take notes on the analysis so they can share their insights with the rest of the class. Some questions for the participants to discuss include:

- What could the school administrators and teachers have done to prevent the accident?
- How would you have handled this situation if you were the teacher in charge?
- Could the emergency responders and government officials have done anything different to help contain the accident?
- Have you ever experienced a similar chemical accident at your school?

After the 15-minute participant discussion period is over, have one participant from each group share their analysis orally with the rest of the class. Presentations may be made in Thai with English translation if needed. Instructors should facilitate the participant presentations by asking questions about the case studies. Encourage the other participants in the class to discuss each group's analysis and ask questions about the actions of the administrators, teachers, students, emergency responders, and government officials.

**Conclusion (Take-home Message):** The best way to deal with an accident is to prevent it in the first place. However, because accidents do happen, schools need to have established plans and procedures to appropriately deal with accidents. Teachers need to know how to quickly recognize the potential dangers of an accident, remove students from danger, and cleanup or coordinate with authorities for appropriate cleanup. Spill cleanup will be addressed more specifically later in this training, and is addressed in Section 3.4 of the Participant's Manual.

## III.B Activity 2: Identifying Chemical Hazards

**Purpose:** To emphasize to participants that there are many types of mercury and chemical products found throughout schools. This activity also gets the attention of participants by showing them that **everyone** has something new to learn from this training (even chemistry teachers!).

**Time required:** 30 minutes

**Materials required:** It is best to do this exercise with individual pictures (large photographs or drawings) of containers and equipment representing different common items found in schools. A set of pictures that could be printed (before the training course begins) and handed out is included at the end of the Activity 2 instructions.

**Instructions:** Start by explaining the purpose of the activity as listed above. Next, ask participants to break into groups of 5 persons each. Pass out the picture packets (one packet per group). Each packet contains photos of chemicals or equipment found in schools. Alternatively, actual items may be brought in and placed on a table at the front of the class, but remember to follow proper handling and safety precautions.

The following is a sample list of items that you may wish to include, but this list should be tailored so that it is relevant to local schools:

- Laboratory chemicals (for example, acids, bases, solvents, metals, salts)
- Laboratory equipment (for example, mercury thermometers, mercury barometers)
- Industrial arts or "shop" classes (for example, inks, degreasers)
- Art supplies (for example, paints, photographic chemicals)
- Pesticides and fertilizers
- Maintenance supplies and equipment (for example, drain cleaners, ammonia, bleach, floor stripping products, paints, oils, boiler cleaners, fuels)
- Health care equipment (for example, mercury thermometers)
- Common household items that students or teachers may bring to school, such as batteries, light-up tennis shoes, and skin whitening creams

Ask the participants to discuss amongst themselves the classifications of the chemical in each photo according to the categories listed in Table 1 of the Participant's Manual (flammable, explosive, corrosive, oxidizer, poison, low-level hazard, sever chronic hazard, environmental hazard). Note that some chemicals fall into more than one category. For each chemical, the participants should also discuss appropriate safety measures that they would require of their students (and follow themselves) if they were working with the chemical. Examples of safety measures are listed in Table 1 of the Participant's Manual.

After the participant groups are done classifying the chemicals and identifying appropriate safety measures, the instructors should facilitate a full group discussion of each chemical in which participants come to consensus on the category (or categories) and appropriate safety measures. Use the PowerPoint slides provided to show each picture and then click again on each slide to reveal the answers (categories).

As time allows, the instructor may also ask the following questions in group discussion:

- Which of these items should not be poured down the drain?
- Which of these items should not be disposed of with regular trash?
- Which of these always contain mercury? Which of these sometime contain mercury?
- Which should not be stored near each other?
- Which are highly flammable?
- Which of these are particularly harmful to the environment?
- Which of these can damage the central nervous system?
- Which of these should never be swept up or vacuumed if spilled?

**Conclusion (Take-home Message):** The idea is for participants to recognize that chemical hazards are not just found in science laboratories, and that different chemicals and equipment require different actions for safe management.

**Answers:**
1. Oxidizer, corrosive
2. Corrosive, environmental hazard
3. Explosion hazard, suffocation hazard
4. Highly flammable, harmful
5. Poison, corrosive
6. Flammable
7. If broken, poison, severe chronic hazard, environmental hazard
8. None (note that alcohol thermometers can be different colors, like blue or green also)
9. If broken and inhaled, poison, severe chronic hazard, environmental hazard (adequate ventilation would be important here).

**Which of these items should not be poured down the drain?**

Hydrogen peroxide and peroxyacetic acid, ammonium hydroxide, 1,4-dioxane, and sodium hydroxide, plus mercury from the thermometer if it were to break

**Which of these items should not be disposed of with regular trash?**

Mercury thermometer (really, all of them)

**Which of these always contain mercury?**

Mercury thermometers and fluorescent lamps

**Which should not be stored near each other?**

Acids and bases are incompatible – so hydrogen peroxide and peroxyacetic acid should not be stored near ammonium hydroxide or sodium hydroxide. 1,4-dioxane is flammable, so it should be stored in a Flammable Storage Cabinet, away from combustible materials.

**Which are highly flammable?**

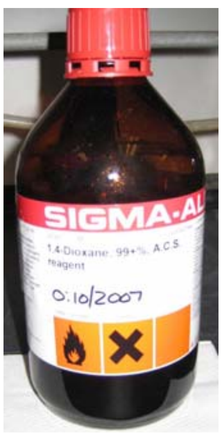
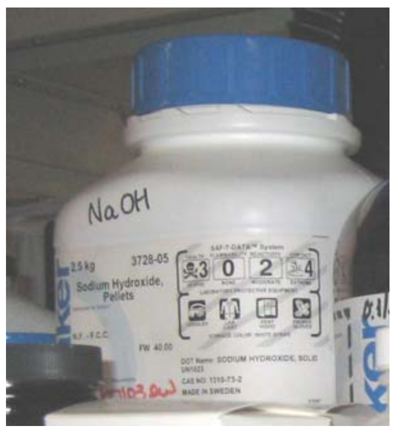
1,4-Dioxane and the unidentified compressed gas

**Which of these are particularly harmful to the environment?**

Mercury thermometers (although fluorescent lamps also contain mercury, they are generally considered a good option for the environment since they are energy efficient and therefore minimize power plant emissions from electricity generation)

**Which of these can damage the central nervous system?**
Mercury

**Which of these should never be swept up or vacuumed if spilled?**
Mercury

<table>
<tr><th>1. Hydrogen Peroxide and Peroxyacetic Acid</th><th>2. Ammonium Hydroxide</th><th>3. Carbon Dioxide</th></tr>
<tr><td>
</td><td>
</td><td>
</td></tr>
<tr><th>4. 1,4-Dioxane</th><th>5. Sodium Hydroxide</th><th>6. Unidentified compressed gas</th></tr>
<tr><td>
</td><td>
</td><td></td></tr>
</table>

| 7. Ammonium Nitrate | 8. Carbon Tetrachloride | 9. Hydrochloric Acid |
|---|---|---|
|  |  |  |
| **10. Mercury thermometer** | **11. Alcohol thermometer** | **12. Fluorescent lamps** |
|  |  |  |

## Activity 3: Brainstorming on School Policies and Actions

**Purpose:** To engage participants in a discussion of the materials presented in Session 3 (Policies and Actions or School Administrators and Teachers) focused on specific actions and policies that their schools can take (or have taken) to improve mercury and chemical safety.

**Time required:** 30 minutes (could be longer or shorter depending on audience size and enthusiasm)

**Materials required:** Chalkboard or large paper/poster (flip charts) and chalk or markers in several colors.

**Instructions:** Start by explaining the purpose of the activity as listed above. Tell the participants that they should think of creative policies and activities their school could conduct to improve chemical safety. Emphasize that the role of the participants is to think through the materials presented and develop practical solutions based on their own experience. Tell the audience that it is important to **be creative and have fun** with this brainstorming discussion. For example, a few ideas that you can mention to get people thinking are:

- Develop a mercury and chemical safety policy, and award prizes for the classrooms that demonstrate compliance.
- Have a contest for students to create a cartoon character that will serve as the "mascot" for all school safety materials.
- Join together with other schools and contact a regional hazardous waste management company to deal with disposal of mercury products.

Ask for people to call out ideas. Write them down (large, and legibly) up front. Stimulate discussion by asking if any of the participants have tried the ideas listed, and have encountered challenges or successes. You can also ask participants to review the listed items and decide which step should be first, second, etc. Finally, restate the conclusion below. If possible, type up the list at the conclusion of the session, and duplicate and distribute it to all participants.

**Conclusion (Take-home Message):** The idea is for participants to realize that there are many ways to approach mercury and chemical safety -- the important thing is to get started on relevant policies and actions at the school and school district levels.

## Activity 4: Mercury Spill Role-Playing

**Purpose:** To have participants practice addressing a mercury spill.

**Time required:** 30 minutes (could be longer or shorter depending on audience size and enthusiasm)

**Materials required:**

- Collection of small plastic black beads, to be used as spilled "mercury"
- 5 1-L plastic bags, self-sealing if possible
- 2 large, thick trash bags
- Rubber or latex gloves, at least 1 mm thick (enough for all members of the Cleanup Team); make sure gloves fit snugly on the hand
- 1 roll of paper towels
- 1 eyedropper or small plastic pipette
- 1 small plastic bowl
- 1 roll of duct tape
- 1 flashlight
- 1 pair of scissors.

**Instructions:**
Have participants volunteer for one of the following roles: one teacher; one assistant teacher; one principal; three mercury-contaminated students; five (or more) clean (not mercury-contaminated) students.

Have one participant read the following scenario aloud:

"In a high school chemistry class, mercury thermometers are provided to students as part of the required laboratory equipment for a science experiment. Three of the students are misbehaving, when one accidentally knocks a glass beaker and a thermometer off the lab table onto the floor. Both items break. "

Turn it over to the students to act out their roles, following the instructions for clean-up of a mercury spill in Appendix J of the Participant's Manual.

Make sure that the contaminated students are identified quickly, and the remaining students are sent "outside" (to a corner of the room, in this case).

When the "clean-up" is finished, lead a discussion on ways the clean-up could have been improved, and any lessons learned from practicing the clean-up instructions. If desired, repeat the exercise with different participants in different roles.

**Conclusion (Take-home Message):** Cleaning up a mercury spill requires advanced planning, assembly of equipment, and also PRACTICE of the spill clean-up procedure.