MERCURY RESPONSE AND CLEANUP

- PRESENTED BY:
- USEPA EMERGENCY RESPONSE REGION 9
- Instructor: Robert Wise, FOSC

IF YOU TAKE NOTHING OTHER THEN THIS FROM THIS COURSE IT IS A SUCCESS

- **ONLY USE A MERCURY VACUUM TO PICK UP MERCURY!**
- **NO MERCURY SPILL IS FULLY CHARACTERIZED WITHOUT THE USE OF A MERCURY VAPOR ANALYZER**
- **NO MERCURY SPILL IS FULLY CLEANED UP WITHOUT THE USE OF MERCURY VAPOR ANALYZER OR AIR SAMPLING**
- **USE PROPER PROTECTION FOR PERSONNEL AND EQUIPMENT WHEN ENTERING A SITE**

Chapter 1:
Chemical Characteristics and behavior

FORMS OF MERCURY

- Elemental
  - Liquid Mercury
- Organic
  - Methyl Mercury
- Inorganic
  - Inorganic Salts

Elemental Mercury Physical/Chemical Properties

- **Chemical Symbol = Hg**
- **Boiling Point: 674°F**
- **Freezing Point: -38.2°F**
- **Air Density as Related to Air: 7**
- **Shiny, silver-white odorless liquid at room temperature**
- **Extremely volatile, odorless, colorless gas**
- **Elemental mercury will volatilize at any temperature above : -38.2°F**
- **Density = 13.535 grams per cubic centimeter.**
- **1 gallon has a mass of 128 lbs.**
- **UN 2806**
- **DOT Hazard Class 8 (Corrosive)**

GENERAL RULE OF THUMB

At temperatures above 60°F, the Mercury concentration in the ambient air doubles for every 10 degrees of temperature increase.

Mercury Vapor Video

Starring

FOSC Eric Nold,
EPA Reg. 7

Chapter 2:
Sources and Uses of Mercury

Mercury Is Naturally Occurring

Mercury mined as cinnabar ore (mercuric sulfide)

Vaporized from ore then captured and cooled to form the liquid metal mercury

Uses of Elemental Mercury

- Batteries
- Fluorescent Lights
- Mercury Arc Lamps
- Vapor Lamps
- Medical Equipment
- Hydrometers
- Manometers
- Dental Amalgam
- Lubricant in large pumps

Compact Fluorescent Lights

- Contain a small amount of mercury
- Minimal threat
- https://www.epa.gov/cfl/cleaning-broken-cfl
- Ventilate Room
- Pick up any loose mercury
- Do not vacuum

Ritualistic Uses of Mercury

Several Caribbean, Central and South American and African religions ceremonies use Mercury as talismans.

Mercury is also used in Hindu practice as a major constituent of Parad, from which religious relics are made.

Used in drug cartel Santa Muerte sects in ceremonies.

Used in traditional Chinese medicine.

Called Azouge in Hispanic culture.

Uses of Inorganic Mercury Salts

- Latex paints manufactured before 1992
- Old chemistry sets
- Some pesticides manufactured before 1994
- Some skin lightening creams illegally imported into the United States
- Some Asian medicinals
- Rubber gym floors
- Teething remedies
- Laxatives
- Treatment of syphilis
- Photography
- Explosives

Chapter 3: Human Health Effects

Pathways of Exposure

- Ingestion
- Dermal Absorption
- Inhalation
- Injection

Acute Health Effects

- Inorganic mercury compounds if swallowed can cause nausea, vomiting, diarrhea and severe kidney damage.
- Acrodynia (shown)
- Visual disturbances
- Metallic taste in mouth
- Memory loss
- Fretfulness
- Flu-like symptoms
- Chest tightness
- Respiratory distress

Chronic Health Effects

- Gum problems: soft, spongy gums, loose teeth, sores may develop, and possibly increased saliva
- Mood and mental changes: wide swings of mood, irritable, frightened, depressed or excited very quickly for no apparent reason
- Hallucinations, memory loss and inability to concentrate can occur
- Nervous system: shaking hands, tremor may also occur in the tongue and eyelids, trouble balancing and walking
- Chronic Mercury Poisoning is often mistaken for Parkinson's Disease

Chapter 3:
Action Levels

Employee Exposure Limits

OSHA Permissible Exposure Limit (PEL)	100,000 ng/m^3
NIOSH Relative Exposure Limits (REL):	50,000 ng/m^3
NIOSH Immediately Dangerous to Life or Health (IDLH):	10,000,000 ng/m^3
ACGIH Threshold Limit Value (TLV):	25,000 ng/m^3

How to Determine An Employee Exposure Limit

- Choose and Exposure Level
- EPA uses TLV
- Use Safety Factor (i.e.: ½ Exposure Limit)
- Exposure Limit x Safety Factor
  - Example: TLV x 0.5 Safety Factor = 12,500 ng/m^3
- Level D: < Exposure Limit x Safety Factor
- Level C: >Exposure Limit x Safety Factor
- Level B: 50,000 ng/m^3 or Respirator Cartridge End of Life Indicator Activates

Cleanup Limits

- **ATSDR/EPA Suggested Residential Occupancy Level (SROL):**
  - **1,000 ng/m^3**
- **ATSDR/EPA Suggested Non-Residential Occupancy Level (SNROL):**
  - **1,000 – 3,000 ng/m^3**
- **EPA Site Screening Level Residential Soil (SSL_{RS}):**
  - **11 mg/kg**
- **EPA Site SSL Industrial Soil (SSL_{IS}):**
  - **46 mg/kg**

Chapter 4:
Worker Health and Safety

Worker Health and Safety

Constant air monitoring with a Mercury Vapor Analyzer is required if Level C is being used.

APR cartridges for mercury use an End of Service Life Indicator (ESLI)

Mercury concentrations that activate the ESLI require the use of Level B.

Chemical Protective Clothing must be splash resistant

3M/Scott cartridges don't have ESLI anymore!

Chemical Protective Clothing

- Suits
  - Tychem-F
  - Tychem CPF-3 and CPF-4
  - Tychem BR
  - Tychem SL (Saranex) T
  - Tychem Responder CSM
  - Tychem TK
  - Any Poly-Coated Material will work
- GLOVES
  - Silver Shield
  - PVC
  - Latex
  - Nitrile
  - Neoprene
- Latex Booties

Chapter 5:
Instruments

JEROME J 405:

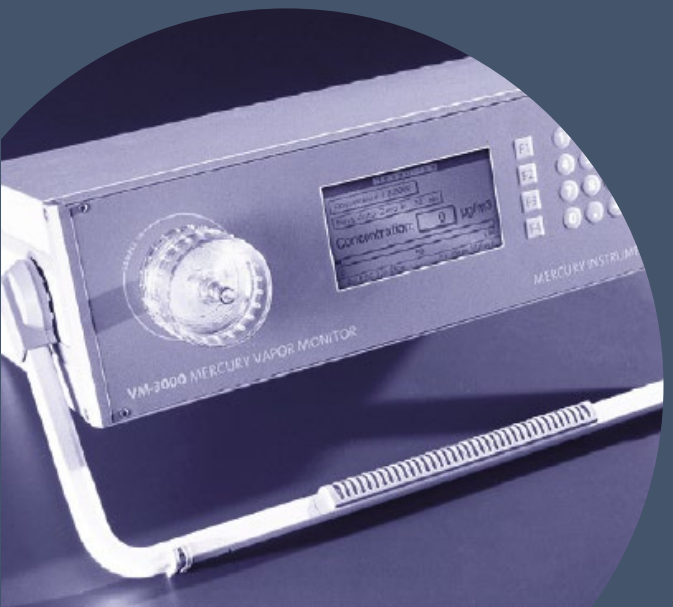
- Gold Film Technology sensitive to saturation
- Detection Range = 500 ng/m^3 to 999,000 ng/m^3
- Accuracy is ± 5-10% depending on concentration
- Detects mercury in the Hg^0, Hg^{+2} , Hg^{+3} forms
- Manufactured by Arizona Instruments
- NOT APPROVED FOR CLEARANCE
- Purchase Price: $11,998-15,418

Jerome 505 Mercury Meters

- Sensitivity: 50 ng/m^3
- Range: 50 to 500,000 ng/m^3
- Atomic Fluorescence Methodology
- **Detects Elemental Mercury Only**
- Two Independently Adjustable High Limit Alarms
- Programmable Auto Sampling Mode
- 3 Units of Measurement (ng, ug, mg)
- Color Display with Easy to Use Menu System
- APPROVED FOR CLEARANCE
- $24,076

RA-915M Portable Zeeman Mercury Analyzer

- Range of detection is 2 ng/m^3 to 200,000 ng/m^3
- Accuracy is ±20%
- Detects mercury in the Hg^0, Hg^{+2} , Hg^{+3} forms
- Detects low level mercury vapors using portable atomic absorption spectrometer technology
- Internal rechargeable source and external rechargeable battery
- Data collection and data logging
- Can analyze ambient air, stack gases, soil, water, sorbent tubes
- Purchase Price: $27,100 with $1000 annual maintenance costs

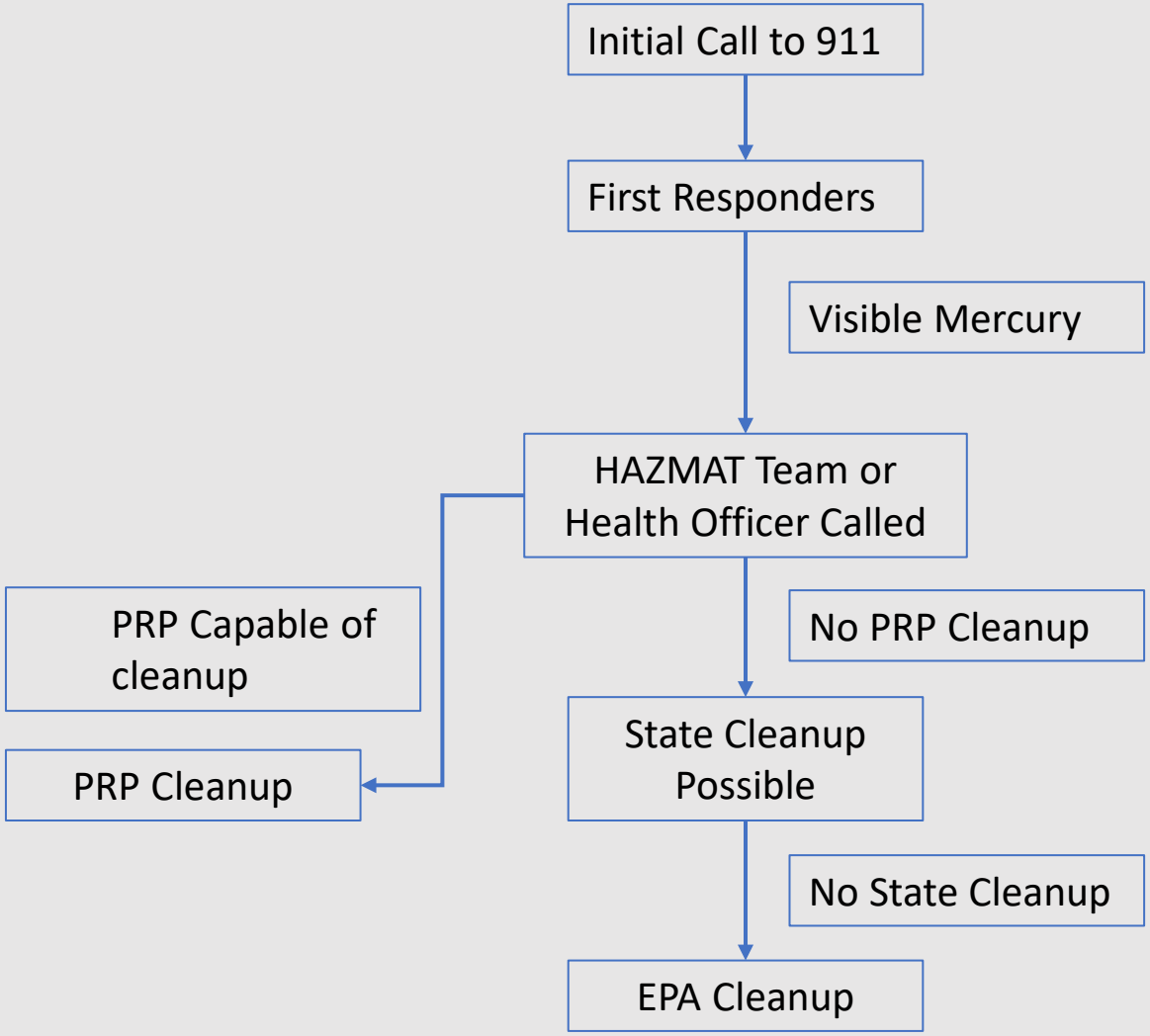


OTHER INSTRUMENTS FOR SURVEYING ONLY

- Nippon Instruments Corporation EMP-Gold+ Field Portable Mercury Monitor
- Nippon Instruments Corporation EMP Mercury Monitor
- Ion Science MVI Mercury Detector
- Picoyune MA-1 Wearable Mercury Vapor Monitor
- Mercury Instruments Analytical Technologies VM-3000 Mercury Vapor Monitor
- Mercury Instruments Analytical Technologies Mercury Tracker -3000 XS
- Ohio Lumex Portable Zeeman Mercury Vapor Analyzer Light 915M2
- Draeger X-Act 7000 (Mercury Tubes)

Chapter 6:
Initiation of a Response

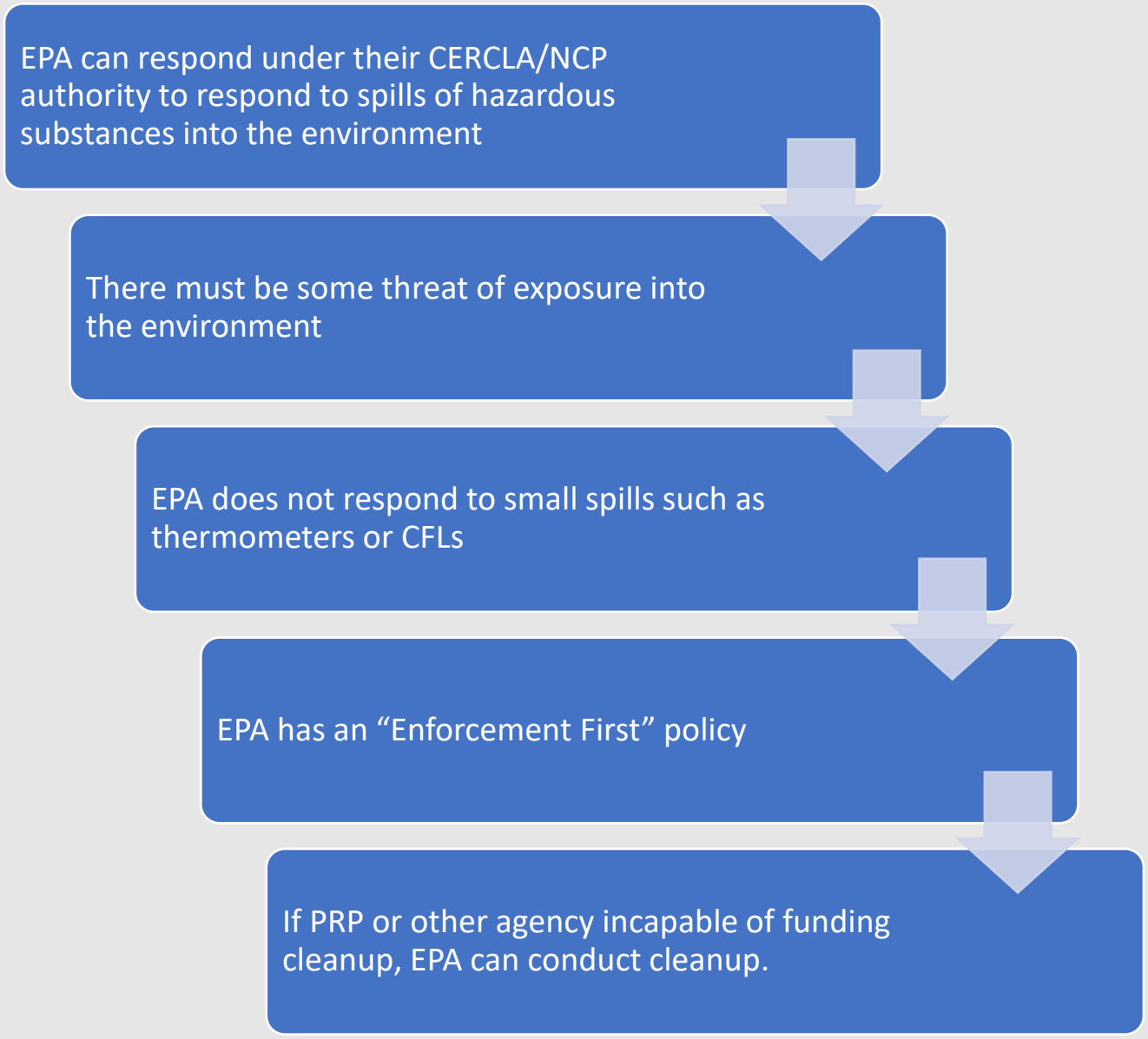
Initial Response Notification



Role of Health Department

- Determine if potentially exposed individuals should be referred for clinical assessment.
- Determine biological testing should be conducted.
- Provide clinical assistance via public health nurse or doctor.
- Determine whether to post a residence “Unfit for Human Habitation”.
- Make final decision on “How Clean is Clean”.
- Assist in relocation of residents.

EPA and Their Role in a Mercury Spill



Initial Info to be Obtained

1. How did the spill occur, including estimated volume and time since spill occurred?
2. Was a cleanup attempted?
3. How was the cleanup conducted?
4. What actions have been taken, including instruments used?
5. Who handled the spill or who was present during the spill?
6. Where did the mercury originate?
7. Where was the mercury detected?
8. Was the mercury taken to another location?
9. Was the mercury container opened or was the mercury handled anywhere else?
10. Has any individual been in direct contact with mercury?
11. What is the number, ages, and ethnicities of people living in the home (understand sensitive populations: ATSDR will ask for this information if you call them)?
12. Who rents, leases or owns the property and is it insured?
13. For businesses or schools, has a qualified environmental cleanup contractor been contacted? If so, does the contractor have mercury cleanup experience?

Initial Entry and Assessment

1. Verify that there is a release of Mercury.
2. Estimate whether the spill would be considered small (1 tbsp), medium (1 shot glass), or large (1 pint) and whether the extent of the spill is small or significant!
3. Measure the average concentration of breathing zone air to determine proper level of PPE and Health and Safety procedures using the MVA with the highest detection range.
4. Determine whether relocation should be recommended.
5. Verify if the spill has migrated and where.

Monitoring Techniques

- Collect background data off-site.
- Survey entire potentially impacted area at breathing zone starting at area of lowest concentration to ground zero.
- If meter pegged at doorway assume area wide contamination.
- Once breathing zone completed, monitor at 1-3’’ off the floor
  - Check baseboards
  - Expansion joints
  - Under cabinets and appliances
- Other areas to monitor
  - Drains
  - Ventilation System

Residential

- Conduct initial assessment using Mercury Vapor Analyzer (MVA).
- Document the inside condition of the house using a video camera.
- The residents and pets must be out of home during survey.
  - If Mercury concentration exceeds 10 ug/m^3, resident and pets should be evacuated.
  - Have Fire Department, Building and Safety or Health Officer quarantine/red tag if necessary.
  - Utilize Red Cross for relocations.
- Initial entry can be conducted in Level D with gloves and booties until monitoring proves otherwise.

Residential

- If Mercury vapor concentration using MVA exceeds 12,500 ng/m^3, responders should upgrade to Level C.
- Responders should remove gold and silver jewelry.
- Start in areas of low contamination and move to areas of high contamination.
- Check P-traps.
- Check appliances
  - Washing machine
  - Dryer
  - Fridge
  - Oven
- Close all windows and doors to the outside environment.
- If origin room can be isolated during assessment, do it.

Residential

- Check cleaning supplies
  - Vacuum
  - Mops and mop buckets
  - Brooms
- Check anywhere beads may roll
  - Under furniture and appliances
  - Under floor cabinets
  - Floor moldings
- Remove all personal items from contaminated rooms after initial survey and then resurvey
- If temperature inside the house is less then 80^{o}F turn on heater in house.

Personal Effects

Remove from contaminated room or area
Pack in clear plastic bags and close bag with zip tie or duct tape
Do not over stuff bags
Inventory items as they are loaded into bags
Photo document items
Action Levels: 3,000 – 6,000 ng/m^3

Personal Items Assessment

1. Allow bags to bake in sun or heated area for at least 30 minutes.
2. Make small slice in bag and insert MVA probe
3. If bag head space is greater then action level, then the bag is allowed to vent for ½ hour.
4. Repeat steps 1 through 3 as necessary.
5. EPA follows a three-strike rule.
6. If personal items do not pass action level, dispose of as hazardous waste.
7. Notify property owner ahead of time of the procedure for personal items and that things may be disposed of. Notify them of your agency's replacement policy. **EPA DOES NOT REPLACE ANYTHING!**

Personal Items Not Releasable

- Porous Items
  - Fabric covered furniture
  - Carpet
  - Books and other paper products
- Washing machines that have been deconned and still are over 6,000 ng/m^3
- Items with mercury concentrations over 6,000 ng/m^3

Non-Residential: Industrial and Commercial

- Notify landlord and all tenants immediately of the spill.
- May need to get access from both the landlord and the tenants.
- May have to check all suites in an office building.
- Collect personal items before employees leave for the day.
- May need to contact customers.
- Start at areas of low concentration and move towards origin location. Be careful not to track contamination into clean areas.
- May need to survey common areas, parking lots and break rooms.
- Shut all doors and windows to the outside.
- If a medical clinic, HIPA laws may apply.
- Shut off ventilation for building if spill location has common ducting.
- Isolate origin room.

Mercury in Schools

Dependent on how long it has been released

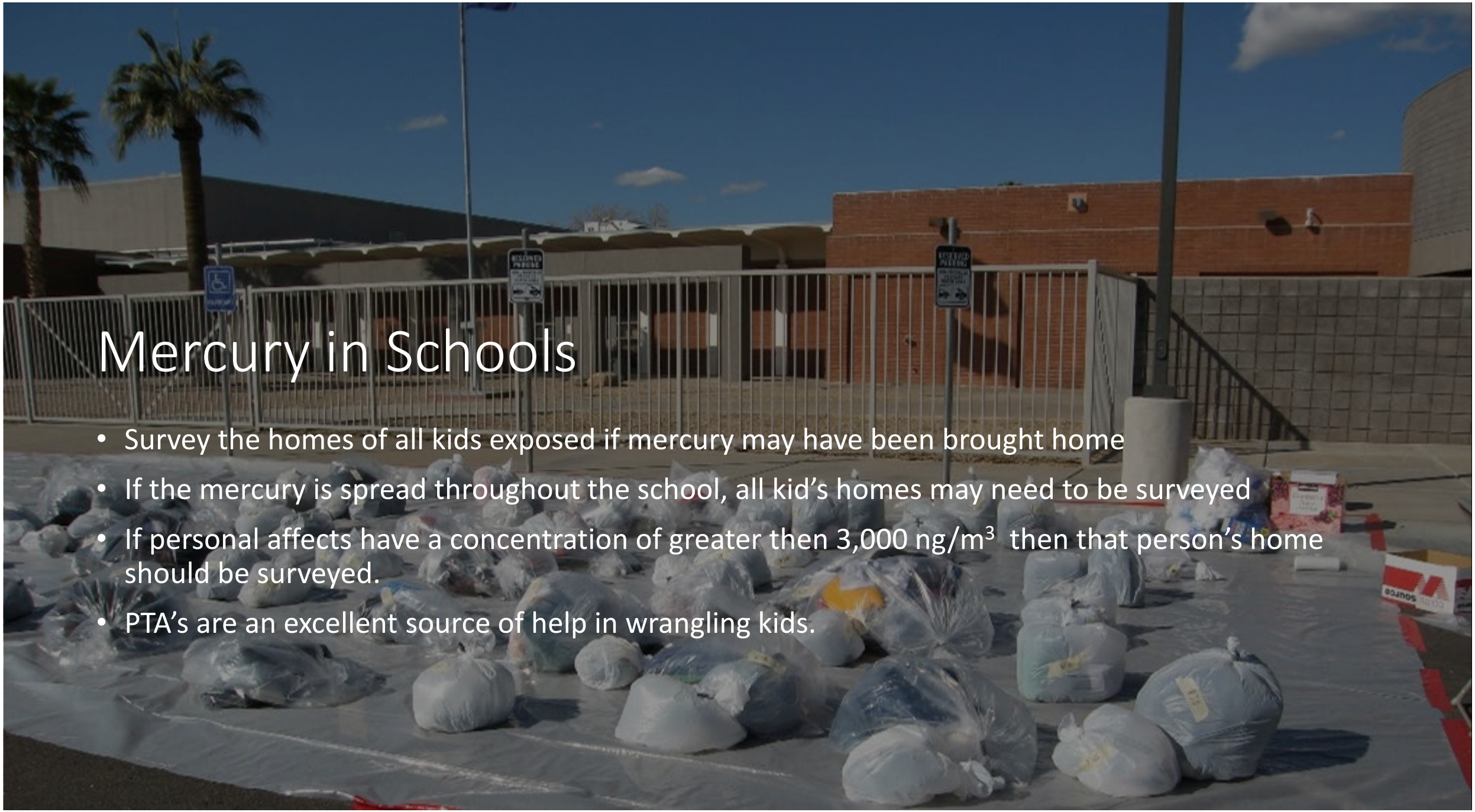
If it has been more then one day that the kids have been playing with it, entire school might have to be surveyed

It may not be possible to survey kids before they leave

Have school assist in the collection of personal affects and clothes of potentially contaminated students, staff and visitors

If multiple classrooms are contaminated, close school

May require order of Public Health Officer.



Mercury in Schools

- Survey the homes of all kids exposed if mercury may have been brought home
- If the mercury is spread throughout the school, all kid's homes may need to be surveyed
- If personal affects have a concentration of greater then 3,000 ng/m^3 then that person's home should be surveyed.
- PTA's are an excellent source of help in wrangling kids.

Mercury in Schools

- Get written access for schools and personal residences
- May need to have community meetings and press support
- Action Levels
  - Re-occupancy: 1,000 ng/m^3 or less
  - Personal Effects: 3,000 – 6,000 ng/m^3
- ***CALL EPA FOR ASSISTANCE***
  - ***800-300-2193, ext. 3***

Contaminated Vehicles

- Roll up all windows and turn vehicle on and turn on heater for 20 minutes
- Check breathing space in car with MVA.
- Action Level: 3,000 ng/m^3
- If less then 6,000 ng/m^3, heat and vent car and resurvey
- If greater then 10,000 ng/m^3, survey carpets and seats
- Look for mercury beads

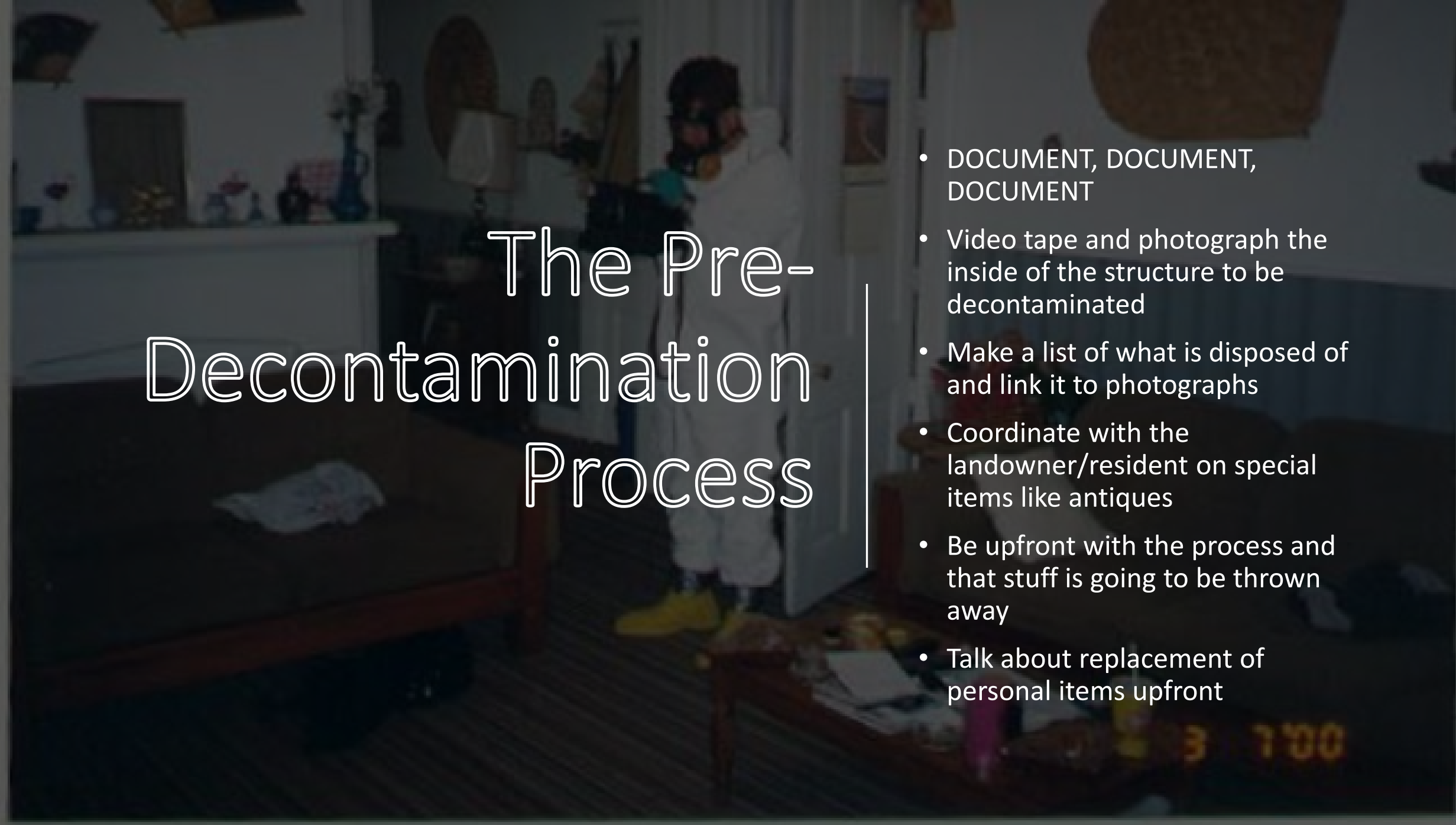
Assessing Outdoor Contamination

- Cordon off potentially contaminated areas
- Conduct breathing zone assessment first
  - Less then 12,500 ng/m^3 then use Level D
  - Greater than 12,500 ng/m^3 , then use Level C
- Conduct surface survey next
  - Don’t let hose touch the surface
  - Check interface of different types of surfaces
- Action Level: 3,000 -6,000 ng/m^3

Outdoor Contamination

- Matrix Effects
  - Soil
  - Asphalt
  - Sidewalks
- Weather Effects
  - Wind
  - Rain
  - Heat
- Bucket Method

Chapter 7:
Indoor Elemental Mercury Cleanup Process

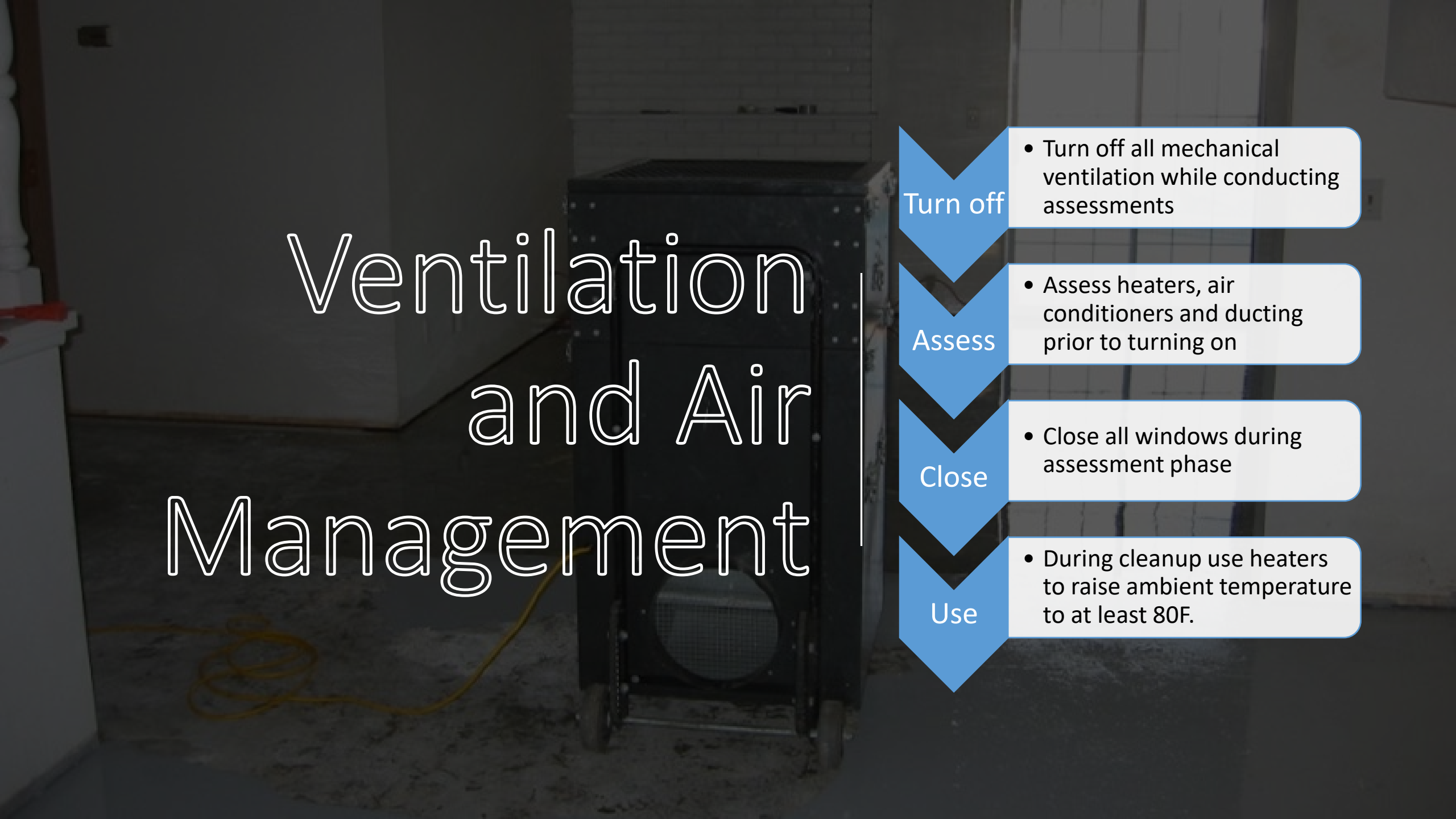


The Pre-Decontamination Process

- DOCUMENT, DOCUMENT, DOCUMENT
- Video tape and photograph the inside of the structure to be decontaminated
- Make a list of what is disposed of and link it to photographs
- Coordinate with the landowner/resident on special items like antiques
- Be upfront with the process and that stuff is going to be thrown away
- Talk about replacement of personal items upfront

Work Zones and Containment Operations

- Set up like a standard hazmat incident
- Items removed for evaluation should be bagged until cleared for release
- Personal decontamination may include the use of sulfur in pans for boots, sticky pads and surveying of personnel
- If generating decontamination or dust suppression liquids, contain using berms
- Cover decon area in visqueen to prevent the flow of migration



Ventilation and Air Management

Turn off
- Turn off all mechanical ventilation while conducting assessments

Assess
- Assess heaters, air conditioners and ducting prior to turning on

Close
- Close all windows during assessment phase

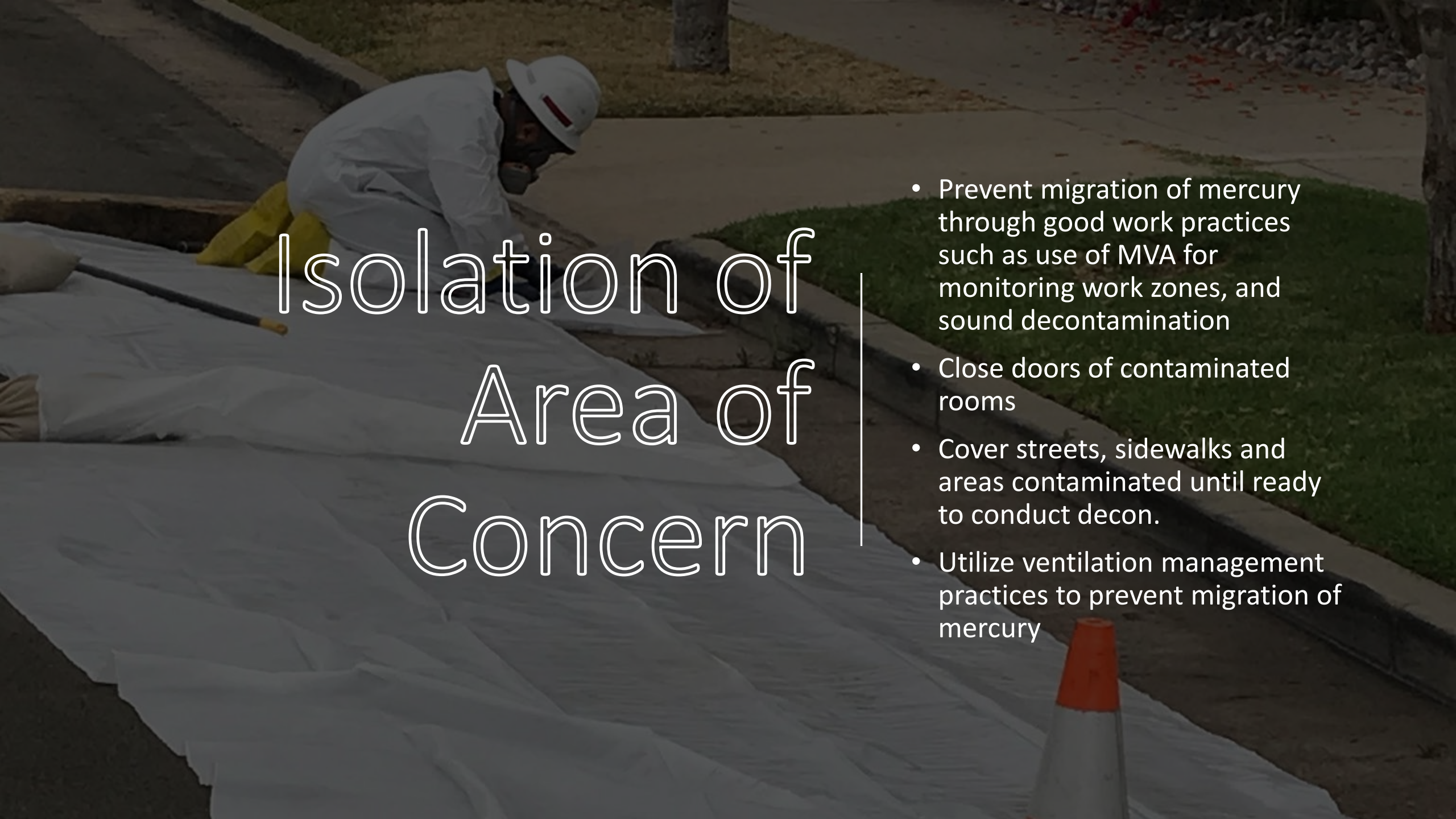
Use
- During cleanup use heaters to raise ambient temperature to at least 80F.

Ventilation and Air Management

If structure is commercial (i.e.: hospital) determine if ventilation is room specific or interconnected.

During removal phase use fans to assist in air movement outside the structure to reduce ambient concentrations.

If ventilation to the outside is not possible use and negative air machines with sulfur treated carbon filters to reduce ambient concentrations.



Isolation of Area of Concern

- Prevent migration of mercury through good work practices such as use of MVA for monitoring work zones, and sound decontamination
- Close doors of contaminated rooms
- Cover streets, sidewalks and areas contaminated until ready to conduct decon.
- Utilize ventilation management practices to prevent migration of mercury

Mercury Cleanup Tools

- Mercury Spill Kits
- Mercury Vacuums
- Tools for picking up Mercury
- Chemical decon and amalgamating products

Mercury Vacuums

- Specific to Mercury
- Must have a receptacle collect Mercury
- Specialty filter to remove micro beads
- Must be decontaminated after each use
- Use to collect liquid Mercury, Mercury contaminated solids and amalgamated Mercury.

Chemical Decon and Amalgamation

Mercury Indicator Powder	Mercury Vapor Absorbent	*MerconvapTM*	*MerconwipesTM*	*Hg AbsorbTM*
HgX®	*DeconGelTM*	*Mercury MagnateTM Amalgamation Spill Powder*	***Powdered Sulfur - BEST***	*Shampoos with Sulfur and Selenium*

Sulfur Amalgamation

- The process: add elemental mercury to an inorganic reagent
- Sulfur works the best
- Must be talcum powder consistency
- Creates a semi-solid, low volatility compound

Removal from Non-Porous Surfaces

- Examples: concrete, tile, porcelain, metal, plastic, and newer floor materials.
- Use MVA to find Mercury Contamination
- Physical removal using vacuums
- Amalgamation
- Coat surfaces with floor epoxy
- Heat and Vent
- Demolition as last resort

Removal of Mercury from Porous Items

Examples: Carpet, fabric, paper, wood, some older floor materials

Vacuuming and Amalgamation may not work.

Smaller items like clothes and some furniture may be able to be bagged, heated and vented.

Demolition and disposal

Decon of Humans

- ATSDR Medical Management Guidelines (MMGs) for Mercury
  - Victims exposed to mercury vapor do not pose secondary contamination risks to rescuers.
  - Contaminated clothing or equipment can pose a contamination issue to anyone who comes in contact with it.
  - Wash all impacted areas with lots of soap and water.
  - Wash hair with dandruff soap containing selenium.
  - Seek medical treatment.

Decon of Animals

- **National Alliance of State Animal and Agricultural Emergency Programs (NASAAEP) – Emergency Animal Decontamination Best Practices Sept 2014**
- **Do not shave animals**
- **Use a mild dandruff soap that contains selenium**
- **For animals that may bite use a muffle**
- **Consult with a vet**
  - **May have to sedate**

Chapter 8:
Post Cleanup Clearance

Air Sampling Clearance Procedures

- Follow 11/13/2014 EPA Environmental Response Team Indoor Mercury Spills – Area Clearance Procedure Protocols for Sample Collection approach.
- Heat-and-vent for two to eight hours periods prior to clearance sampling
- Clear with MVA
- Allow room to reach normal temperature and close all windows and external doors for at least 2 hours prior to sampling.
- Collect samples in multiple rooms and at adult and child breathing zones
- Use either Air Sampling or MVA Clearance Methods

Air Sampling – Laboratory Methods

National Institute of Occupational Safety and Health (NIOSH) Method 6009

Detection Limit – 30 ng/m^3

Cold vapor, atomic absorption spectrometry for measurement of elemental mercury

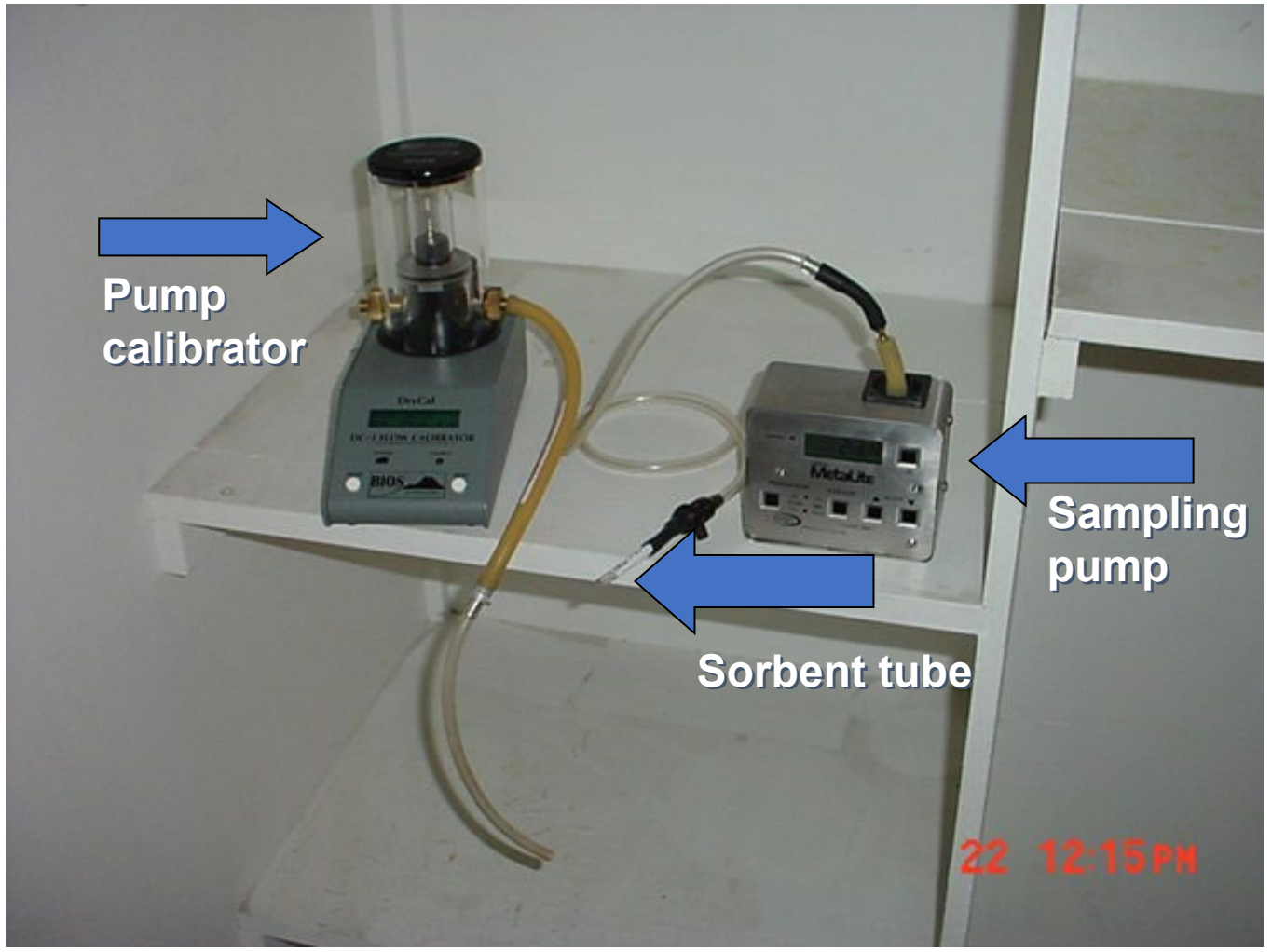
Pump flow rate: 0.15 to 0.25 L/min

Total Volume of air collected: 2-100 liters (larger volume = lower detection limit)

Sample media = sorbent tubes (example: SKC tube #226-17-A @ www.skcinc.com)

Sample Cost ~ $40–$70 per sample (media)

Post-Cleanup Air Sampling



Lumex MVA Clearance

- Follow 11/13/2014 EPA Environmental Response Team Indoor Mercury Spills – Area Clearance Procedure Protocols for Direct Reading Analyzer approach.
- Must have a detection limit of 200 ng/m^3 or lower
  - Lumex 915 M MVA
  - Jerome 505 MVA
- Follow same heat and vent protocols as air sampling
- Collect monitoring data for 8 hours.

Re-Occupancy and Restoration

- EPA does not have the jurisdiction to authorize re-occupancy
- Agencies that can include:
  - Health Officer
  - Fire Department
  - Building and Safety/Code Enforcement
- Notify tenant or landowner of restoration policy prior to the start of work
- If restoration is to occur, agree in writing prior to the commencement of work.

Disposal

- Mercury is a RCRA Characteristic and Listed Waste
  - U151 Listed Waste
  - D009, TCLP >0.2 ug/l Characteristic Waste
- Soil and Debris with a concentration of 260 ppm or greater Mercury must be sent in for retort
- For debris, place 1-2’ of dusting sulfur in the bottom of the bin to amalgamate any free Mercury that may pool in the bottom of the roll-off-bin
- Must comply with the RCRA Land Disposal Restrictions
- Must comply with the Mercury Export Ban Act

Chapter 9:
Public Relations

Community Relations

- EPA Mercury Guidebook has pre-scripted Fact Sheets.
- ATSDR can assist in Community Relations and Risk Communication.
- All Fact Sheets should at a minimum be in English and Spanish.
- Fact Sheets should be issued for all residential and school spills.
- If schools have been impacted, a community meeting for the parents is a must.
- Explain the cleanup, item replacement and restoration process upfront.

Press Relations

- Use Press Officers
- If multi-agency response, use Joint Information Center
- For schools, daily press conference may be necessary
- Never say “NO COMMENT”
- Issue a daily press release if media interest is medium to high.

CHAPTER 10: GETTING HELP

Mercury Response Assistance

- Region 9 Spill Phone: 800-300-2193, ext. 3
- National Response Center: 800–424-8802
- California Office of Emergency Services: 916-845-8510
- Arizona Dept. of Environmental Quality: 602-771-2300
- Nevada Dept. of Environmental Quality: 775-687-4670
- Hawaii Office of Environmental Quality Control: 808-586-4185
- Guam EPA: 671-475-1609

Chapter 15: Dealing with Contractors

- Contractors must be 40-hour HAZWOPER trained pursuant to 29 CFR 1910.120(e).
- Contractors must be in full compliance with HAZWOPER.
- Contractors must own either a Jerome 505 or a Lumex 915M to do clearance. They can have any of the other meters to do surveys.
- Contractors must own a Mercury vacuum
- Contractors must have PPE specific for Mercury.
- Contact your local County or State agency for a list of qualified contractors.

Robert Wise Federal On-Scene Coordinator

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EPA Duty Officer: 800 – 300 – 2193, ext. 3