

# Mercury Detection and Response



Mercury flask



Mercury recovered from residential spill

Mercury “bullets” used for amalgamation in dental offices



# Instructors and Handouts

**Robert Wise**

USEPA – Federal On-Scene Coordinator

Signal Hill, CA

562-889-2572 (cell)

[wise.robert@epa.gov](mailto:wise.robert@epa.gov)

Handouts are located at

[www.epaossc.org/Hgresponseresources](http://www.epaossc.org/Hgresponseresources)

# Course Agenda

- ❖ **Introduction**
- ❖ Mercury Basics
- ❖ Health Effects of Mercury
- ❖ Using Personal Protective Equipment
- ❖ Intro to Mercury Responses
- ❖ Cleanup Techniques and Response Issues
- ❖ Mercury Vapor Analyzers and Other Instrumentation

# What Number Do I Call?

**National Response Center: 800-424-8802**

**EPA Region IX Spill Phone: 800-300-2193**



# Introduction

## Mercury Experience

### EPA's Mercury Website:

<http://www.epa.gov/mercury/>

(2009 public service announcement geared toward children can be found on this page)

### Course and Mercury Guidebook:

[www.epaossc.org/mercury\\_guidebook](http://www.epaossc.org/mercury_guidebook)

(look under the “documents” section of this page)

# EPA National Mercury Task Force

- ❖ Representatives from all 10 EPA Regions
- ❖ Highlights of topics and changes coming from the task force:
  - **Changes to action levels**
  - SOP for using Lumex for confirmation of cleanup
  - Evaluation of available mercury detection instruments
  - National guidance for restoration of properties (internal EPA)

# Continued Highlights – Hg Task Force

- National guidance for demolition vs. cleanup of residential properties (internal EPA, but made public)
- Updated, consistent national guidebook
- Updated, consistent training slides (differences will only be regional case studies)
- National policy on relocation of residents
- Discussion of when EPA will become involved in residential cleanups

# Saylor Way Mercury

Residential Mercury Nightmare

Las Vegas, NV

Jan. – Feb. 2004

# Summary

- ❖ Mercury spill over several months at a single family residence.
- ❖ 17 year old male played with the mercury contaminating the house, backyard, pool and sidewalk
- ❖ 17 year old victim hospitalized with severe acute mercury poisoning.
- ❖ Site discovered as the result of a 911 call.
- ❖ Visible elemental mercury spread throughout the house.
- ❖ Ambient concentrations  $>50,000 \text{ ng/m}^3$ .
- ❖ USEPA notified via the NRC and assumes responsibility for the site.
- ❖ USEPA conducts removal action pursuant to Superfund.
- ❖ Interior of residence gutted to remove mercury below  $1,000 \text{ ng/m}^3$  action level (ATSDR).
- ❖ Backyard demolished to remove contaminated pool.



Decontamination  
of doggy  
contaminated  
with mercury



# ASSESSMENT

- ❖ Monitoring with real-time instruments
  - Jerome Mercury Meter
  - Nippon Mercury Meter
  - Lumex Mercury Meter
    - Ambient air
    - Soil
- ❖ Confirmation with air sampling



# RESIDENCE DECONTAMINATION

- ❖ Removal of free elemental mercury via vacuuming
- ❖ Removal of contaminated personal effects
- ❖ Demolition
- ❖ Heat and filtering of air
- ❖ Amalgamation of mercury
- ❖ Sealing with epoxy of contaminated areas



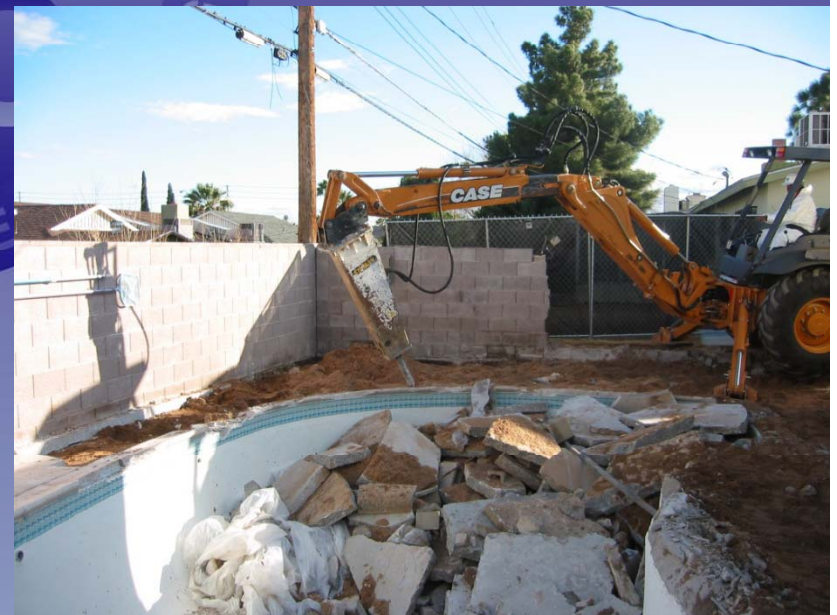
# BACKYARD DECONTAMINATION

- ❖ Remove pool water
- ❖ Vacuum up free mercury in pool
- ❖ Remove contaminated concrete cracks
- ❖ Remove Contaminated Soil
- ❖ Pressure wash
- ❖ Amalgamation of mercury
- ❖ Not Successful – Pool Contaminated.



# Pool Demolition

- ❖ Remove concrete patio
- ❖ Assess soil using Lumex
- ❖ Confirmation samples
- ❖ Demolish pool
- ❖ Rehab Backyard



# Removal Summary

- ❖ Cost as of 04/20: \$ ~250,000
- ❖ 21 days to complete
- ❖ 80 cubic yards of mercury contaminated debris removed
- ❖ 120 cubic yards of concrete removed

# Course Agenda

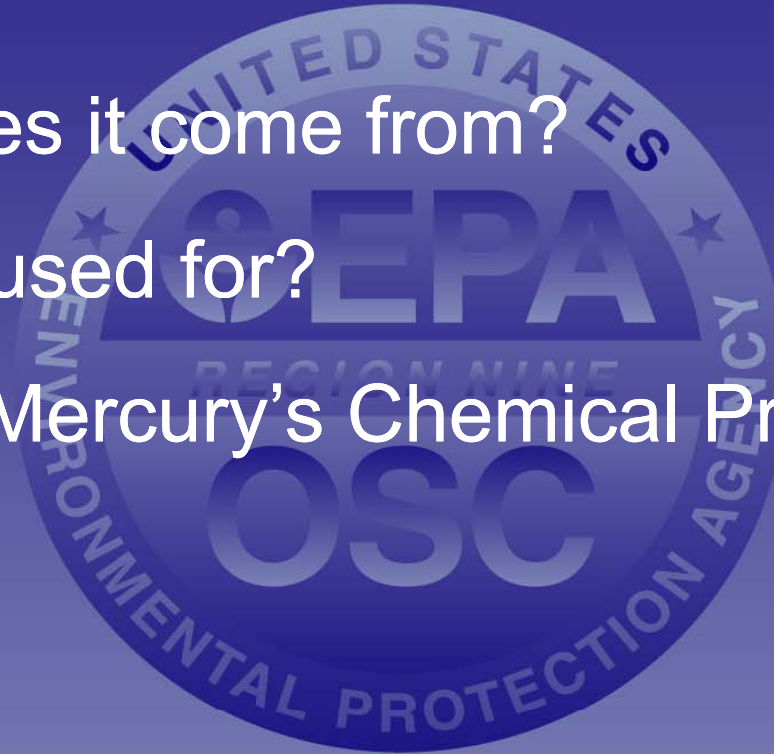
- ❖ Introduction and Recent Responses
- ❖ **Mercury Basics**
- ❖ Health Effects of Mercury
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# Elemental Mercury



# Introduction to Mercury

- ❖ Where does it come from?
- ❖ What is it used for?
- ❖ What are Mercury's Chemical Properties?



# Naturally Occurring

Mercury mined as cinnabar ore (mercuric sulfide)



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

# Forms of Mercury

- ❖ Mercury comes in three forms:
- ❖ Elemental
  - Most residential mercury responses
- ❖ Inorganic
- ❖ Organic
  - Most common type is methyl mercury

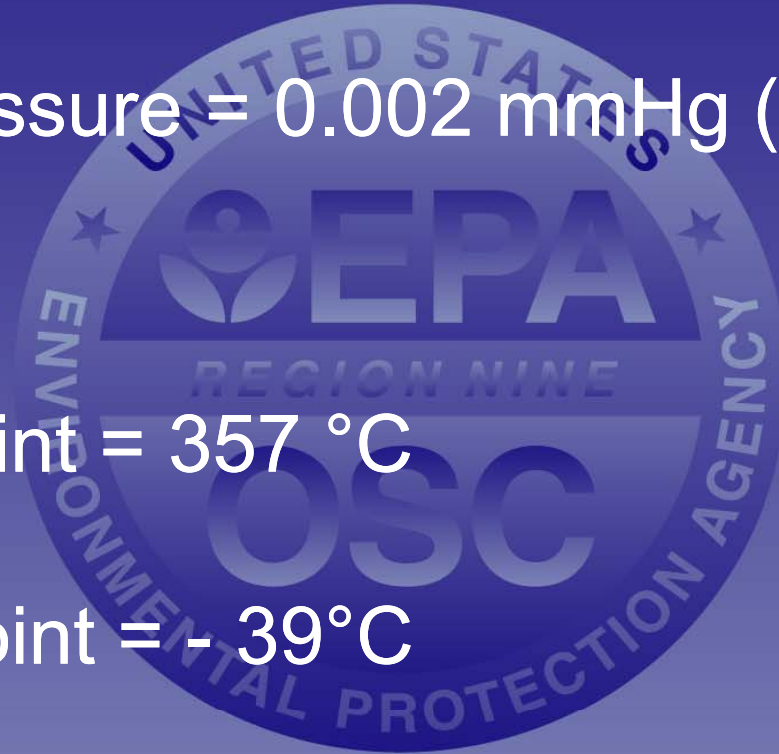


# Physical/Chemical Properties

- ❖ Chemical Symbol = Hg
- ❖ Elemental Mercury is...
  - Shiny, silver-white odorless liquid at room temperature
  - Extremely volatile
    - Easily converted to a colorless, odorless gas

# Physical/Chemical Properties

- ❖ Vapor Pressure = 0.002 mmHg (at “room temp)
- ❖ Boiling Point = 357 °C
- ❖ Melting Point = -39°C



# Surface Tension

Mercury has the highest surface tension of any liquid. Mercury does not flow, it fractures into small “beads”



Mercury beads that were behind baseboard

# Mercury Vapor Video

**MERCURY VAPOR EXPERIMENT**  
**BOWLING GREEN STATE UNIVERSITY (OHIO)**  
**VIDEO**



# Mercury “Fun Facts”

## Mercury (elemental) has many uses:

- Thermometers, barometers, batteries, electrical devices and dental fillings
  - Home thermometer: 500 mg Hg
  - CFL: 4 mg Hg
- A silver-colored mercury amalgam filling normally contains 52 percent mercury.
- On average, amalgam fillings weigh 1 gram and contain  $\frac{1}{2}$  gram of mercury.
- The typical adult carries 10 amalgam fillings containing 5 grams of mercury.

# Mercury Facts

- Half a gram of mercury (the amt in a typical dental filling) released in a 10-acre lake would warrant issuance of a fish advisory for the lake.
- One gallon of mercury weighs 128 Lbs.



# Mercury Facts Continued

Solid



These people are  
idiots...

Please do not attempt  
these stunts at home.

Liquid



Gas



# Mercury Mines

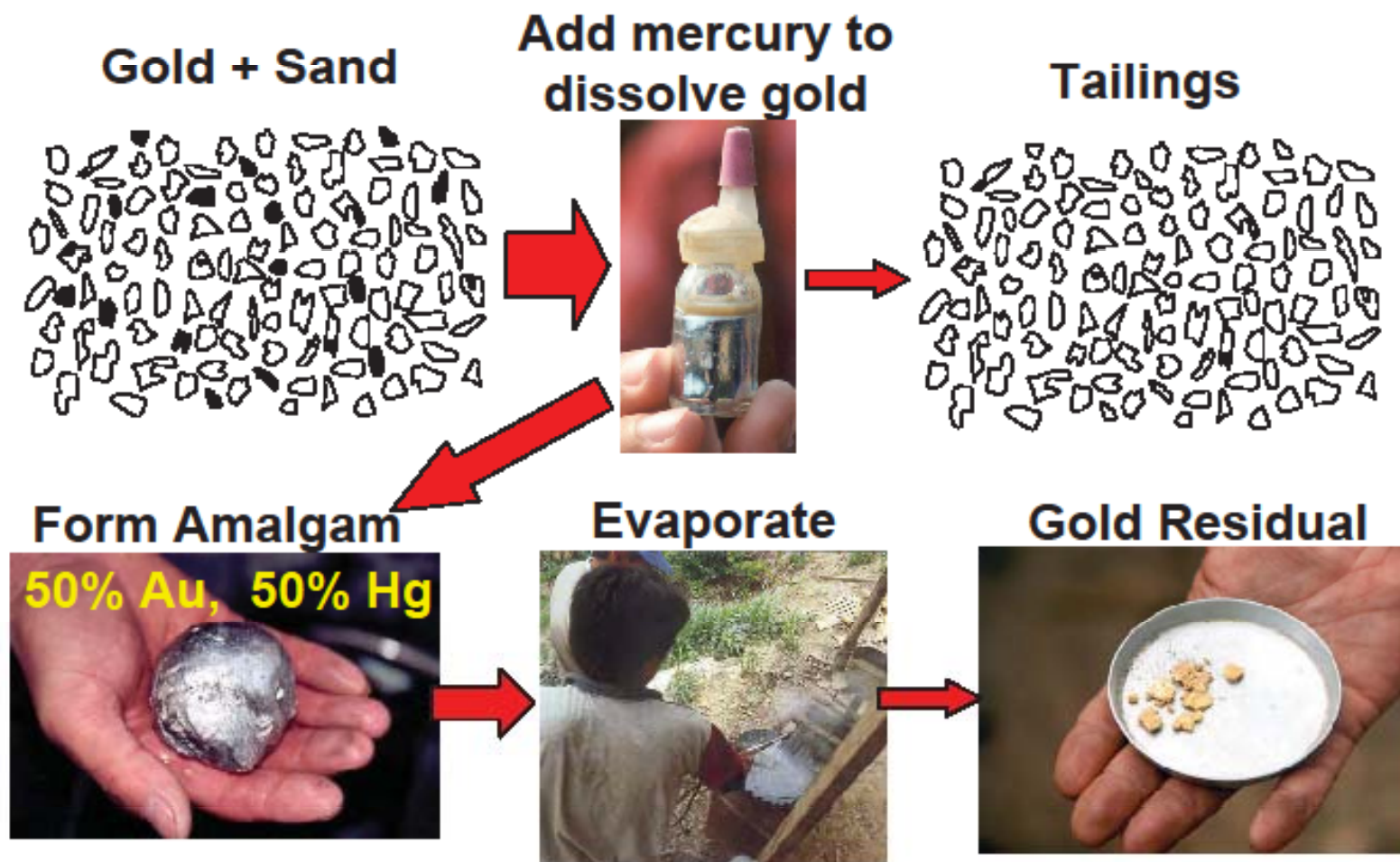
- ❖ EPA has assessed & cleaned up several mercury mines in Region 9 in the past 8 years.
- ❖ Inefficient mining operations left behind waste rock/ tailings piles that contain levels of mercury that are harmful to people/ fish – which drives cleanup
- ❖ XRF/ Lumex with soil attachment have been key in cost effective assessment and removal



# Gold Mining and Mercury

- ❖ Mercury is used at gold mines to extract gold from ore
- ❖ Mercury (and use in Gold Mining) has created hazardous waste sites. (e.g. Carson River Area/ Comstock, NV)
- ❖ Barrick Goldstrike produced ~140,000 lbs. of mercury and ~ 130,000 lbs. of gold in 2005 – **Not very efficient**

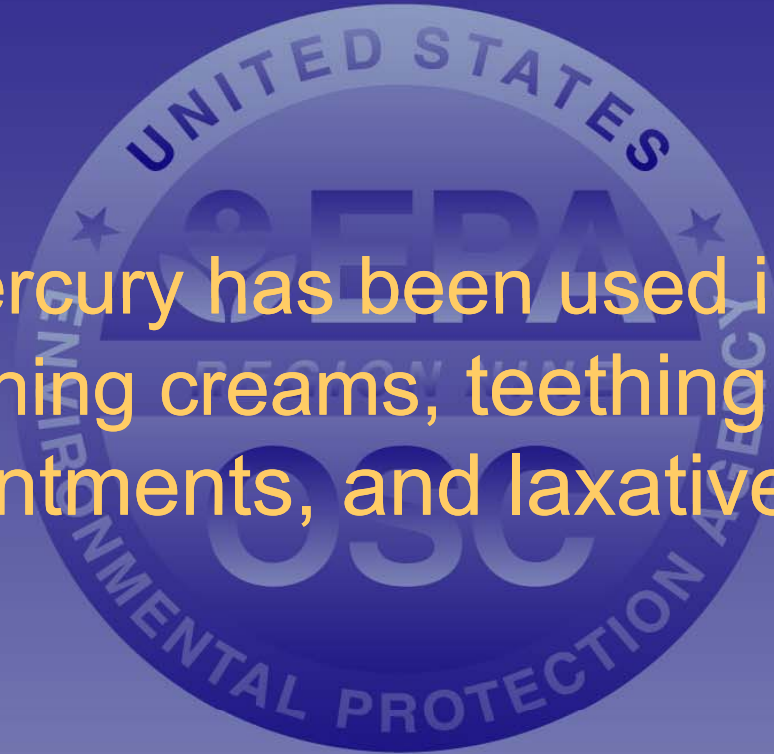
# How Is Mercury Used?





# Inorganic Mercury Uses

Inorganic mercury has been used in fungicides, skin-lightening creams, teething powders, ointments, and laxatives





# Uses of Inorganic Mercury

- Thermometers
- Thermostats
- Some household switches (silent switches) manufactured before 1991
- Fluorescent and high intensity discharge (HID) lamps
- Some alkaline batteries manufactured before 1994
- Some button batteries
- Latex paints manufactured before 1992
- Dental amalgam
- Old chemistry sets, mercury maze toys, and jewelry with liquid mercury
- Lighted athletic shoes (L.A. Gear's My Lil'Lights and L.A. lights purchased before June 1994 contain mercury. Other brands may contain button batteries)
- Some pesticides manufactured before 1994
- Some skin lightening creams illegally imported into the United States
- Some Asian medicinals
- Azogue (elemental mercury) used for Santeria or Esperitismo religious rituals and folk medicine
- Some septic tank and sump pump control switches
- Some dairy barn manometers

# Organic Mercury

Bacteria in soil and water convert elemental mercury to methyl mercury (organic) which is soluble in water, and bioaccumulates



# Course Agenda

- ❖ Introduction and Recent Responses
- ❖ Mercury Basics
- ❖ **Health Effects of Mercury**
- ❖ Using Personal Protective Equipment
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# Health Effects of Mercury

- ❖ Acute
- ❖ Chronic
- ❖ Fetal



# Acute Health Effects

- ❖ High exposures to mercury vapor can cause short-term (acute) poisoning
  - Symptoms include cough, chest tightness, trouble breathing and upset stomach
  - Symptoms can lead to pneumonia, which can be fatal
- ❖ When inorganic mercury compounds are swallowed nausea, vomiting, diarrhea and severe kidney damage can occur

# Chronic Health Effects

Chronic mercury poisoning includes three primary symptoms

- ❖ 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

# Chronic Health Effects (continued...)

- ❖ Nervous system: most frequent symptom is shaking hands
  - A tremor may also occur in the tongue and eyelids
  - Eventually this can progress to trouble balancing and walking

# Developing Fetus

- ❖ Elemental and methyl mercury can cross the placental barrier
  - Mercury levels that wouldn't normally effect the adult, cross into the brain during neonatal development stages and transform mercury to it's ionic form
  - The mercury remains where it has been transformed

# Elemental mercury elimination

- ❖ Kidney excretion through urine
- ❖ Ingested mercury passes through feces
- ❖ Mercury in blood volatilized from skin and lungs
- ❖ Physiological half life: 30-60 days

# Mercury Levels

- ❖ Background levels
  - ❖  $\leq 10 \mu\text{g/L}$  in whole blood
  - ❖  $\leq 20 \mu\text{g/L}$  in urine
- ❖ Non-Specific symptoms
  - ❖  $35 \mu\text{g/L}$  in blood
  - ❖  $150 \mu\text{g/L}$  in urine
  - ❖ Blood mercury should be  $<5.8 \mu\text{g/L}$  for women who are or intend to become pregnant

# ATSDR Suggested Action levels – Hg Vapor

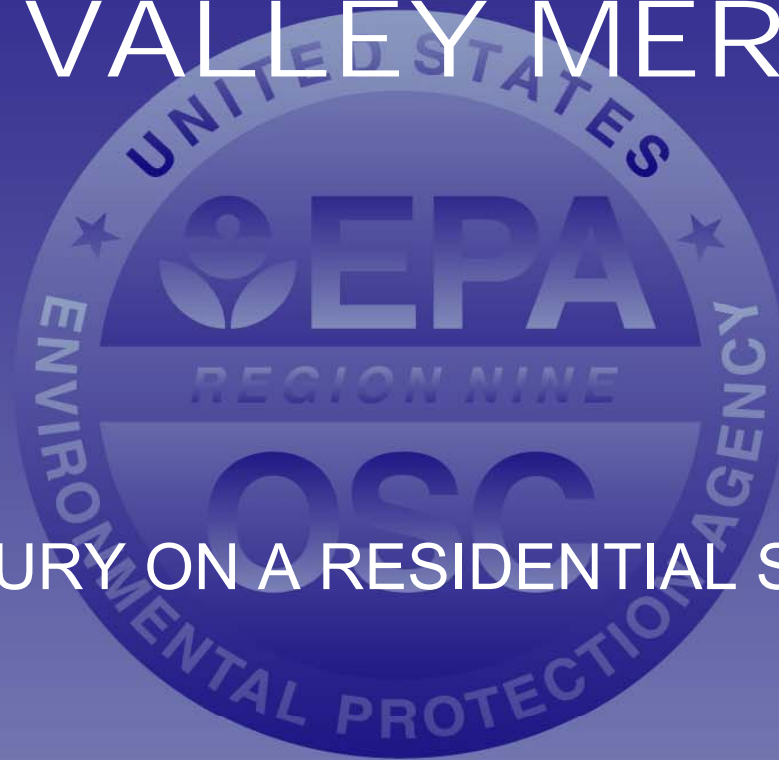
- ❖ Residential occupancy  $< 1 \mu\text{g}/\text{m}^3$ \*
- ❖ Commercial / schools  $< 1 - 3 \mu\text{g}/\text{m}^3$ \*
- ❖ Isolation of personal effects  $3-6 \mu\text{g}/\text{m}^3$ \*\*

\* source of mercury has been eliminated

\*\* Personal effects action level adjusted down from  $10 \mu\text{g}/\text{m}^3$  by EPA National Mercury Taskforce and ATSDR.

# APPLE VALLEY MERCURY

MERCURY ON A RESIDENTIAL STREET





# SUMMARY

- ❖ Spilled on three residential streets probably on December 28, 2002
- ❖ Spill discovered on January 1
- ❖ Initial Response by AVFD, SBCoFD and DTSC
- ❖ EPA response January 2 – Federalized on January 3
- ❖ Mercury amalgamation used to mitigate spill
- ❖ Monitoring with Lumex Mercury Meter of streets and adjacent homes
- ❖ Number of Homes Screened: 20

Approximately 8,000 pounds of sulfur was put down and collected to amalgamate the mercury













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# H&S Action Levels for Mercury Vapor

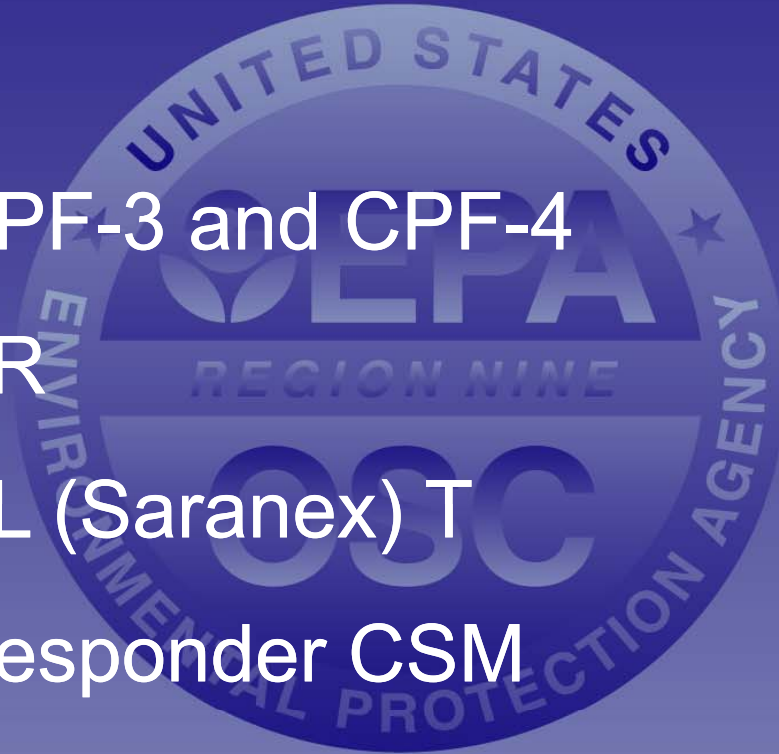
- ❖  $< 1,000 \text{ ng/m}^3$  (residential) – ATSDR
- ❖  $25,000 \text{ ng/m}^3$  (ACGIH – TLV based on 8-hr day)
- ❖  $0.1 \text{ mg/m}^3$  (OSHA – PEL, ceiling)
- ❖  $0.05 \text{ mg/m}^3$  (NIOSH – REL, skin based on 10-hr day)

# Personal Protective Equipment – Respirator Cartridges

- ❖ All cartridges used for mercury vapor must have end-of-service-life indicators (ESLI)
- ❖ Examples
  - Mersorb® - P100 Indicator Type Combination Cartridges should be used with MSA respirators
  - Mercury Vapor/ Chlorine with P100 should be used with the Scott respirators

# Personal Protective Equipment – Suits

- ❖ Tychem-F
- ❖ Tychem CPF-3 and CPF-4
- ❖ Tychem BR
- ❖ Tychem SL (Saranex) T
- ❖ Tychem Responder CSM
- ❖ Tychem TK



# Personal Protective Equipment – Gloves and Booties

## ❖ GLOVES

- Silver Shield
- PVC
- Latex
- Nitrile
- Neoprene

## ❖ Booties

- Latex



On Monday, June 4, 2007 a mercury spill was discovered in an alley in a residential neighborhood of Wilmington (Los Angeles), CA. Children playing in the alley, aquired the mercury (approximately 15 pounds) and released the material (estimated 20% of the contents of the container) onto the concrete and exposed soil in the alley.



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# Mercury in Schools

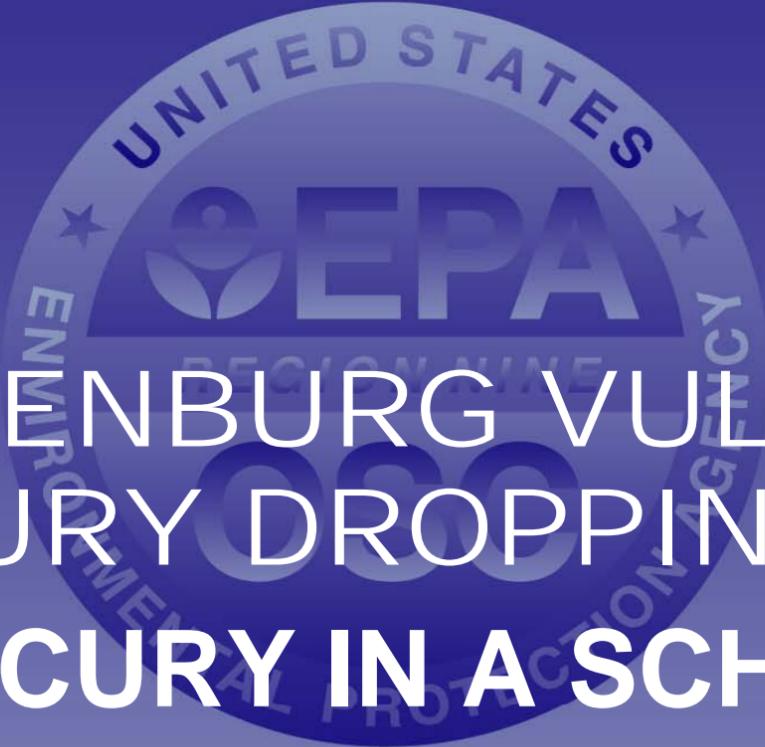
- ❖ Dependent on how long it has been released
- ❖ If it has been more than one day that the kids have been playing with it, entire school might have to be surveyed
- ❖ Survey kids prior to leaving school
  - **Keep all contaminated items at school**
- ❖ If multiple classrooms are contaminated, close school

# 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 kids homes may need to be surveyed
- ❖ Action Levels 1- 3 ug/m<sup>3</sup>
- ❖ **CALL EPA FOR ASSISTANCE**
  - **800-300-2193**

# Response: Most Important

- ❖ Turn off ventilation
- ❖ Use only a vacuum designed specifically for mercury
- ❖ Conduct constant air monitoring
- ❖ No mercury spill is ever fully assessed without a MERCURY VAPOR ANALYZER



WICKENBURG VULTURE  
MERCURY DROPPING SITE  
**MERCURY IN A SCHOOL**

# SUMMARY

- ❖ Gym, locker room, cafeteria, and music room contaminated
- ❖ 10 homes surveyed
- ❖ Mercury amalgamation used
- ❖ Fact sheet sent out to community
- ❖ Agencies: EPA, ADEQ, ADH









# Course Agenda

- ❖ Introduction and Case Study
- ❖ Mercury Basics
- ❖ Health Effects of Mercury
- ❖ Using Personal Protective Equipment
- ❖ Intro to Mercury Responses
- ❖ **Cleanup Techniques and Response Issues**
- ❖ Mercury Vapor Analyzers and Other Instrumentation

# Techniques and Response Issues

- ❖ Action Levels
- ❖ Source Removal
- ❖ Sulfur Amalgamation
- ❖ Decontamination
- ❖ Disposal Considerations
- ❖ Documentation



# Units of Measure

- ❖  $1 \text{ mg} = 1,000 \text{ } \mu\text{g}$
- ❖  $1 \text{ } \mu\text{g} = 1000 \text{ ng}$
- ❖  $1.0 \text{ ng} = 0.001 \text{ } \mu\text{g}$
- ❖  $1.0 \text{ } \mu\text{g} = 0.001 \text{ mg}$
- ❖ Old Jerome reads in mg
- ❖ Lumex usually set to read in ng
- ❖  $1000 \text{ ng} = 1.0 \text{ } \mu\text{g} = 0.001 \text{ mg}$

# Action Levels for Mercury in Air

- ❖  $< 1,000 \text{ ng/m}^3$  (residential) – ATSDR
- ❖  $25,000 \text{ ng/m}^3$  (ACGIH – TLV based on 8-hr day)
- ❖  $0.1 \text{ mg/m}^3$  (OSHA – PEL, ceiling)
- ❖  $0.05 \text{ mg/m}^3$  (NIOSH – REL, skin based on 10-hr day)

# Where does 1,000 ng/m<sup>3</sup> come from?

- ❖ ATSDR
- ❖ Based on risk to human health
- ❖ Review ATSDR Toxicological Profile (1999) available on internet
- ❖ First publication of this AL for residential indoor air came out of Nicor Gas response in Region 5 (Chicago)
- ❖ Chemical-Specific Health Consultation for Joint EPA/ATSDR National Mercury Cleanup Policy Workgroup, 3/22/12

# Action Levels for Mercury in Soil and Waste

- ❖ For Waste Disposal
  - ❖ 20 mg/kg (CA TTLC)
  - ❖ 0.2 mg/L (TCLP/ STLC)
  - ❖ 260 mg/kg (LDR)
- ❖ In Soil (elemental Hg)
  - ❖ 6.7 mg/kg (residential soil RSL)
  - ❖ 28 mg/kg (industrial soil RSL)

# Action Levels for Mercury in Water

- ❖ In Water (elemental Hg):
  - ❖ Surface Water – 1.2 ng/L
  - ❖ Drinking Water (MCL) – 2 µg/L
  - ❖ Tap Water (PRG) – 0.63 µg/L
  - ❖ Tap Water (PRG for methyl mercury) – 3.7 µg/L
  - ❖ CA RWQCB RBSL (drinking water) – 0.012 µg/L

# After Detection - Isolation

## ❖ Isolation

- Limit the number of people entering the house until a clean-up plan is in-place
- Mercury contamination is spread easily into cracks in floor tiles, sink drains, and cracks/treads in your work boots!!!
- Fire Departments beware...consider booties and tyvek instead of turnouts.

# Source Removal

Before decontamination ensure **VISIBLE** mercury has been removed – use a **mercury – specific vacuum**



# Sulfur Amalgamation

**The process: add elemental mercury to an inorganic reagent (copper, gold, nickel, zinc or sulfur) to form a semi-solid substance (AMALGAMATION)**



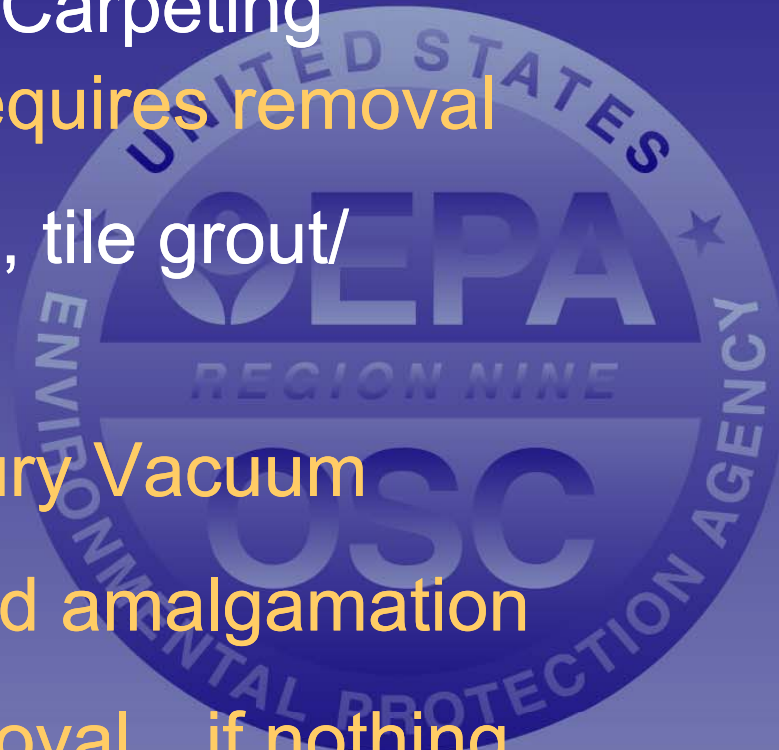
# Sulfur Amalgamation

Use it after all visible mercury has been removed



# Decontamination

- ❖ Upholstery/ Carpeting
  - Usually requires removal
- ❖ Baseboards, tile grout/ mastic
  - Try Mercury Vacuum
  - Then liquid amalgamation
  - Then removal...if nothing works...use epoxy (encapsulate as last resort)



# Decontamination

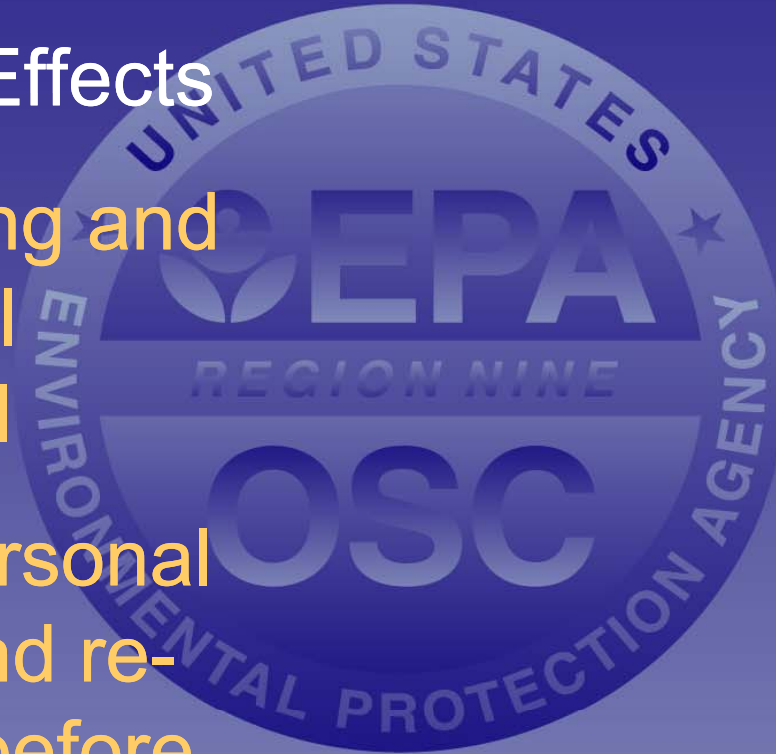
- ❖ Drains (p-trap) and Garbage Disposals
  - Removal



# Decontamination

## ❖ Personal Effects

- Screening and Potential Disposal
- Heat Personal Items and re-screen before disposal



# Heating and Ventilating

- ❖ Try to use existing HVAC\*
- ❖ Monitor with thermometers
- ❖ Check for sprinkler system
- ❖ Use activated carbon filter when venting



If contamination is widespread (e.g. whole house); otherwise you can also use space heaters and sealing off of rooms to use this technique on larger buildings

# Special Disposal Considerations

- ❖ Waste Sulfur (Mercury)
- ❖ Carbon Filters
- ❖ Soil and Debris
  - Appliances – additional issues
  - Contaminated HHW
- ❖ RQ, NA3077, Hazardous waste solid (D009), 9, III
- ❖ Waste Management in Wisconsin will recycle elemental mercury

# Documentation

- ❖ Keep a log of personal items
- ❖ Home Screening Forms in Guidebook
- ❖ Community Fact Sheet
  - ❖ PR person — there will be Press
- ❖ EPA has generic fact sheets available (see website)

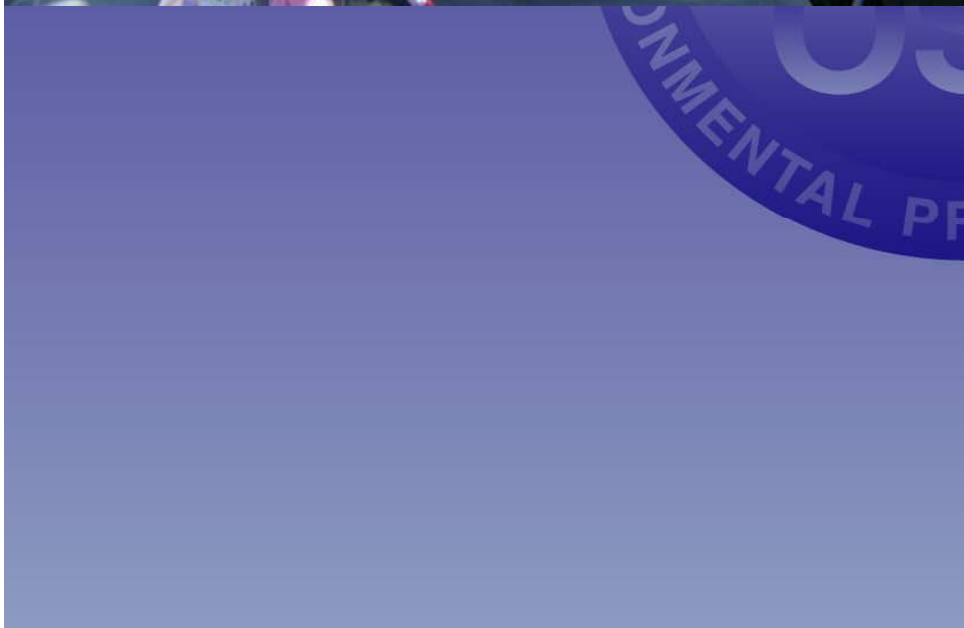
# Mission Viejo Mercury

- ❖ Spill from a blood pressure cuff in a residence
- ❖ Spill cleanup by contractor to the PRP with oversight and assistance from EPA.









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# Mercury Response Equipment



# Mercury Vapor Analyzers – First Response

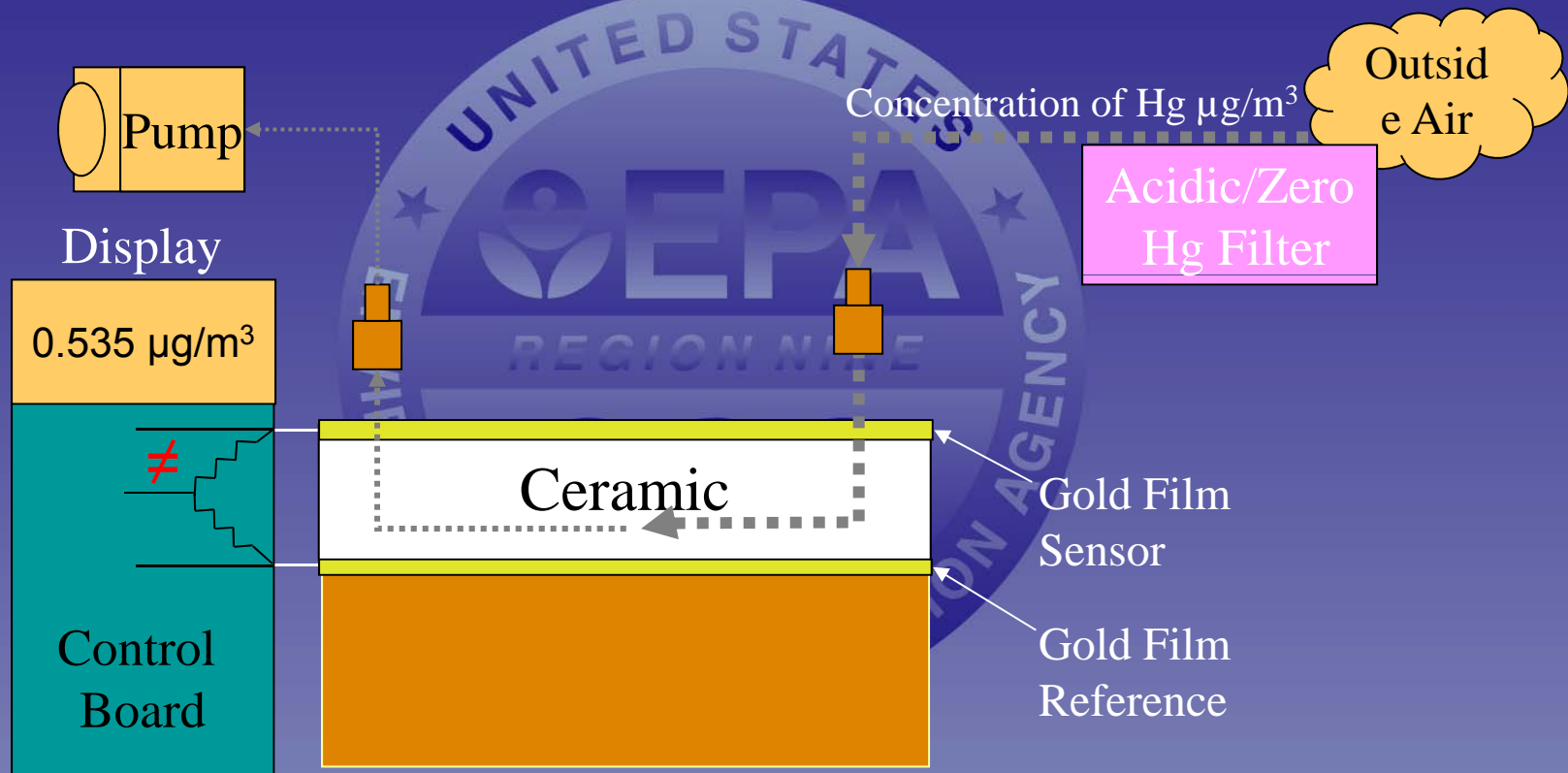


Most commonly used: Jerome  
431-X (Gold Film Technology)

Better Detection Technology:  
Atomic Spectroscopy

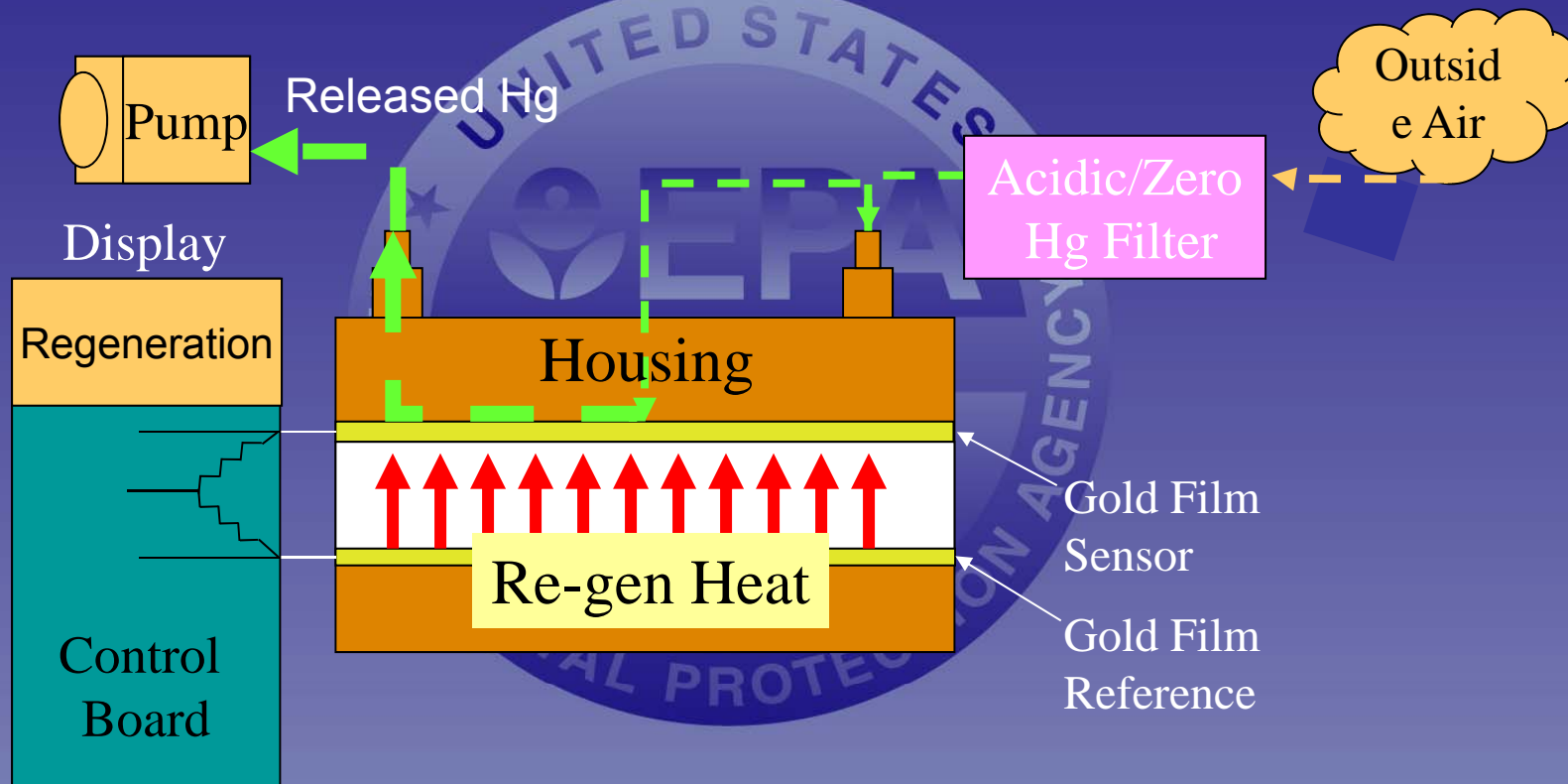


# General Gold Film Technology Sampling Flow



\*\*\*Slide graphic courtesy of Arizona Instruments

# General Gold Film Technology Regeneration Flow



\*\*\*Slide graphic courtesy of Arizona Instruments

# JEROME 431-X: Least Sensitive



# Jerome 431-X Uses



- ❖ Most useful for gross mercury contamination assessment
- ❖ At EPA Region 9 ERS sites, the Jerome is mostly used for health and safety monitoring (instrument detection limit of approximately 5,000 nanograms per cubic meter ( $\text{ng}/\text{m}^3$ ) ( $0.005 \text{ mg}/\text{m}^3$ ))

# Jerome 431-X Limitations



- ❖ Sensitivity of the Jerome =  $3,000 \text{ ng/m}^3$  ( $0.003 \text{ mg/m}^3$ )
- ❖ Detection Range =  $3,000 \text{ ng/m}^3$  to  $999,000 \text{ ng/m}^3$  ( $0.003 \text{ mg/m}^3$  to  $0.999 \text{ mg/m}^3$ )
- ❖ Accuracy is  $\pm 5\%$  at  $100,000 \text{ ng/m}^3 \text{ Hg}$  ( $0.100 \text{ mg/m}^3 \text{ Hg}$ )

# Jerome 431-X Costs



## ❖ Made by Arizona Instruments

Arizona Instruments  
1912 West 4th Street  
Tempe, Arizona 85281  
(800) 390-1414

❖ Purchase Price      Approximately \$5,500

❖ Rental Price      Approximately \$540/week  
or \$1620/month

# JEROME J 405: More Sensitive, Still Gold Film Technology



# Jerome J 405



- ❖ 1st units out in the field July 2006
  - Side-by-side comparison at Vineyard Mercury Response was less than perfect
  - San Bernardino Co. Fire has 2 units
- ❖ May be a potentially-good middle-of-the road instrument (middle price and middle level of sensitivity range)
- ❖ Have to regenerate. Need to practice with it.

# Jerome J 405 Attributes



- ❖ Sensitivity of the J405 =  $500 \text{ ng/m}^3$  ( $0.0005 \text{ mg/m}^3$ )
- ❖ Detection Range =  $500 \text{ ng/m}^3$  to  $3,000,000 \text{ ng/m}^3$  ( $0.0005 \text{ mg/m}^3$  to  $3 \text{ mg/m}^3$ )
- ❖ Accuracy is  $\pm 10\text{-}20\%$  (survey mode is  $20\%$ )
- ❖ These are manufacturer's published values

# Jerome J 405 Manufacturer and Cost



## ❖ Made by Arizona Instruments

Arizona Instruments  
1912 West 4th Street  
Tempe, Arizona 85281  
(800) 390-1414

## ❖ Purchase Price — Approximately \$8,500 (without data logging)

# Detection Instruments

## JEROME J405 & 431-X Comparison

*Residential Limit 1.0*

*Industrial Limit 25.0*

$\mu\text{g}/\text{m}^3$

$\mu\text{g}/\text{m}^3$

Gold Film  
Technology

Jerome® 431-X

Jerome® J 405

0.1 0.2 0.3 0.4 0.5 0.6 0.7 0.8 0.9 1.0 2.0 3.0 4.0 5.0 6.0 7.0 8.0 9.0 10 50 100 500 1000 3000

Micro-grams/cubic meter ( $\mu\text{g}/\text{m}^3$ )

\*\*\*Slide graphic courtesy of Arizona Instruments

# After Detection – Isolation Equipment

Atomic Absorption



# Lumex 915+

## Most Sensitive and Most Versatile



# Lumex RA-915+ Basics

- ❖ Designed to determine the mercury vapor content in ambient air, water, soil, natural and stack gases, etc.
- ❖ Detects low level mercury vapors using portable atomic absorption spectrometer technology
- ❖ Built-in compressor
- ❖ Internal rechargeable source
- ❖ Capability to use an external rechargeable battery for field monitoring in remote areas



# Lumex RA-915+ Detection Limitations

- ❖ Sensitivity is 2 ng/m<sup>3</sup> (0.000002 mg/m<sup>3</sup>)
- ❖ Range of detection is 2 ng/m<sup>3</sup> to 50,000 ng/m<sup>3</sup>
  - In “high concentration” mode, the range is 500 ng/m<sup>3</sup> to 200,000 ng/m<sup>3</sup>
- ❖ Accuracy is ±20% in both the regular and high concentration modes
- ❖ Potential hydrocarbons interference issues



# Lumex RA-915+ Other Features



- ❖ Sample volume = 20 liters per minute (L/min)
- ❖ Data collection and data logging are done in real time and stored as a separate file
- ❖ Two attachments: mercury in soil and mercury in water

# Lumex RA-915+ Costs

## ❖ Manufacturer

Ohio Lumex Company  
9263 Ravenna Road, Unit A-3  
Twinsburg, Ohio 44087  
(888) 876-2611  
<http://www.OhioLumex.com>



- ❖ Purchase price – Approximately \$25,000  
\$18,000 for air mode only
- ❖ Rental price – Approximately 1,000/week  
or \$2,900/month

# Instruments for Isolation



Attribute	Lumex 915+	Jerome J405
Detection Range	0.002-25 $\mu\text{g}/\text{m}^3$	0.5-3000 $\mu\text{g}/\text{m}^3$
Precision	< 25% R* @ baseline	20% RSD @ 0.50 $\mu\text{g}/\text{m}^3$ 15% RSD @ 1.0 $\mu\text{g}/\text{m}^3$ 3% RSD >25 $\mu\text{g}/\text{m}^3$
Accuracy		+/-20% @ 0.5 $\mu\text{g}/\text{m}^3$ +/-10% @ 1.0 $\mu\text{g}/\text{m}^3$
Calibration		4 point 106,25,1,0.5 $\mu\text{g}/\text{m}^3$
* %D is not the same as %RSD. See Calculations.		

# Instruments for Isolation and Cleanup

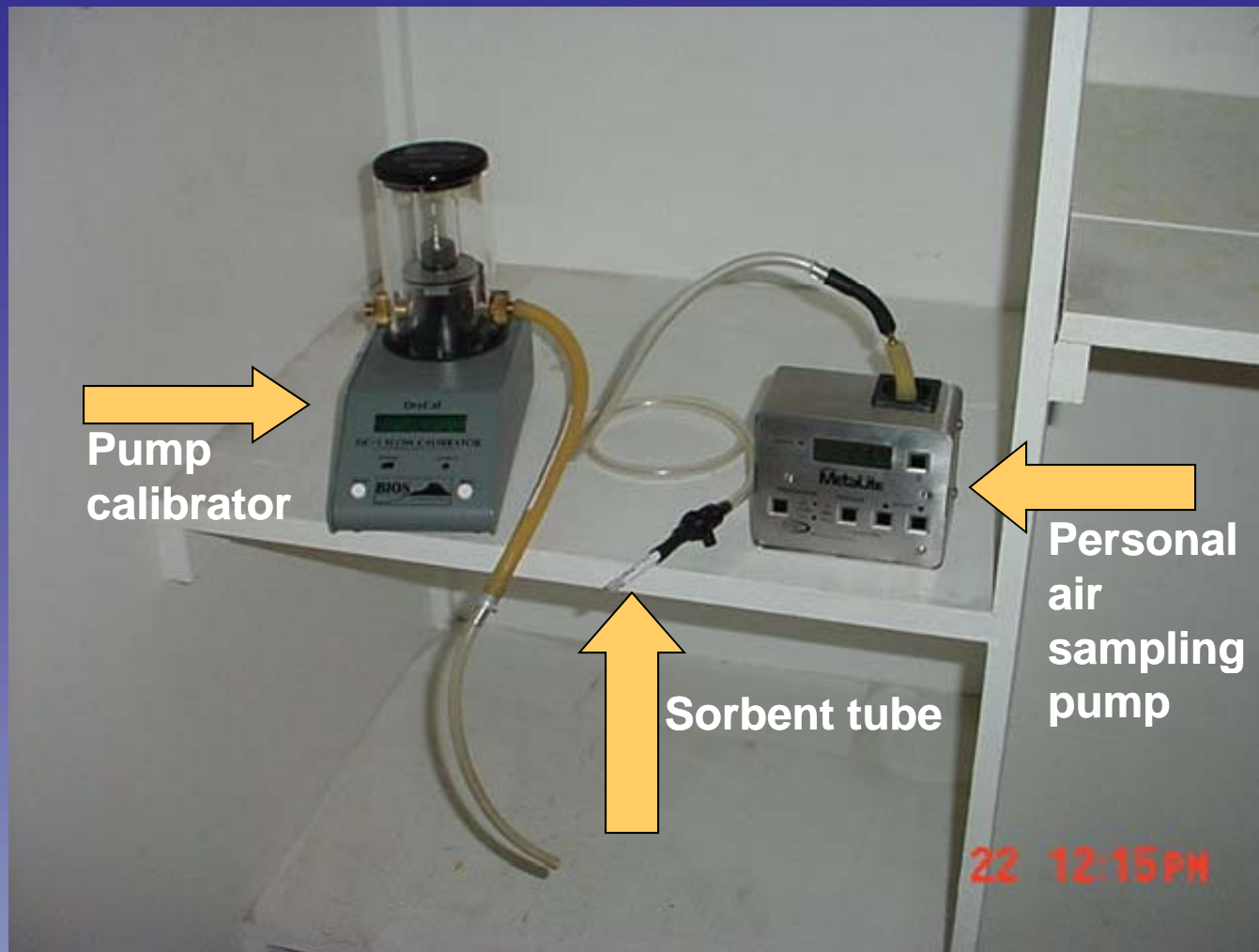


Attribute	Lumex 915+	Jerome J405
Warm up time	20 Min	0-5 Min**
Reference Cell	No	Yes
Zero (Baseline)	Manual	Automatic at begin of sample
Flow Volume	20 L/min	0.750 L/min closed loop
Size	460x210x110mm	280x160x170mm
Weight	7.58kg	2.5kg
** Special warm-up for reading $<1.0 \mu\text{g}/\text{m}^3$		

# After Mercury Cleanup – Air Sampling



# Air Sampling – Set-up



# Air Sampling – Laboratory Methods

- ❖ National Institute of Occupational Safety and Health (NIOSH) Method 6009
- ❖ Detection Limit – 3,000 ng/m<sup>3</sup>
- ❖ 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: 100–200 liters (larger volume = lower detection limit)
- ❖ Sample media = sorbent tubes (example: SKC tube #226-17-A @ [www.skcinco.com](http://www.skcinco.com))
- ❖ Sample Cost ~ \$40–\$70 per sample

# EQUIPMENT HANDS - ON

