



U.S. EPA



CARNEGIE  
INSTITUTION FOR  
SCIENCE

DEPARTMENT OF  
GLOBAL ECOLOGY

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# Mercury Capture in Artisanal and Small Scale Gold Processing

# Why focus on Gold Processing?

- Mercury-gold amalgam burned during gold purchasing – secondary processing of gold doree which still has mercury content of 5 – 20%
- Typically little or no control of emitted airborne mercury
- Regional funnel points for ASM gold production
- Located in regional economic centers
- Located in regional population centers – high human exposure rates



Gold Shops are a common selling point for mercury in artisanal scale mining communities



# Simplified ASGM gold shop processing cycle

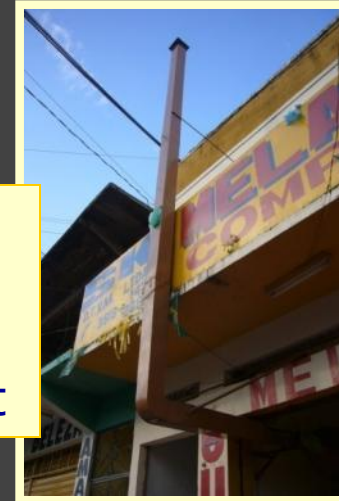
Amalgam or  
Doree

(5-15 % mercury)



Burned in the  
Gold shop

Mercury  
Released to  
the  
Environment



Purified Gold



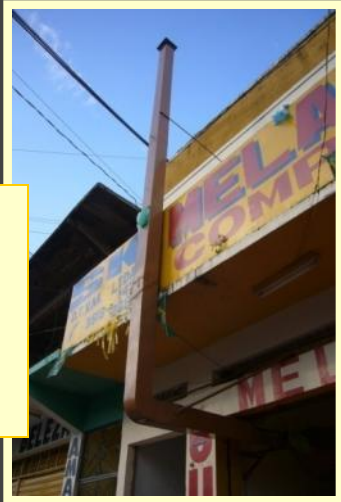
# Simplified ASGM gold shop processing cycle

Amalgam  
(5-15 % mercury)



Burned in the  
Gold shop

Mercury  
Released to  
the  
Environment



Mercury  
Capture System



Purified Gold



# Mercury Emissions Occur in High Population Areas in Brazil



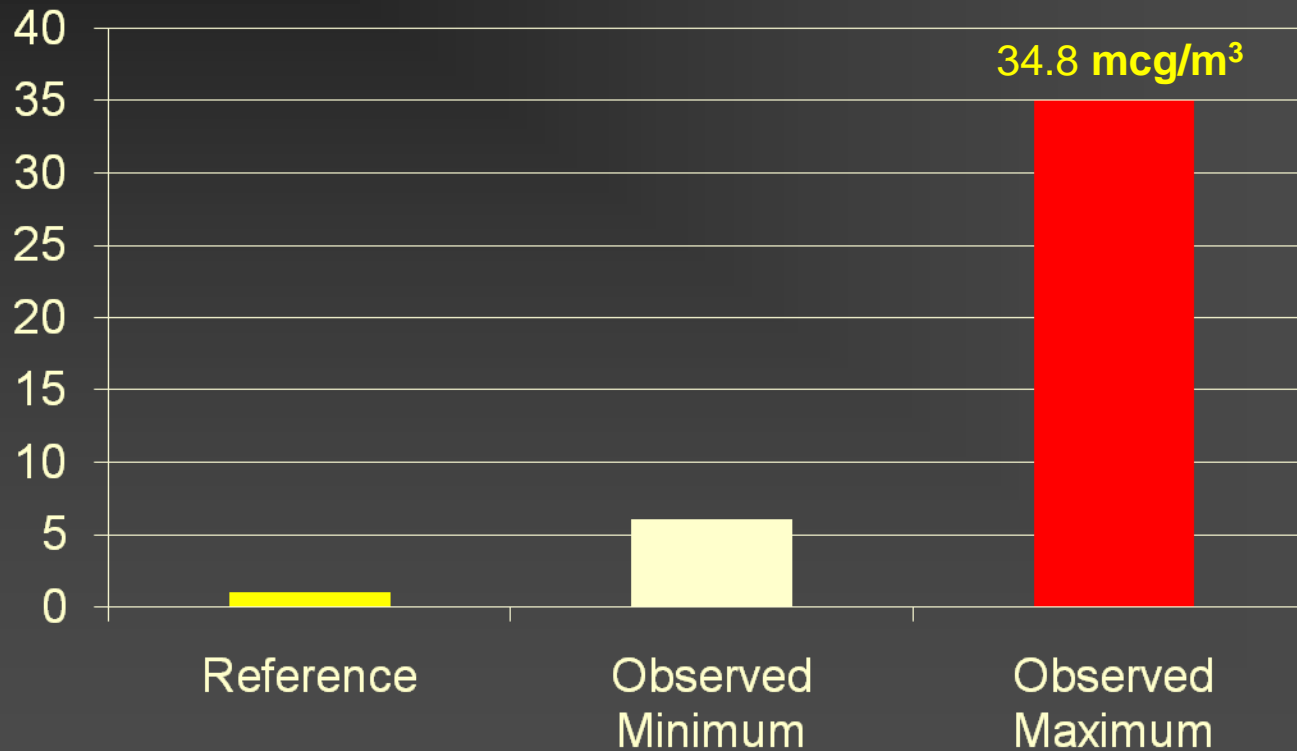


# Ambient Air Mercury Concentrations

Ambient air @ 1 block from gold shops, Puerto Maldonado, Peru

## Mercury Concentration (mcg/m<sup>3</sup>)

In streets in front of gold shops

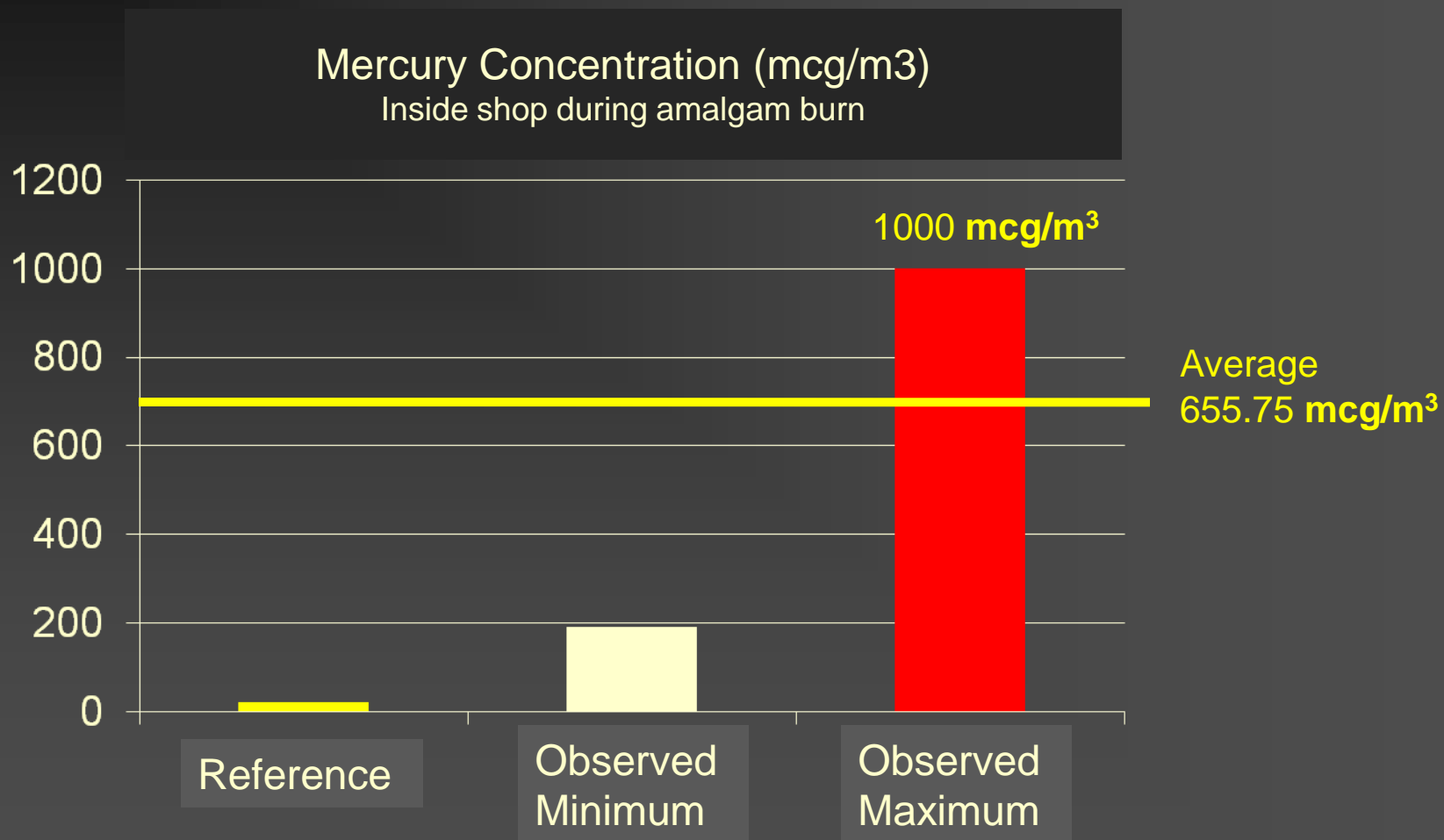


Reference Value: WHO maximum ambient air standard : **1 mcg/m<sup>3</sup>**



# Mercury levels in Gold Shops

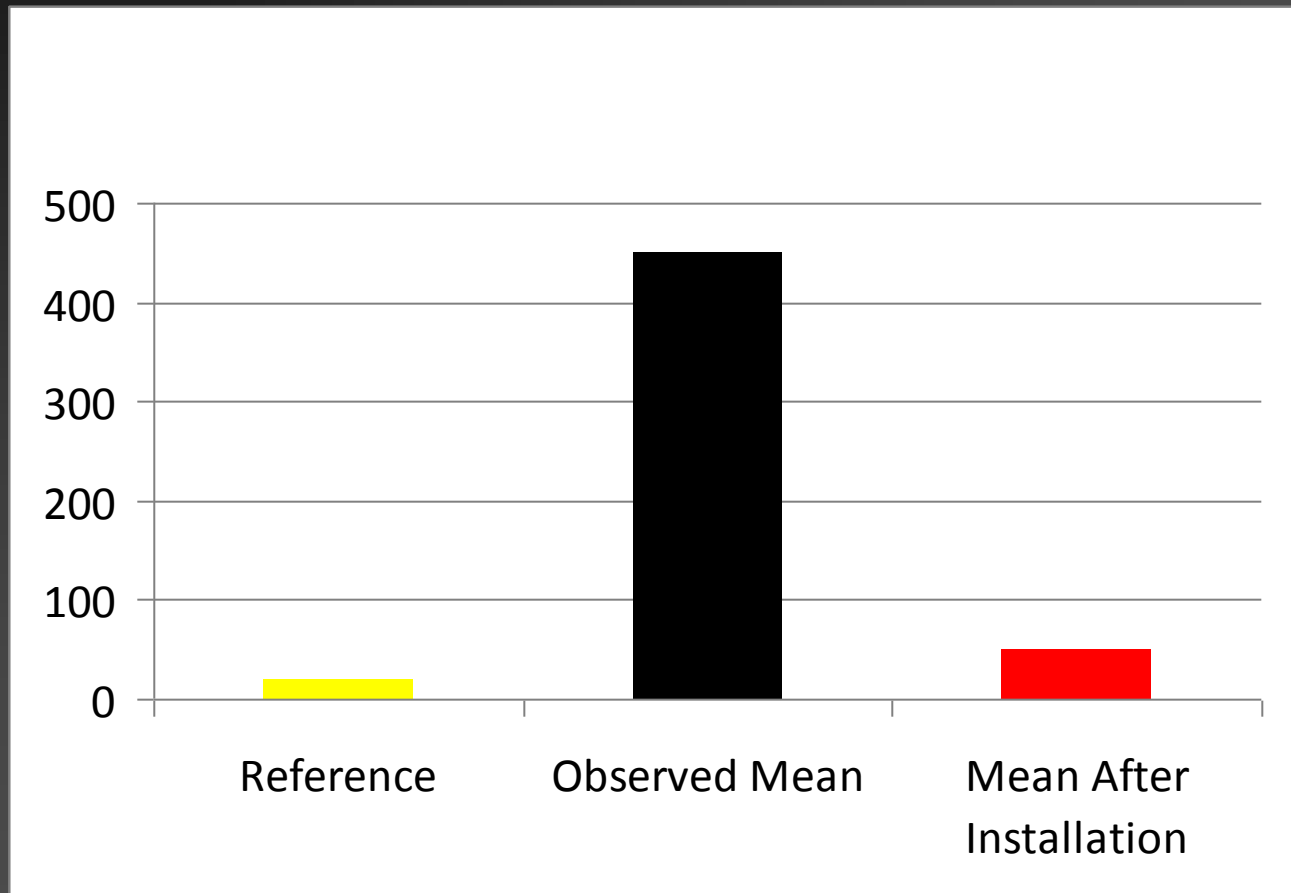
Average values: 14 shops. Madre de Dios, Peru



Reference Value: WHO maximum occupational Air Standard OSM: **20 mcg/m<sup>3</sup>**

# Occupational Safety Improvements after Installation

Mercury Concentrations Inside shop - A & M Metals , Puerto Maldonado



Reference Value: WHO maximum occupational air standard OSM: **20 mcg/m<sup>3</sup>**

# Example Mercury Emissions Reduction Calculation

If a gold shop processes 100 kg of gold amalgam per year

*and*

Assuming the amalgam contains 10% mercury

*then*

Mercury emissions for this shop = **10 kg mercury per year**

*(100 kg x 10% mercurio = 10 kg)*

With recommended installation and use,  
a Mercury Capture System running at 80 % capture efficiency would result  
in

**8 kg of mercury emissions prevented per year per gold shop**

# Designing a Mercury Capture System

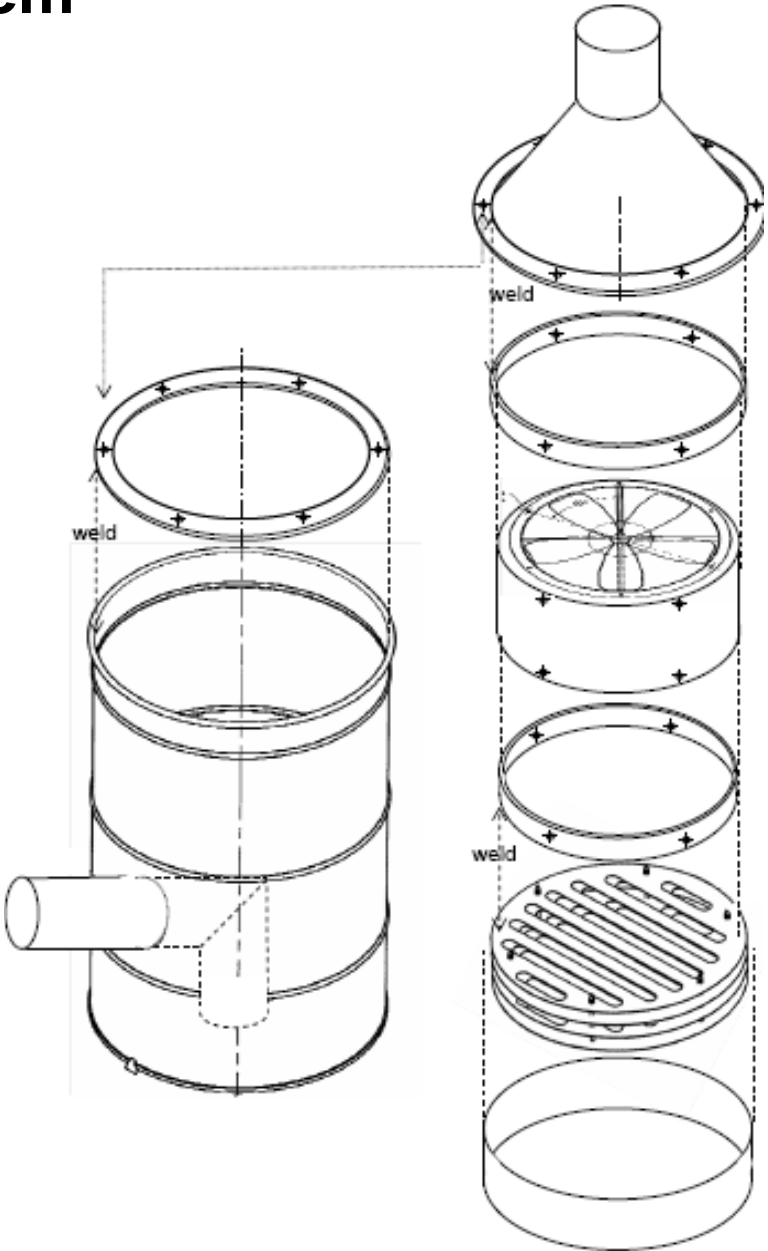
## Design Principles

1. Effective in capturing mercury vapor and aerosols to reduce environmental release and human exposure
2. Affordable for the majority of gold shops in developing countries
3. Easy to construct using locally available materials and local technologies
4. Low maintenance

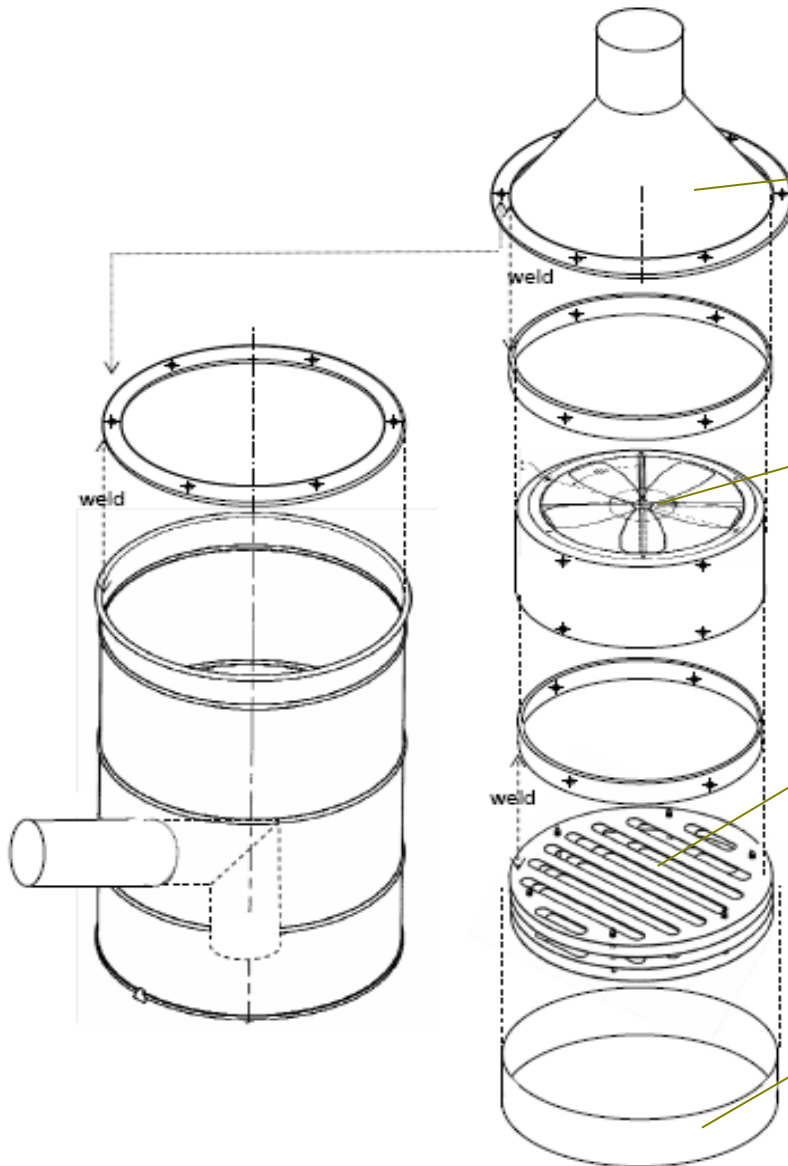


With EPA funds, Argonne engineers developed a mercury capture system prototype using thermodynamic mercury aerosol simulation models.

# EPA/ANL Mercury Capture System



# EPA/ANL Mercury Capture System



Interior of the top cone showing the flow-smoothing vane



The system contains a powerful extractor fan to create negative air pressure to draw exhaust into the System



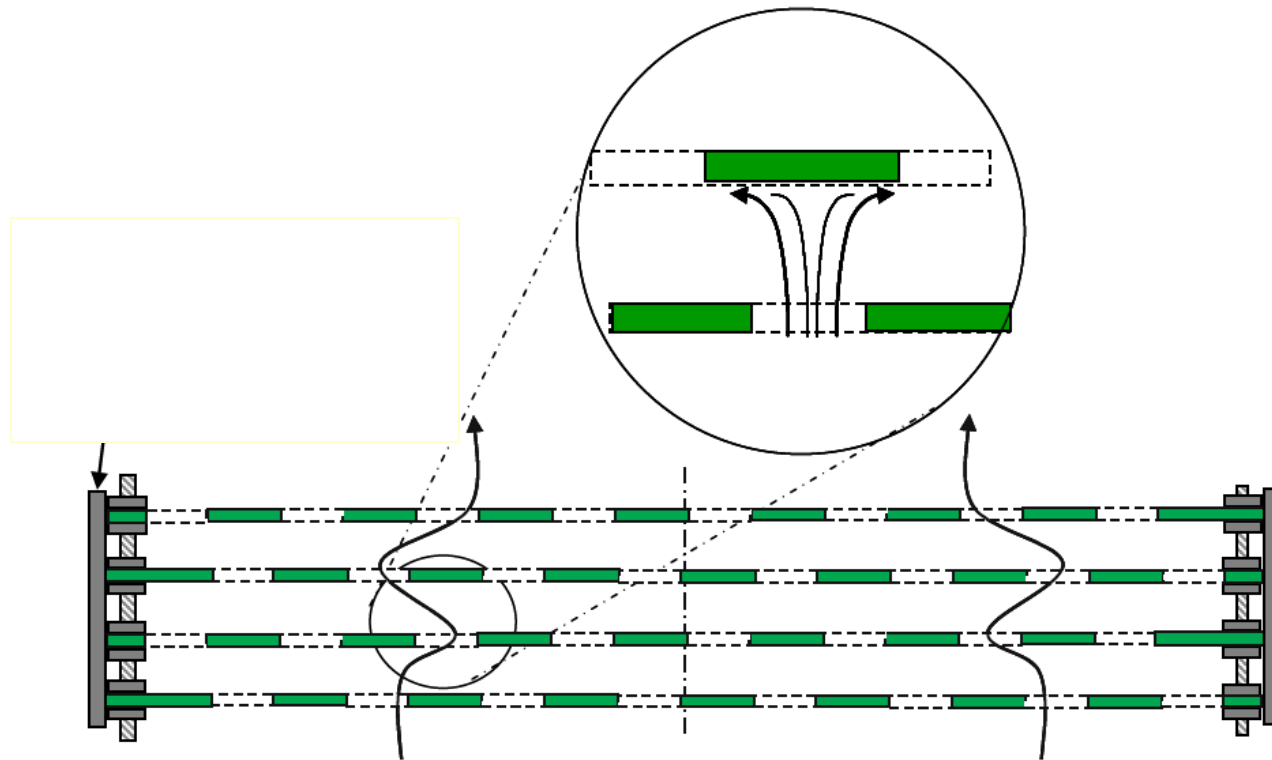
A series of baffle plates act as impaction surfaces for mercury aerosols to strike and coagulate .



The extractor fan and the baffle plates are joined in a single unit that is easy to transport and insert into a 200 liter drum.

# Mercury Aerosol Particles Impinge on the Baffle Surface

1



# Simple Construction







# Modular Assembly



# Flexible System Installation

Itaituba and Creporizao, Brazil



# Pilot System Capture Efficiency

Field efficiency tests: 2007-2008

## Mercury Concentrations in Exhaust

Mean of 6 tests runs burning 100% mercury samples

Exhaust without treatment: 1580 mg/m<sup>3</sup>

Exhaust with treatment : 330 mg/m<sup>3</sup>

>80% measured removal efficiency



Cost of system: Materials + Labor + Installation ~ US \$450

# Installation of Pilot Mercury Control System

## Ananea, Puno



# Installed Mercury Control System

Cooperativa Santiago. Ananea, Puno

November 2009



# Madre De Dios – Return to See Mercury Capture System Replication

- Puerto Maldonado
- Masuko
- Huepetue



# Puerto Maldonado, Madre de Dios November 2009 – Ongoing Replication

- **Gold shop : Golden Peru Oro**
  - Installed EPA Design system August 2009
  - Owner purchased system from a local manufacturer and is now selling the systems to other gold shops in Madre de Dios
  - The owner actively promotes system use , and is a source for information on more responsible use of mercury
- **Conclusion**
  - Private sector may promote the spread of appropriate technologies, if local markets are provided needed information to develop demand.





# Masuko, Madre de Dios

## Ongoing Replication Background

- Gold shop: E +M Gold
  - EPA design system installed in June 2009
  - Owner purchased system from a local business in Puerto Maldonado
  - Reasons owner stated for buying system
    - Health of children
    - To reduce pollution of the environment
  - Owner also sold retorts and promoted use



# Huepetue, Madre de Dios

## Ongoing Replication

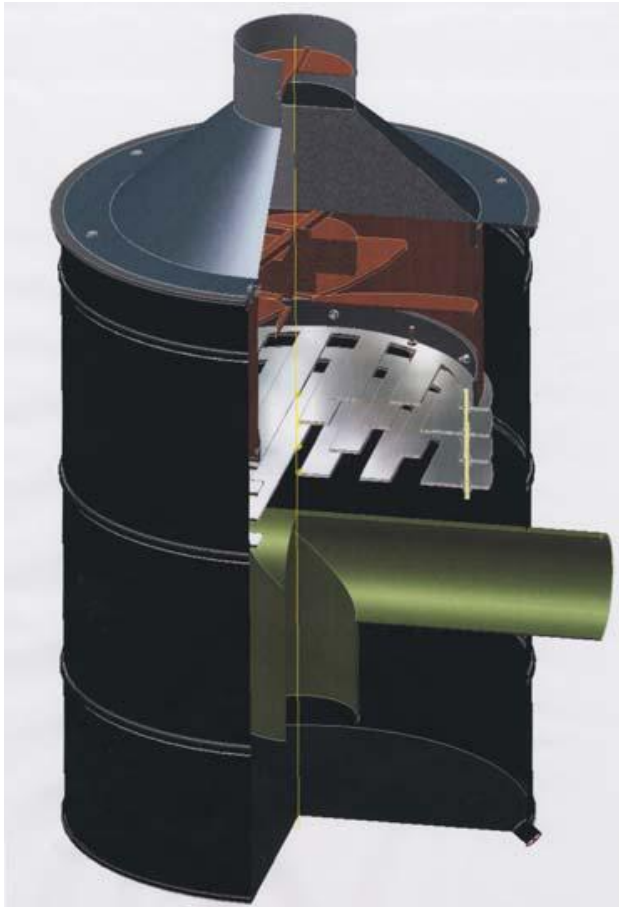
November 13, 2009

- **Gold shop : Oro Yornet**
- Installed EPA Design system May 2009
- System was donated by DREM (Regional Mining Agency) as a demo Pilot to incentivize use in Huepetue
- The owner actively promotes system use , and is a source for more responsible use of mercury in Huepetue
- **Conclusion**
- If trained, agents can promote solutions multiplying efforts to disseminate appropriate technologies



# EPA / Argonne Mercury Capture System For ASM Gold Shops

## Summary



Effective, low cost, field tested Hg reduction system for ASM gold shops

Base system reduces Hg emissions more than 80%

Add on filters in development to further reduce emissions

- Affordable - US\$ 450 materials + labor (Brazil and Peru Amazon)
- Lightweight - 50 kg
  - Easily transportable
- Simple Construction:
  - Uses commonly available 200 liter drums
  - 1- 1.5 days in a small metal shop
- Simple straight-forward installation
  - 3 hours labor (avg; Peru and Brazil)
- Mercury captured and retrieved through a spigot at bottom can be recycled