



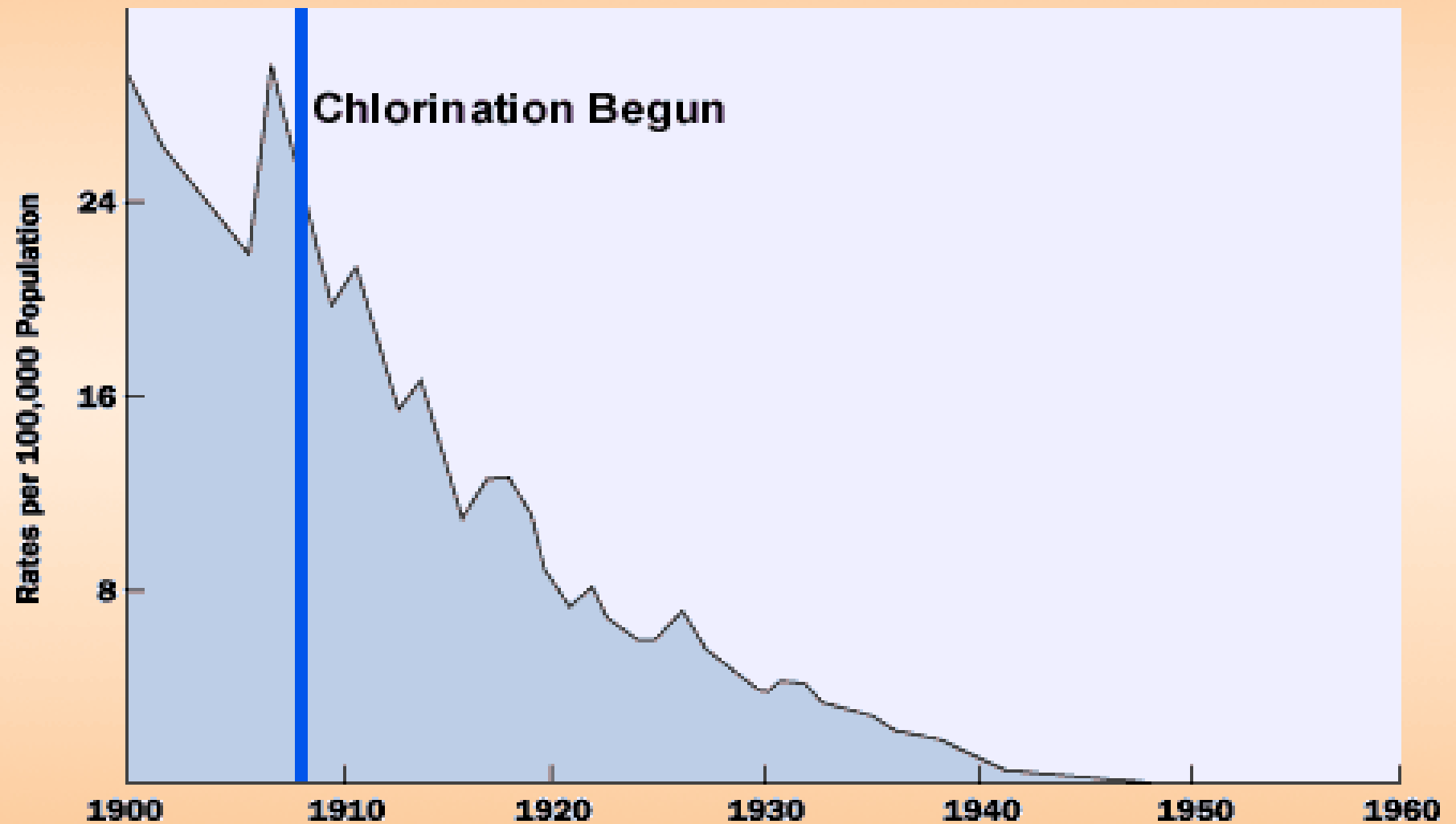
Disinfection of municipal water systems through on-site hypochlorite generation

Saipan Environmental Conference 22-June-09

History of chlorination in potable water

- **1850-** John Snow attempts to disinfect Broad Street pump in London after Cholera outbreak
- **1897-** Sims Woodhead uses "bleach solution" to sterilize potable water distribution mains in England following a typhoid outbreak
- **1908-** New Jersey begins using continuous chlorination.

Death Rate for Typhoid Fever United States, 1900-1960



Source: U.S. Centers for Disease Control and Prevention, Summary of Notifiable Diseases, 1997.

3 Most Common Types of Chlorination

- **Gas Chlorine:** 100% available chlorine
- **Bulk Sodium Hypochlorite:** 12.5-15%
- **On-Site Generation:** 0.8%

Why Convert from Gas Chlorine to Liquid?

- “Chlorine gas shipped to municipal water treatment facilities could be terrorist target” Naturalnews.com, September 03, 07 Author: David Gutierrez
- “Chlorine Gas From South Carolina Train Crash Kills Nine” Environmental news service
- “NIGERIA: Chlorine gas from water plant kills three in southeast” www.irinnews.org

The Road to On-Site Chlorination For Navy WTP, Guam



Guam Navy WTP

- Produces on average 10.5 MGD/day
- Chlorine Demand= 300 lb/day
- Source: 1 Ton Cylinders
- Decided to convert to on-site generation during P-256 Upgrade in 2006.

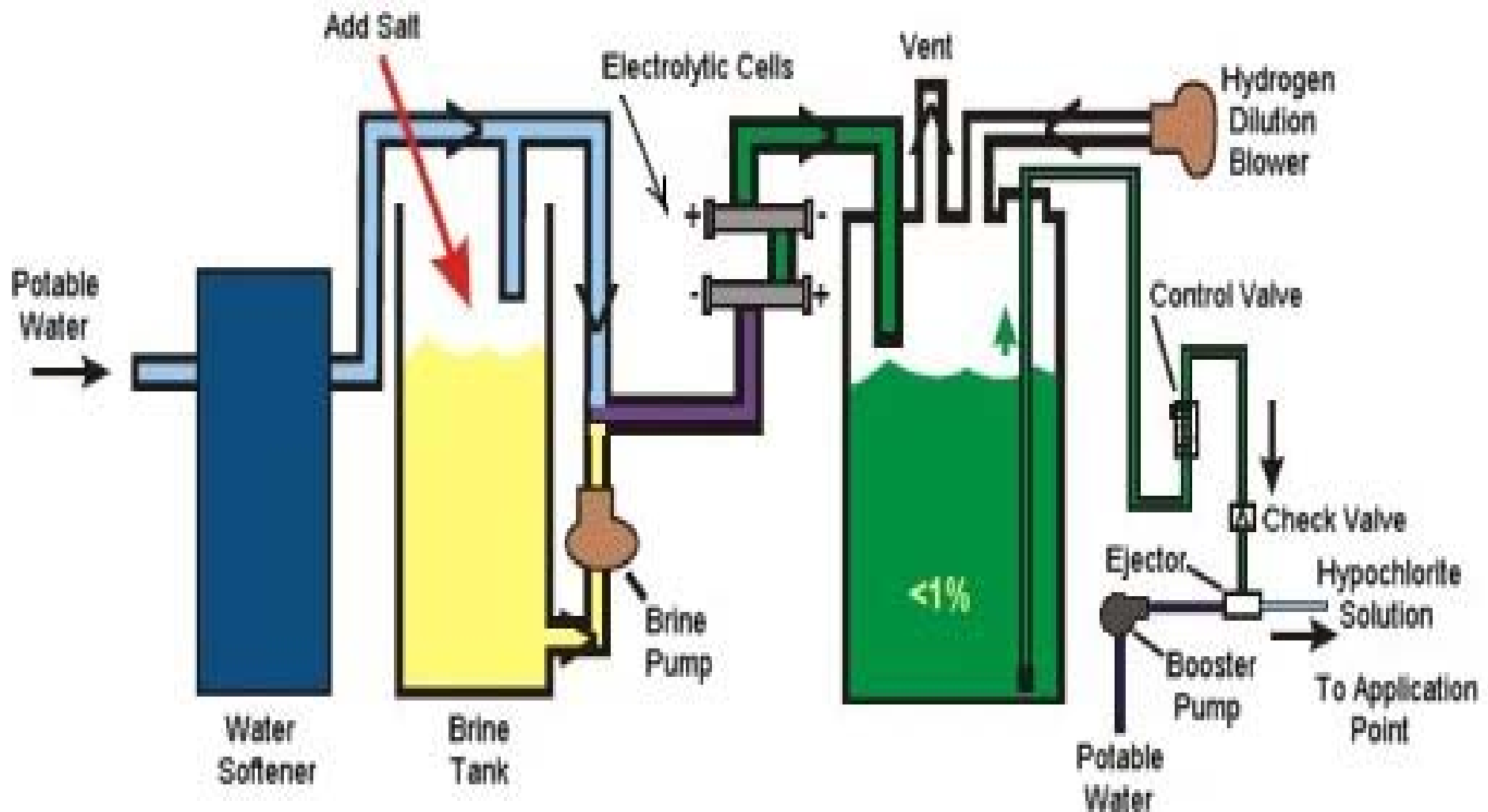




Why On-Site Generation?

- Safety of water treatment personnel and nearby residents.
- Eliminates the need for chlorine storage, reducing overall footprint.
- Does not require a Risk Management Plan or Hazmat Training like Bulk Hypochlorite and Gas Chlorine.
- Operating Cost

Hypo-Chlorite Generator







EXIT

↑ CHILLED WATER RETURN

← CHILLED WATER SUPPLY

MOCK #1

Normally Open

→ CHILLED WATER SUPPLY

← CHILLED WATER RETURN

↑ CHILLED WATER RETURN

← CHILLED WATER SUPPLY

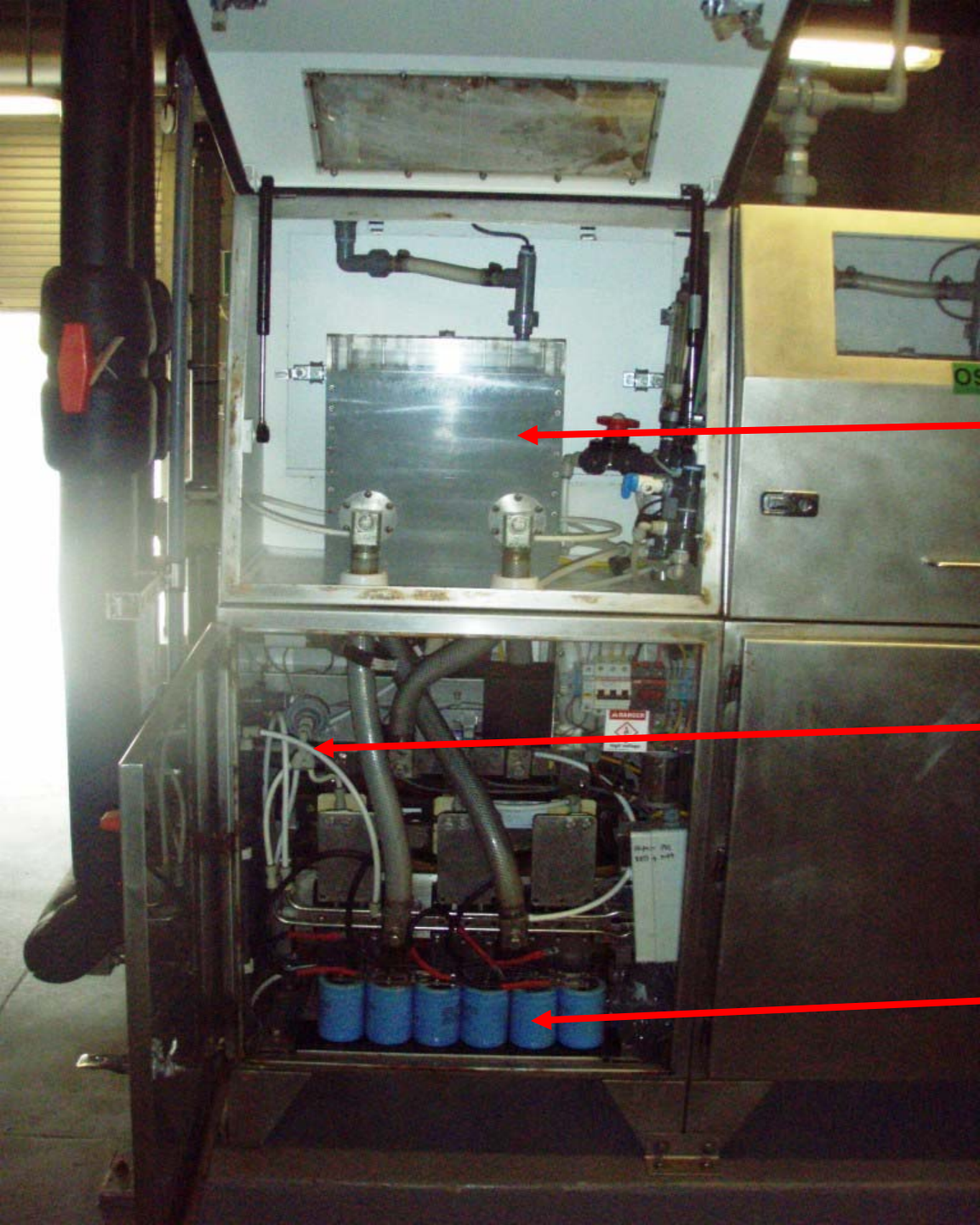
MOCK #2

Normally Open









On Site Generator
Converts salt water
to hypochlorite

Water Lines For
Cooling

High Voltage
Transformers

OSEC *Economics*



Salt

Water



Sodium
Hypochlorite

Hydrogen

3.0 lb. Salt / lb. Cl₂

+

2.0 kWh / lb. Cl₂

+

15 gallons H₂O / lb. Cl₂

15 gallons Hypo @ 0.8% concentration

On Site Generation Vs. Gas Chlorine Costs

○ On-Site Generation

- Salt Costs
 - Requires 3lb/1lb
 - \$1.12/lb
- Energy Costs
 - 2 kWh/ 1lb cl₂
 - \$0.55/ 1 lb cl₂
- **Total Costs=1.67/lb**

○ Gas Chlorine

- \$5,361/Ton (Average)
- **Total Costs=\$2.68/lb**

Maintenance

- Acid Wash Cells
- Repair Leaks
- Change Cartridge Filters
- Clean Brine Tank





Set backs along the way!

- Corrosion
- Cell Fouling
- Temperature
- Single Point Failures



Pushing Forward

- On-Site Generation is a Continuing Technology
 - Reduced Corrosion Impacts through coating electrical connections
 - Replaced stainless steel with plastic
 - Replaced Water Cooling Lines with Air cooling blower w/redundancy
 - Balanced Voltage/Amp Supply to generate less heat



Future of Chlorine for Potable Water Disinfection

- DBP's
 - Precursor Removal
 - GWUDI
 - Cost
 - Gas
 - On-Site Generation
 - Multi-Barrier Approach
 - Residual in distribution system



On-Site Hypochlorite Generation Review

- It's Safe
- It's Relatively New
- It's Proven Efficient
- It's Transportable
- It's Here to Stay