Disinfection of municipal water systems through on-site hypochlorite generation

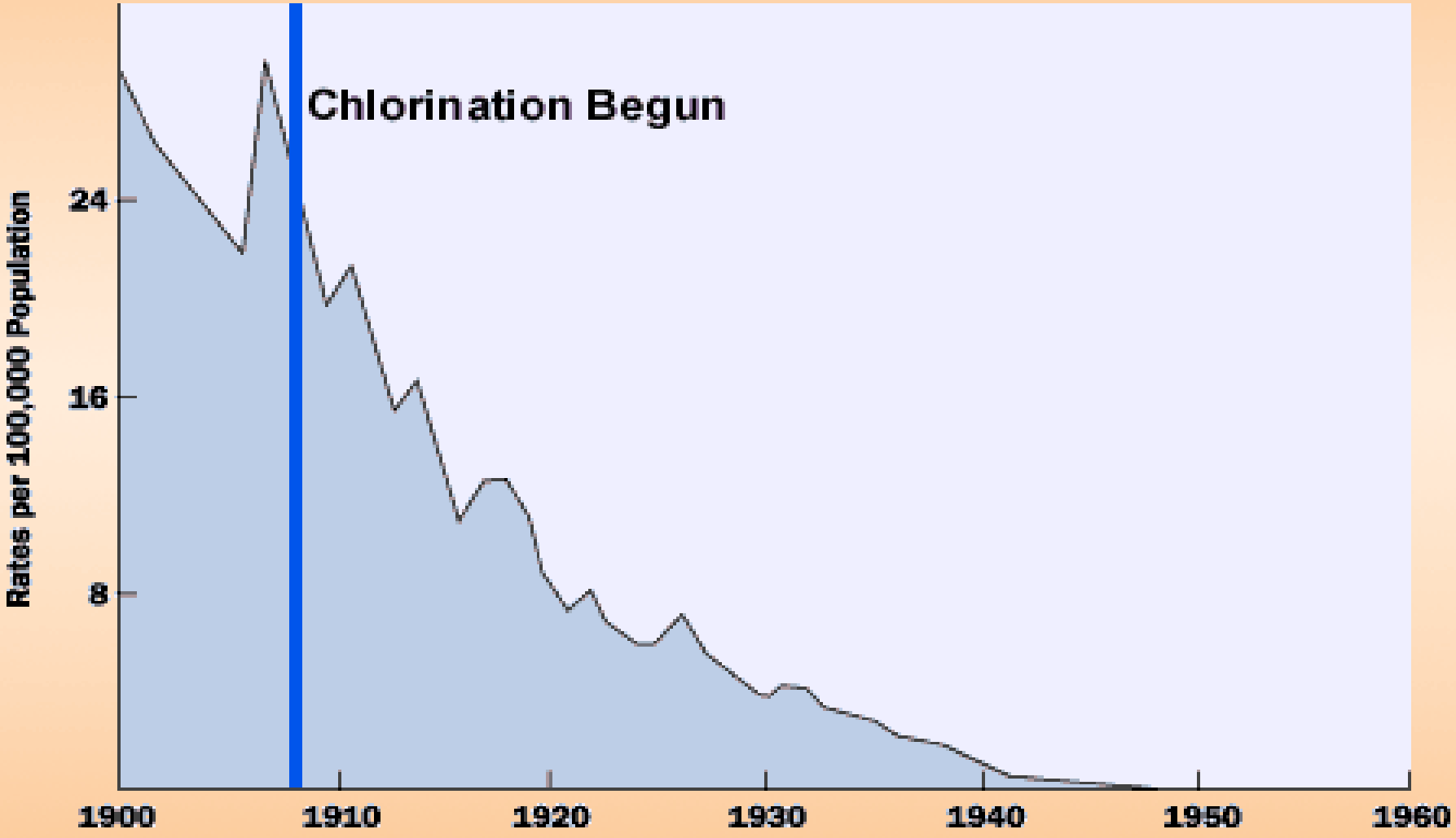
Saipan Environmental Conference 22-June-09

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.

Source: “The History of Chlorine” By Keith Christman
http://www.waterandhealth.org/drinkingwater/history.html

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%

Source: “The History of Chlorine” By Keith Christman
http://www.waterandhealth.org/drinkingwater/history.html

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

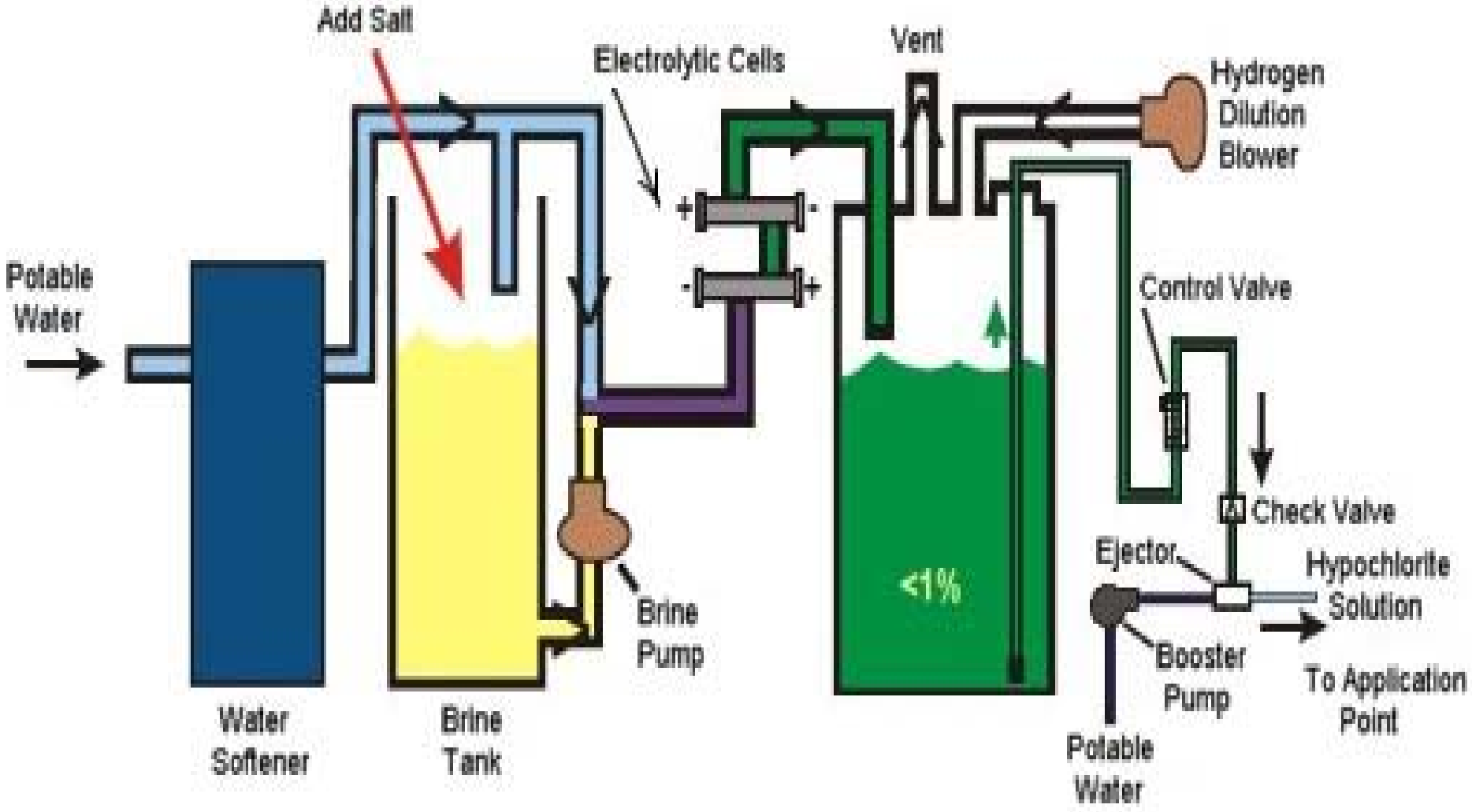
Guam Navy WTP

- 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




ON
OFF
COLD WATER SUPPLY
COLD WATER SUPPLY


EXIT
CHILLED WATER RETURN
CHILLED WATER SUPPLY
BOX #1
BOX #2
Normally Open

On Site Generator
Converts salt water
to hypochlorite

Water Lines For
Cooling

High Voltage
Transformers

OSEC *Economics*

$$NaCl + H_2O + Electricity \longrightarrow NaOCl + H_2$$

Salt + Water → Sodium Hypochlorite + Hydrogen

3.0 lb. Salt / lb. Cl_2

+

2.0 kWh / lb. Cl_2

+

15 gallons H_20 / lb. Cl_2

→ 15 gallons Hypo @ 0.8% concentration

Source: www.pollutionenginneering.com

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