Sodium Hypochlorite – an Alternative to Chlorine Gas: Considerations & Lessons Learned

Presentation to the

South Texas AWWA/WEAT

By:

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Engineers...Working Wonders With Water™

Agenda

1. Considerations when switching to an alternate disinfection storage and feed system
2. Discussion of alternatives
   a. Dilute on-site sodium hypochlorite generation (OSHG)
   b. High strength OSHG
   c. Bulk sodium hypochlorite
3. Lessons learned
4. Questions

Considerations if switching to an alternate system

Low probability of a major Cl_2 gas leak can be overshadowed by consequences of exposure

Cl_2 Exposure Concentration	Effects
1-3 ppm	Mild mucous membrane irritation
5-15 ppm	Moderate irritation of upper respiratory tract
30 ppm	Immediate chest pain, vomiting, dyspnea and cough
40-60 ppm	Toxic pneumonitis & pulmonary edema
430 ppm	Lethal over 30 minutes
1,000 ppm	Death within a few minutes

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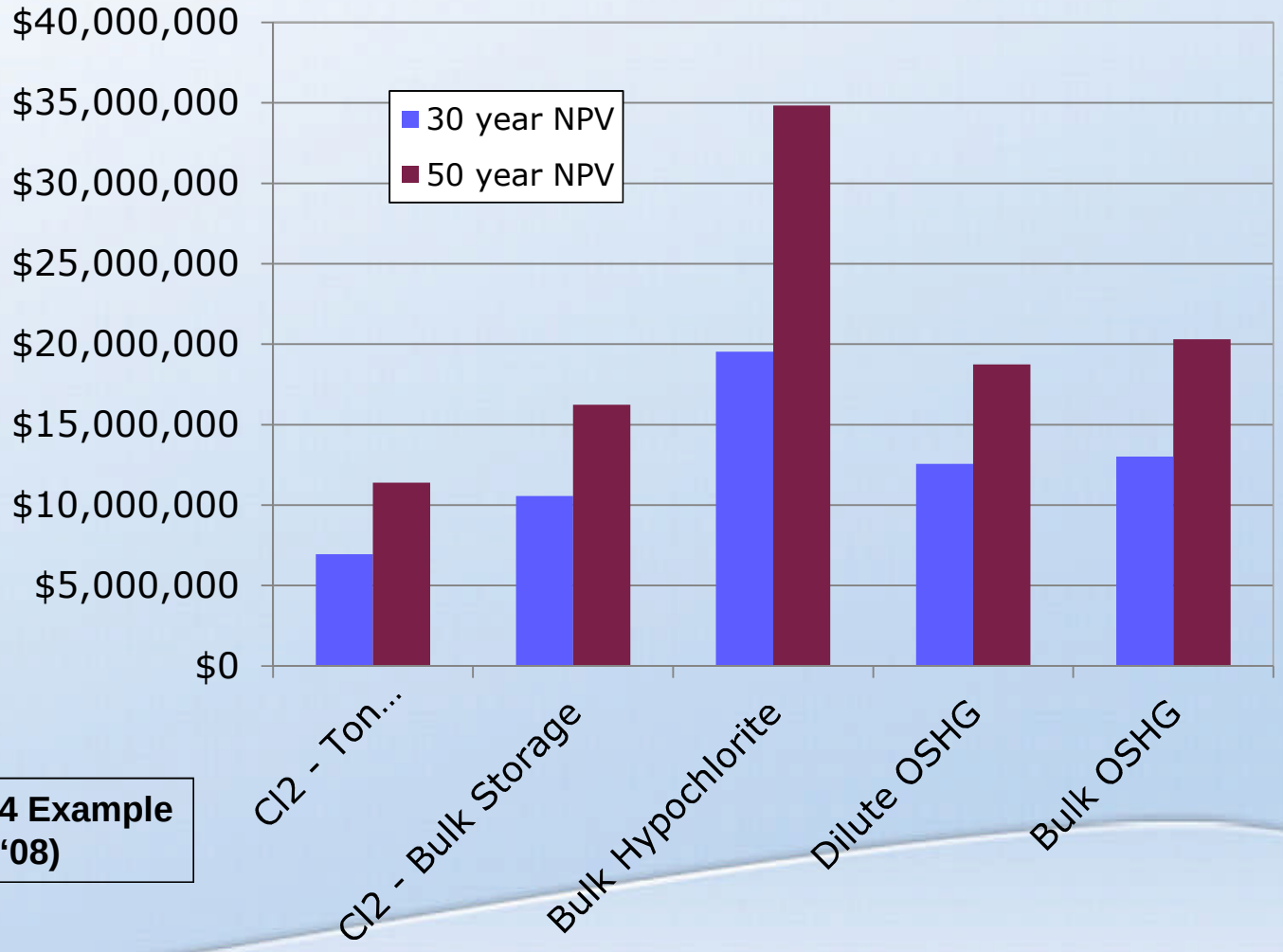
OSHG & Bulk Hypo Reduce Risk

Alternatives Reduce Regulatory Requirements

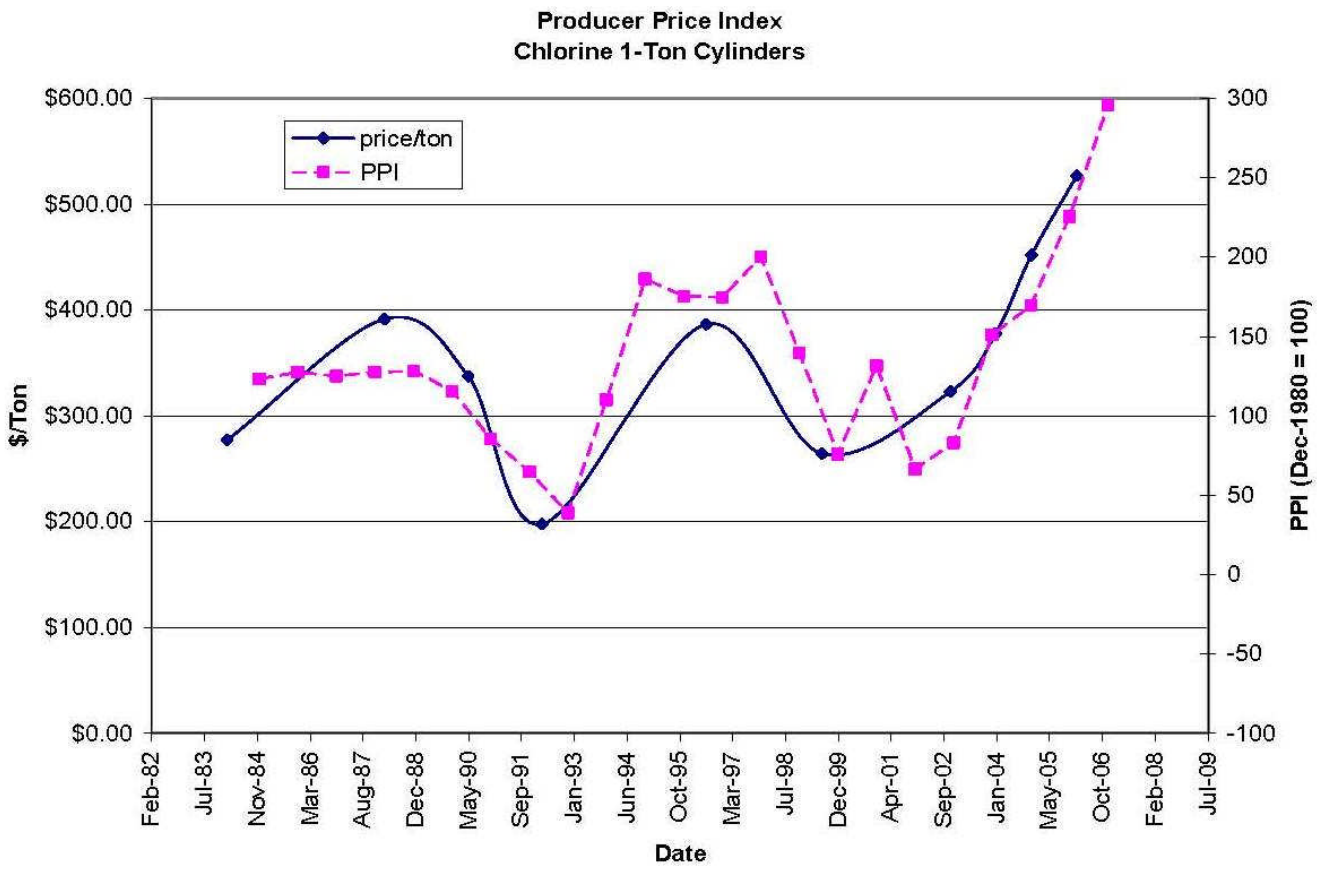
- EPA Risk Management Planning (RPM) not required
  - Exception if using bulk OSHG & storing hydrochloric acid above threshold amount
- Chemical Facility Anti-Terrorism Standards Act (CEFAT) would not apply if water sector exemption ever removed
- Still requires hazardous occupancy classification due to H_2 generation

Alternatives to Cl_2 gas are usually more expensive



Austin WTP4 Example (Dec '08)

OSHG can reduce supply volatility



Source: US Department of Labor, Bureau of Statistics, provided by Rick Coronado, City of Austin

HISTORICAL PRICE OF CHLORINE AND PRODUCERS PRICE INDEX TRENDS

Sodium Hypochlorite Generation, Storage, & Feed Alternatives

Three alternatives are available when using sodium hypochlorite

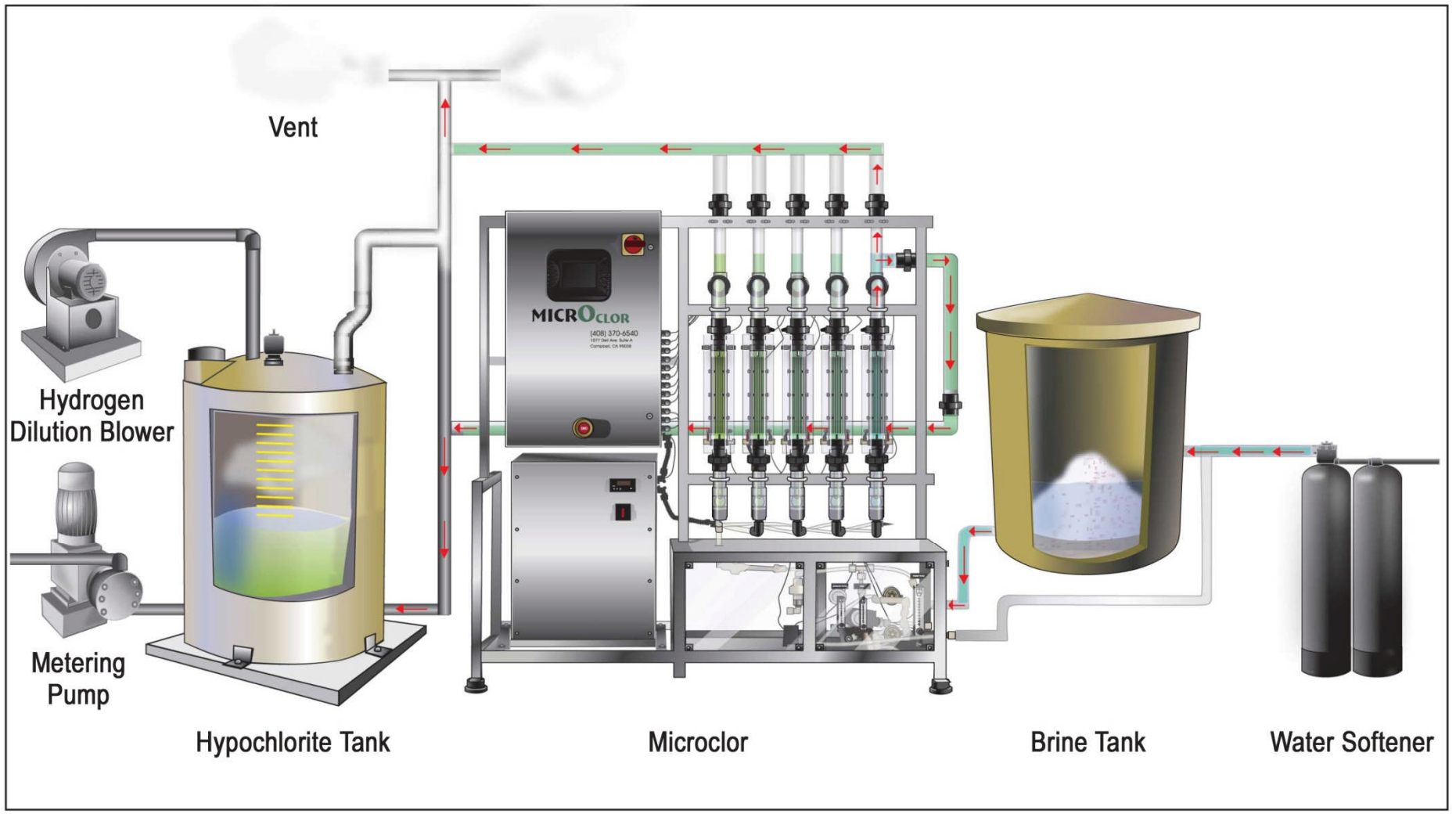
Dilute OSHG (<0.8%)	High strength OSHG (12.5%)	Bulk Liquid (10 – 15%)

Dilute OSHG is fundamentally simple

Salt
+ Water
+ Electricity
= Sodium Hypochlorite Solution
+ Hydrogen Gas

$$NaCl + H_2O + 2e = NaOCl + H_2$$

A dilute OSHG system is a batch process



Materials needed to produce a solution are not insignificant

1.0 lb of chlorine equivalent requires approximately:

- 15 gallons of water
- 2.5 - 3 lbs of salt
- 2.0 kw-hr of power

Brine tanks store salt & produce brine

Brine systems come in a variety of sizes

Softeners are a critical component of the system

Water chillers improve generation efficiency

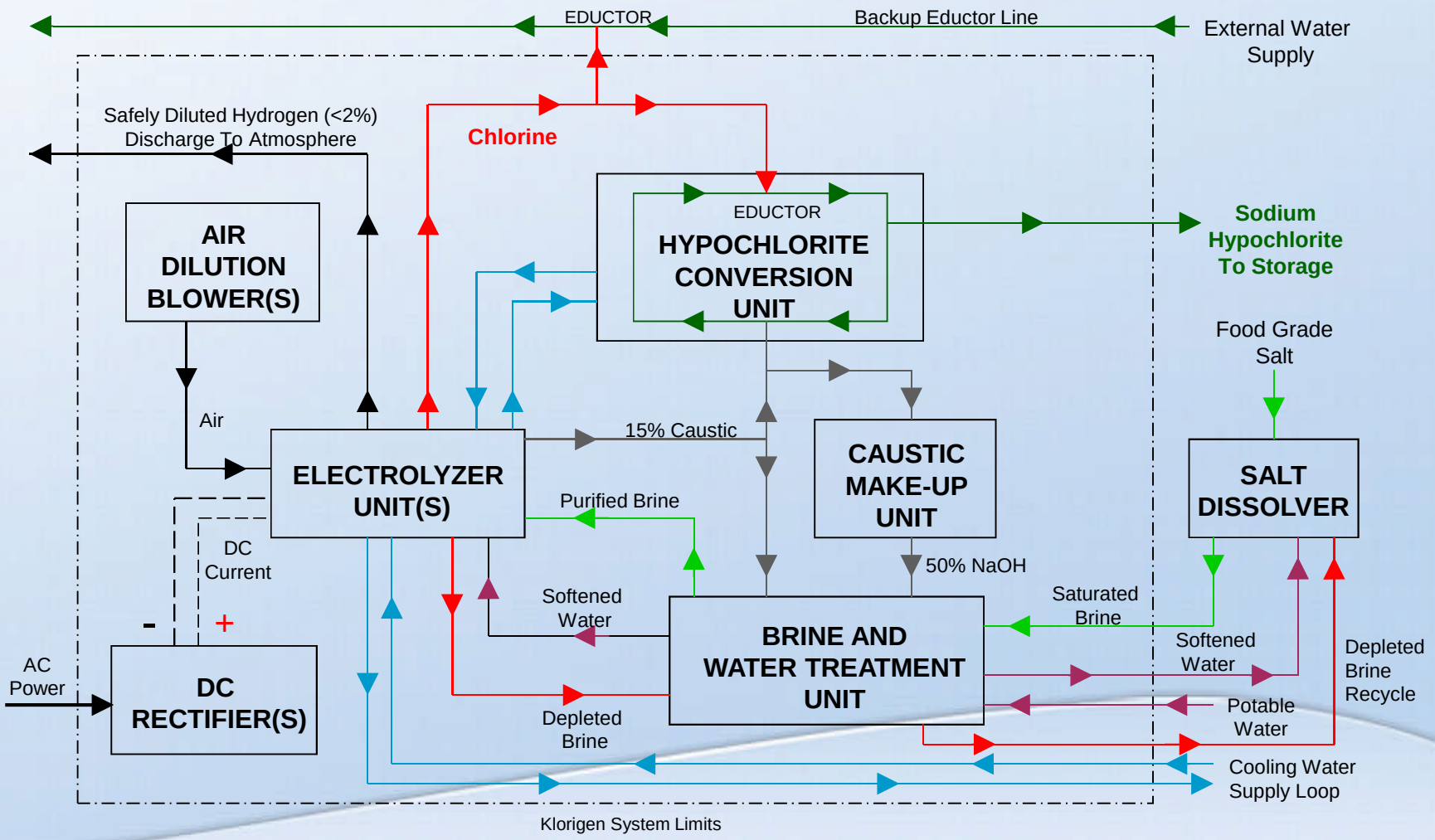
The rectifier and generator are the heart of the system

Vertical & horizontal generators are available

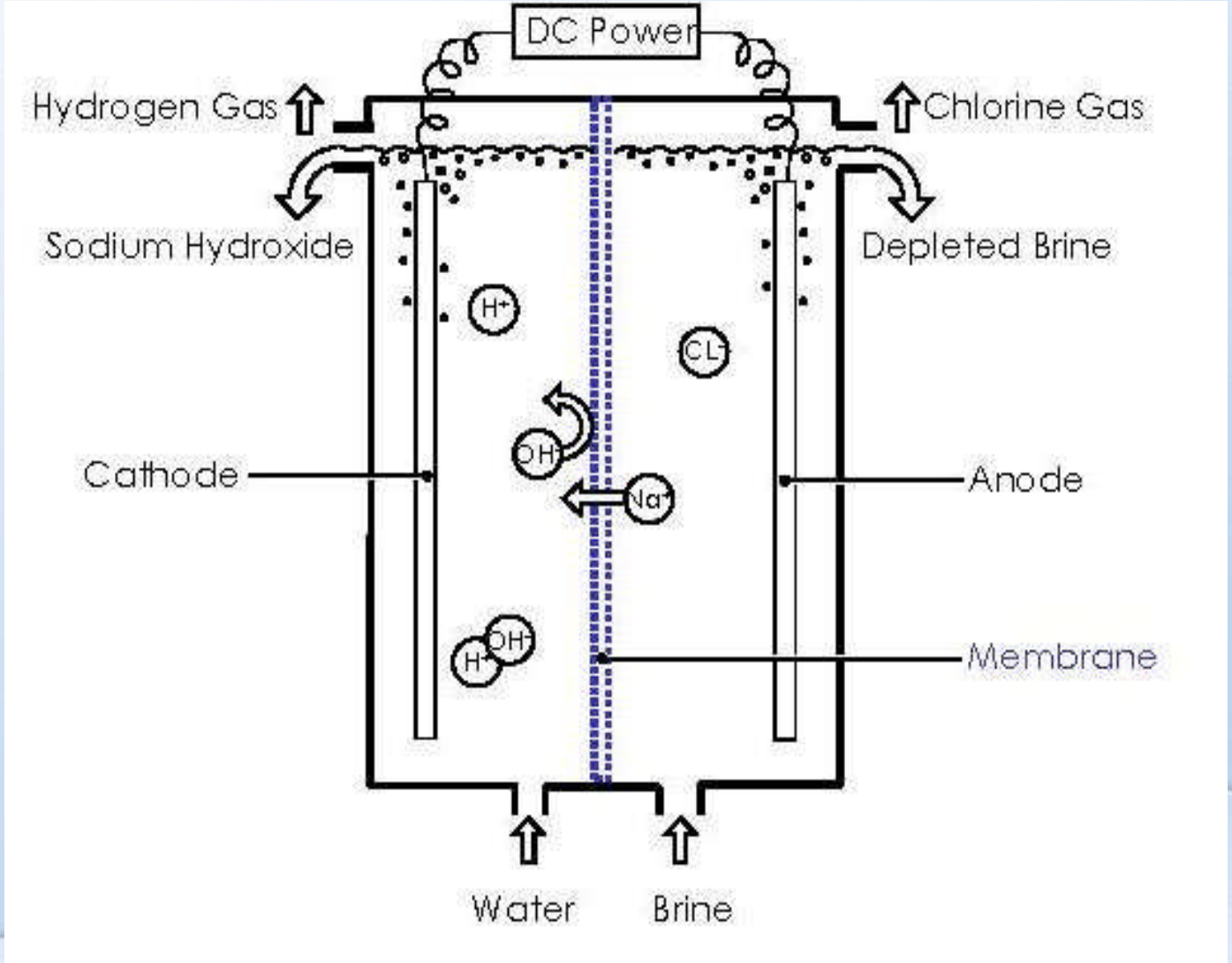
Blowers provide continuous venting of hydrogen gas

The low solution strength increases metering requirements

High strength OSHG relies on chlor-alkali process



High strength OSHG is more efficient, but complex



High strength OSHG uses less salt & water than low strength, but more chemicals

1.0 lb of chlorine equivalent requires approximately:

- 1 gallon of water
- 1.8 lbs of salt
- 1.8 kw-hr of power
- .012 gal NaOH (50%)
- .017 gal HCl (37%)
- .007 NaHSO3 (38%)

The rectifiers and electrolyzer modules are heart of the system

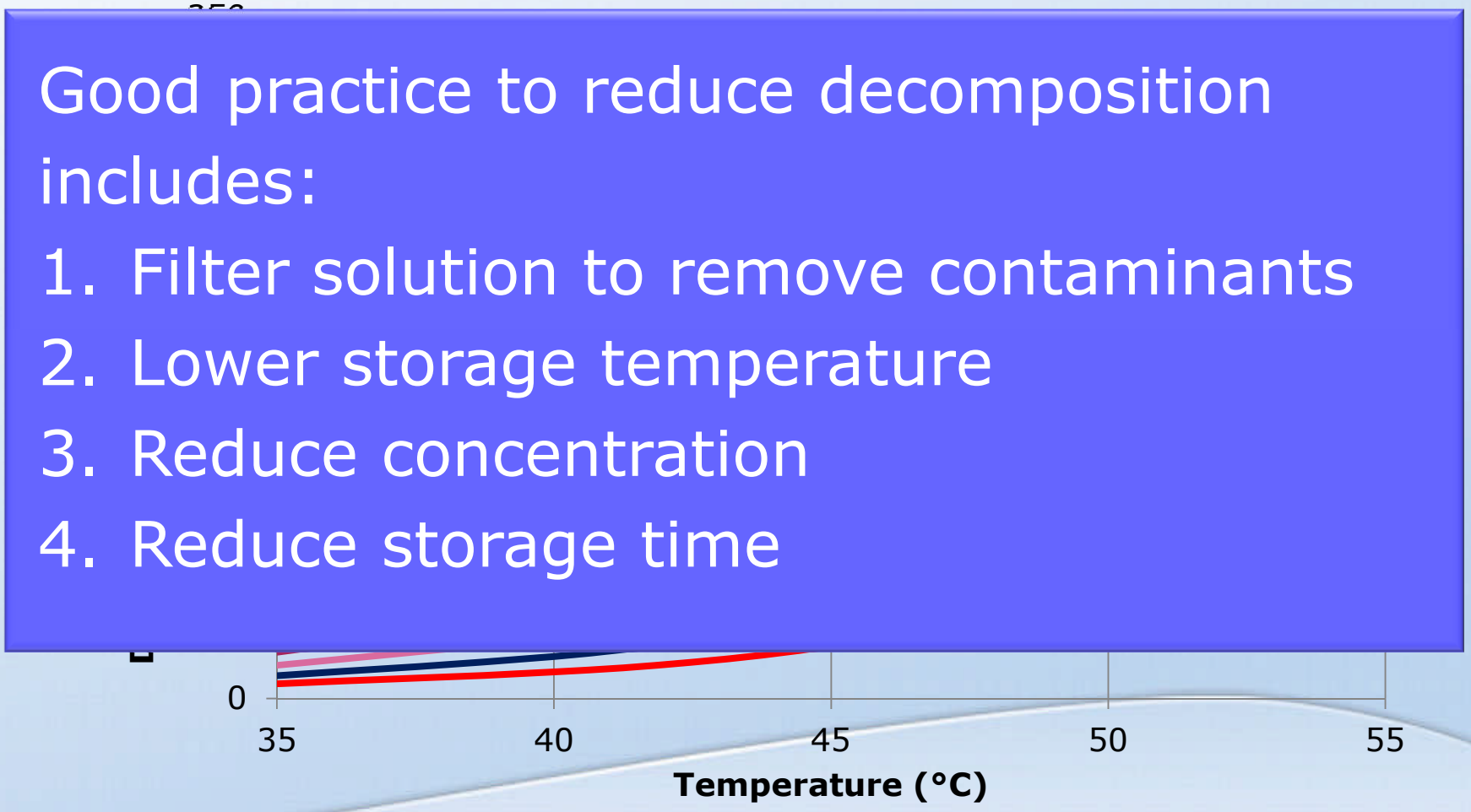
Bulk salt storage can be used instead of a briner tank

A turnkey approach is an option for high strength OSHG

- Operation of system is responsibility of manufacturer (ETC)
- End user does not inherit operation of complex technology
- Available for systems that feed a combined capacity of at least 5,000 ppd
- Can include design assistance, installation, and operation

Bulk sodium hypochlorite requires liquid storage & metering

Bulk hypo decomposes & chlorate is one of pathways



Good practice to reduce decomposition includes:

1. Filter solution to remove contaminants
2. Lower storage temperature
3. Reduce concentration
4. Reduce storage time

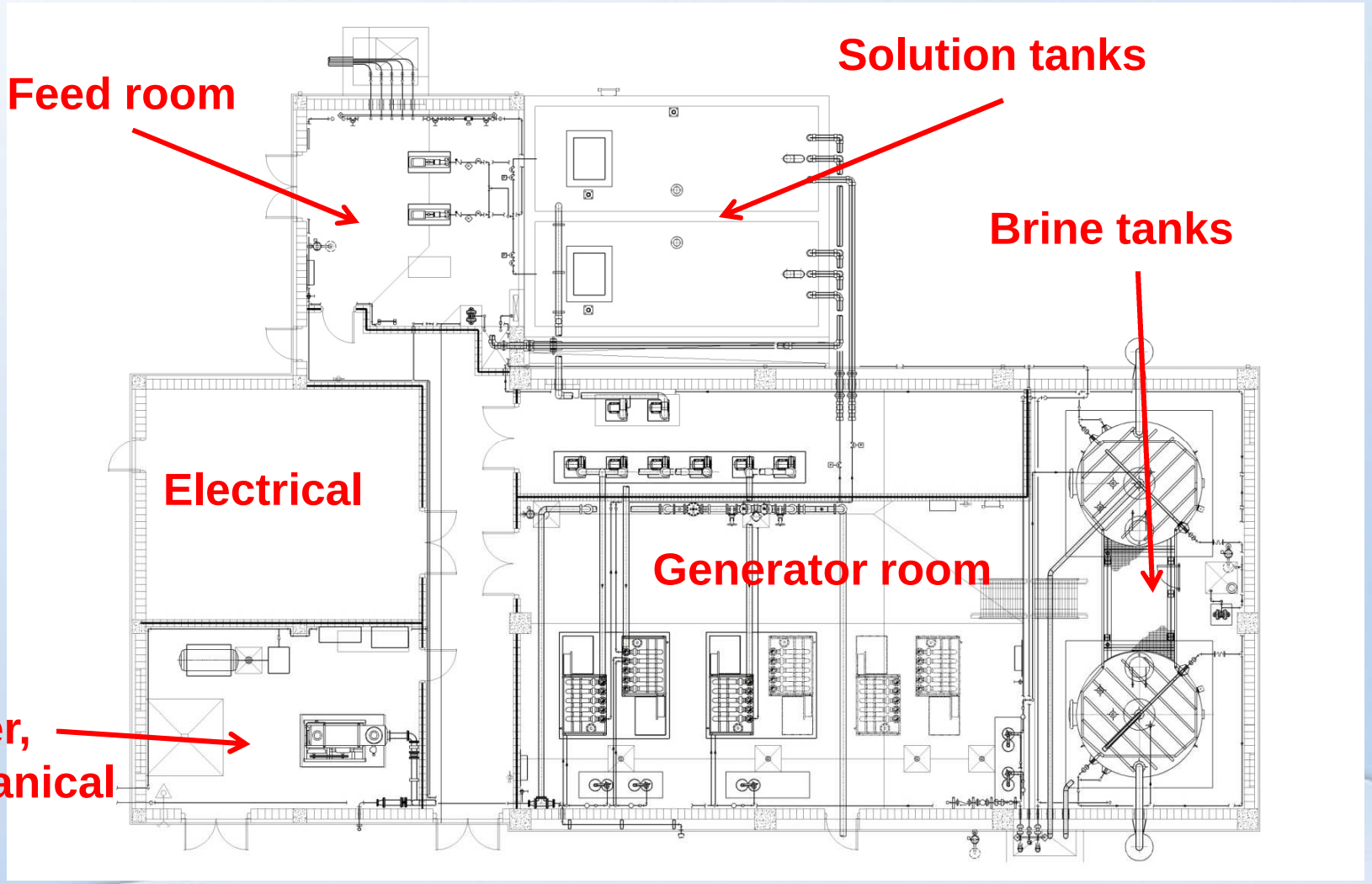
Off-gassing is an issue when feeding bulk hypochlorite

1. Avoid high spots in piping that can trap off-gas
2. Use diaphragm valves
3. Consider adding de-gassing valves

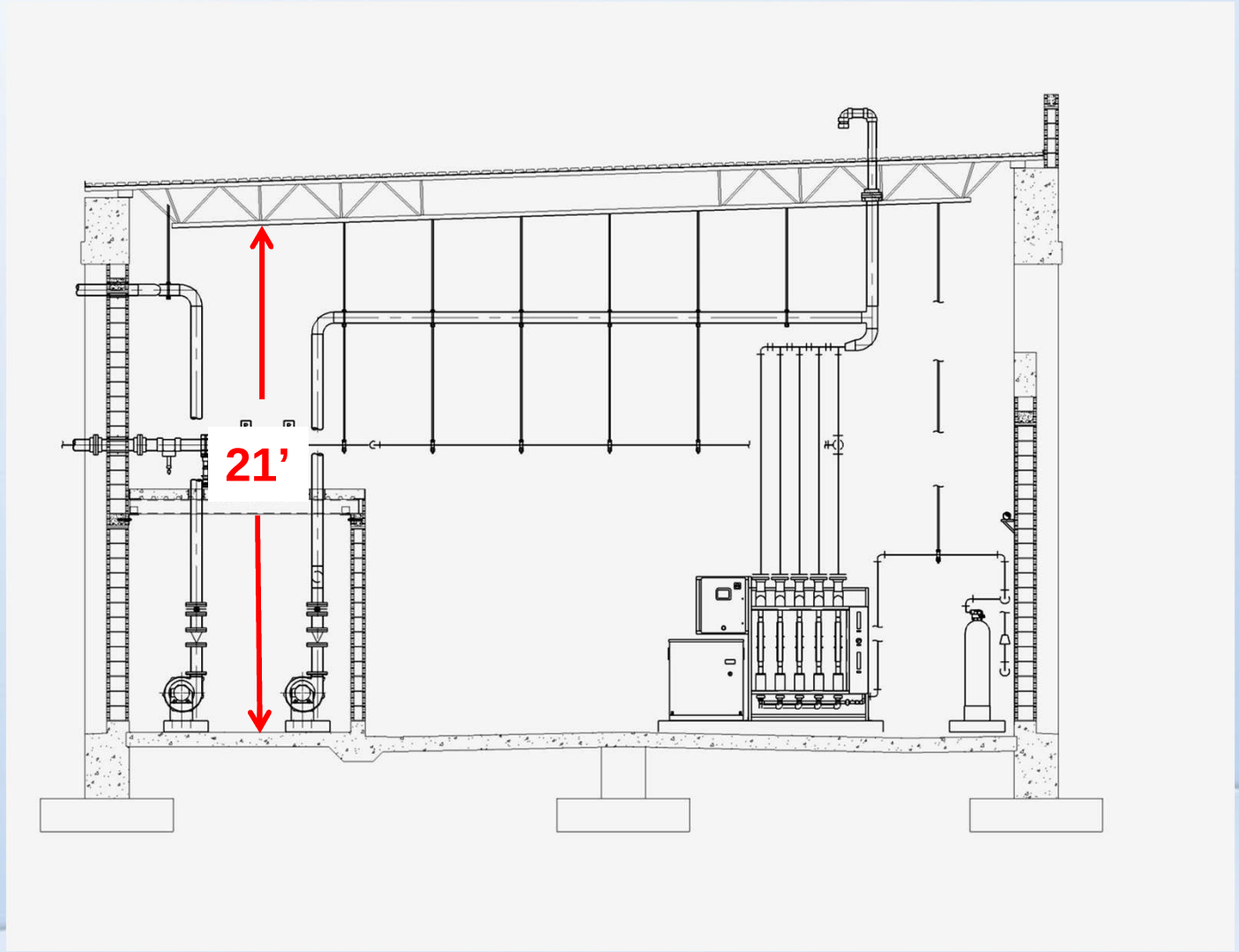
Lessons Learned

- 4,500 pounds per day capacity
- Can treat 75 mgd in Phase I, expandable to 150 mgd by adding equipment
- Selected PSI equipment after using a base bid/alternate bid approach
- OSHG Building Bid for ≈$6 million (Mar 2011)

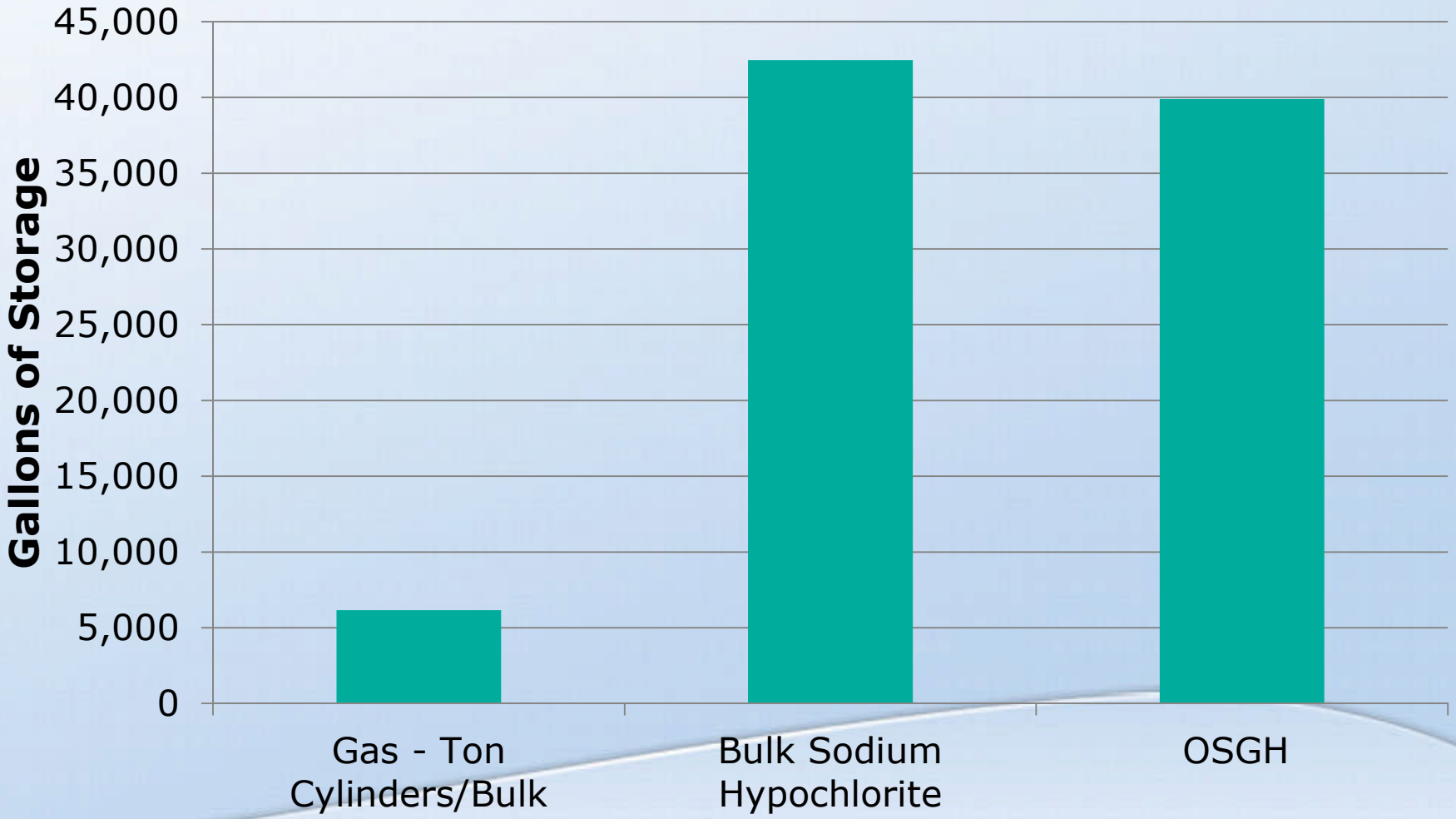
WTP 4 building layout



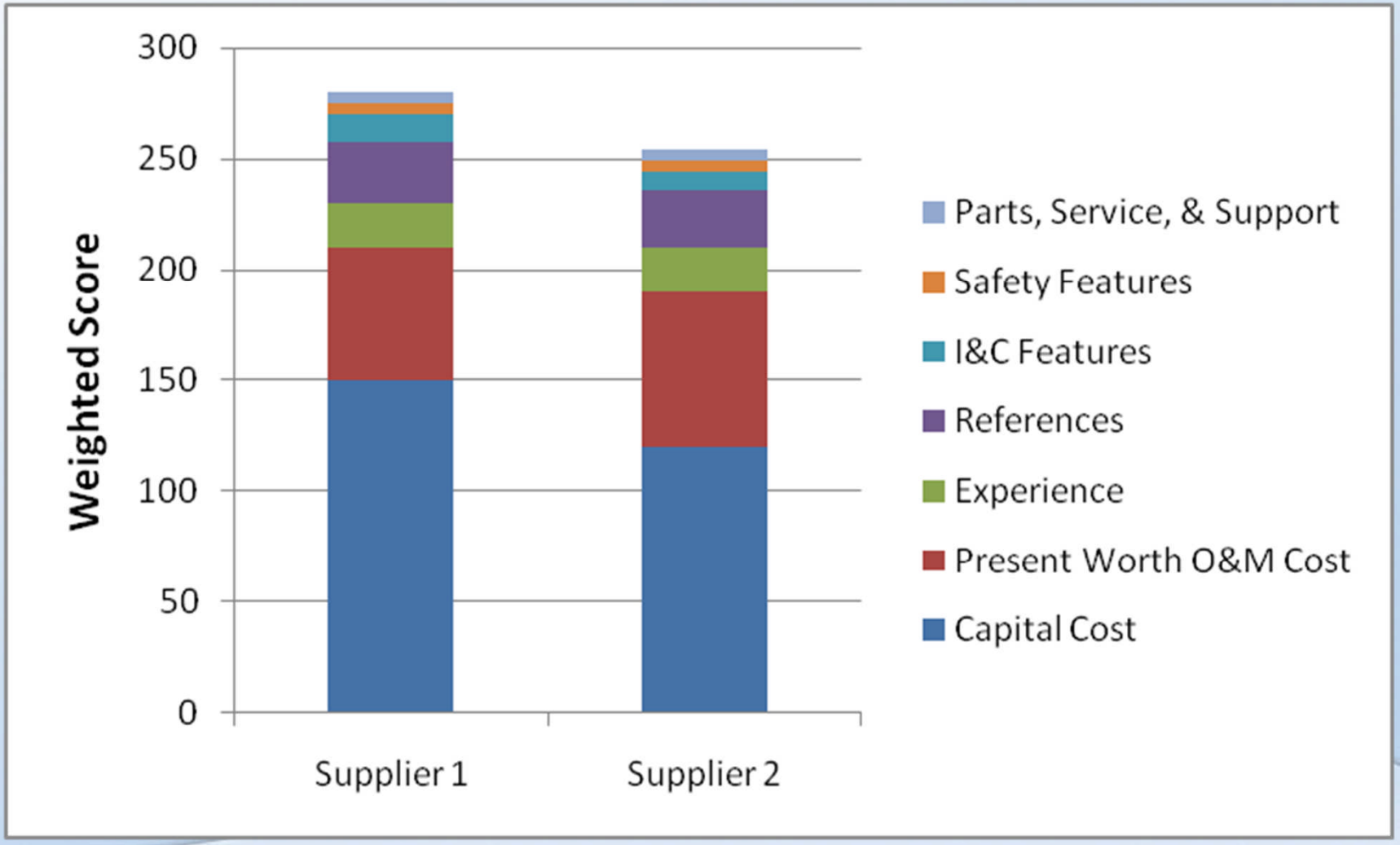
WTP 4 OSHG building section



WTP 4 shows magnitude of OSHG storage requirements



Selecting on price + qualifications improves results

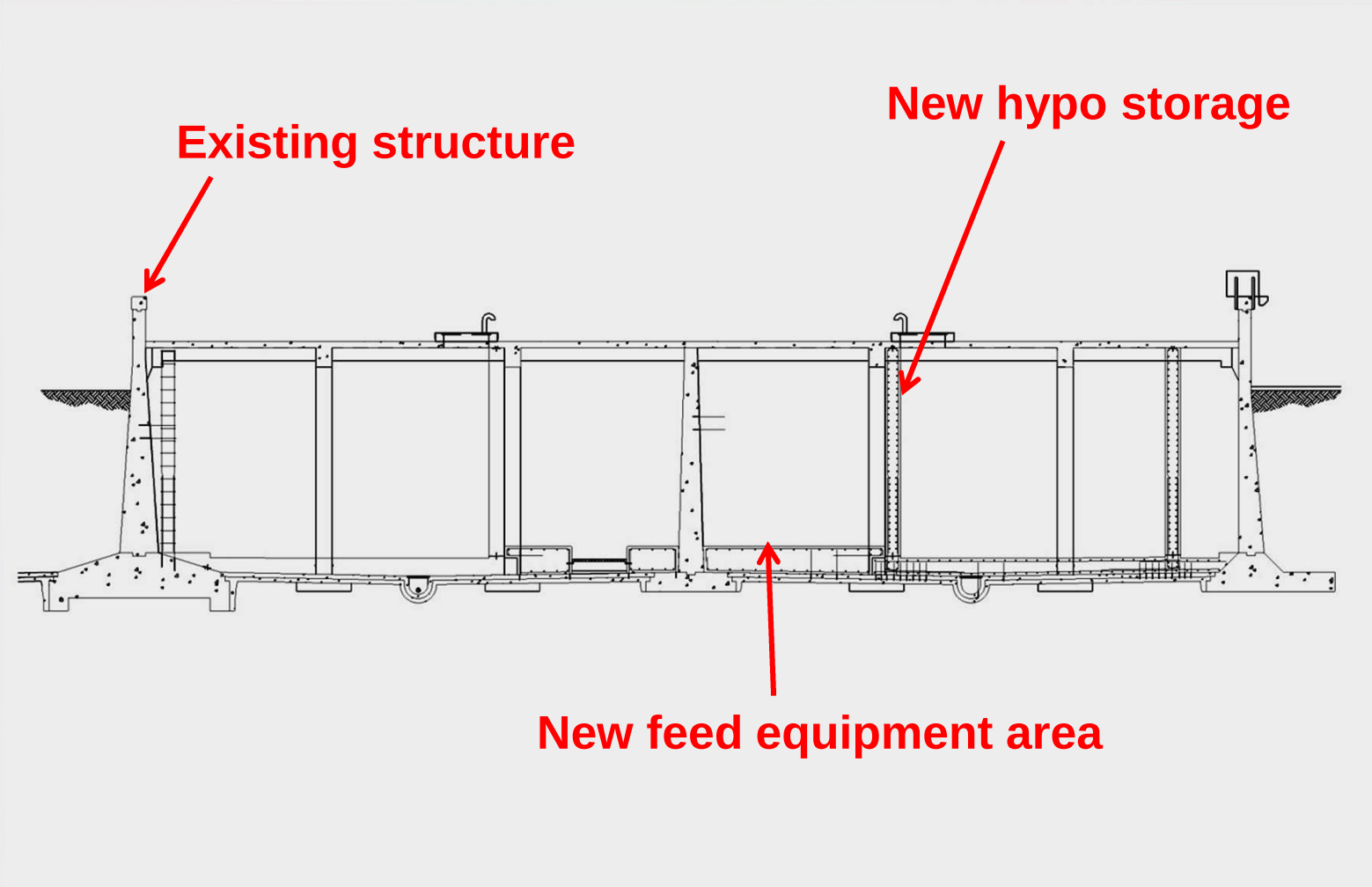


Holly WTP retrofit provides an example of how to convert from Cl_2 to bulk hypochlorite

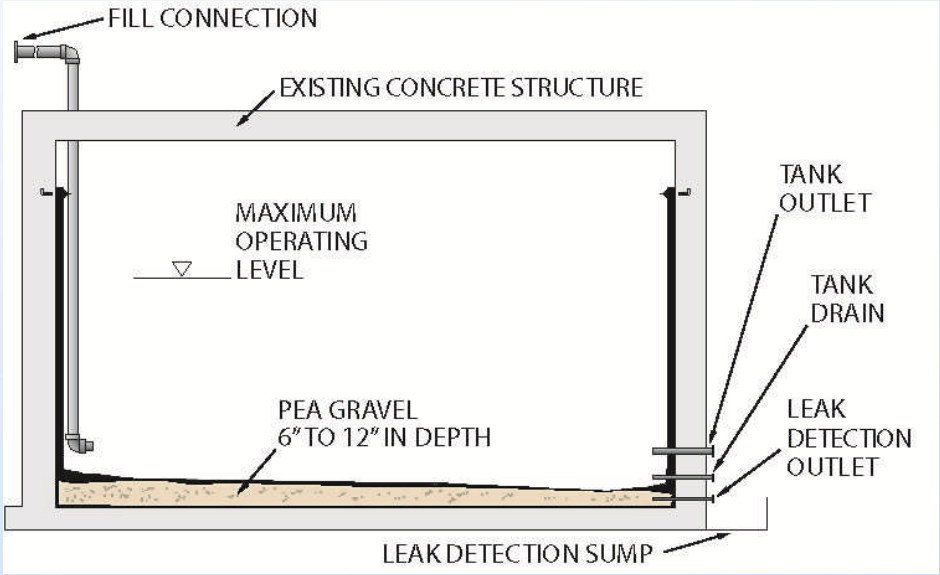
- 210 MGD (North & South Plants)
- Converting from bulk CL_2 in 2 phases:
  - Phase I: Bulk Hypochlorite
  - Phase II: OSHG ahead of bulk storage
- Bid for $2.4 million – June 2011

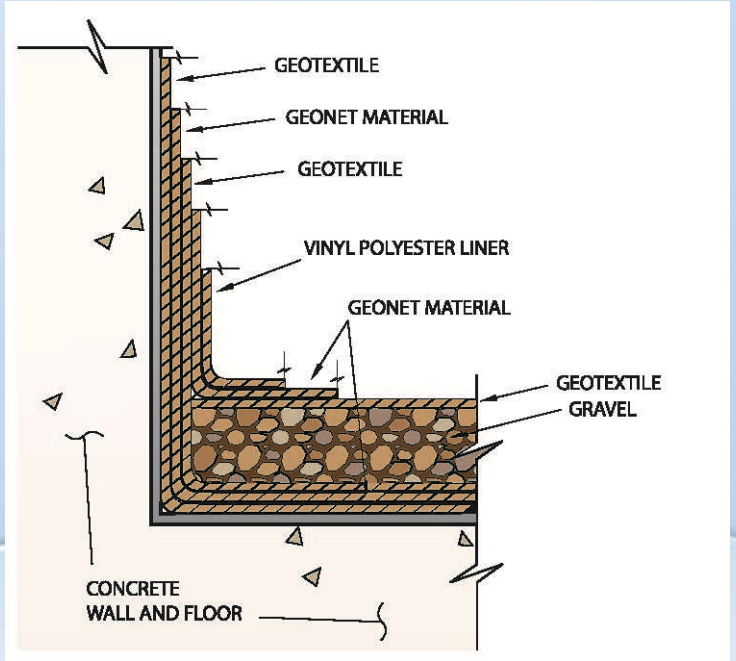
FORT WORTH

Existing, unused basins repurposed for hypo system



Lined, concrete tanks offer cost – effective solution storage





Tom Taylor Regional WTP provides example of a dilute OSHG refurbishment

- 70 mgd of capacity
- 6,000 ppd generation capacity
- Pre-selected PSI equipment after evaluating suppliers
- Bid for ≈$2.1 million – December 2010

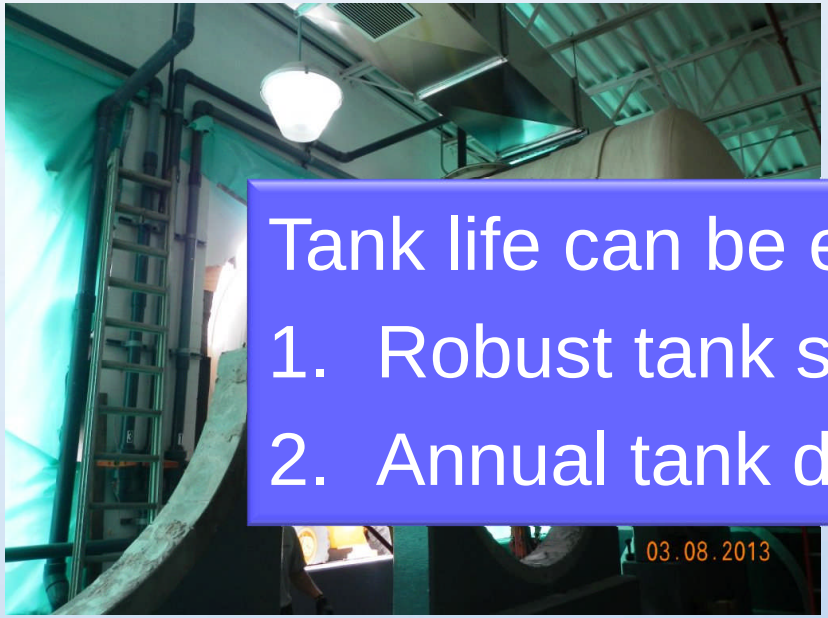
UPPER TRINITY
REGIONAL WATER DISTRICT

Generator room completely refurbished

Good reminders:

1. Make sure manufacturer is clear on temperature requirements
2. Pay attention to service water pressure

Bulk hypo storage tanks eventually need to be replaced, so plan accordingly



Tank life can be extended by:

1. Robust tank specifications
2. Annual tank drainage & cleaning

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