

REINHOLD ENVIRONMENTAL Ltd.



2016 APC-Wastewater Round Table & Expo Presentation

July 18 & 19, 2016 in Dearborn, MI / Hosted by DTE Energy

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FGD WASTEWATER SOLUTIONS OVERVIEW

2016 APC-Wastewater Round Table

Nelson Fonseca – Product Manager

Ray Gansley – Product Manager

Agenda

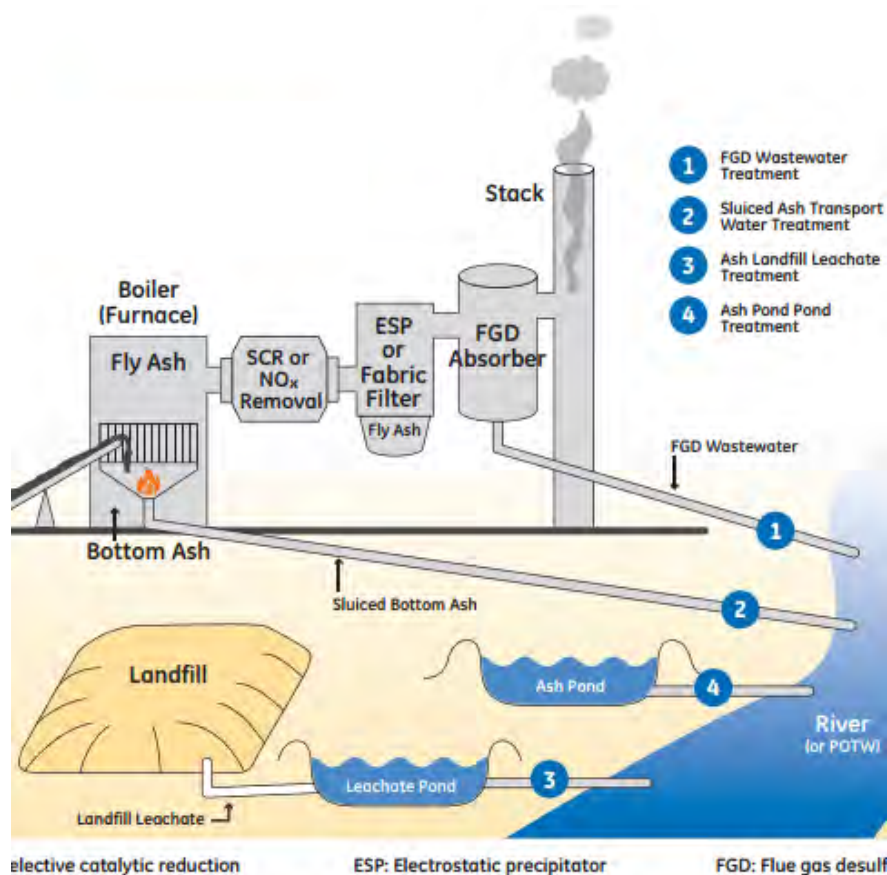
- The Regulatory Challenge
 - ELG, CCR, local regulations
- ELG Compliance Planning
 - Solutions Focused, Technology Neutral, Early Collaboration
- Technology Overview
 - WFGD Scrubber Optimization, Treat & Discharge Solutions, Zero Discharge Solutions



The Regulatory Challenge



Discharges at Coal-Fired Power Plants Impacted by New Regulations



- FGD wastewater treatment is a significant challenge
- Variability due to type of coal, scrubber operation, load, etc
- Other Effluents controlled by local regulators
- All streams part of the overall water management strategy
- Common ponds, common treatment, common outfalls

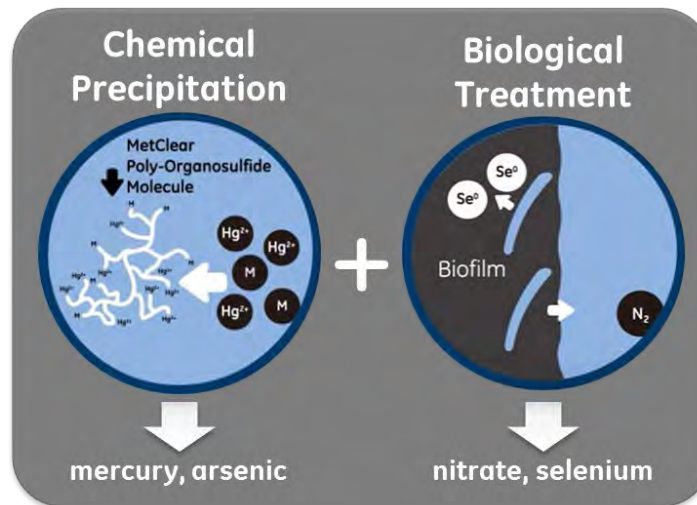


Regulatory Drivers for FGD WW Treatment

ELG Discharge Limits for FGD Discharges

EXISTING SOURCES

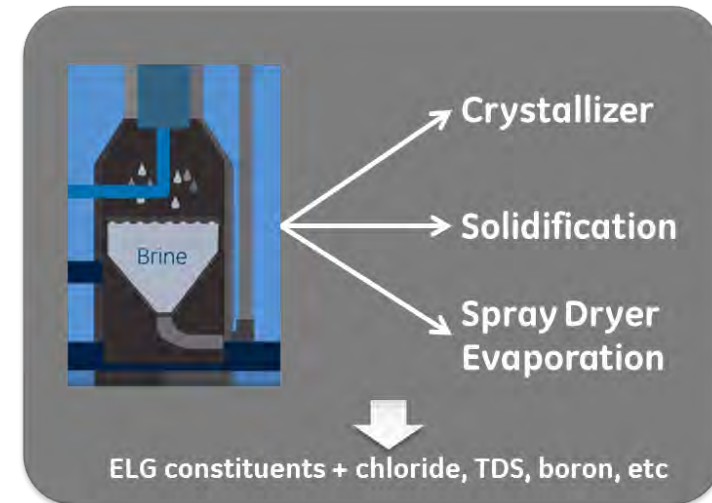
Constituent	units	30-day avg.	1-day max
Arsenic (total)	µg/L	8	11
Mercury (total)	ng/L	356	788
Selenium (total)	µg/L	12	23
Nitrate/nitrite as N	mg/L	4.4	17
TDS	mg/L	-	-



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Local Regulators can Require Additional Limits Beyond ELGs

- Lower limits on arsenic, mercury, selenium and nitrate
- Limits on other constituents, e.g. chlorides, TDS, or boron



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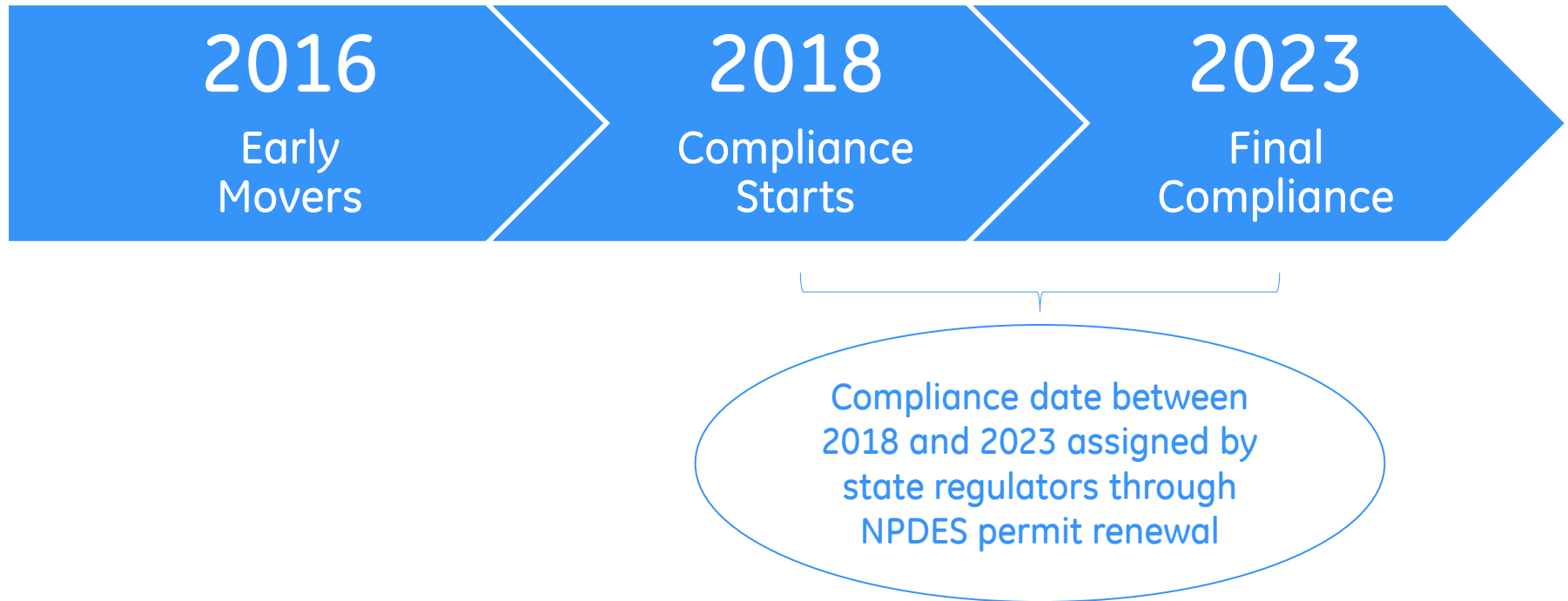
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Coal Combustion Residuals Rule (CCR)

- Impacts the design and use of surface impoundments for the storage and coal combustion residuals such as dry or sluiced ash
- ash ponds are particularly impacted
- Significant impact on the overall water management strategy within the power plant's footprint



Compliance Timeline Issued by the EPA



ELG Compliance Planning

- Solutions Focused
- Technology Neutral
- Early Collaboration



Implementation Timeline from 3 to 4.5 years



Important Considerations In Planning Phase

What is currently done with the FGD Blowdown? Discharge, recycle, fly-ash conditioning, etc.

How important is pushing out the compliance date?

Does the facility generate Class C or Class F fly ash?

Does the discharge permit include limits on boron, TDS, sulfate, bromides, or boron?

What is the expected life of the generating units?

What treatment is being currently done on the FGD stream?

Is the facility managing treatment residual solids with on-site or off-site landfill?

What other regulations can potentially be imposed over the life of the generating units?

Existing scrubbers and AQCS train operations? Future changes? Impacts on waste water.

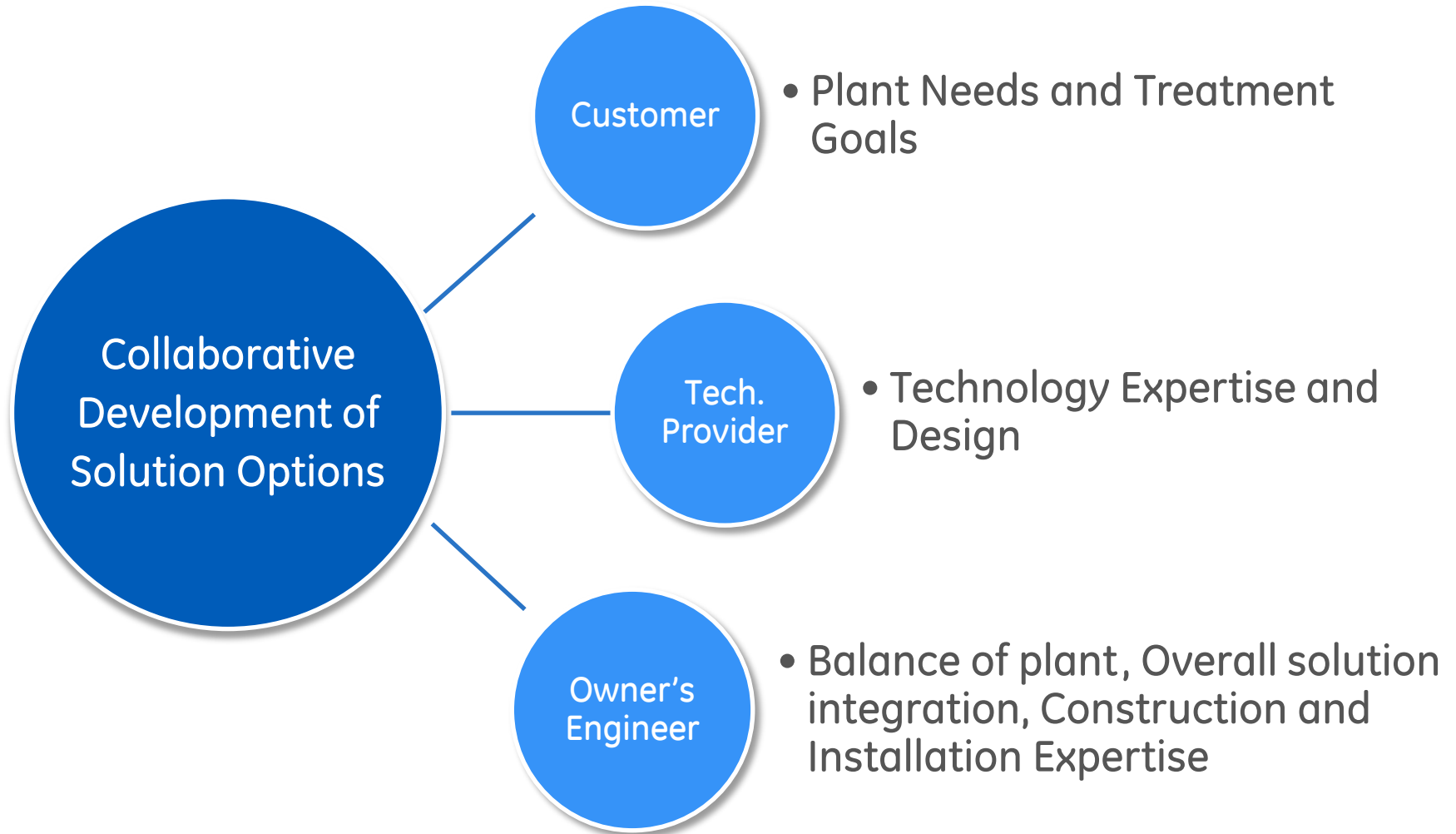
What is the on-line factor of the generating units and how will that change?

Planning
(6-12 months)

- Fleet Wide Planning
- Solution development
- Technical evaluation
- Economical evaluation
- Permit requirements
- Budgeting



Planning Phase Collaboration



Technology Overview





WFGD Optimization & Integration

Assess current and
planned
design/operation

Recommend
modifications

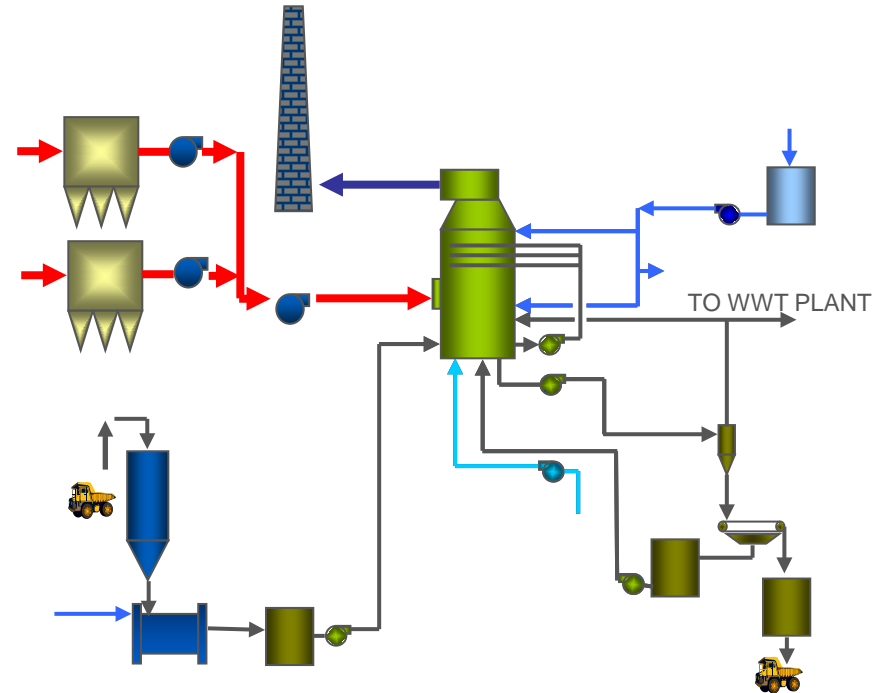
Implement
optimization

Optimize downstream treatment through
volume reduction and water quality stability

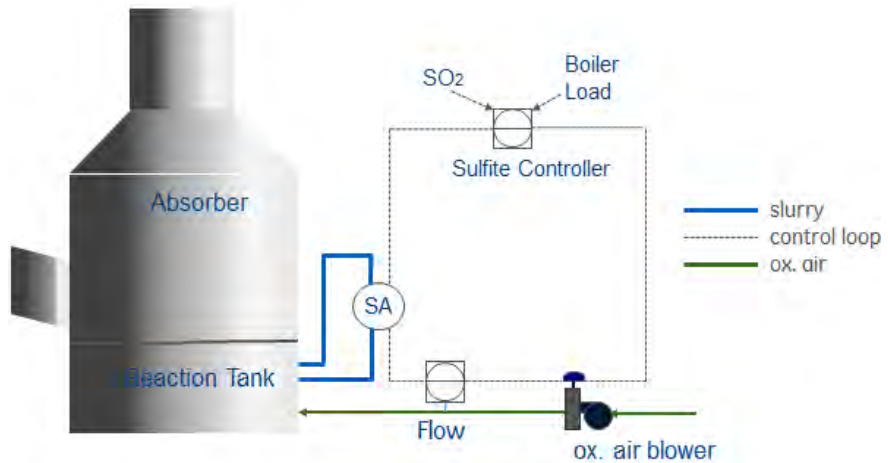


Key Factors in WFGD WW Production

- Flue gas components
 - Ash content/composition – WFGD absorber removes 50-90%
 - Trace components – Hg, Se, As, ...
 - HCl and HBr – key driver for Cl/Br level in WW, and WW quantity
- Make-up water sources
 - Fresh water/river water
 - CTB
 - Other
- Commercial or disposal gypsum
- Limestone source
- WFGD operation
 - Sulfite control
 - ORP Control
 - WFGD additives (Hg re-emissions, organic acids, ...)



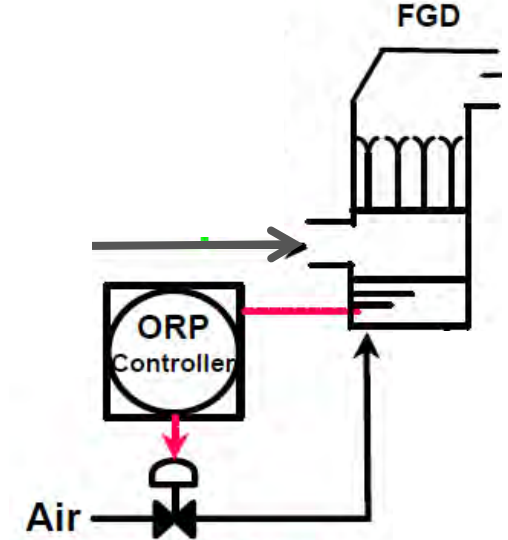
Sulfite control, ORP control, Hg re-emission additives



GE sulfite control



GE sulfite analyzer



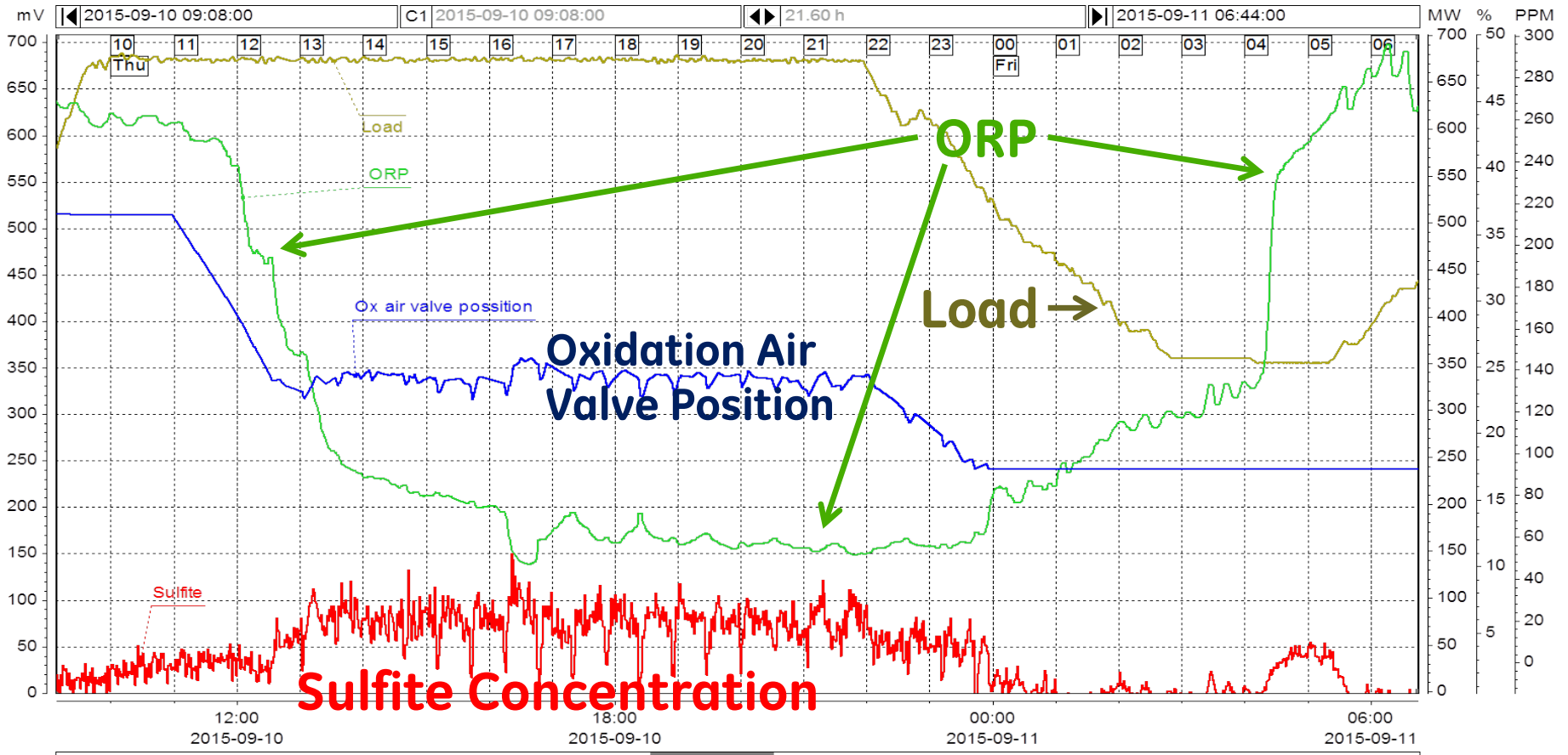
MHI ORP control

Benefits for Scrubber Optimization

Lower mercury in WFGD purge, favorable selenium speciation in WFGD purge, lower ORP, lower power consumption (sulfite/ORP control), lower mercury re-emissions, reduced corrosion potential



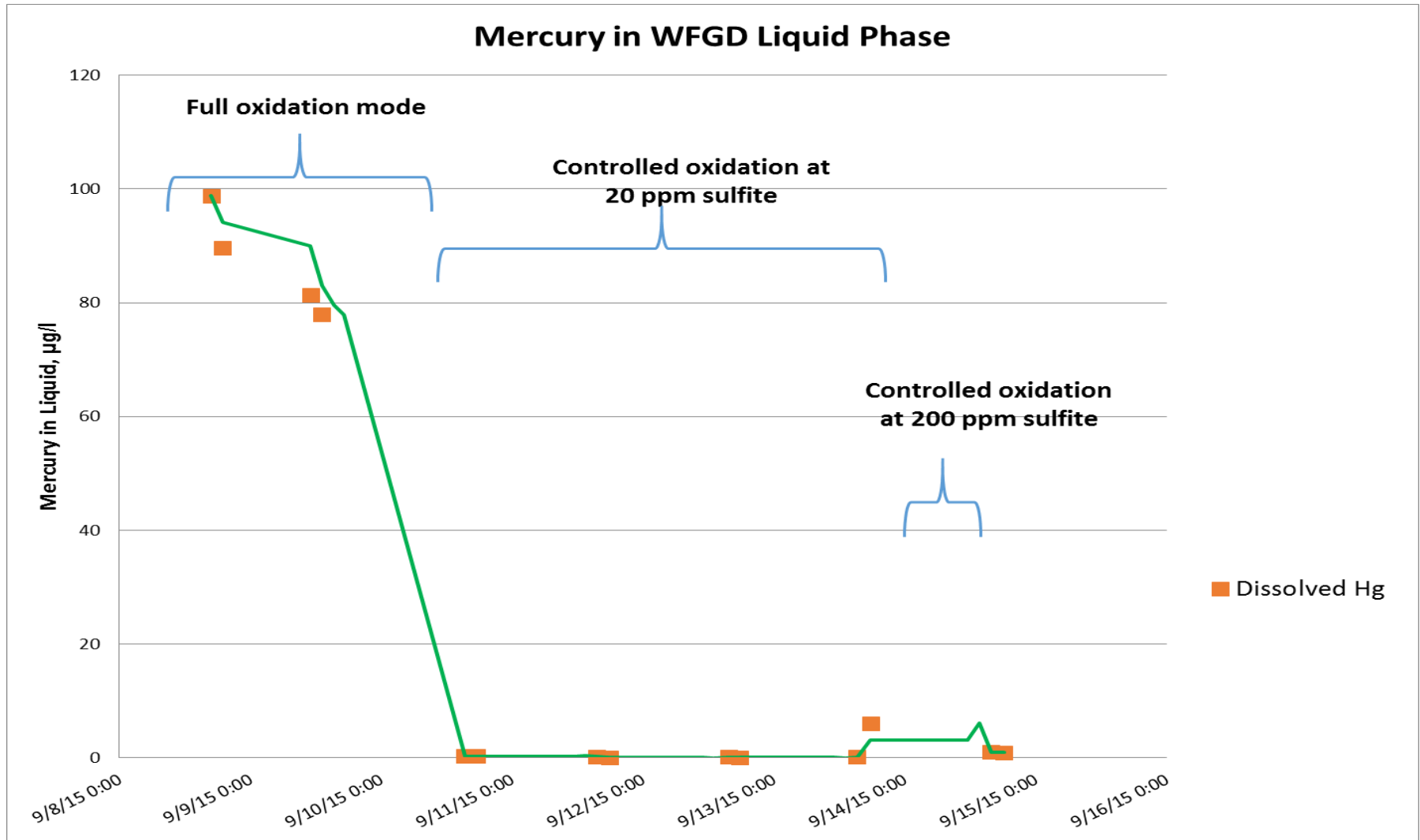
T&D - Improved ORP with Sulfite Control



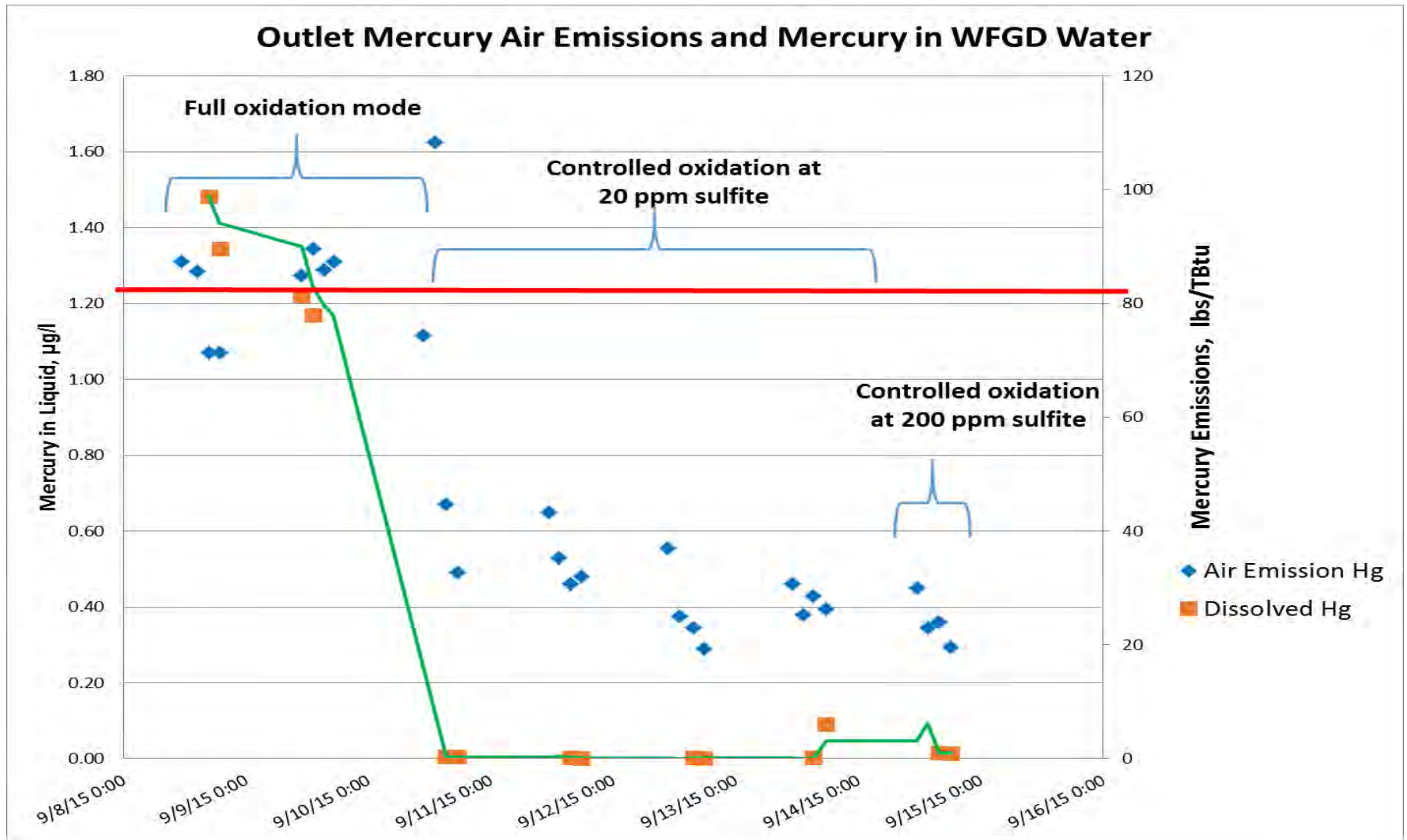
ORP lowered from > 500 mV to < 200 mV



Mercury changes with Sulfite Control



Mercury changes with Sulfite Control





Treat & Discharge (T&D)

Remove constituents → Discharge effluent

Zero Discharge (ZD)

Eliminate Stream → No Discharge Permit



Unless discharge requirements dictate a ZD solution, decision to go with T&D or ZD is based on many factors

Treat & Discharge (T&D)

Remove constituents → Discharge effluent

Zero Discharge (ZD)

Eliminate Stream → No Discharge Permit

Scrubber Sulfite
Control

Chemical
Precipitation

Thermal Brine
Concentration

Crystallization

Membrane
Filtration

Biological
Treatment

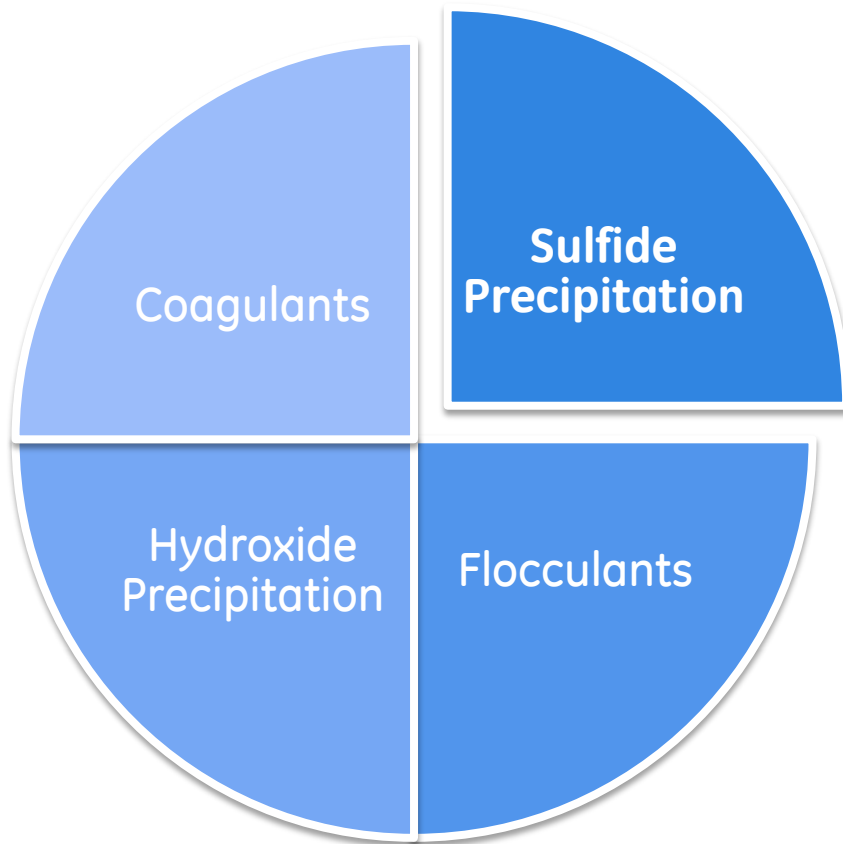
Solidification

Spray Dryer
Evaporation

Process, construction, and installation considerations are all important to determining the “best” solution



T&D – Chemical Precipitation, Coagulation and Flocculation for Mercury and Metals Removal



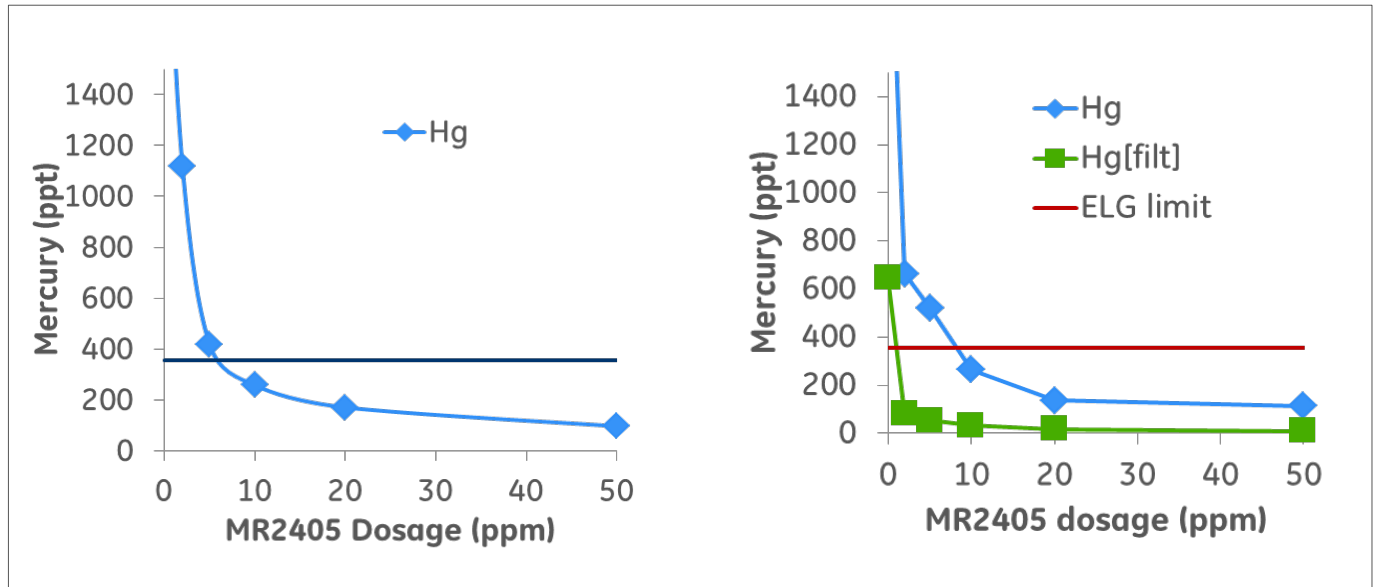
Poly-organosulfide chemistry

- leading soluble Hg removal solution
- Can be effective for Se precipitation



T&D – Chemical Removal of Se and Hg with Poly-Organosulfide Precipitation

Hg removal

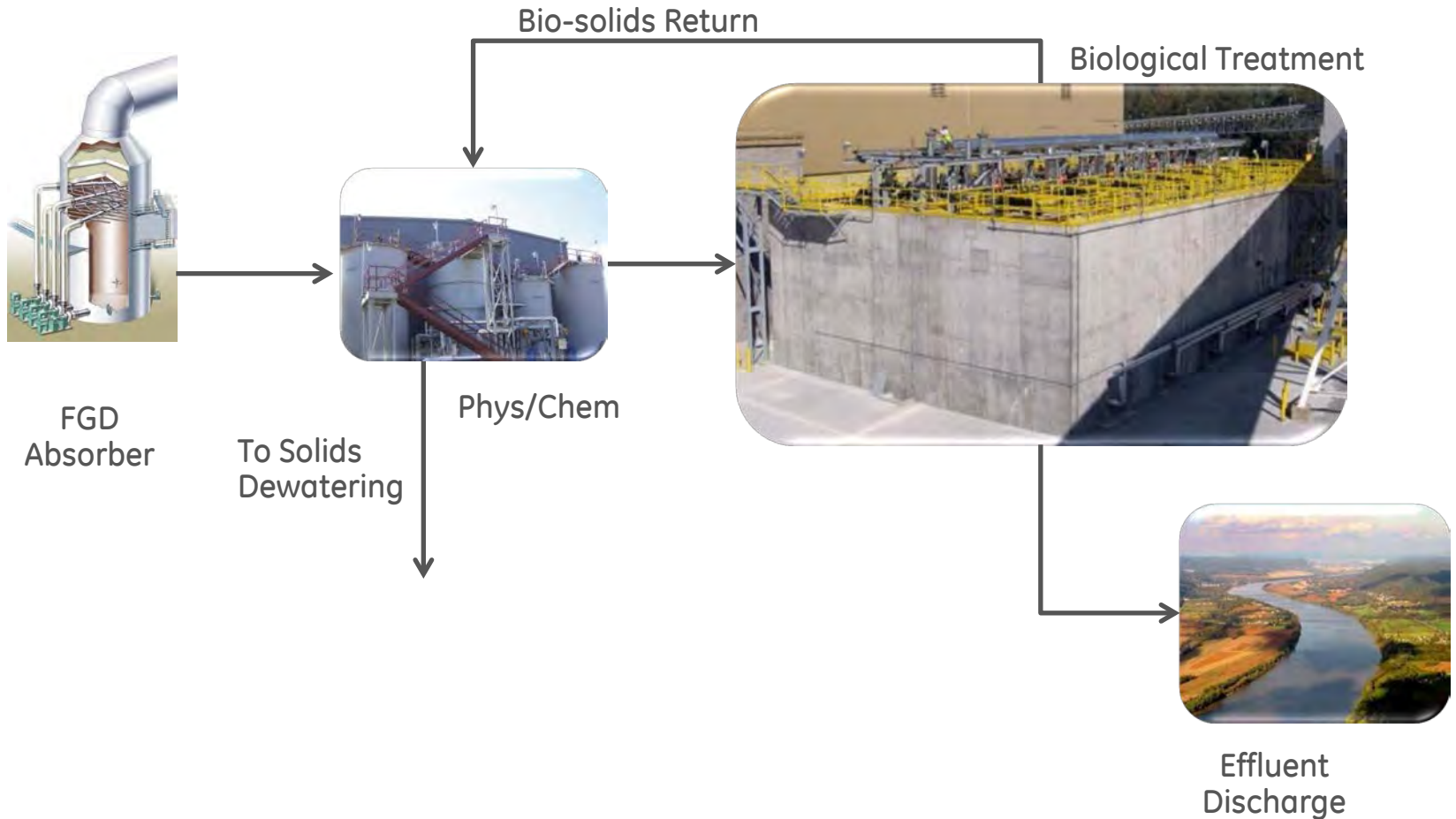


Se removal

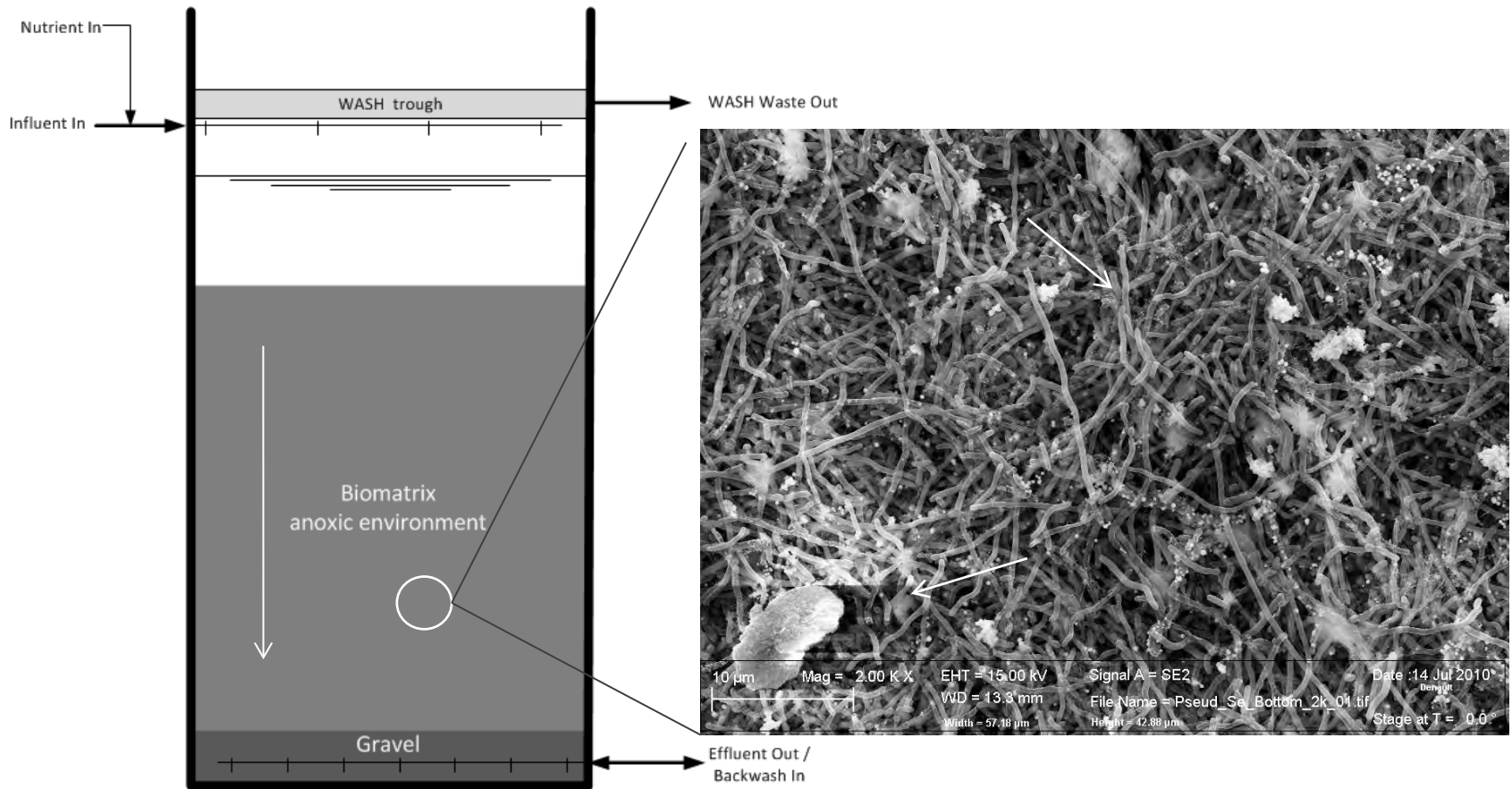
	Selenite	Selenate
Se speciation (hydroclone overflow)	73%	3%
Se Removal	88-92%	50-70%



T&D - Chemical Precipitation + Biological Treatment



T&D - Fixed-Film Biological Removal of Selenium and Nitrate (Packed or Fluidized Bed)



T&D - Full-Scale Bio. Systems Treating FGD Blowdown for Selenium and Nitrate Removal



T&D - Ultrafiltration Membrane Systems

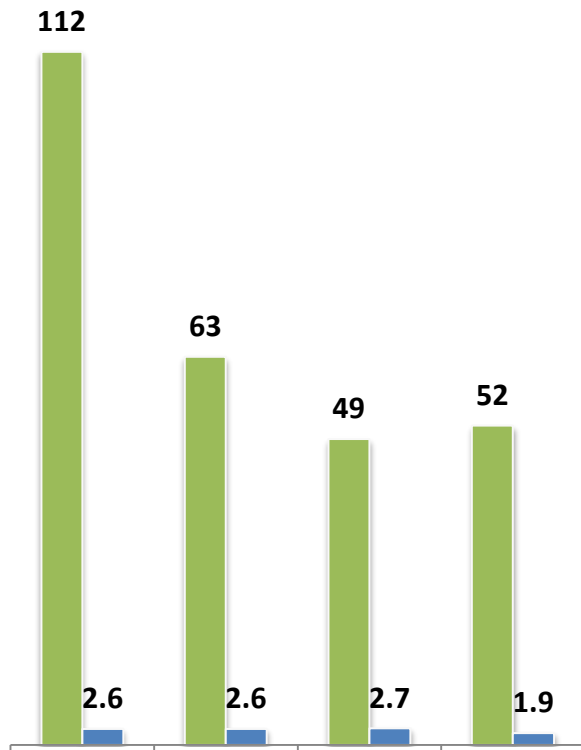
- **Advanced Filtration**
Removal Of colloidal mercury and other small particulates through a 0.02 nm membrane
- **Biological Process (MBR)**
removal of nitrate and selenium species



T&D - Performance of UF System (MBR) Treating FGD Blowdown

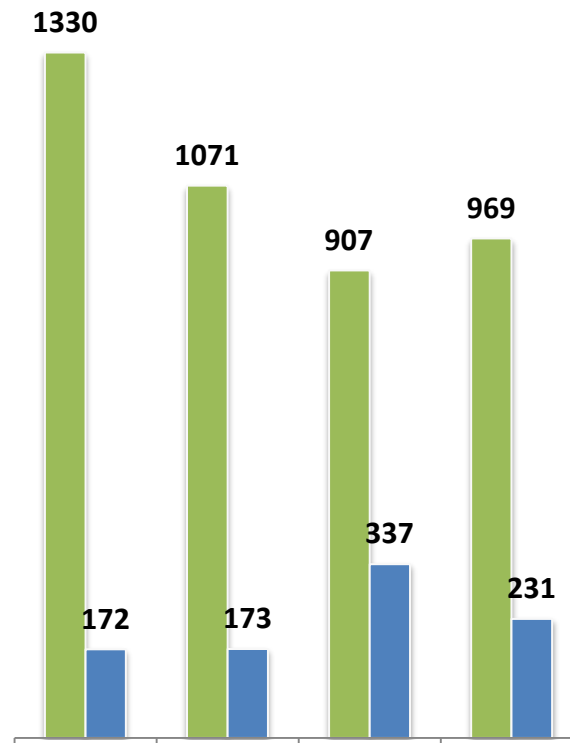
Hg-total (ppt)

■ Feed ■ Effluent



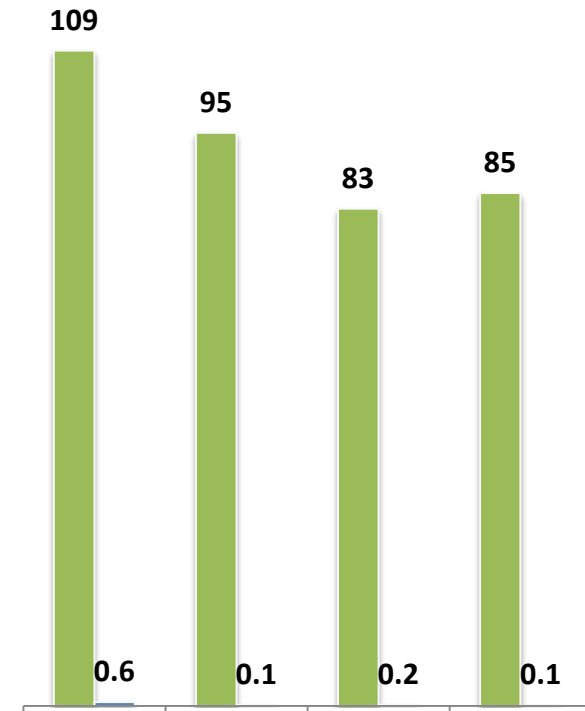
Se-total (ppb)

■ Feed ■ Effluent



Nitrate (ppm)

■ Feed ■ Effluent



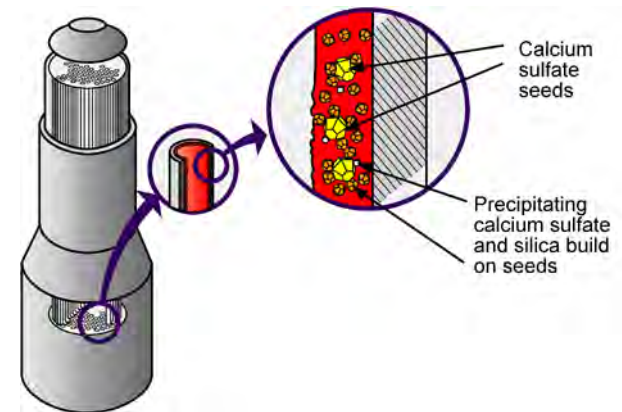
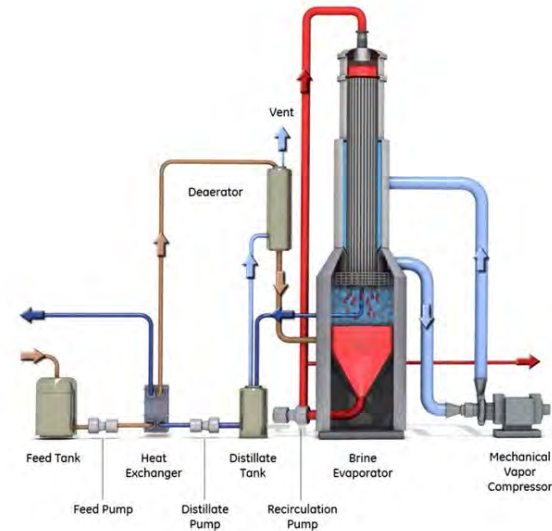
ZD - RO Membrane Systems

- **Volume Reduction**
Pre-concentration step in Zero Discharge flowsheets
- Limited volume reduction especially in already concentrated blowdownstreams



ZD – Seeded Slurry Brine Concentrator

- **Volume Reduction** - Commercially proved, industry standard for concentrating calcium sulfate saturated wastewater
- Seeded slurry technology prevents scaling of heat transfer surfaces
- Over 65 Brine Concentrators operating in Power Industry
- Recovery high quality water for recycle to facility



ZD - Indianapolis Power & Light Zero Discharge Case Study (Petersburg, IN)

Challenge

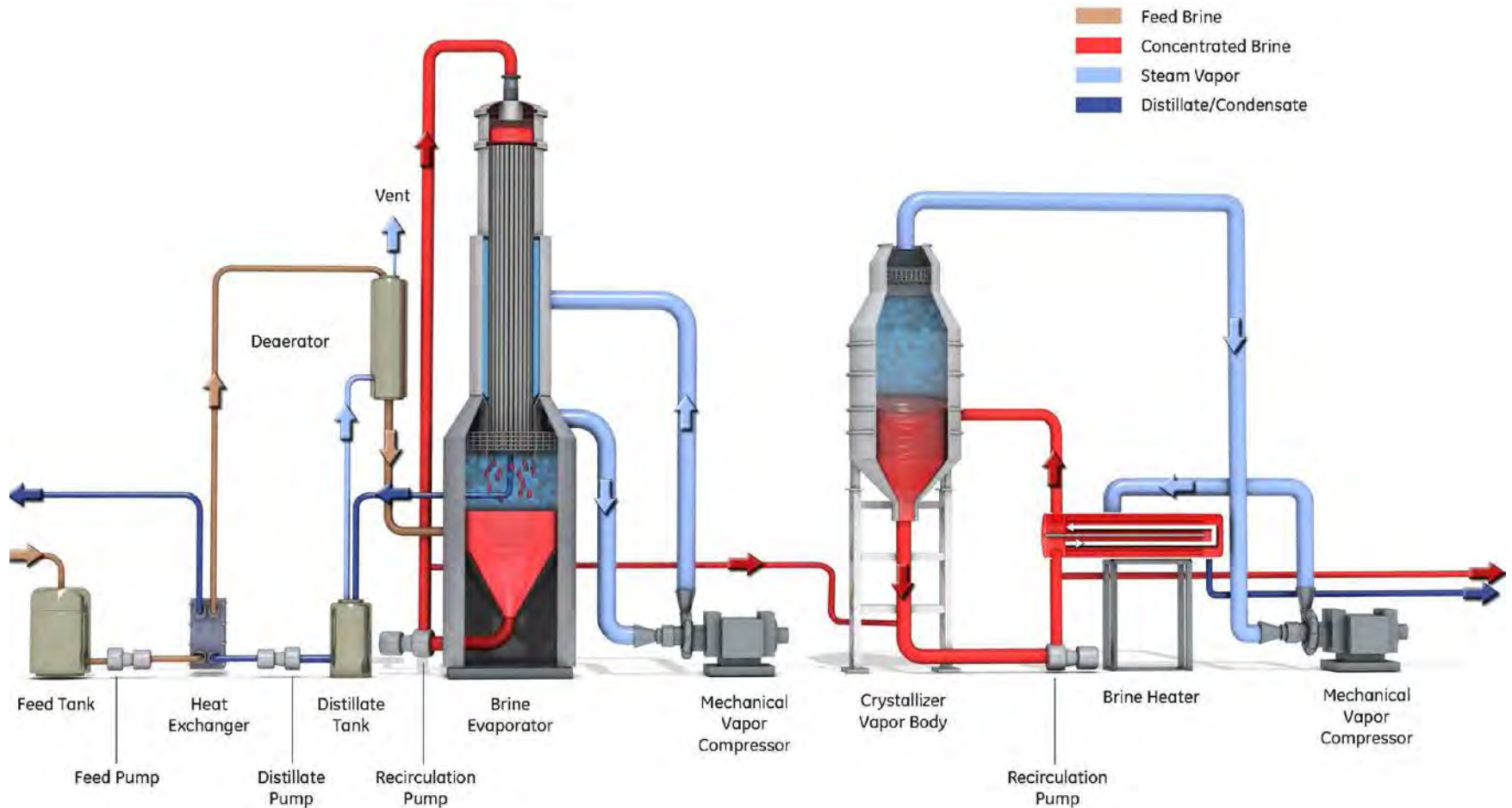
- FGD wastewater treatment to meet discharge limits for selenium, nitrate, mercury, arsenic, and boron

Solution

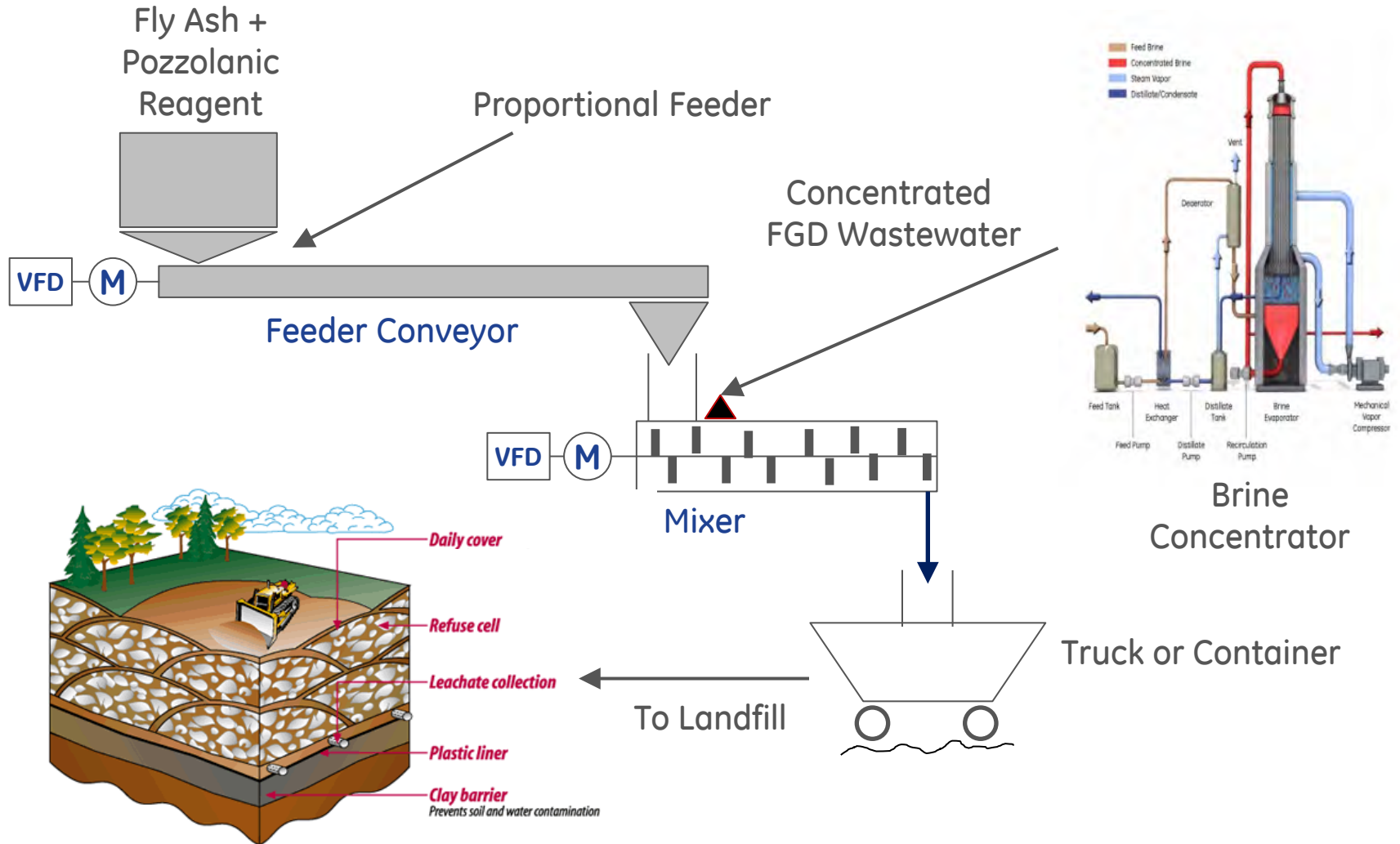
- 2 x 150 gpm brine concentrators
- Integrated GE offering includes...
 - Clarification
 - Softening
 - Brine concentrators



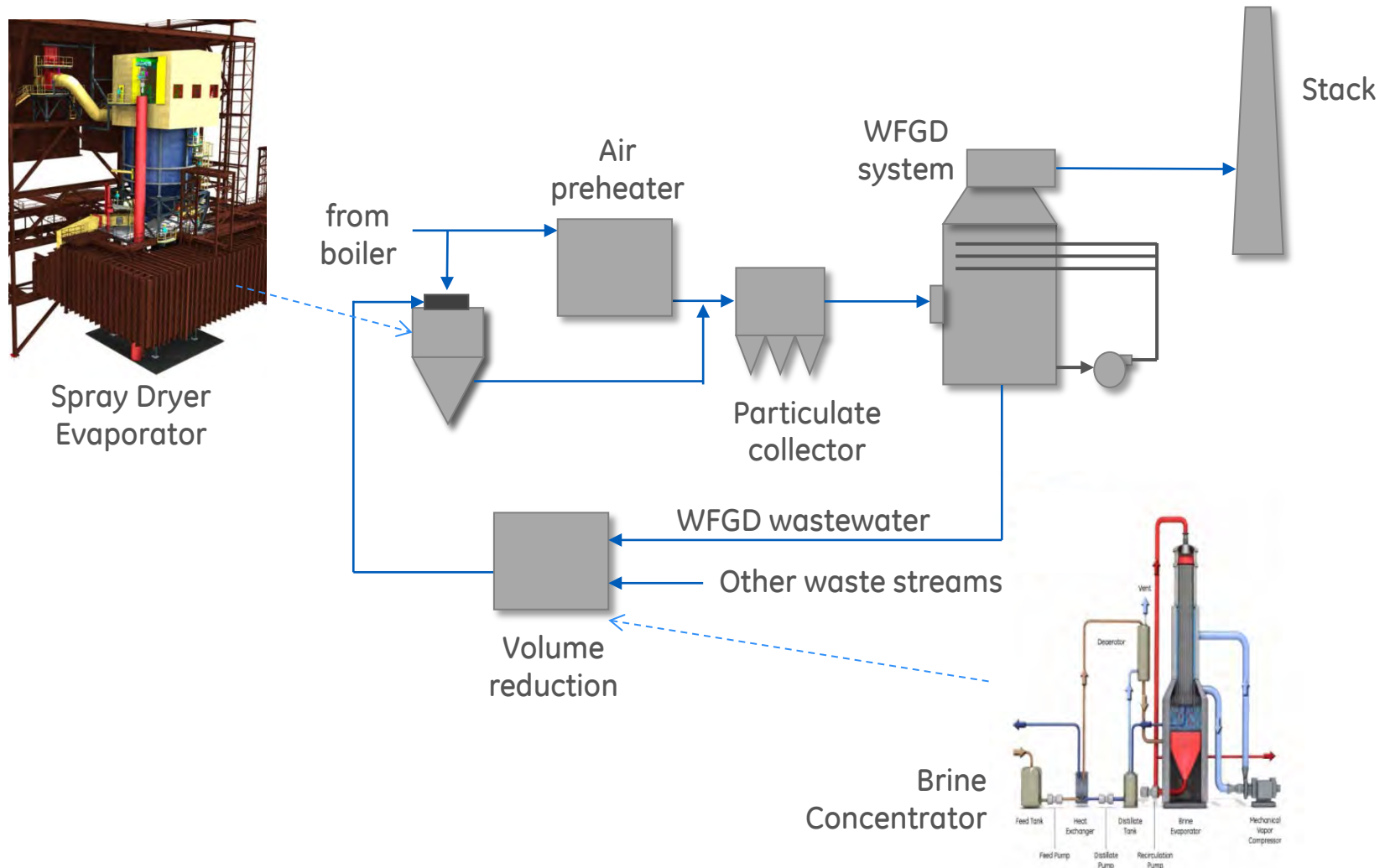
ZD - Brine Concentrator + Crystallizer System



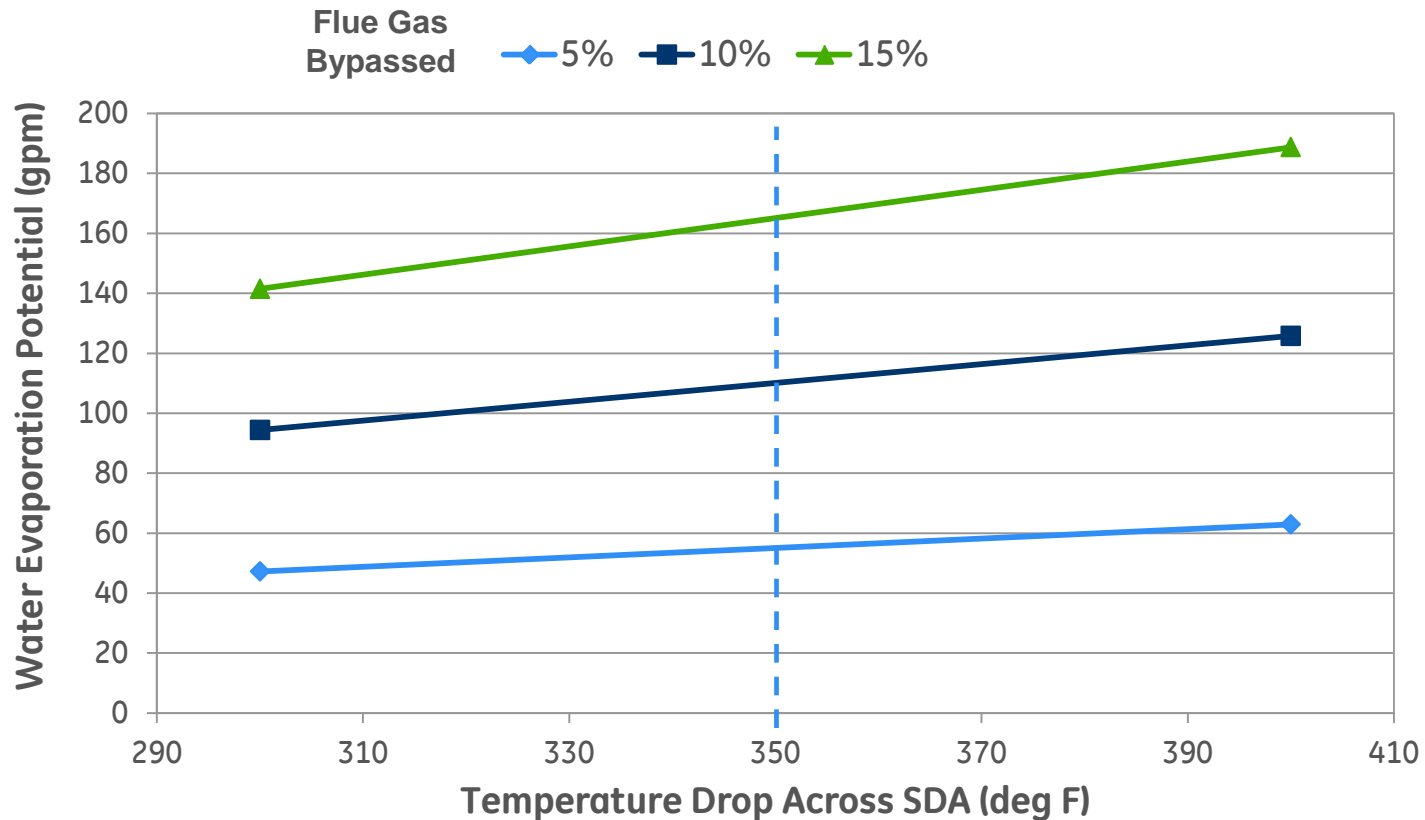
ZD - Brine Concentrator + Solidification



ZD - Brine Concentrator + Spray Dryer Evap.



ZD - Water Evap. Potential for 600 MW Plant



Slipstream SDA offers significant evaporation capacity



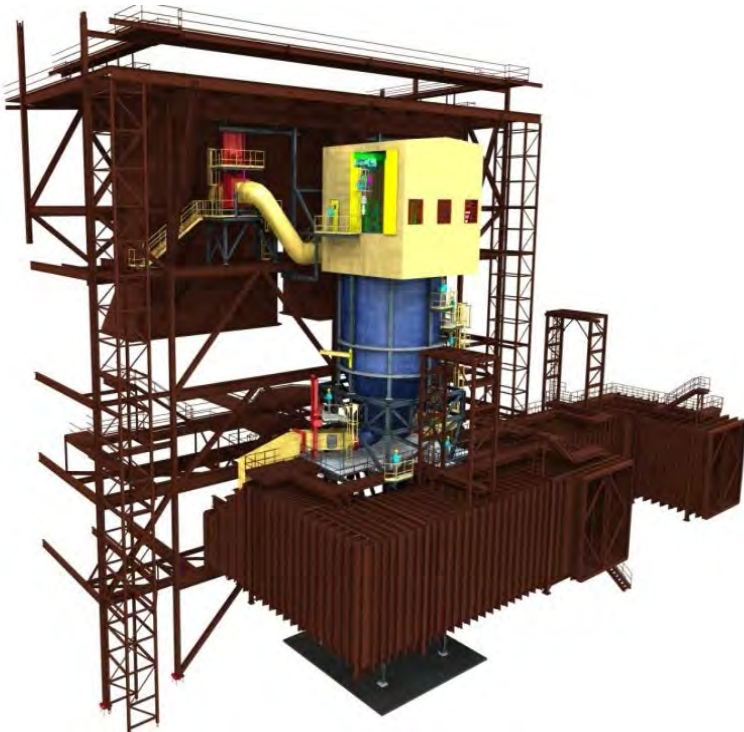
Case Study of First Full-Scale Slipstream SDE Installation in U.S.

Solution

- Spray dryer evaporator, rotary atomizers, ducts, dampers, support steel, access platforms, penthouse

Application

- 850 MW Midwest utility with a capacity of 50 gpm from wet FGD absorber
- Startup in 3rd quarter of 2016



Treatment System Advantages Comparison

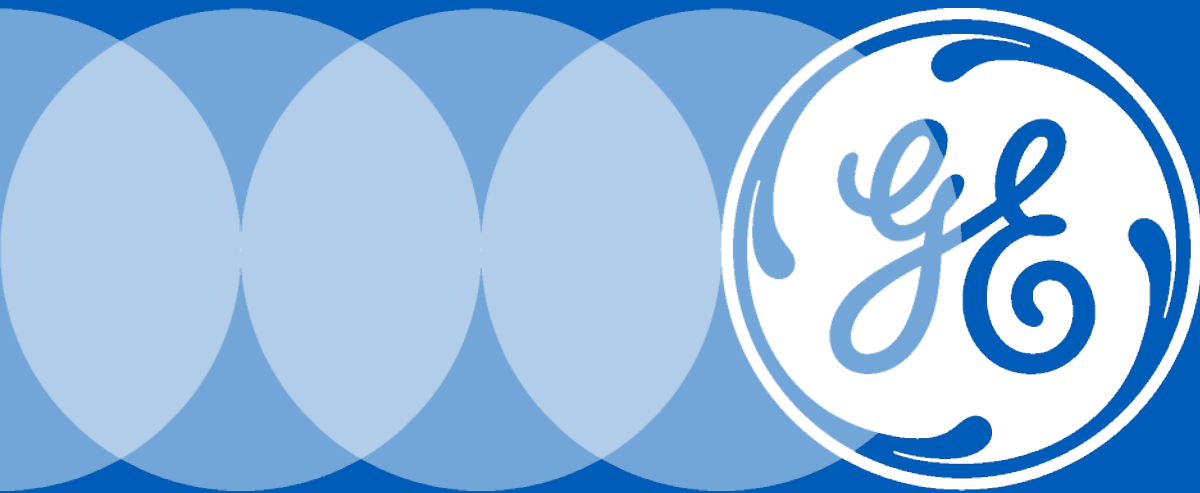
Zero Discharge

- **Future Proof**
Cradle to grave FGD Zero Discharge Solution
- **Extended Timeline**
EPA Voluntary Incentives Program – December 2023
- **Removal of constituents not typically removed by T&D systems**
TDS, boron, chlorides, etc

Treat & Discharge

- **Lower Capital Cost**
Cost effective solution to meet ELG limits
- **Lower Operating Cost**
Biological nutrient and chemical costs





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