



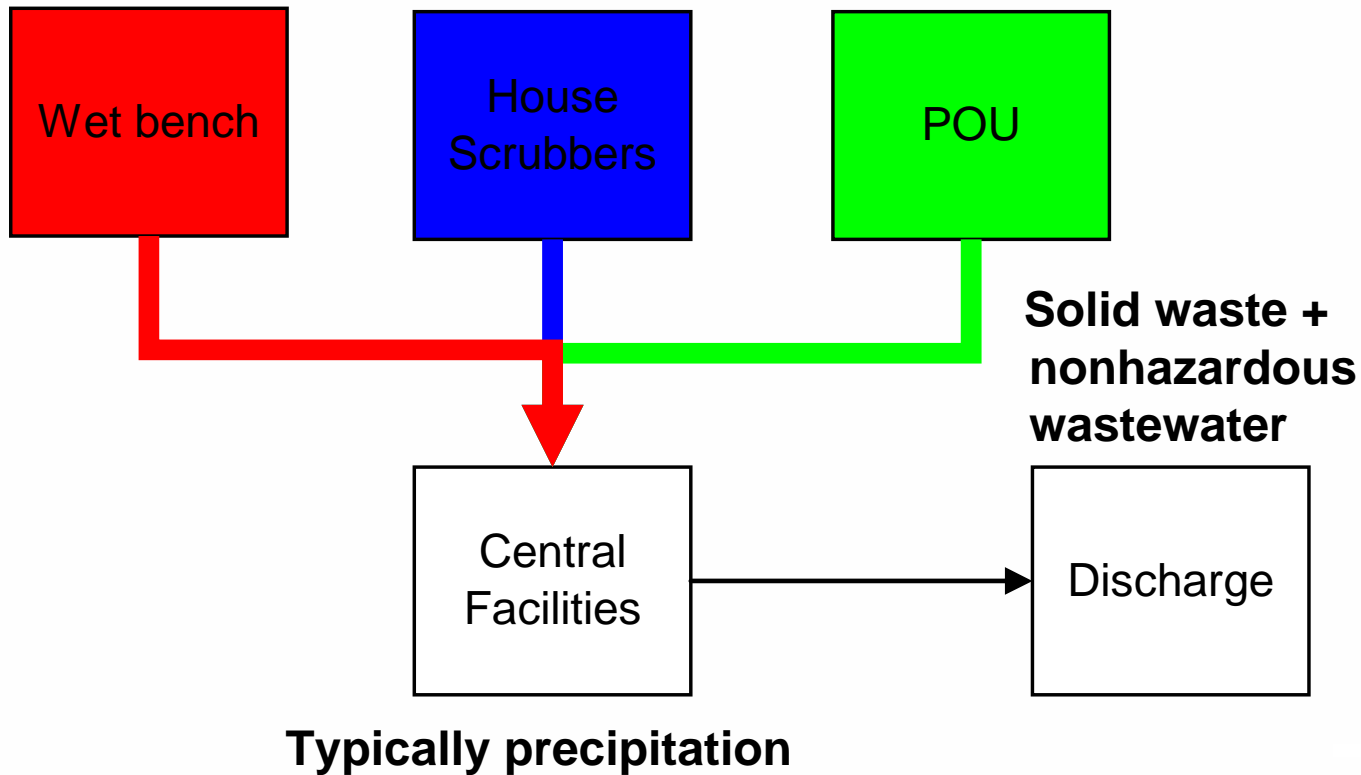
# Using Electrodionization Technology to Recycle HF Wastewater

Dr. Chris P. Jones

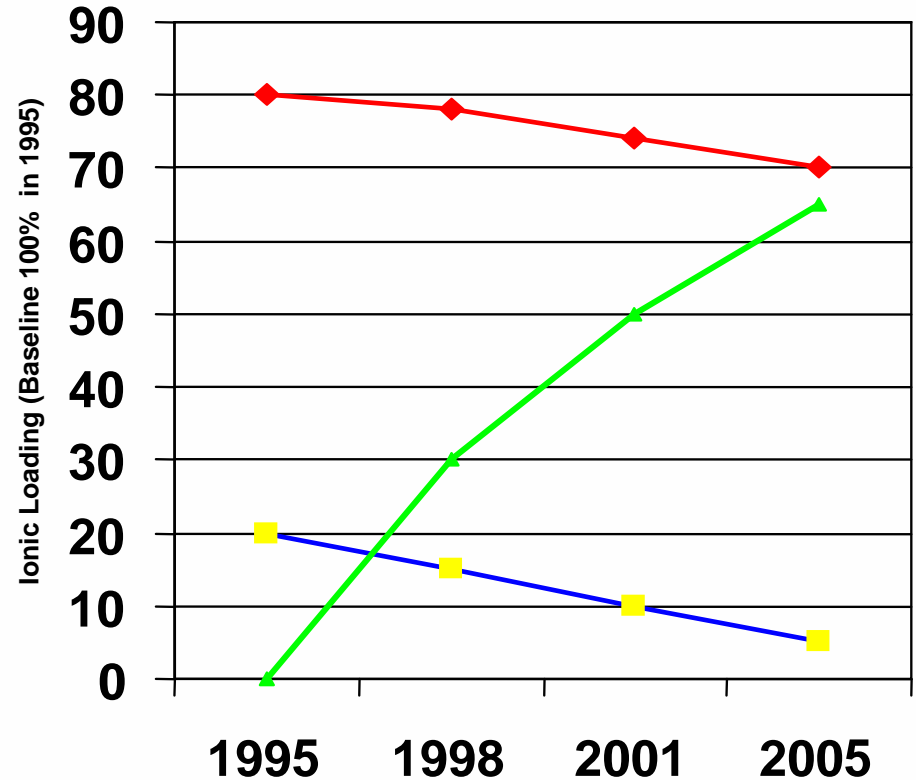
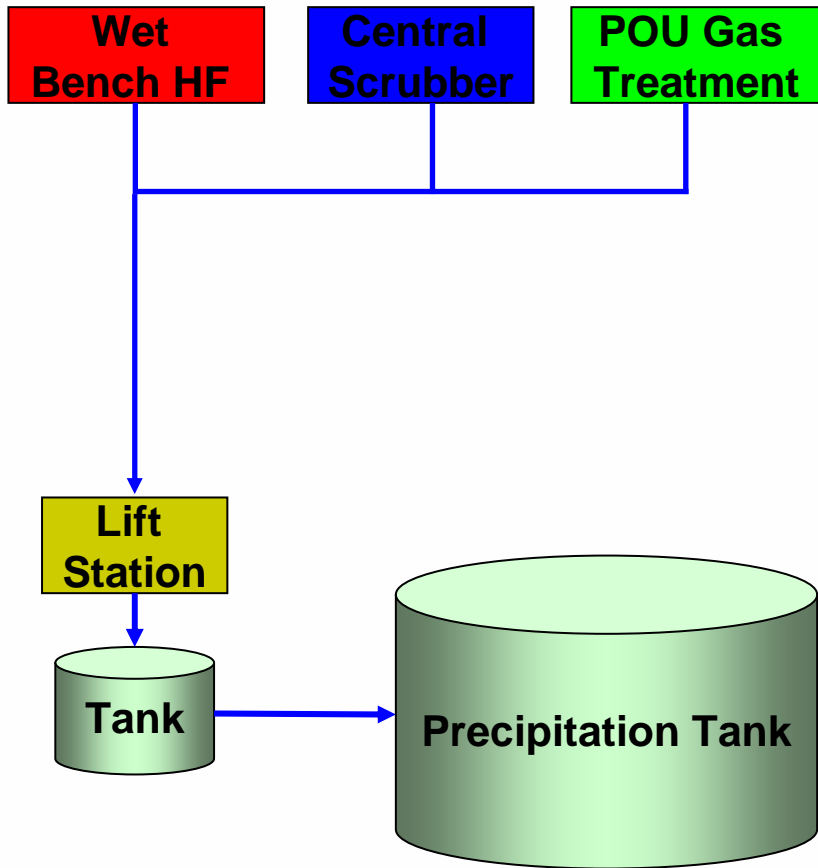
Presenter: Adrienne Pierce

# FAB HF Management

3 primary sources of HF to segregated drain



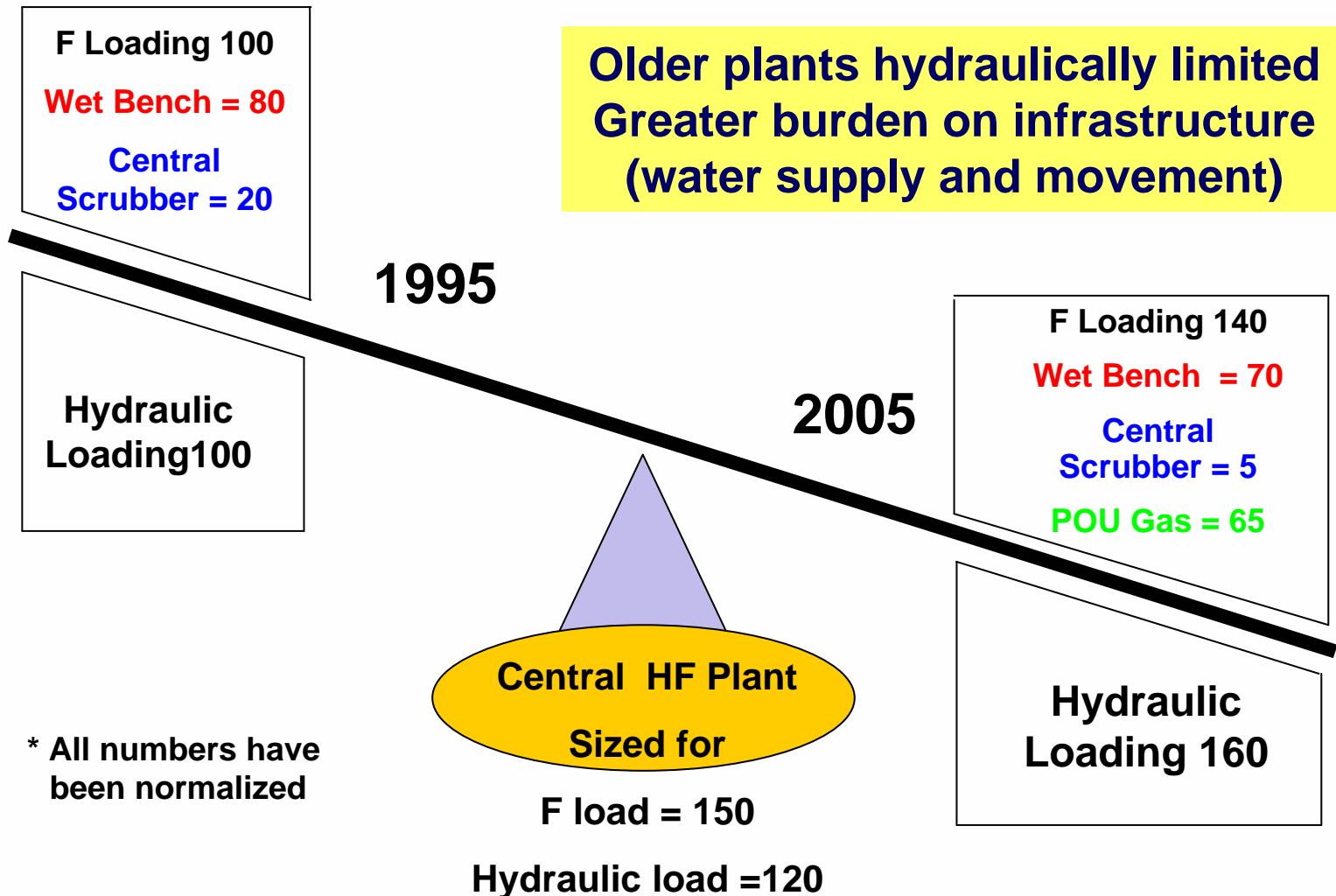
# Changing Trends - Sources of HF



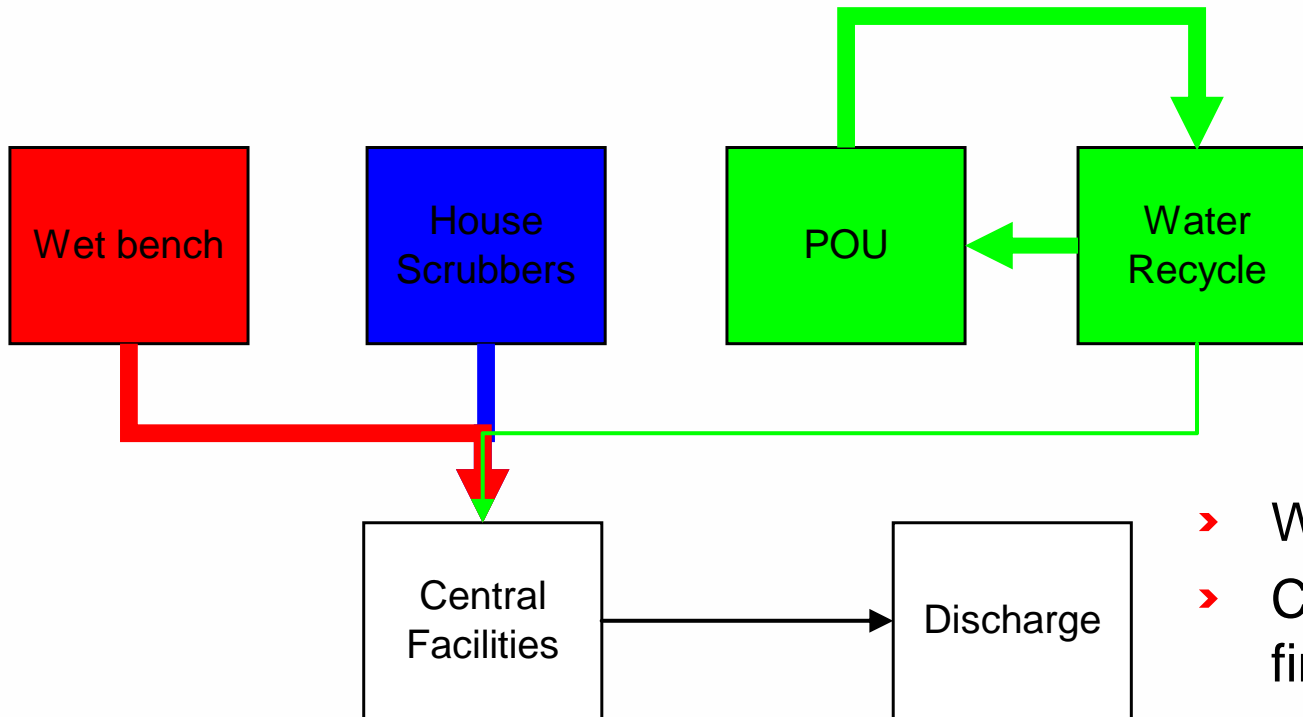
**HF loading has increased  
by > 40% since 1995**

Based upon survey of European manufacturers

# Impact on Wastewater Treatment



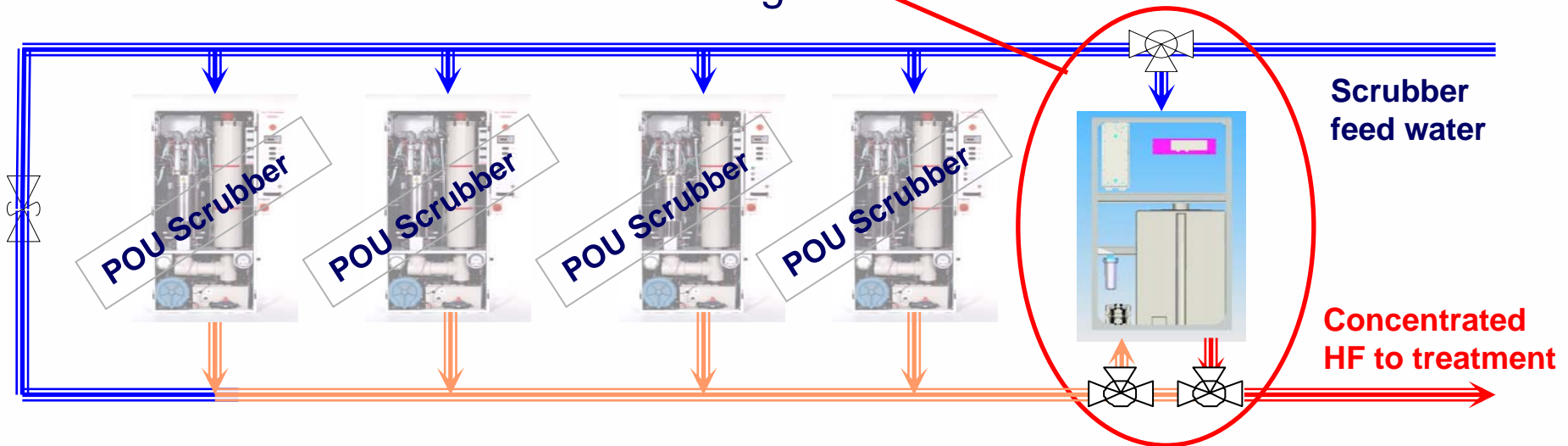
# FAB HF Management and Water Reuse



- > Water reuse
- > Conc HF for better final treatment
- > Frees up volume capacity for HF treatment

# Resolution – POU Concentration

**ERIX™** - Stabilization tank, solids filtration, heat removal and removal/concentration of fluoride ion loading



- Removes acids from a solids laden waste water
- Returns cleaned water to the POU gas abatement units
- Sends volume reduced, concentrated HF liquor to the site treatment plant

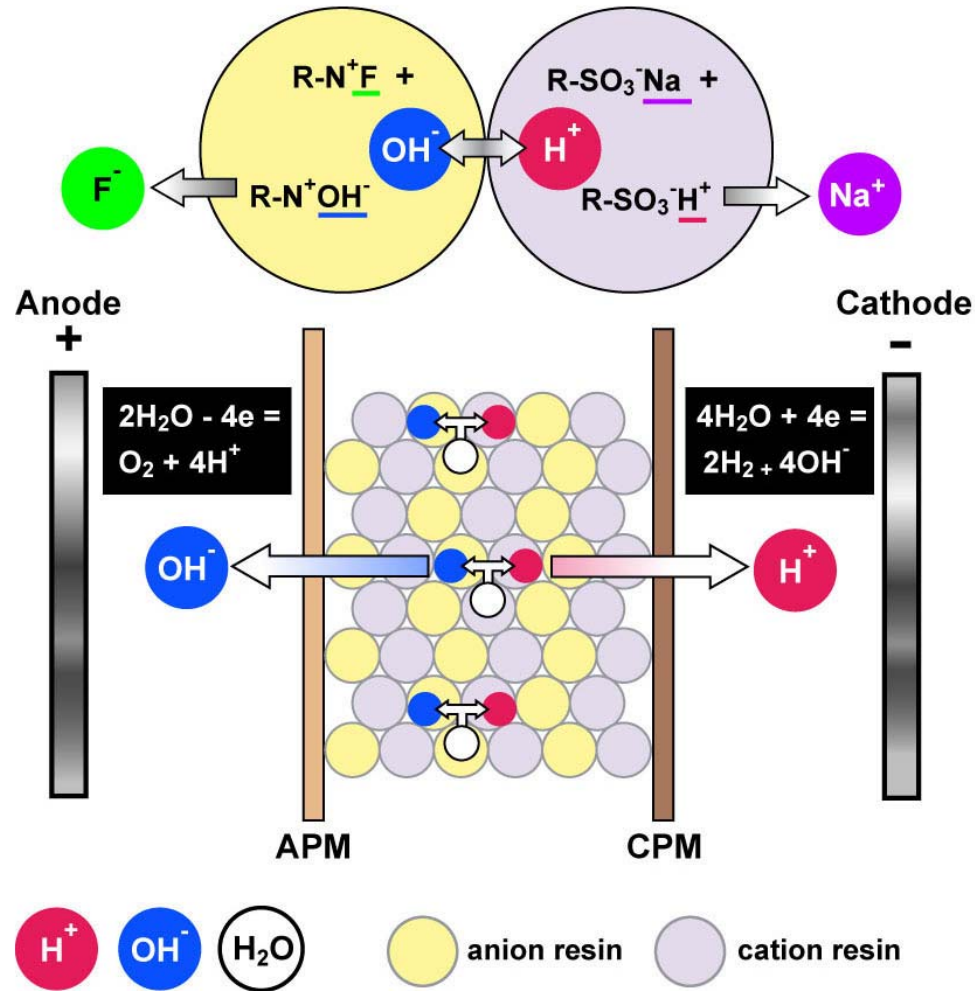


# ERIX™ System Specifications

- Aim to minimize cost of ownership
  - Minimize operator intervention
- Manage solids
- Minimize chemical additions
- Maintain POU sump < 500 ppm HF
- Recycle > 90% of water to POU units
- Manage up to 7kg/d HF (ionic equivalent)
  - 10 gal/min (50m<sup>3</sup>/d water)

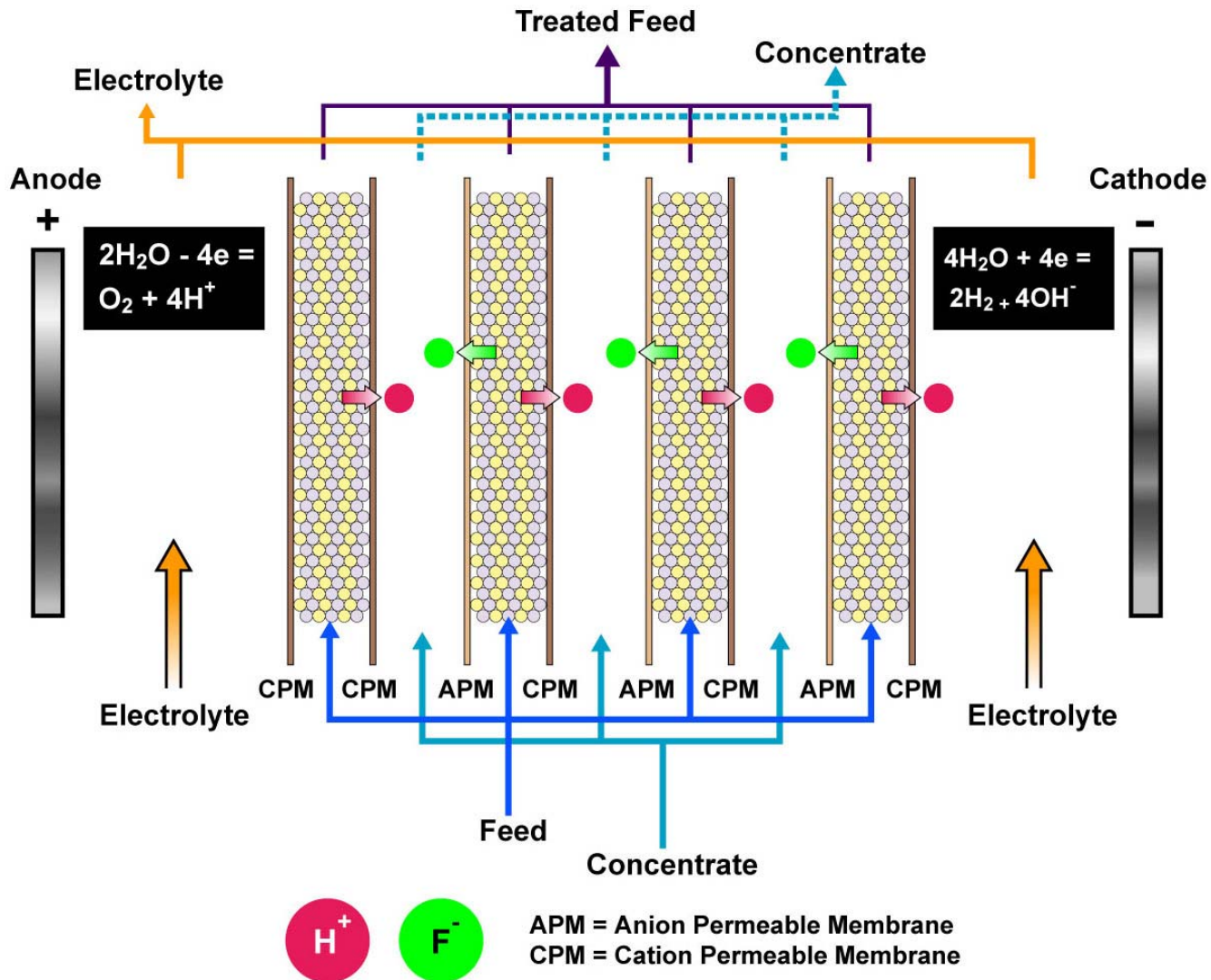
# Electrochemical Regeneration

## How Electrodeionization (EDI) Works



APM = Anion Permeable Membrane CPM = Cation Permeable Membrane

# Electrodeionization (EDI) Cell



# SUNY Albany – ERIX Beta Placement

COLLEGE OF NANOSCALE SCIENCE & ENGINEERING  
UNIVERSITY AT ALBANY State University of New York

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- Small Times Magazine 2006

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**BOC Edwards Installs Innovative ERIX Water Treatment System at UAlbany Nanocollege's Albany Nanotech Complex**  
Sep 8, 2006  
**ERIX Recycles Scrubber Water and Improves Efficiency of Back-Pad Treatment Facilities**

*This story ran on Business Wire, AZoNano.com, Semiconductor Fabtech and EuroNanotech News.*

CNSE On the Air:  
Listen to 810-WGY's Tech Valley Report on CNSE's 2006 Internship Program  
Listen to Assistant Professor Dr. Anand Gadre on "Science and Society"  
Listen to CNSE's Dr.

Installed on etch tool  
Recirculating water  
to two TCS systems

## Gases

- $C_4F_6$ ,  $C_4F_8$ ,  
 $CH_2F_2$ ,  $CHF_3$ ,  
 $NF_3$ ,  $NH_3$

## Evaluate

- F
- Water reuse
- Ammonia

# ERIX Project Plan Milestones

- **3 project milestones**
- **Chemical treatment validation**
  - Acid removal rates
  - Water recycling rates
  - Concentration factor
- **Equipment function and parameter setting**
  - Pressures, temperatures and flow setting refinement
  - Automatic operation
- **Production worthiness**
  - Unattended uptime, mean time to failure, mean time to repair.
  - Operating costs





# ERIX Project Plan Milestones

## > Chemical treatment validation

- Acid removal rates / Water recycling rate / Concentration factor

### **ERIX commissioned October 2006**

DOE called for high chemical loads

ERIX EDI cell operational and able to remove mixed acids from waste water under high gas loads

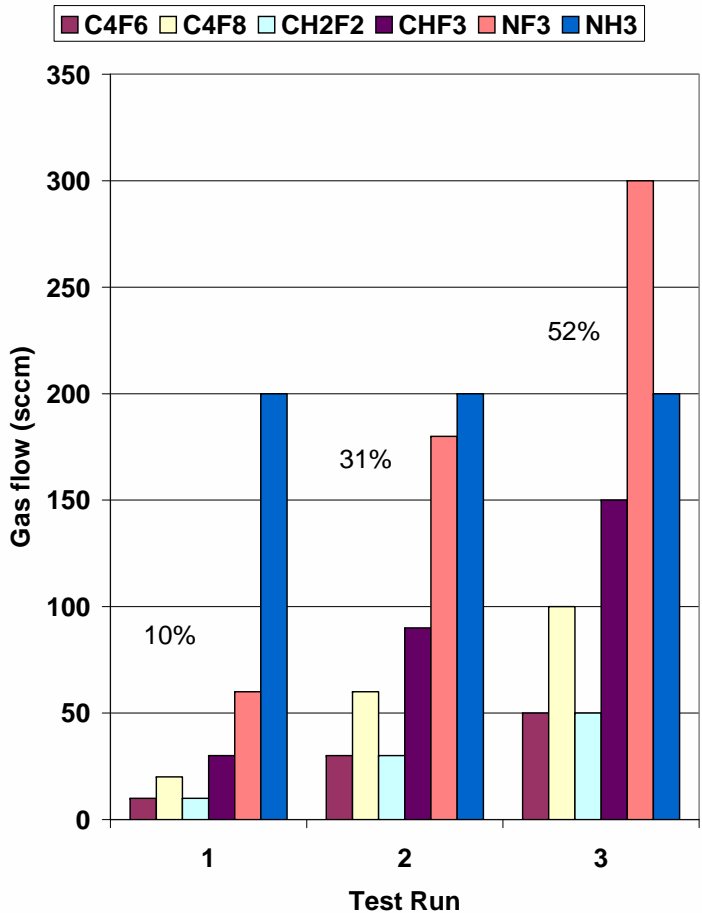
**Gas trial 1** -  $C_4F_6$ ,  $C_4F_8$ ,  $CH_2F_2$ ,  $CHF_3$

**Gas trial 2** -  $C_4F_6$ ,  $C_4F_8$ ,  $CH_2F_2$ ,  $CHF_3$ ,  $NF_3$ ,  $NH_3$

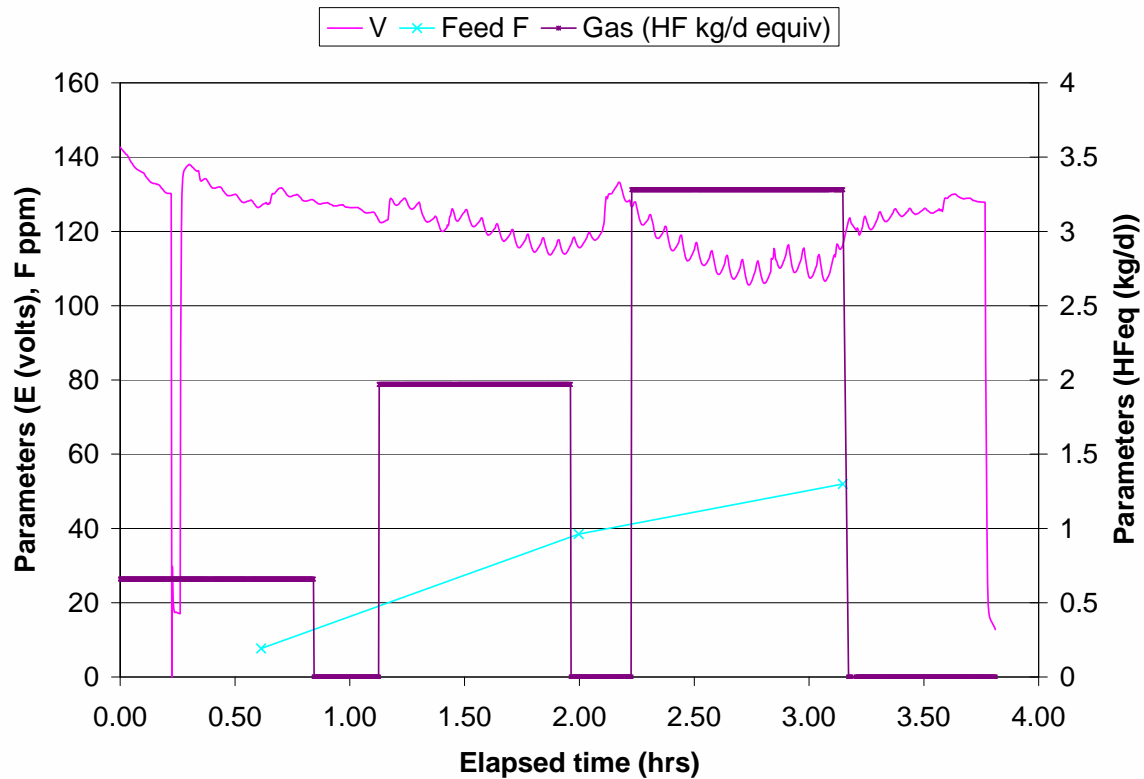
**Gas trial 3** – Standard recipes for tool operating a peak wafer throughput (~25 wafers per hour)

# Acid Removed <<500 ppm

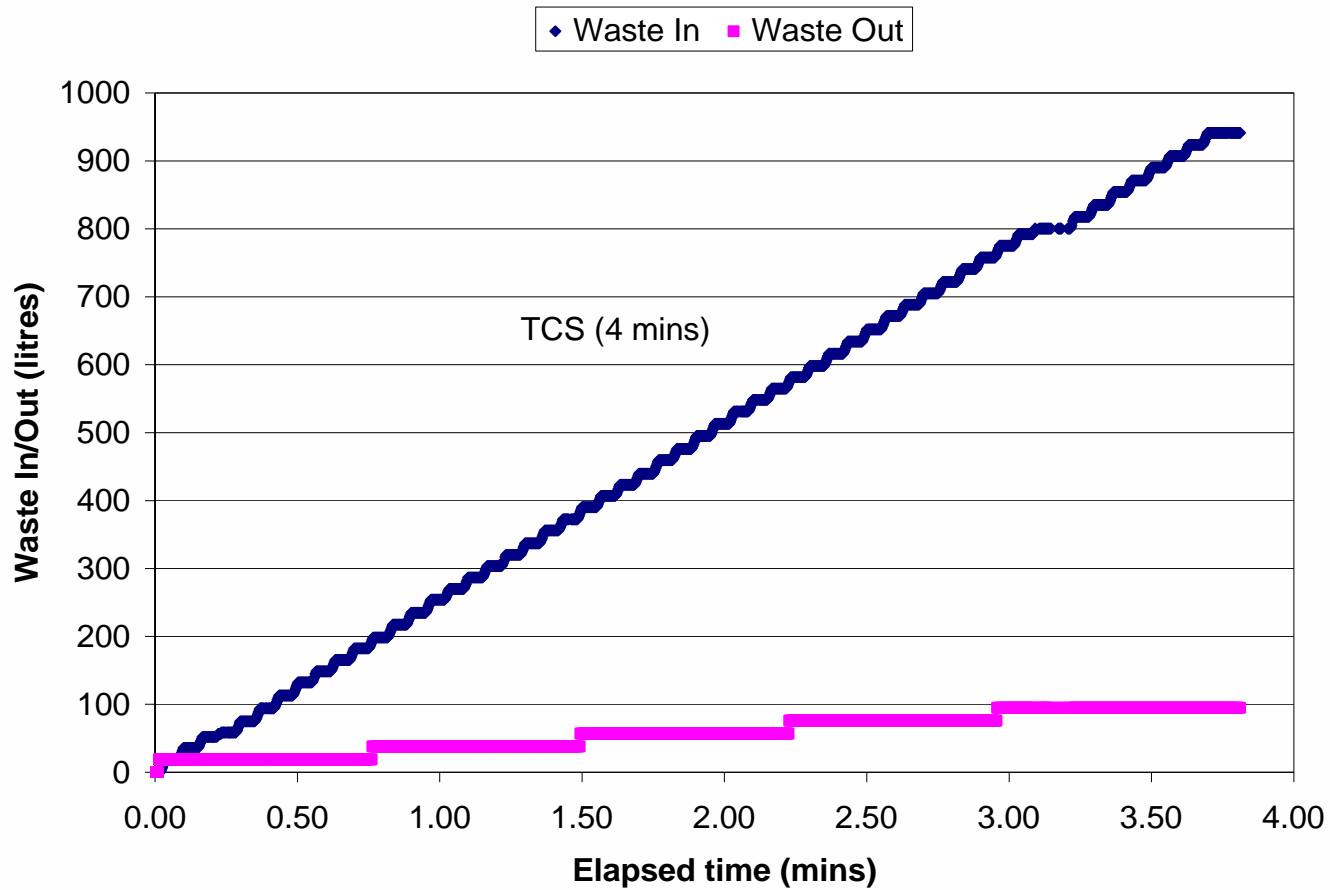
## Cell capacity vs. gas flow



## Managing the HF in the reuse water to < 60 ppm (Target < 500 ppm F)

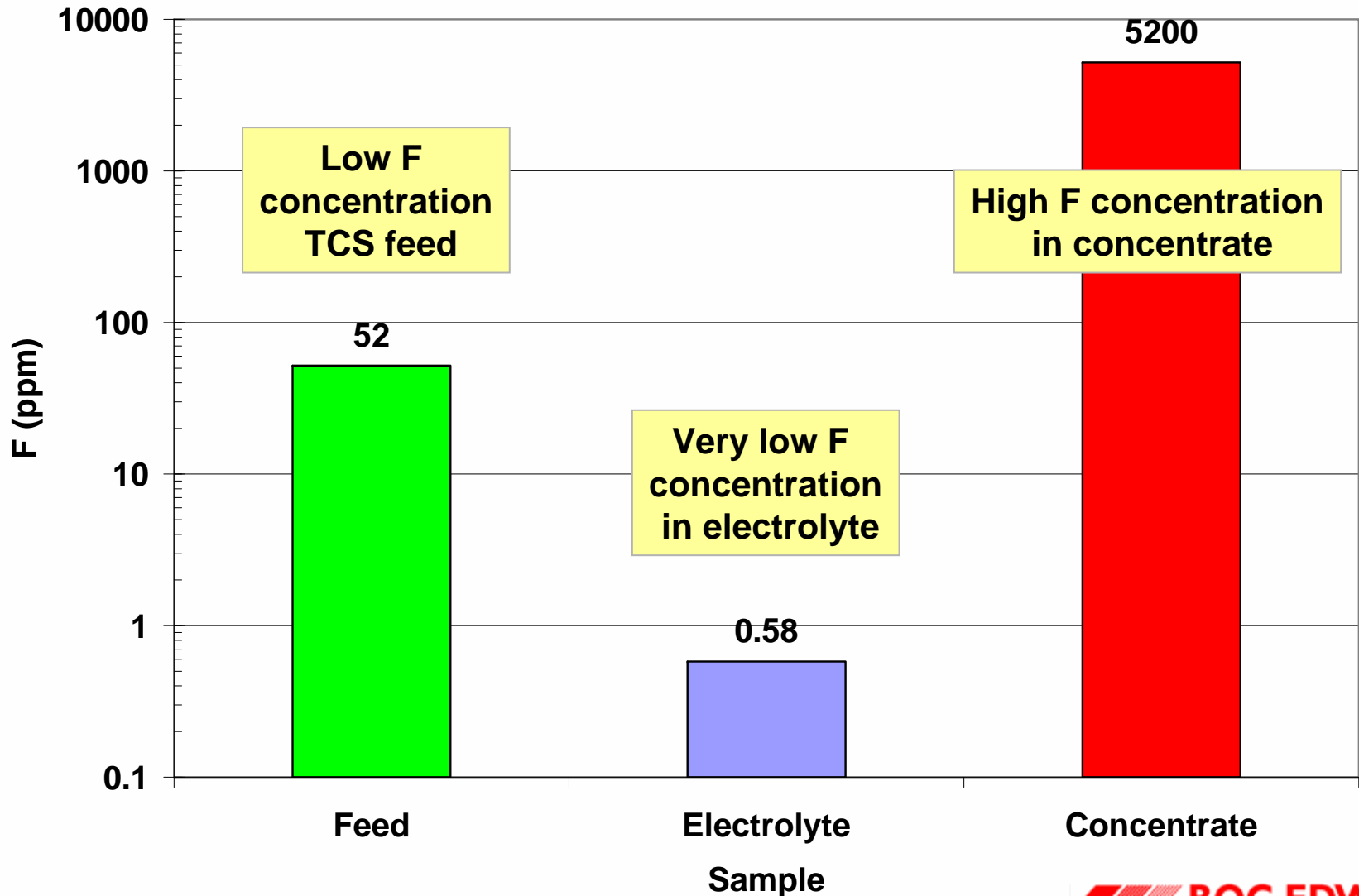


# Wastewater Recycled 90%



Wastewater reduction by 90% (operator set)

# Fluoride Waste Concentrated



# High Gas Throughput - Other Species

- > Fluoride effectively removed and concentrated

- Cations

- $\text{NH}_4^+$  and  $\text{Na}^+$  removed and concentrated

- Silica moved to concentrated
- Some corrosion products also to concentrate

- > No phosphate (i.e. no electrolyte leaking)

Species	2. Feed ppm	2. Conc ppm
F	56	4450
$\text{SO}_4$	<2	<2000
Cl	<1	<1000
Na	0.2	72.3
$\text{NH}_3(\text{N})$	<1	21
$\text{NO}_3(\text{N})$	0.05	<20
$\text{PO}_4(\text{P})$	<0.02	<20
Si	0.373	16.6
Fe	0.143	9.86
pH	2.9	3.4
Ni	<0.02	0.35
Cr	0.018	0.207



# ERIX Project Plan Milestones

## Equipment function and parameter setting

Pressures, temperatures and flow setting refinement  
Automatic operation

- Technical verification completed November 2006
- Dec 25 – conductivity probe failure, safe shut down
  - Waste treated 13000 gallons, discharge 1250 gallons
  - Water recycled 90%
  
- **Next steps: Production worthiness**
  - Marathon operational testing
    - Collect up-time data
    - Service intervals
    - Optimize operations
    - Cost of ownership

# Operating Benefits Verification

- Water usage decreased by a minimum of 90%
  - Can increase internal POU recirculation
- Daily water from POU to central F treatment decreased by 90%
  - No requirement to build new precipitation plants or extend water supply infrastructure

