

# **REINHOLD ENVIRONMENTAL Ltd.**



## **2011 NO<sub>x</sub>-Combustion Round Table & Expo Presentation**

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# **An Integrated Approach to SO<sub>3</sub> Mitigation and Multi-Pollutant Controls**

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2011 NOx Roundtable Birmingham,  
Alabama

# An Integrated Approach to SO<sub>3</sub> Mitigation and Multi-Pollutant Controls

- GENERAL
  - Interactive Presentation (35-45 min)
    - Questions during presentation OK
  - Discussion/ Q&A (15-25 min)
    - Questions From Audience & For Audience
- OVERVIEW
  - Discuss Interactive Concepts & Strategies
  - Present Some Examples of Integrated Strategies
  - Open Discussion

# INTEGRATED EMISSION CONTROLS

- Not a new concept but significantly more complicated by existing and emerging regulations
- Must evaluate all new significant modifications to major plant systems from an integrated systems standpoint.
  - Primary Plant Systems
  - Pollution Control Systems
  - Waste Systems
- Driven by need to:
  - Resolve existing operations and environmental concerns
  - Leverage potential operations & environmental benefits
  - Comply with existing & new environmental regulations
  - Comply with New Source Review (NSR) requirements
  - Save \$\$

# Speaker Experience & Perspective

- Co-op Ohio Edison (First Energy)
  - Sammis Dry Scrubbing Test (Mid-Late 1980's)
- Employed Cincinnati Gas & Electric>Cinergy>Duke Energy (1990 – 2011)
  - Boilers, Steam Cycle Performance, APH's, Fans, Exp Jt's, Dampers, FGDs, Misc BOP systems
  - Significant Corrosion Related Issues (SO<sub>3</sub>)
- Last 10 Yrs more focused on back end systems
  - SO<sub>3</sub> Mitigation (1999 - current)
  - FGD/ Gypsum Plant
  - SCRs & Catalyst Mgt
- Learned first hand there are many complex interactions that need to be evaluated but usually are not.

# Background for Duke's IECS Efforts

SO3 Mitigation efforts required a comprehensive evaluation of:

- Negative Side Effects
- Co-Benefits
- 1999 Initiated efforts to mitigate SO3 plume at Zimmer
- 2000-2004 Tested various reagents from fuel additives to DSI & Slurry injection at FGD Inlet
- 2004 & 2005 installed permanent SO3 mitigation systems
  - Hydrated Lime
  - Trona
  - SBS/ Soda Ash
  - Furnace Mag Hydroxide Slurry Injection
  - Dual Reagent Systems
- 2006 thru 2010 Additional Reagent Testing for SO3/ Co-Benefits
- 2010 - Current DSI Testing (Trona, SodiumBicarb, Hydrated Lime) for SO2 removal w/FFDC

# Damper Corrosion



# ID Fan Corrosion



## VISIBLE PLUME



- Opacity due to  $\text{H}_2\text{SO}_4$  (Sulfuric Acid) Aerosols in Flue Gas
- Aerosols  $\text{H}_2\text{SO}_4$  in flue gas when quenched in Absorber Mods

# SO<sub>3</sub> Mitigation Impacts

- SO<sub>3</sub> Mitigation Strategies
  - Initially for Acid Aerosol (Blue) Plume Concerns
    - Sorbent Injection Technologies (Dry & Wet)
    - Fuel Additives
    - Fuel Switching
  - Growing Implementation revealing:
    - Challenges & Limitations
    - Co-Benefit Opportunities
    - Unanswered questions

# SO<sub>3</sub> Mitigation Impacts

- SO<sub>3</sub> is a key pollutant with widespread impacts
- SO<sub>3</sub> Mitigation Processes and reagents also can have widespread impacts
- Pollutants including HCl, Hf, Hg, Nox are directly or indirectly impacted
- Significant HCl Reduction Co-Benefit Possible with various Sorbent injection technologies
  - Numerous secondary benefits from HCl mitigation
- Equipment & System Impacts must be evaluated

# EMISSIONS/ ENVIRONMENTAL ISSUES W/ POTENTIAL IMPACTS OR CO-BENEFITS FROM SO<sub>3</sub> MITIGATION

## Air Emissions

- SO<sub>x</sub>
- NO<sub>x</sub>
- Hg
- HCl/ Hf
- HAPS
- CO<sub>2</sub>??

## Water Issues

- NPDES

## Coal Combustion Products

- Fly Ash
- Gypsum

## Landfill Issues

- Leaching
  - Se, As, Al,
- Groundwater

# COMMON OPERATIONAL ISSUES

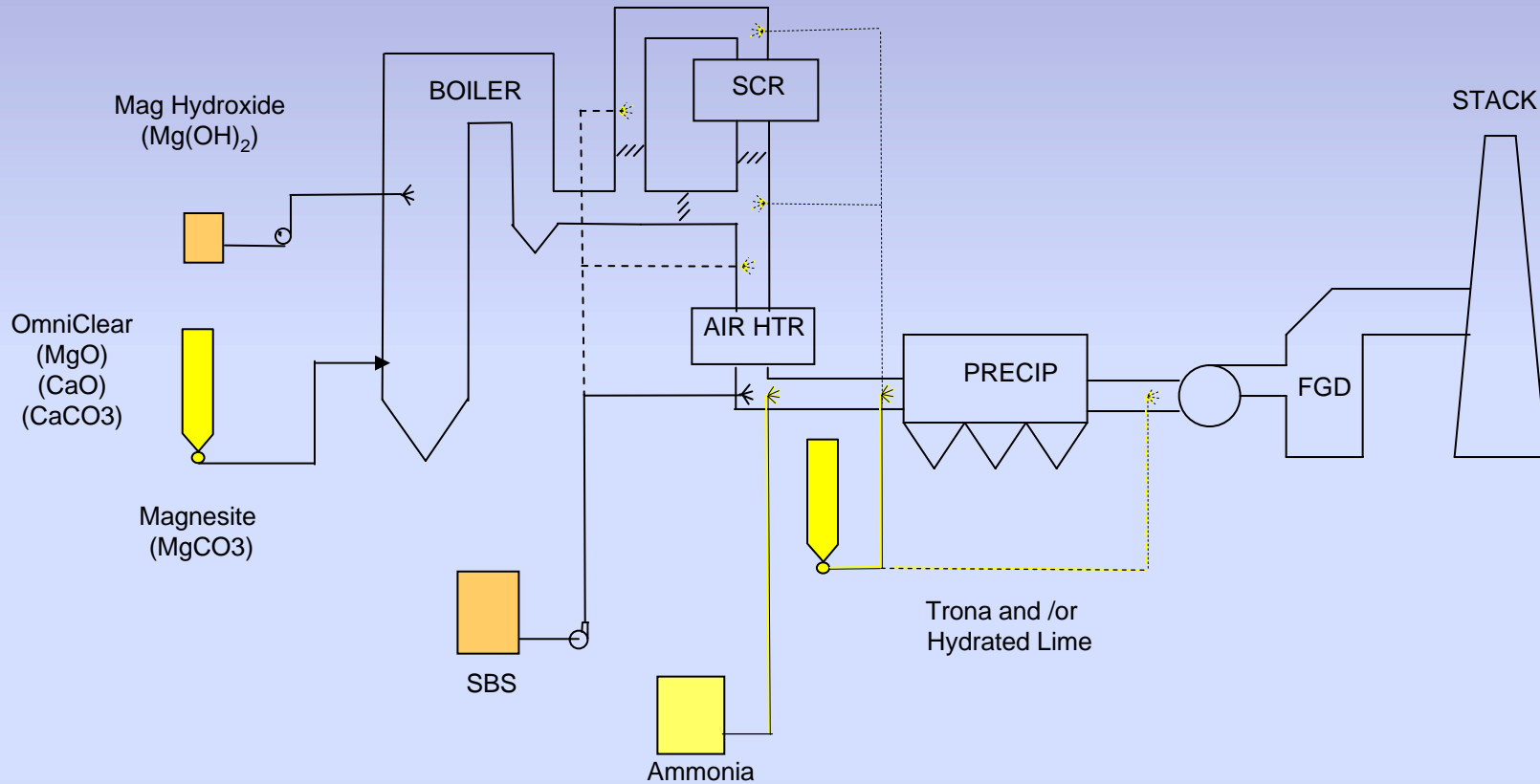
## Basic Plant Systems

- Boiler
  - Slagging
  - Fouling
  - Water Wall Corrosion
  - Bottom Ash pH
- Air Heater
  - Fouling
  - Corrosion
  - Heat Rate Limitations
- Ductwork & Fans
  - Corrosion
  - Fan Hp & Aux Pwr

## Environmental Systems

- SCR Catalyst
  - Deactivation/ Poisoning
  - SO<sub>2</sub>/SO<sub>3</sub> Oxidation
  - Pluggage
  - Unit & Fleet Dispatch
- ESP Problems
  - Ash Resistivity
  - Corrosion
- FFDC Problems
  - Bag Blinding
  - Bag Failures
- FGD Issues
  - Alloy Corrosion (Chlorides)
  - Excessive Chloride Purge Stream

# SO<sub>3</sub> MITIGATION STRATEGIES



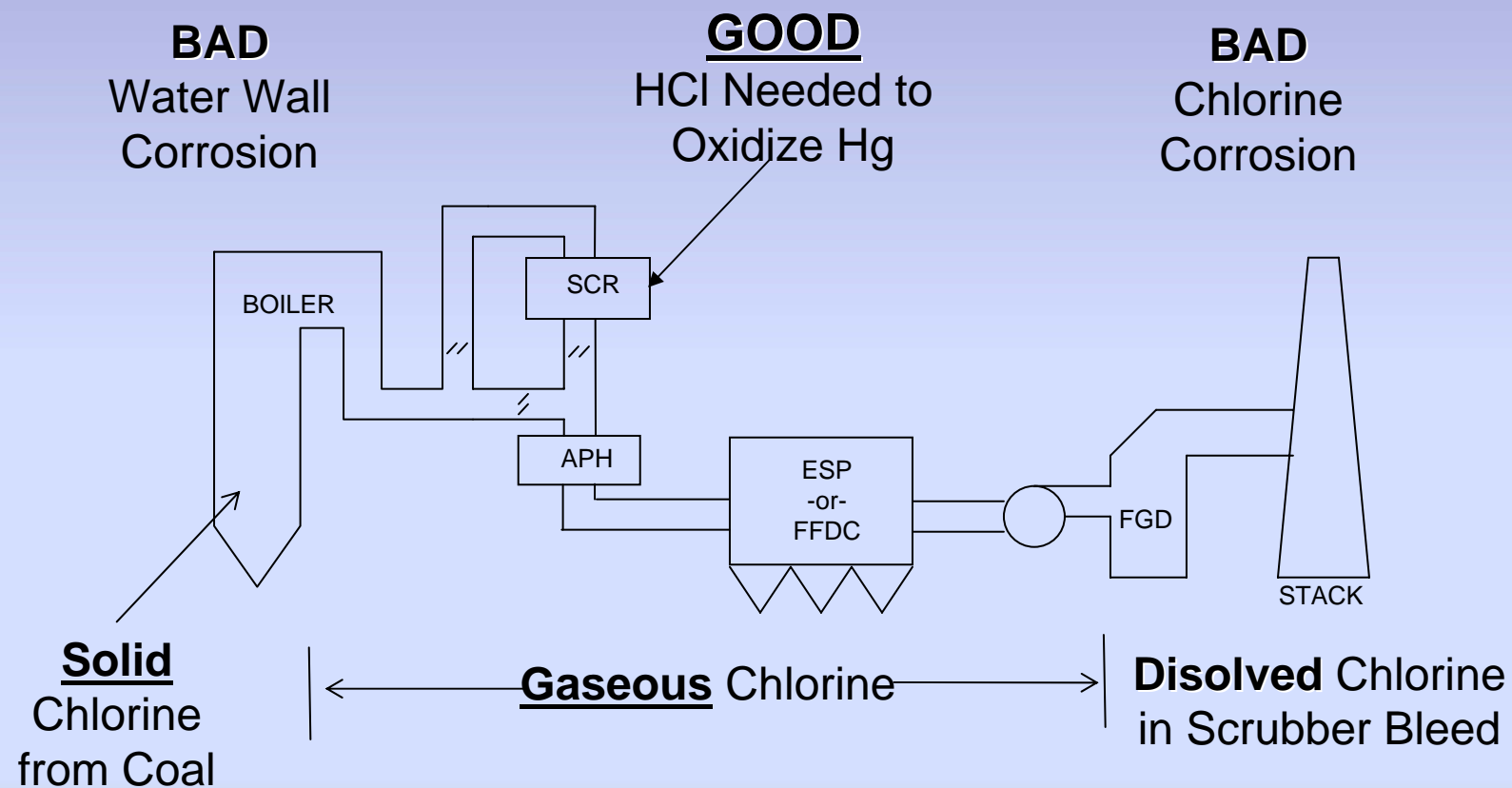
# Examples of IECS Strategies

- SO<sub>3</sub> Mit Pre-SCR
  - Reduced Cat Min Temp Restrictions
  - Potential Arsenic Mitigation Co-Benefit
  - Must evaluate Catalyst Effects
  - Must Evaluate Pre-SCR HCl/ Hg Oxidation impacts
- SO<sub>3</sub> Mit Pre-APH
  - Heat Rate Savings
  - Lower APH Out temps may help ESP Problems
  - Increased NO<sub>x</sub> Removal
  - Air Heater Element Life Extension
  - Reduced Air Heater Washes
  - Extended Catalyst Life
  - Must evaluate potential APH fouling mechanism

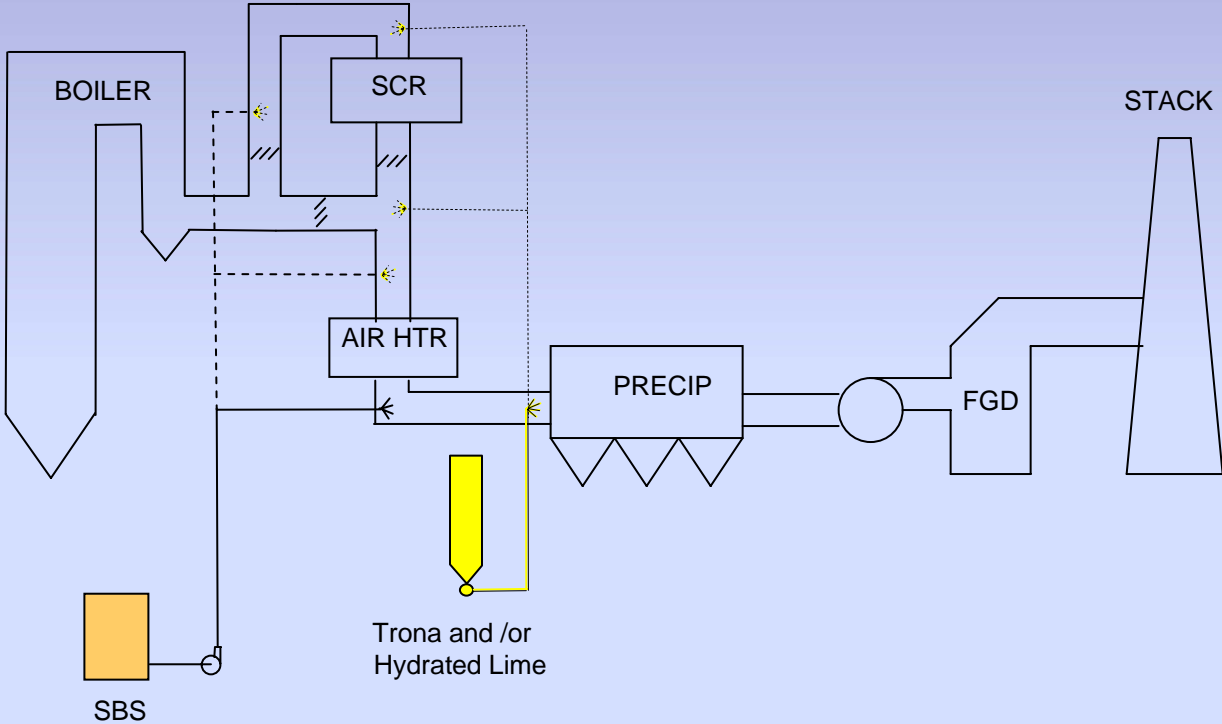
# Examples of Potential IECS Strategies

- SO<sub>3</sub>/ Chlorine Removal Co-Benefits
  - Increased Fuel Flexibility
  - Reduced FGD Chlorides (Corrosion & Scrubber Purge)
  - Boiler Chlorine Tolerance
- EPRI Toxecon (ESP + FFDC) w/ Sorbent Injection
- SCR Catalyst Hg Oxidation
- Switch to FGD Inhibited Oxidation with Fixation

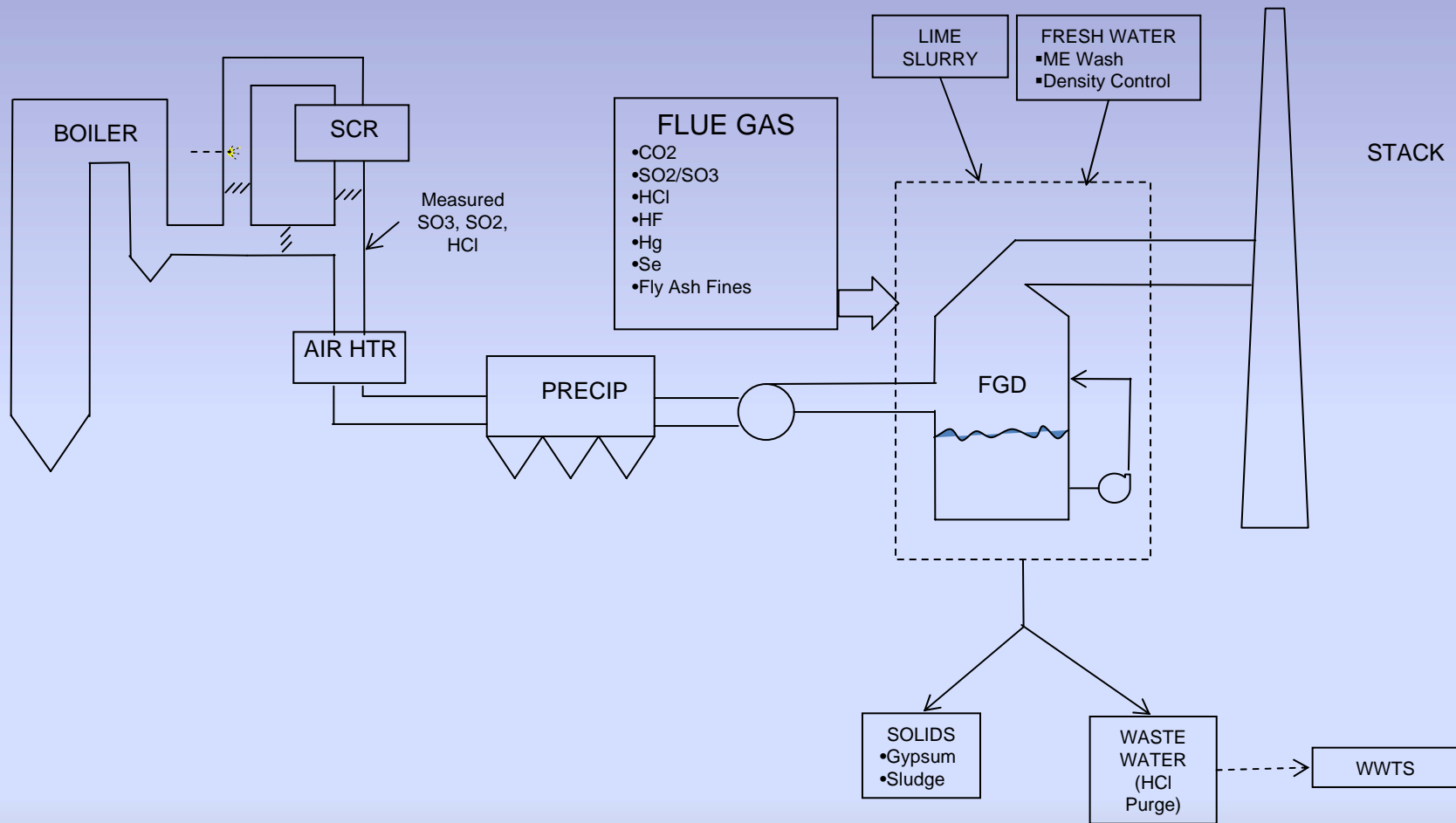
# Chlorine Impacts



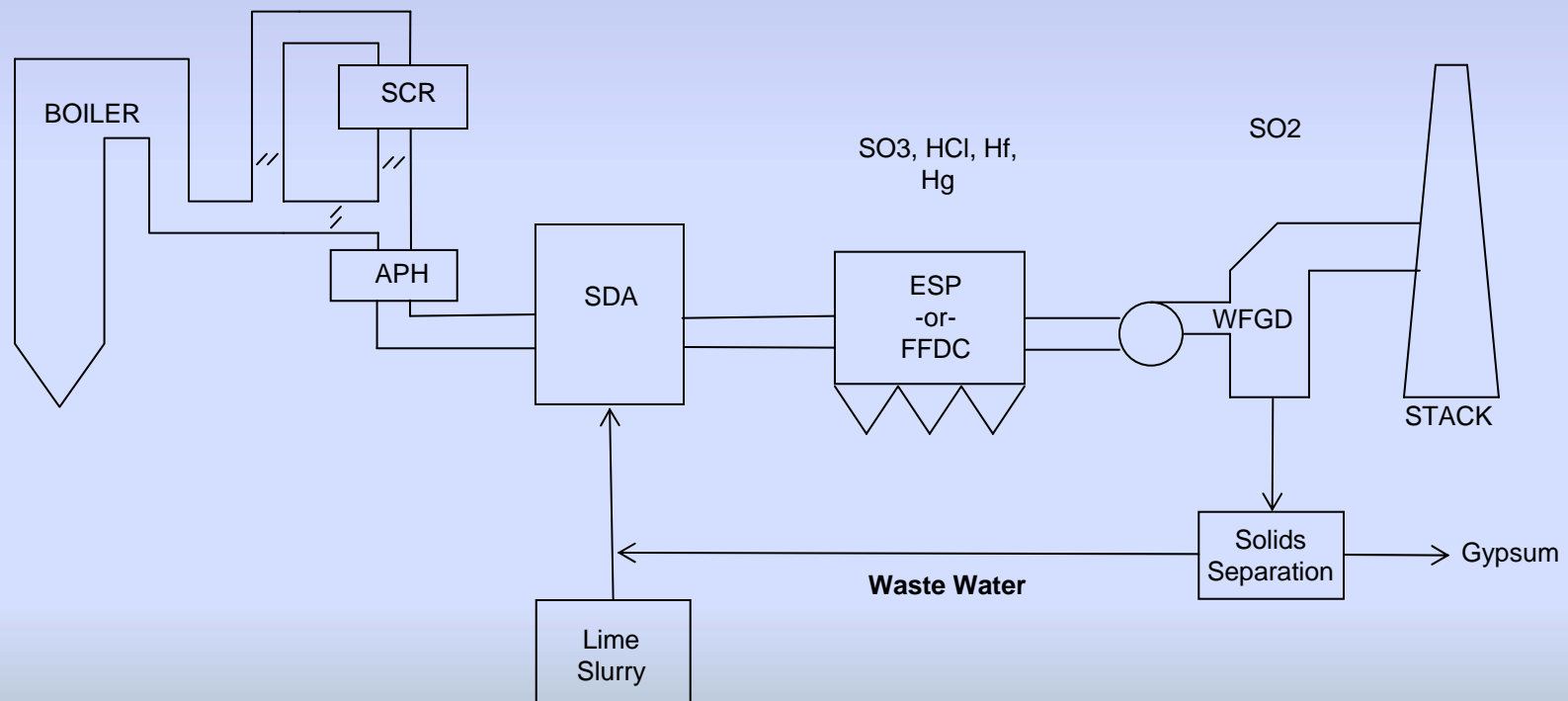
# HCL/ SO3 MITIGATION STRATEGIES



# Basic FGD Mass Balance



# Duke Cliffside AQCS



# Concerns with HCl Mitigation

- Higher Reagent Usage Rates
- ESP Impacts
  - Low SO<sub>3</sub> Levels >> High Ash Resistivity
  - Increased Mass Loading/ Maldistribution
- Fly Ash Impacts
  - Fly Ash Sales
  - Landfill Leaching & Structural Issues
- SCR Impacts
  - Catalyst Deactivation
  - Reduced Hg Oxidation

## Testing of Integrated emissions strategies

- Ongoing Industry Testing should provide guidance
- Extent of Integrated Co-Benefits are plant specific
- Often requires on-site testing to confirm extent of Co-Benefits/ problems
- ***NOTE: SITE TESTING MUST BE WELL THOUGHT OUT AND PLANNED***
- Effects on systems and equipment must be considered prior to:
  - Baseline Emissions Testing
  - Reagent Injection Test Campaigns

# Question & Answer

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# Questions For Audience

- Does your company do comprehensive IECS evaluation for environmental projects, MACT, CATR, NPDES, etc?
  - In-house? Department or Taskforce?
  - Role of A&E's, Consultants, Vendors?
- What Examples do you have of IECS & what are tradeoffs?
- What obstacles to proceeding with IECS ideas?
- Examples of where failure to consider IECS impacts led to significant problems?