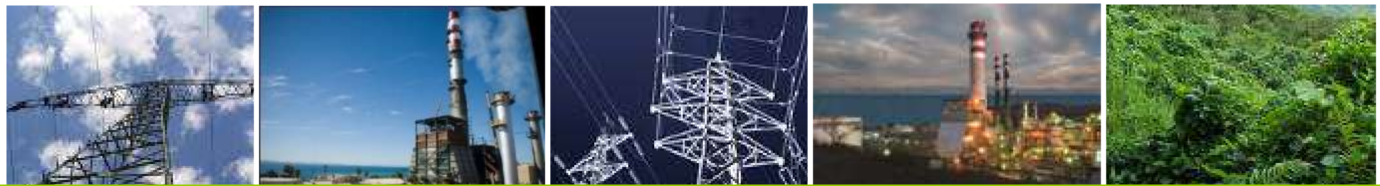

Demonstrated Commercial Operation of ULTRA™ Urea Conversion Process for SCR Reagent Feed System

EUEC 2011
January 31 – February 2
Phoenix, AZ

Amy Strauss, P.E.
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City Utilities of Springfield , MO
Southwest Power Station

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Agenda

- Fuel Tech – Company Information
- Fuel Tech ULTRA™ System
  - Process Description
  - Process Modeling
- City Utilities of Springfield Unit 1
  - Unit Description
  - Urea Reagent Technology Selection
    - Urea vs. NH_3
    - Safety Issues
  - System Scope
  - Operational History
    - Maintenance and Operational Costs
- Start up of CUS Southwest Unit 2
- Fuel Tech Commercial Experience
- Summary

Fuel Tech Overview

- **FUEL CHEM® Technology**
  - Boiler Efficiency and Availability Improvements
  - Slag and Corrosion Reduction
  - Controls SO_3 Emissions and Addresses Related Issues
- **Innovative Approaches to Enable Clean Efficient Energy**
  - NO_X Reduction Technologies include Combustion Modifications, SNCR, ASCR, RRI, ULTRA
  - Field Optimization Services
  - Flue Gas Conditioning Systems for Particulate Control – Outside US and Canada
  - Sorbent Injection for SO_2 Control
- **Flow Modeling and SCR Catalyst Management Services**
  - Computational Flow Dynamics and Physical Flow Modeling for Power Plant Systems
  - SCR System Optimization and Catalyst Management Services
- **Technology solutions based on Advanced Engineering Computer Visualization and Modeling**
- **Strong Balance Sheet (Stock Symbol: NASDAQ – FTEK)**

Fuel Tech's Global Presence

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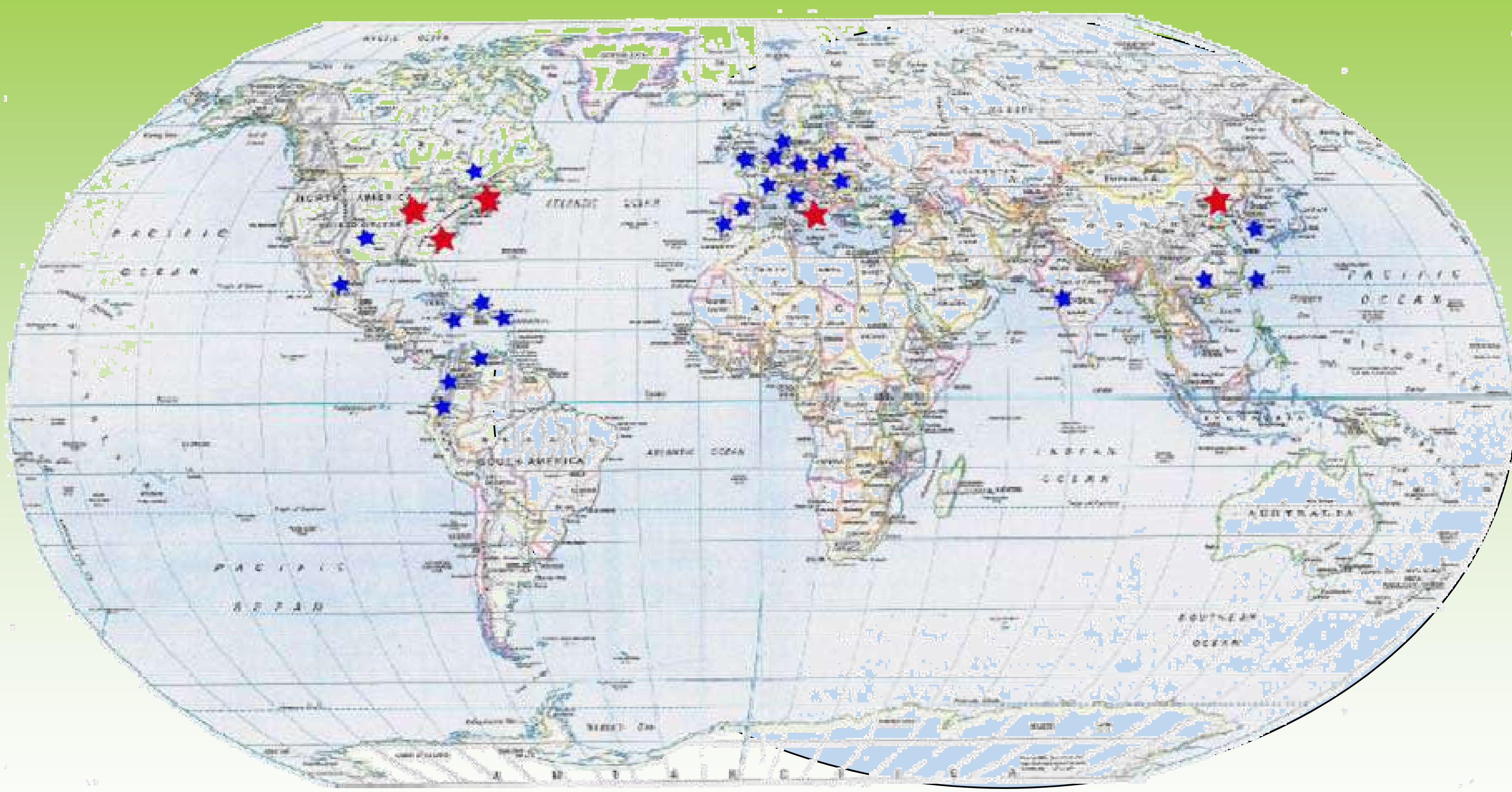

Office Locations: Warrenville, IL; Stamford, CT; Durham, NC; Milan, Italy; Beijing, China

Countries where Fuel Tech does business: USA, Belgium, Canada, China, Columbia, Czech Republic, Denmark, Dominican Republic, Ecuador, France, Germany, India, Italy, Jamaica, Mexico, Poland, Portugal, Puerto Rico, Romania, South Korea, Spain, Taiwan, Turkey, United Kingdom, Venezuela

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ULTRA™ Technology Overview

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- Safe and Effective Alternative to Ammonia for SCR
- Responsive System to Load Demands
- Simple…Simple….Simple
- Avoid Ammonia Storage and Handling Safety Issues
  - Homeland Security Chemical of Interest for Anti-Terrorism
  - DOT and DOT Restrictions
  - Increase in Rail Tariffs due to Risk and Tanker Tracking Requirements
- Levelized Annual Costs Advantage vs. Aqueous Ammonia Systems
- ULTRA™ Experience
  - Small Gas Turbine/HRSG Installations
  - Coal Fired Boilers through 700 MW
  - Contracts Totaling Over 6,600 MW of combined experience
  - Installations in the US, China, Europe

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ULTRA™ Systems
On-site Conversion of Urea

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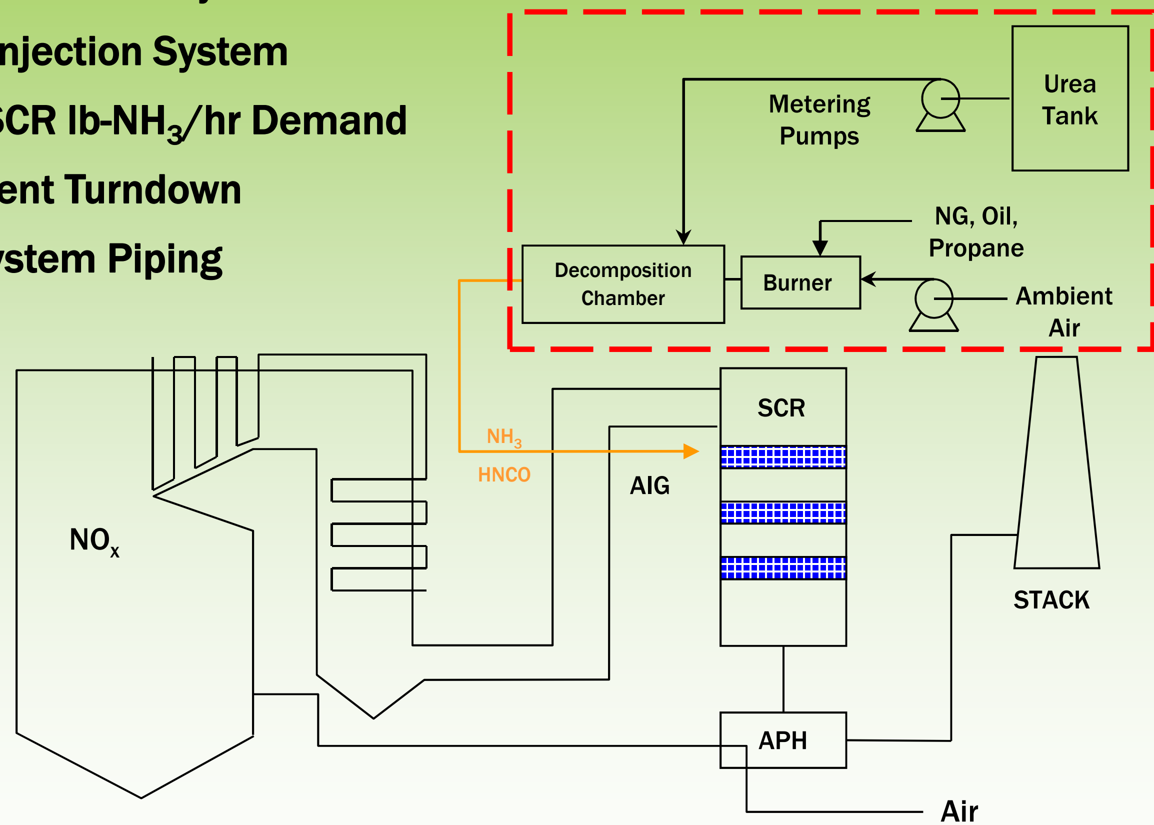
- **Safe Urea Reagent used for SCR Systems**
- **Proven & Simple Urea Injection System**
- **Urea Flow Dictated by SCR lb-NH_3/hr Demand**
- **Rapid Response, Excellent Turndown**
- **Negligible NH_3 in the System Piping**



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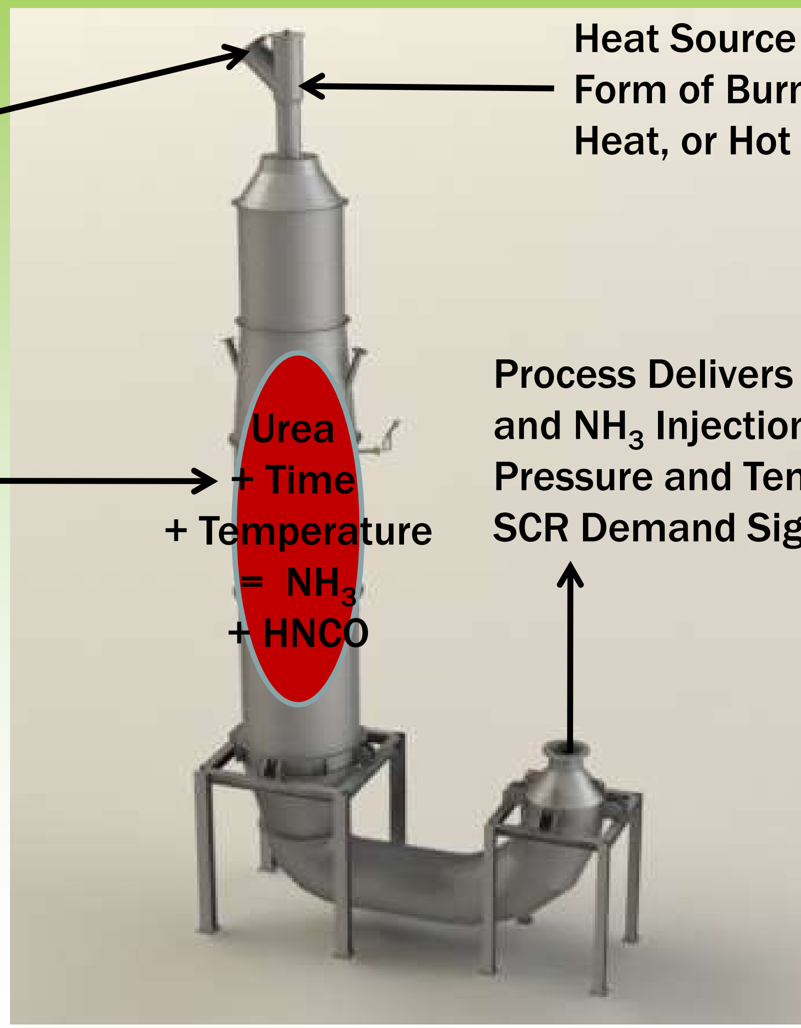
Thermal Decomposition of Urea

- **Patented Technology for On-site Urea Conversion Process that Relies on the Controlled Injection and Thermal Decomposition of Urea to NH_3 and HNCO**

Carrier Medium: Ambient Air, Clean Flue Gas

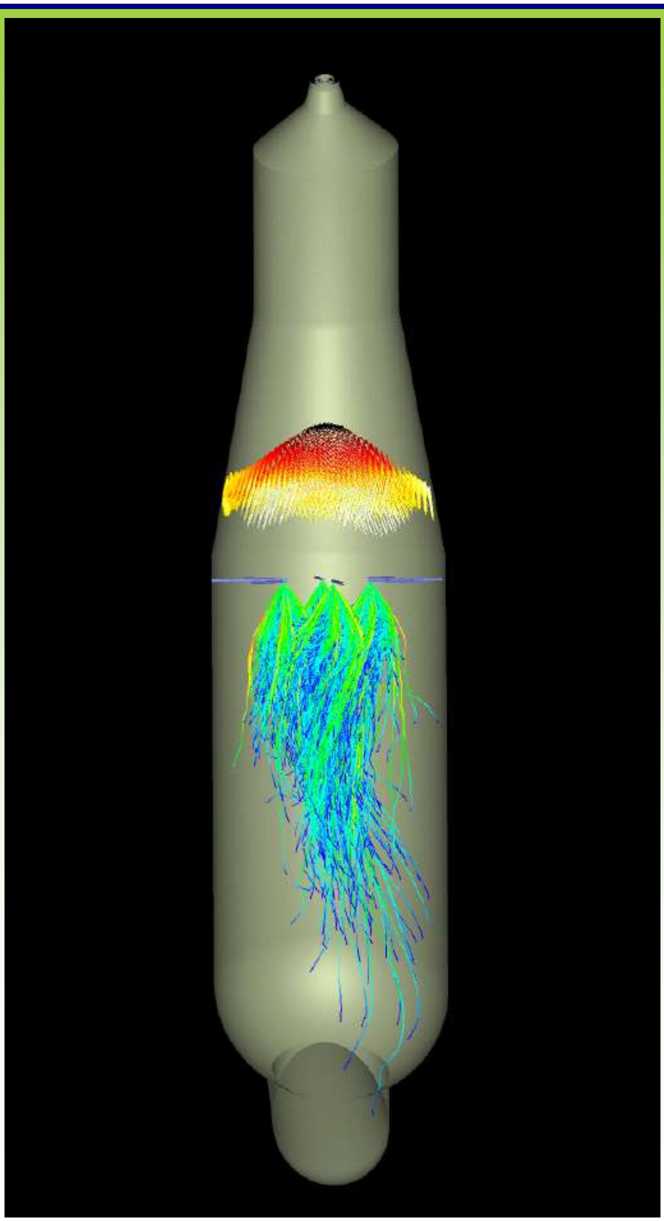
Heat Source in the Form of Burner, Electric Heat, or Hot Flue Gas

Injection of Aqueous Urea in Temperature and Time Dependent Chamber – Fast Load Following Capabilities

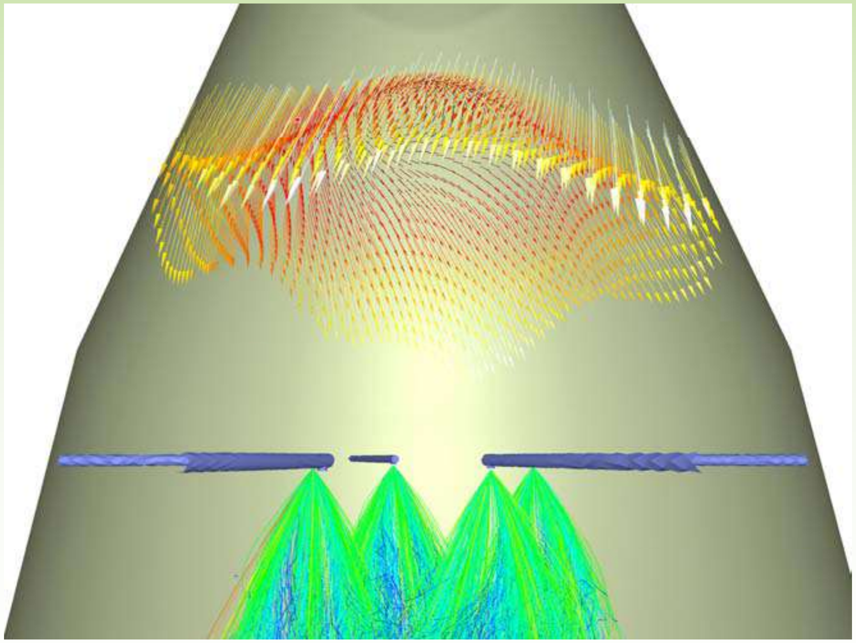


Process Delivers Reagent to Static Mixer and NH_3 Injection Grid (AIG) at Required Pressure and Temperature Based on SCR Demand Signal

Process Modeling



- **Computational Fluid Dynamics (CFD) Modeling of Decomposition Chamber**
- **Modeling of Temperature, Residence Time, and Droplet Dispersion**
- **Evaluation of Urea Injection Strategies**



CITY UTILITIES OF SPRINGFIELD (CUS), MO

Southwest Power Station Unit 1 ULTRA™ System

CUS Unit 1 – Operating Parameters

- The City Utilities of Springfield, MO - Southwest Power Station; One (1) Operational Generating Unit (Unit 1), and One (1) New Generating Unit (Unit 2)

- Unit 1 - 203 MW Riley Turbo Fired Unit Utilizing PRB coal
  - Retrofitted with an SCR System for NO_x Control.
  - NO_xOUT ULTRA™ Urea based NH_3 generation sized to provide 240 PPH SCR Reagent

- SCR NO_x Reduction of 80% to 0.08 lb/MMBTU

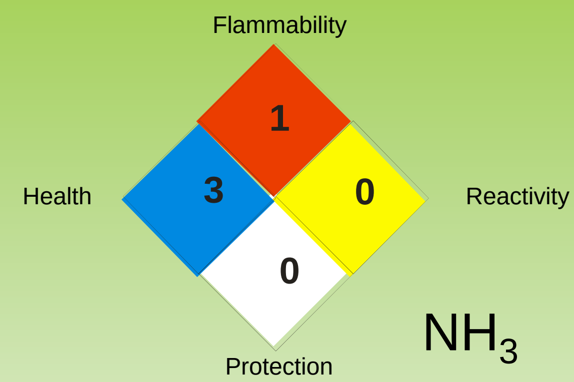
- CUS Unit 1 SCR and reagent system placed into commercial operation in January 2009.

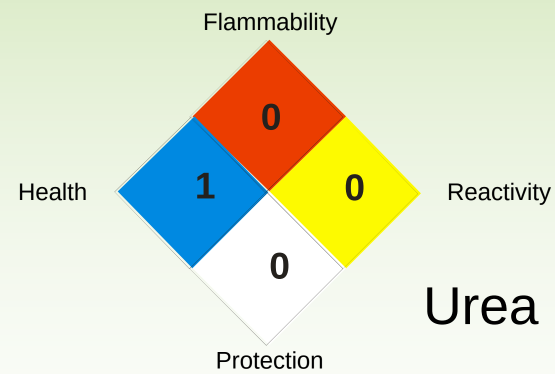
Reagent Alternatives for SCR Systems

- **Anhydrous Ammonia**
  - **Highest Risk Reagent**
  - **Decrease in US Ammonia Production**

- **Aqueous Ammonia**
  - **19% Concentration**
  - **29% Concentration - limited availability**

- **Urea for On-Site Ammonia Generation**
  - **Significant Safety Advantages**
  - **Worldwide Availability of Urea**
  - **Equivalent SCR Performance**





Urea Technology Selection

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- **Safety Considerations Eliminated NH_3 Systems**
  - City of Republic High School Located Within NH_3 Toxic Release Zone
  - Growth of City of Springfield Around Plant
  - NH_3 Truck Traffic Near the City of Springfield
- **Engineered Evaluation Comparing Urea Systems**
  - Fuel Tech ULTRA System Most Cost Effective Compared to Other Urea Conversion Processes
  - Site Visits of Existing ULTRA Systems Confirmed Simplicity and Reliability
- **Evaluation Determined 50% Aqueous Urea was Most Cost Effective Based on Usage Rates**
  - Dry Urea and On-Site Solutionizing vs. Aqueous Urea Delivery Evaluated
  - Formaldehyde Free Urea NOT Required

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Urea vs. Ammonia

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- **Safety Considerations**
  - **Safety can be Engineered into the Design, but Considerations may Drive the Decision**
- **Natural Gas Pricing**
  - **Elevated Price of NG in North America is Forcing the Shutdown of NH_3 Productions and an Increase in Dry Urea Imports**
  - **LNG is an Alternative but Supply Insufficient to Cover Demand**
- **On-site Ammonia Storage**
  - **DHS has Promulgated Final Rule for On-site Storage of Chemicals – Unsure How this Will Impact Anhydrous NH_3 Storage for SCRs**
- **Transportation**
  - **"Chain of Custody" Regulations for TIH* Rail Shipments Driving Transportation Costs Considerably Higher, Some Carriers May Opt and are Currently Being Forced to Reroute Shipments to Avoid HTUAs**

* The TSA component of the DHS is about to implement a series of federal regulations affecting the transportation of Toxic Inhalation Hazard (TIH) materials such as Chlorine and Anhydrous Ammonia – will require "documented chain of command handoffs" along distribution zone.

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Anhydrous Ammonia
Safety Considerations

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- **Ammonia Storage**
  - **Department of Homeland Security (DHS) has indentified ammonia as a chemical of interest for anti-terrorism standards**
- **Transportation**
  - **Rail carrier risks and freight rate increases to handle anhydrous ammonia**
  - **Department of Transportation Restrictions**
  - **State and local restrictions on shipping and routing**
- **Safety Risks**
  - ***EPA Worst Case Release Analysis*** **– Toxic Endpoint for 60,000 Gallon Release Covers a Radius of 7 to 10 Miles[1]**

1 http://yosemite.epa.gov/oswer/ceppoweb.nsf/vwResourcesByFilename/backup.pdf/$File/backup.pdf

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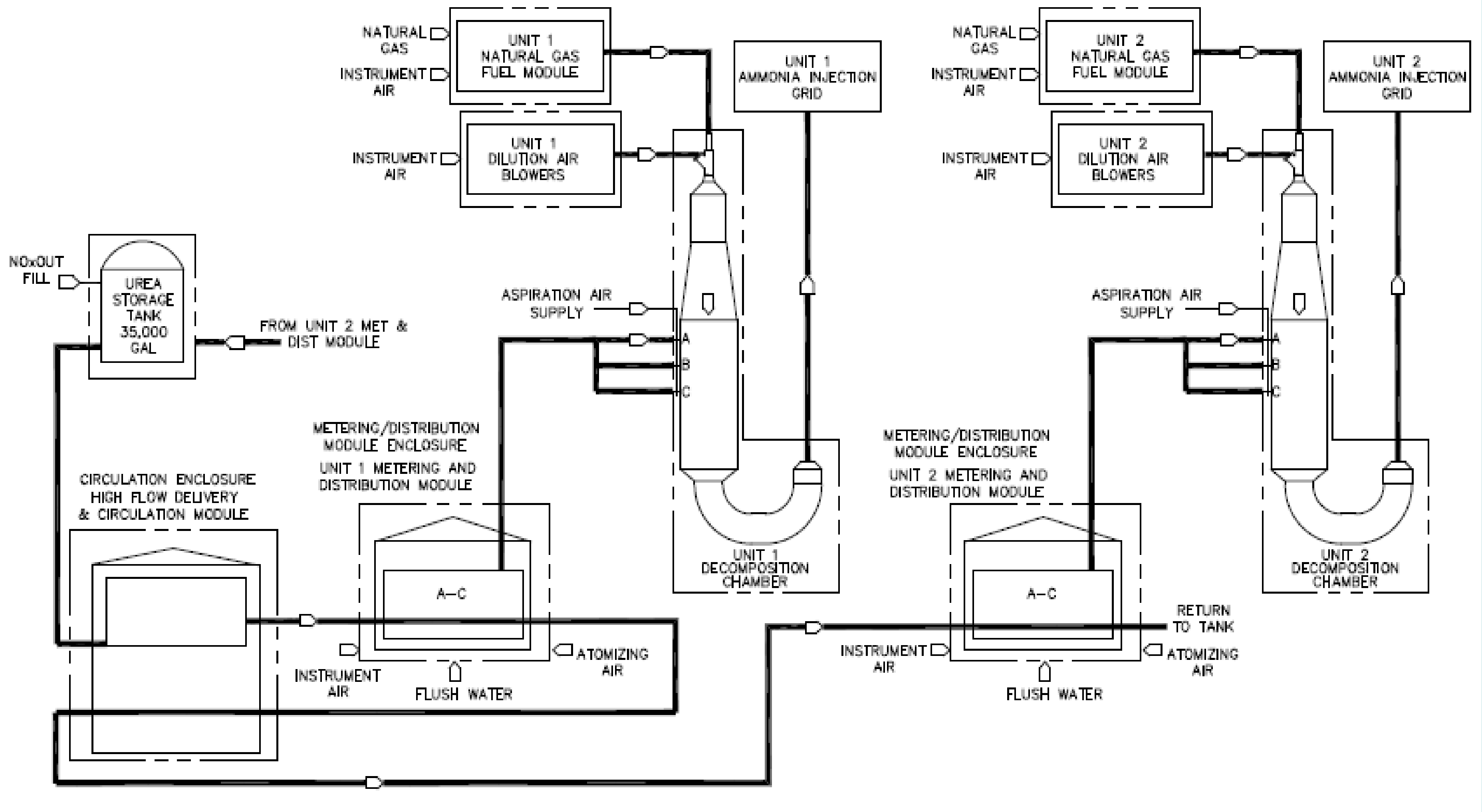
Aqueous Ammonia

Safety Considerations

- **Ammonia Storage**
  - **Containment for possible liquid leaks/spills**
- **Transportation**
  - **29% Aqueous ammonia is restricted by Department of Transportation in many areas**
  - **State and local restrictions on shipping and routing**
- **Safety Risks**
  - **Increased transportation risk due to more shipments of dilute chemical**
  - **1.2 mile toxic radius for 60,000 gallon spill**
  - **Much higher unloading frequency at plant site raises potential incident probability**

System Configuration



System Configuration

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- One (1) 35,000 Gallon FRP Reagent Storage Tank, Common to Both Units, Heat Traced and Insulated
- One (1) Circulation Module with Redundant Pumps Housed in an Enclosure, Common to Both Units
- Per Unit Basis
  - One (1) Metering and Distribution Module Housed in Enclosure
  - One (1) Natural Gas Flow Control Module
  - One (1) Dilution Air Blower with Redundant Fans
  - One (1) Decomposition Chamber with Natural Gas Burner and Injection Lances

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ULTRA™ System Arrangement

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Urea Storage Tank and Circulation Building

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ULTRA™ System Arrangement

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Dilution Air Fan Module

Decomposition Chamber

Unit 1 DCS Screen No. 1

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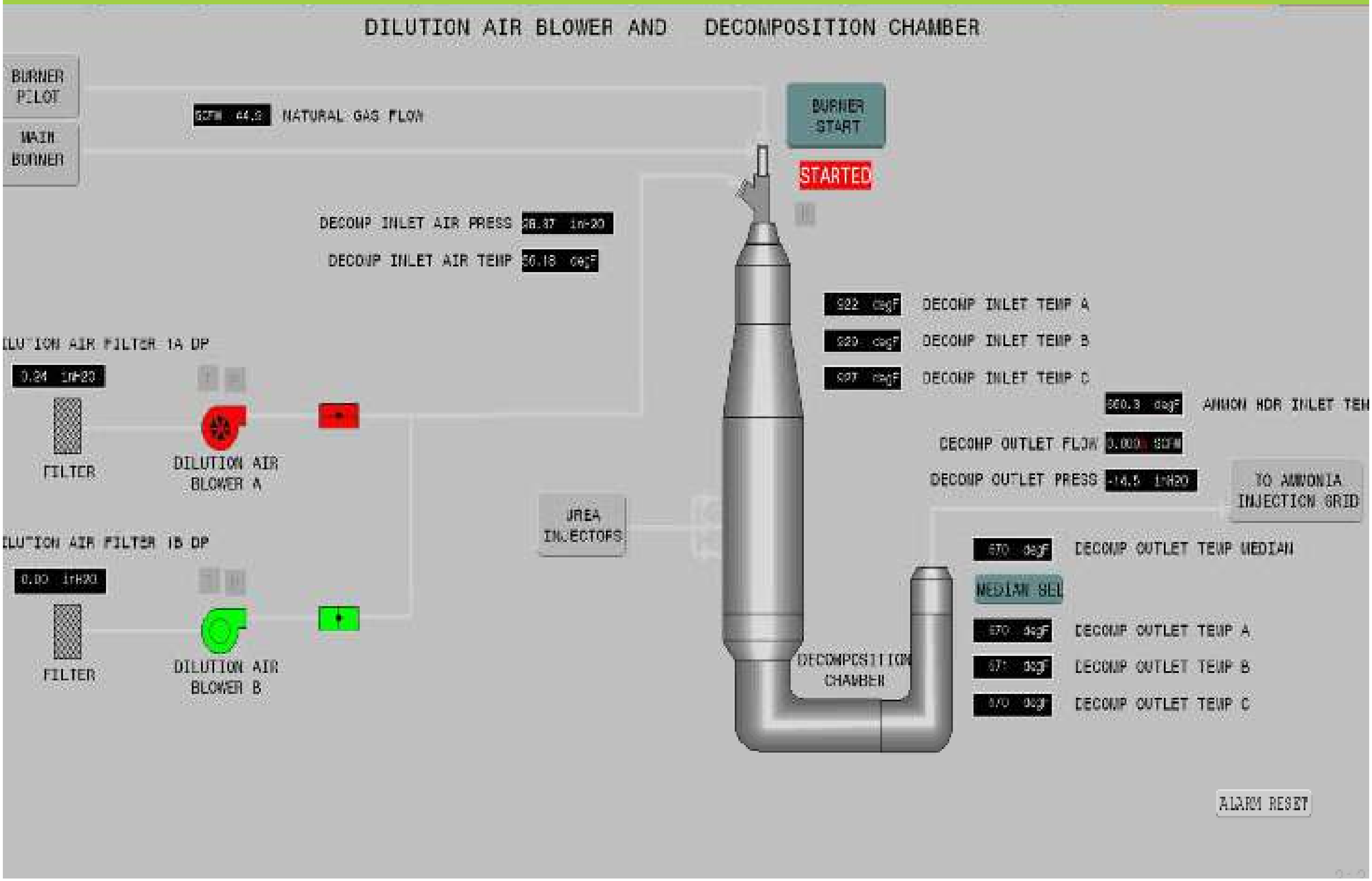
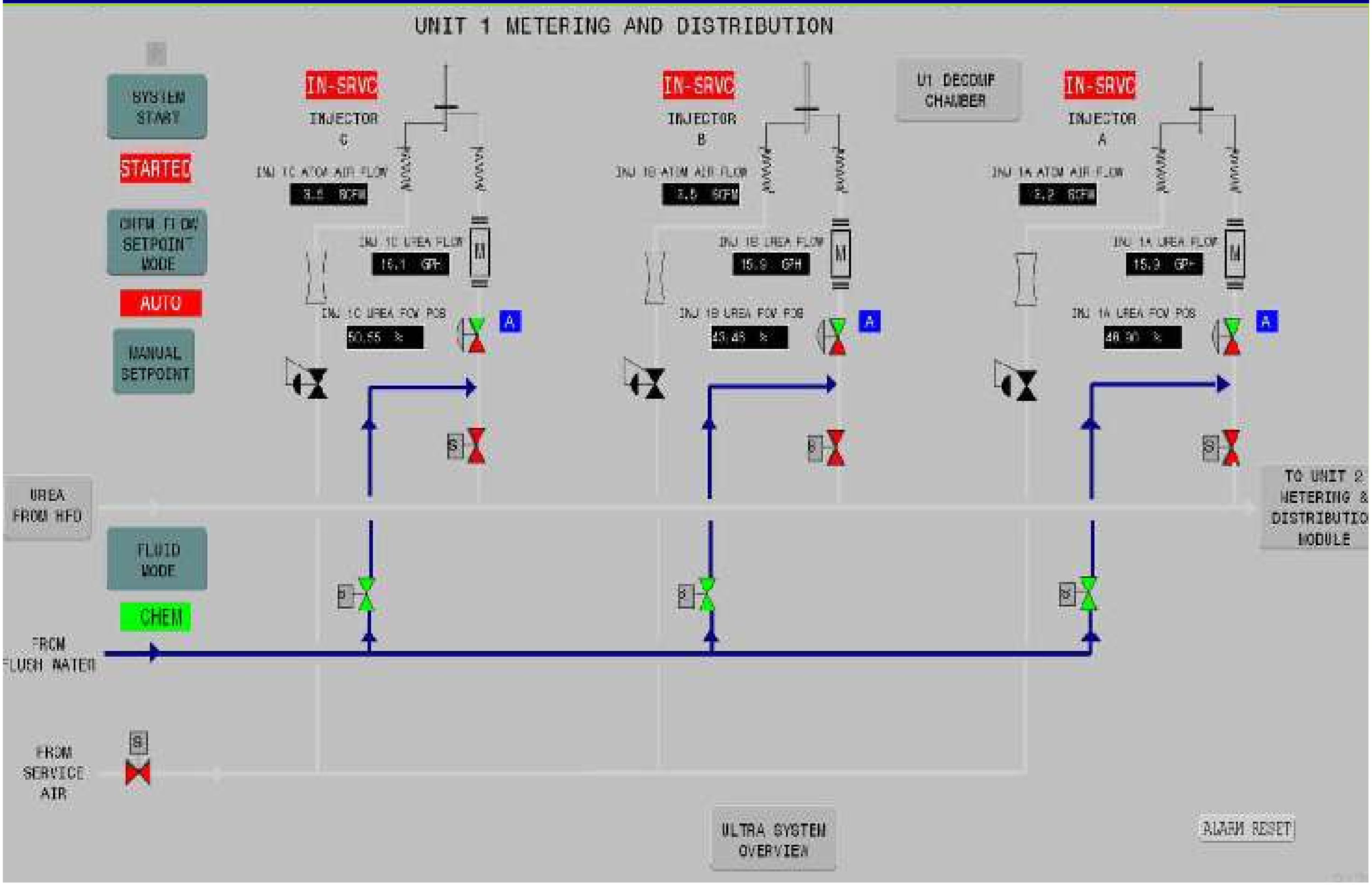


Unit 1 DCS Screen No. 2



Unit 1 DCS Screen No. 3

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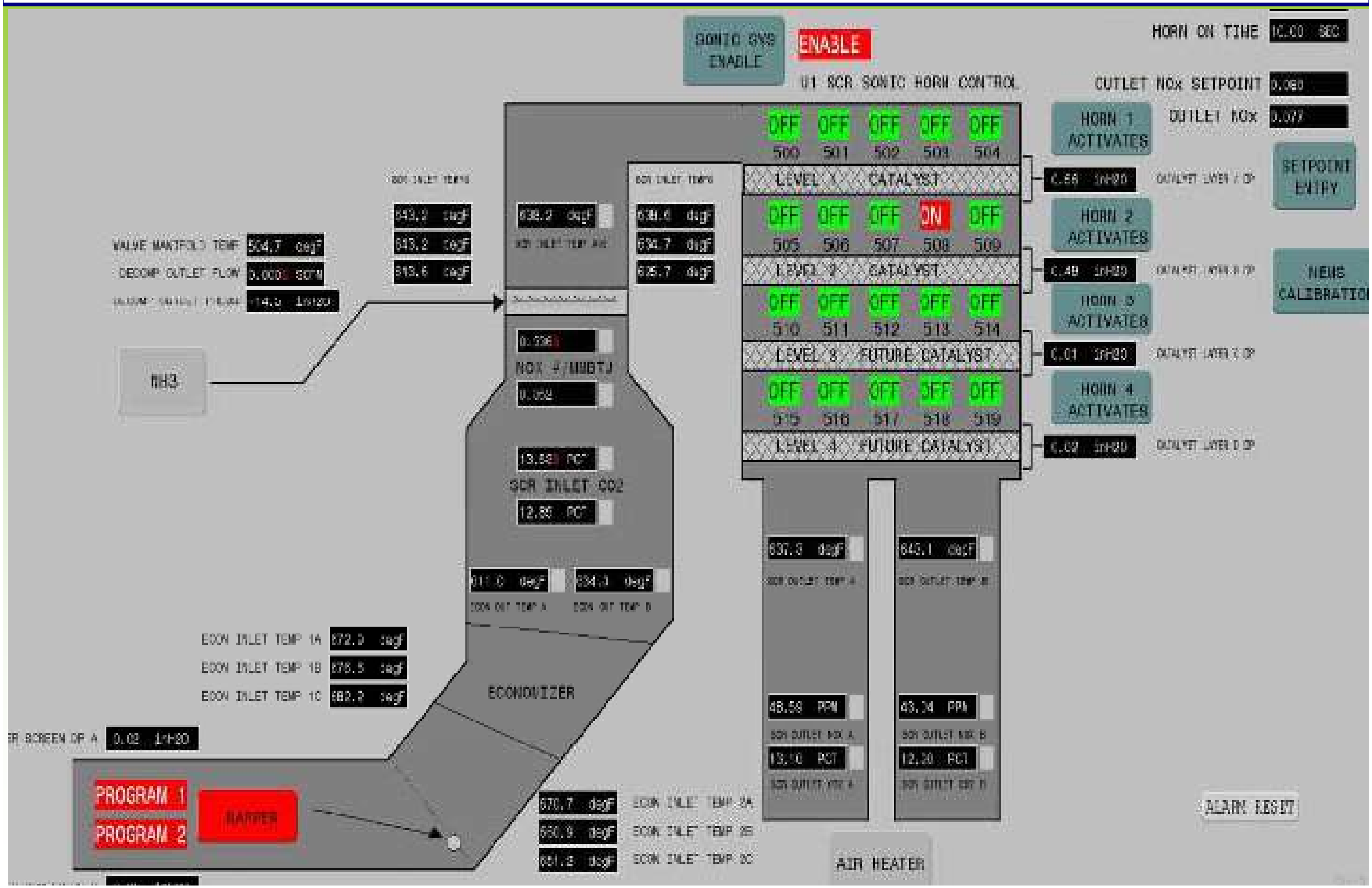

Operational History

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- ULTRA System in Service for Two (2) Years, Since January 2009
- ULTRA/SCR System Availability in 2010 = 97.7%
  - System not Operating During Shutdown and Startup Procedures
- Unit 1 Capacity Factor for 2010 = 88.6%
- Operating Costs (Monthly Average)
  - Average Urea Costs = $0.35/MWn
  - Average Natural Gas Costs = $0.09/MWn
- Maintenance Costs – Labor (Average)
  - Routine Inspection/Maintenance: ULTRA System Maintenance Labor = One (1) Person, Eight (8) Hours Per Week
  - Preventative Maintenance: Two (2) Person, Eight (8) Hours Each Per Quarter
- Maintenance Costs – Materials (Average)
  - Materials (i.e. gauges, injection tips) = $5,000/Year (New).
  - Expected to Rise to ~ $10,000/Year Over Time

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Operational/Equipment Issues and Lessons Learned

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- Burner Light Off Issues on Decomposition Chamber
  - Natural Gas Flow and Pressure Problems
    - Re-Drilled Orifice on Burner – Corrected Problem
    - Unit 2 Started Up With No Problems
- One Time - AIG Pluggage
  - Temperature Related Urea Reformation
    - Replace Some Plugged Pipe – Reinsulated AIG Piping and Installed Temperature Indication/Permissive
    - Problem Solved
    - No Issues on Unit 2
- Temperature at AIG Must Be Maintained Above 375°F @ Farthest Point
- Optimization of Injection and Decomposition Chamber
  - Atomization Air Pressure
  - Tip Selection
  - Total Air Flow
  - Flush Cycle Time

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CUS Unit 2 ULTRA Startup

- **Unit 2 - New Generating Unit**
- **300 MW Foster Wheeler Opposed Wall Fired Unit Utilizing PRB coal**
  - **SCR System for NO_x Control.**
  - **NO_xOUT ULTRA™ Urea based NH_3 generation sized to provide 225 PPH SCR Reagent**
- **SCR NO_x Reduction of 72% to 0.07 lb/MMBTU**
- **CUS Unit 2 SCR and Reagent System Placed into Commercial Operation in January 2011.**

ULTRA™ Experience

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Customer Name	Location of Installation	Capacity	SCR Reagent Demand	Installed
Peerless Manufacturing	MATEP -Boston, MA,	2 × 15 MW	15 lb/hr	2002
Northern Indiana Public Service	Michigan City Unit 12	520 MW	1200 lb/hr	2003
Northern Indiana Public Service	Bailey Unit 8	360MW	1100 lb/hr	2004
Northern Indiana Public Service	Schafer Unit 14	520 MW	1200 lb/hr	2004
Huaneng Beijing Co-Generation Co Ltd.	Gaobeidian Power Plant - Beijing, China	4 × 830 tph Steam	330 lb/hr	2007
Huaneng Beijing Co-Generation Co Ltd.	Shijingshan Power Plant - Beijing, China	4 × 200 MW	400 lb/hr	2007
University of California	Irvine, CA	14 MW	11 lb/hr	2007
City Utilities -Springfield	Southwest Station Units 1 & 2	203 MW, 300 MW	240 lb/hr	2008
D B Doosan Babcock	CLP Power -Castle Peak Units 1-4	4 680 MW	175 kg/h	2008
Northern Indiana Public Service	Bailey Unit 7	175 MW	720 lb/hr	2008
University of Texas	Austin, TX	32.5 MW	25 lb/hr	2008
Kansas City Power & Light	Sibley Unit 3	420 MW	1110 lb/hr	2009
Pensotti Idrotermici Sices	Parma, Italy	245 kNm^3/h	50 lb/hr	2007
Speic	Brest, France	2 x 9 t/h	500 lb/hr	2005
Qinling	China	2 x 660 MW	350 lb/hr	2009
Rentech Boiler Systems	Sinclair, WY	150 KPPH Steam	150 lb/hr	2010
EDF	Martinique, France - Fort De France	2 x 45 MW	300 lb/hr	2010
AZA	Brescia, Italy	275 kNm3/h	70 lb/hr	2010

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CUS ULTRA™ Summary

- **ULTRA System on Unit 1 Operating Successfully for Two (2) Years**
- **Unit 2 ULTRA System Operational**
- **System Chosen Based on Safe Reagent Supply**
  - **Economical Compared to Other Urea Conversion Technologies**
- **Reliable Equipment with Commonality for Two (2) Units**
- **High System Availability**
- **Ability to Follow NH_3 Demand Signal for Repeatable and Reliable NO_x Reductions**

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