Thomas Hill SCR Retrofit

AREGC 2010
June 7
Fuel Tech Incorporated
Agenda

• Thomas Hill SCR Retrofit Project Overview
• Flow Model Results
• Operating Results
Fuel Tech Overview

- **FUEL CHEM® Technology**
  - Boiler Efficiency and Availability Improvements
  - Slag and Corrosion Reduction
  - Controls SO₃ Emissions and Addresses Related Issues
  - SO₂ Control of Marginal

- **Innovative Approaches to Enable Clean Efficient Energy**
  - Capital Projects for Multi-Pollutant Control
  - NOₓOUT® Products including SNCR, CASCADE, RRI, ULTRA
  - Flue Gas Conditioning Systems for Particulate Control – Outside US and Canada
  - Sorbent Injection for SO₂ 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)
Project Background

- Thomas Hill Energy Center
  - Three Boilers: Unit 1-180 MW, Unit 2-303 MW, Unit 3-670 MW
  - Each to be retrofit with Selective Catalytic Reduction (SCR) System by Burns & McDonnell and CERAM
  - FTI Subcontracted For Fluid Dynamic Design and Validation Via Flow Modeling
Design Objectives

• Flow distribution device (turning vanes, static mixer, LPA screen, AIG) optimization/design
• Uniform gas flow conditions at SCR and AIG
• Division of gas flow to APH
• General flow conditions
  • Minimize pressure loss
  • Minimize risk of ash fallout
  • Minimize risk of erosion
• Minimize maldistributions in boiler backpass
• Sensitivity studies
• Minimize changes to ductwork arrangement
Typical SCR Layout
(Thomas Hill Unit 3)

- Riser Duct
- Crossover
- Reactor
- Economizer Outlet
- APH Inlets
Requirements

- Uniform gas flow conditions at inlet to AIG
  - 100% of velocity measurements be within +/- 20% of the mean

- Uniform gas flow conditions at inlet to 1st catalyst layer
  - 100% of velocity measurements be within +/- 15% of the mean
  - 100% of NH$_3$ measurements be within 5% (later relaxed to 100% within 12% of the mean)
Fluid Dynamics

- Fluid Dynamics is the study of fluids in motion, governed by the Navier-Stokes Eqns.
- Traditionally studied analytically or experimentally
- Recent advances in computer hardware allow the computational study as well
Computational Fluid Dynamics

- Navier-Stokes Equations solved numerically on discrete grid of “computational cells”
- Able to model full scale conditions accurately such as
  - Temperature and chemical reactions
  - Maldistributions on model inlets
- Provides information not obtainable from experimental model
  - Full field data
- Reduces optimization time
Experimental Fluid Dynamics

- Scale model built from economizer outlet to the air heaters
- Tunable AIG for tracer gas testing
- Provides information not obtainable from computational models
  - Ash dropout testing
- Check for computational results
Flow Model Results

Summary

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<th>Thomas Hill 1</th>
<th>Thomas Hill 2</th>
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<td>Goal</td>
<td>Achieved</td>
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<td></td>
<td>RMSE</td>
<td>% Abs.</td>
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<td><strong>AIG Inlet</strong></td>
<td>+/- 20%</td>
<td>6.7%</td>
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<tr>
<td><strong>SCR Inlet (Vel)</strong></td>
<td>+/- 15%</td>
<td>5.9%</td>
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<tr>
<td><strong>SCR Inlet (NH3)</strong></td>
<td>+/- 5%</td>
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Results that were not met were all had at least 90% within the goal
And all results were accepted by AECL, Burns and MacDonnel, and CERAM
Optimized Arrangements

Thomas Hill 1  Thomas Hill 2

Thomas Hill 3
LPA Screen Design
AIG CFD
Velocity Profiles

Thomas Hill 1

Statistics
100% w/in
20% absolute

Thomas Hill 2

Thomas Hill 3
AIG Experimental Velocity Profiles

Thomas Hill 1

Thomas Hill 2

Thomas Hill 3

Statistics
100% w/in 20% absolute
Graduated Straightening Grid Development

Typical Arrangement

GSG Arrangement
Graduated Straightening Grid Development

GSG Supports and Close-up

GSG Installation
Catalyst CFD
Velocity Profiles

Statistics
100% w/in
15% avg absolute

Thomas Hill 1

Thomas Hill 2

Thomas Hill 3
(no GSG)
Catalyst Experimental Velocity Profiles

Thomas Hill 1

Thomas Hill 2

Statistics
100% w/in
15% avg absolute

Thomas Hill 3
(no GSG)
Operating Results
(Flow) Unit 2

• Unit 2 ash problems on catalyst due to large trusses designed after flow models completion
• Additional work made some improvement, but did not completely fix the problem
Operating Results
(Flow) Units 1 & 3

- Catalyst inspections show no ash accumulation
- No other catalyst issues
Operating Results (NOx)

- Guarantees met easily on all units at startup
- New targets set and easily met
Summary

- GSG provides a much better velocity profile than traditional vanes and straightening grid
- Large structural members above the catalyst can lead to ash deposition
- Flow models require as much detail as possible to determine possible problems
- Thomas Hill SCR successful project