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Implementation of SCR at Southern Company

U.S. Department of Energy

2000 Conference on
Selective Catalytic and Non-Catalytic
Reduction for NOx Control

May 17-18, 2000
Pittsburgh, PA

Ed Healy
Darryl Wall
Krista Paseur

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Presentation Outline

Regulated Business

- Regulatory Drivers
- Strategy Development
- SCR Design Philosophy
- Project Examples

Non Regulated Business

- Business Issues and Drivers
- SCR Design Philosophy
- Project Examples

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Regulatory Drivers

- Title IV of 1990 Clean Air Act
  - Acid Rain Program
- Title I of 1990 Clean Air Act
  - Old, 1-hour Ozone Standard
  - Regional NOx SIP Call
  - New, 8-hour Ozone Standard
- EPA NSR Lawsuit

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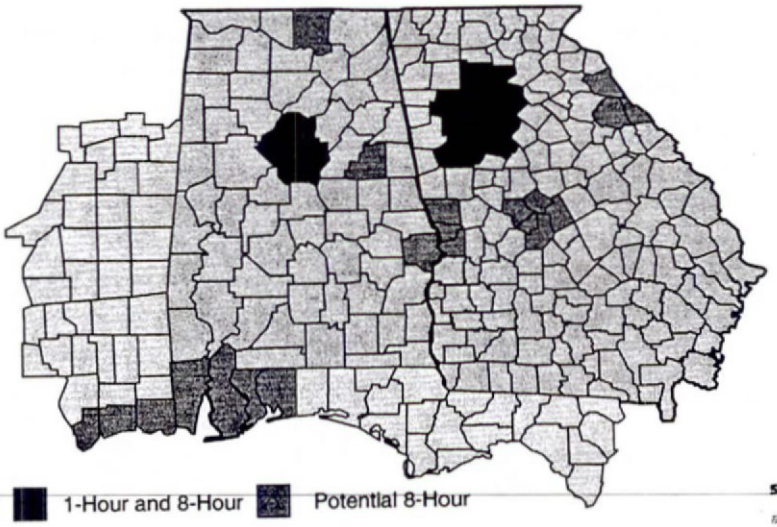
Ozone Non-Attainment Counties



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Old 1-Hour Ozone Standard
Potential NOx Compliance Requirements*

* Assumed tonnage cap in 2007 based on 0.15 lb/MBtu NOx rate

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Developing a NO_x Compliance Strategy

- Develop unit specific conceptual capital / O&M cost estimates and performance expectations.
- Use projected future years' generation/fuel burn to project future NO_x emissions
- Develop a menu of NO_x control technologies and combinations of technologies for each unit
- Rank the controls for each unit on a $/ton of NO_x removed basis
- Select units and controls based on least $/ton basis to achieve required NO_x reduction

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SCR Design Philosophy - New Generation

- Natural Gas (only) Combined Cycle Plants
- GE Frame 7 Combustion Turbine
- Year Round SCR Operation (No HRSG Bypass)
- SCR Designed for Power Augmentation
- SCR Procured as part of HRSG Suppliers Scope
- SCR Emission Performance
  - 3.5 ppm NOx
  - 10 ppm NH_3 Slip
  - 5 year catalyst life

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SCR Design Philosophy - Retrofit

- Large Pulverized Coal-fired Boilers
- Non Attainment Area Emission Averaging Between Plants
- Ozone Season Operation (full flow bypass)
- Anhydrous Ammonia Reagent
- SCR Emission Performance
  - 85% NOx Reduction
  - 2 ppm NH_3 Slip with NOx and Slip Distribution
  - 16,000 Hour Catalyst Life
  - 1% SO_2 to SO_3 Oxidation (maximum)
  - Pressure Drop Determined on Plant by Plant

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SCR Design Philosophy - Retrofit
(continued)

- Use Combination of Cold Flow and CFD Modeling
- Maximum Leverage Engineering
- Volume Procurement of SCR Components
  - Catalyst
  - Dampers
  - Sootblowers
  - Ammonia Storage and Vaporization
- Maximize Use of Modularized Design & Construction
- Utilize Combination of Implementation Contracts
- Maximize Current Planned Outage Schedule

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Regulated Project Example - New Generation

Barry / Daniel Combined Cycle Project

- 2 x 500 MW Combined Cycle Blocks at Each Site
- GE Frame 7FA Combustion Turbine
- NOx Reduction: 14 ppmvd to 3.5 ppmvd (@15% O_2)
- Ammonia Slip: 10ppmvd (@ 15% O_2)
- Natural Gas (only) Fuel
- Vogt / Hitachi SCR Furnished with HRSG
- Hitachi Plate Catalyst
- Anhydrous Ammonia
- Commercial Operation - Ozone Season 2000

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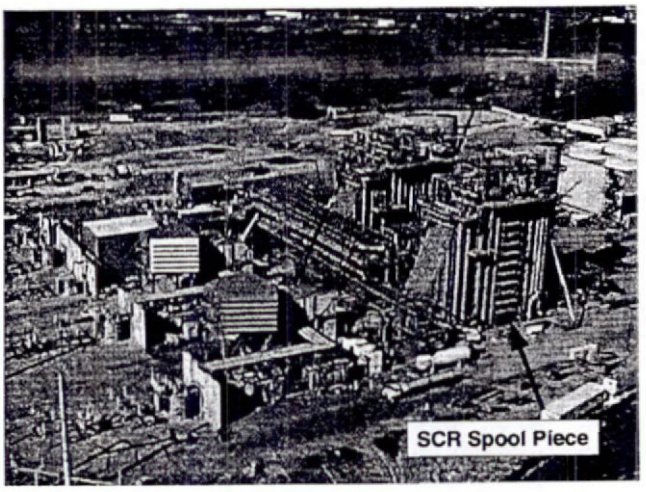
Barry Combined Cycle Project



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Regulated Project Example - Coal Retrofit

Georgia Power Plant Bowen

- Units 1&2: 756 MW Supercritical T-Fired Boilers
- Units 3&4: 950 MW Supercritical T-Fired Boilers
- Central Appalachian Coal (~1% Sulfur, 12% Ash)
- 85% NOx Removal: 0.45 #/MBTU / 0.07 #/MBTU
- 2 ppm NH_3 Ammonia Slip
- Southern Company Generation Design
- Cormetech Catalyst
- Anhydrous Ammonia
- Two Construction Outages
- Commercial Operation - U1/2 Ozone Season 2001
  - U3/4 Ozone Season 2003

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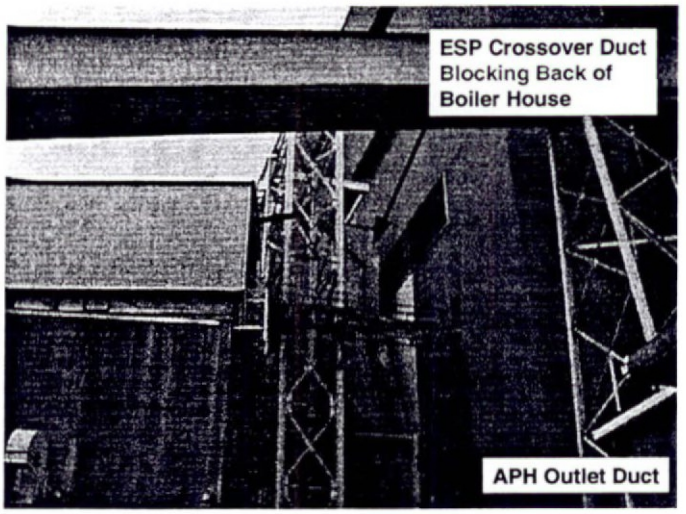
Plant Bowen Unit 1 SCR Construction



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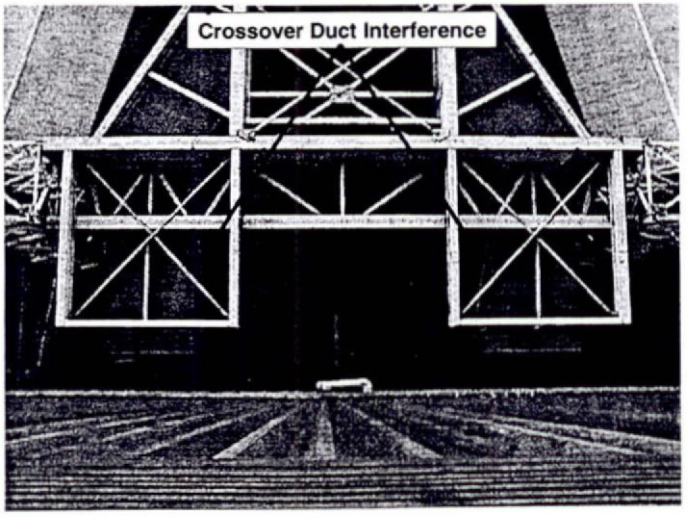
Plant Bowen Unit 1 SCR Construction



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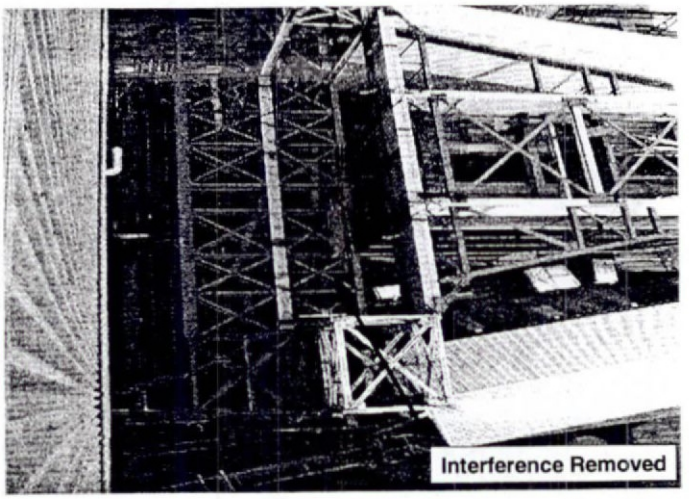
Plant Bowen Unit 1 SCR Construction



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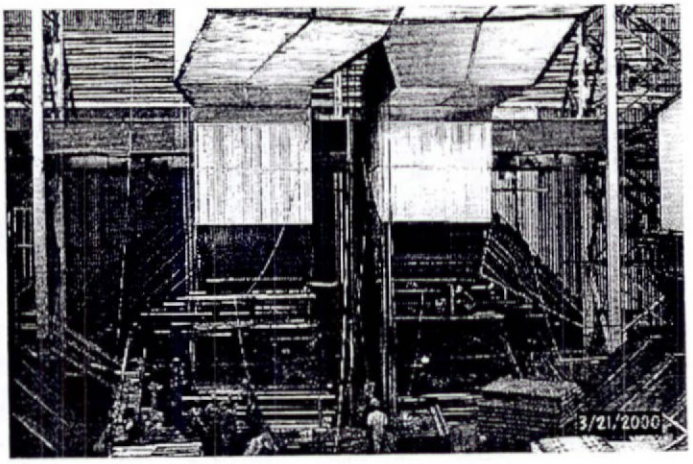
Plant Bowen Unit 1 SCR Construction



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Plant Bowen Unit 1 SCR Construction

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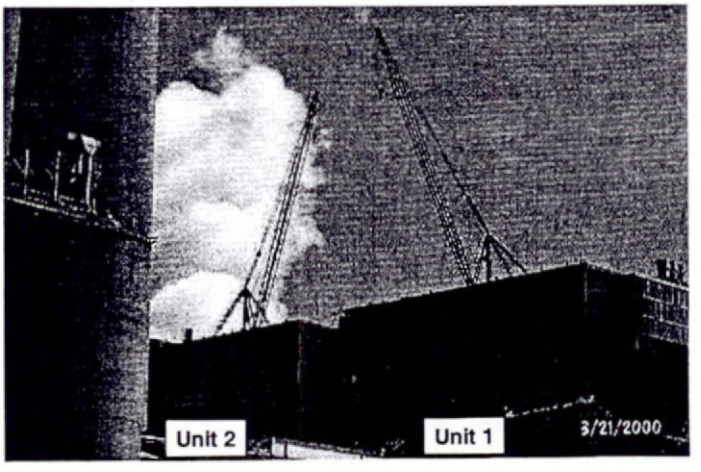
Plant Bowen Unit 1 SCR Construction



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Regulated Project Example - Coal Retrofit

Alabama Power Power Plant Gorgas Unit 10

- 780 MW Supercritical T-Fired Boilers
- Alabama Coal (~1.5% Sulfur, 12% Ash)
- 85% NOx Removal: 0.55 #/MBTU / 0.08 #/MBTU
- 2 ppm NH_3 Ammonia Slip
- Southern Company Generation Design
- Cormetech Catalyst
- Anhydrous Ammonia
- One Construction Outage Required
- Commercial Operation - Ozone Season 2002

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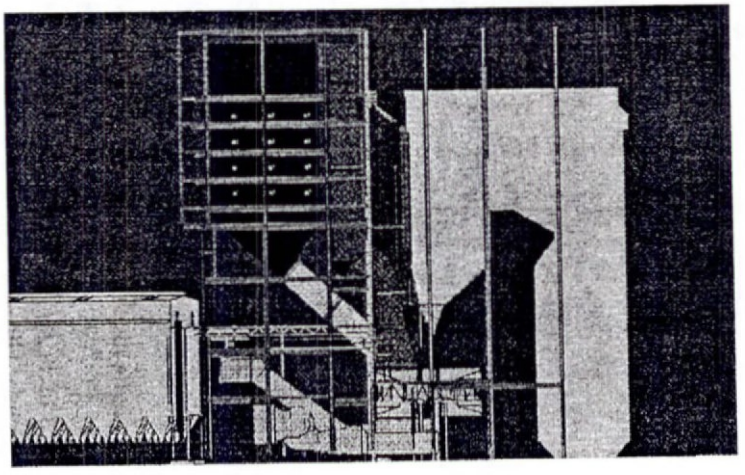
Plant Gorgas Unit 10 SCR Concept



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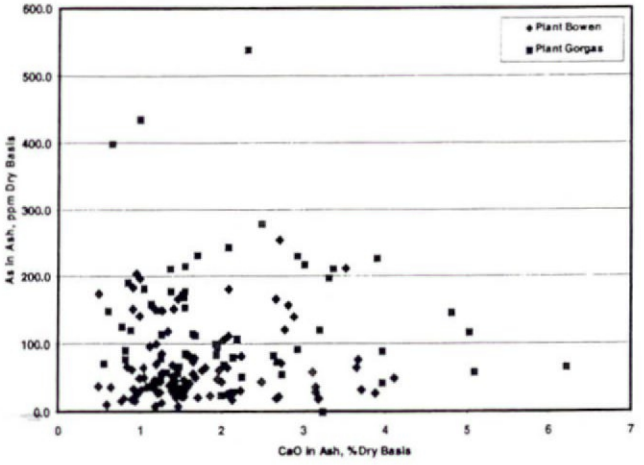
Plant Gorgas Unit 10 SCR Fuel Analysis

Comparison of Arsenic and CaO Fuel Content



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Non-Regulated Business Drivers

- Permitting of New Projects and Additional Generating Capacity
- Local Non-attainment Requirements
- Local State SIP Requirements
- NOx Allowance Trading Revenue
- Offsets for Various Industrial Sources
- Deregulation and Merchant Plant Dispatch Considerations
- Wide Range and Variety of Spot Market Fuels
- Satisfy Local Regulatory Requirements

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Non-Regulated Project Example

Southern Energy Canal

- 2 x 600 MW No. 6 Oil-fired Boilers
- 80% NOx Removal: 0.28 #/MBTU / 0.06 #/MBTU
- 2 ppm NH_3 Ammonia Slip
- ABB Alstom Power Turnkey Contract
- Cormetech Catalyst (special formulation for oil)
- First Demonstration of Ammonia on Demand (AOD)™ Urea Based Reagent System
- Commercial Operation - Ozone Season 2000

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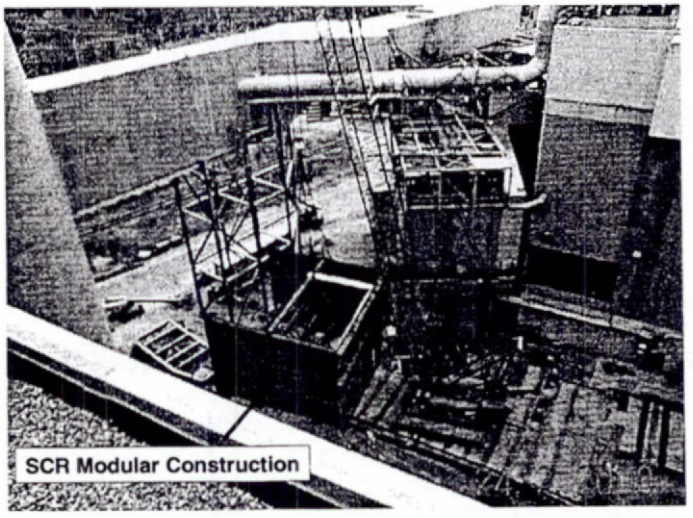
Implementation of SCR at Southern Company

Canal Unit 1 SCR Construction



SCR Modular Construction

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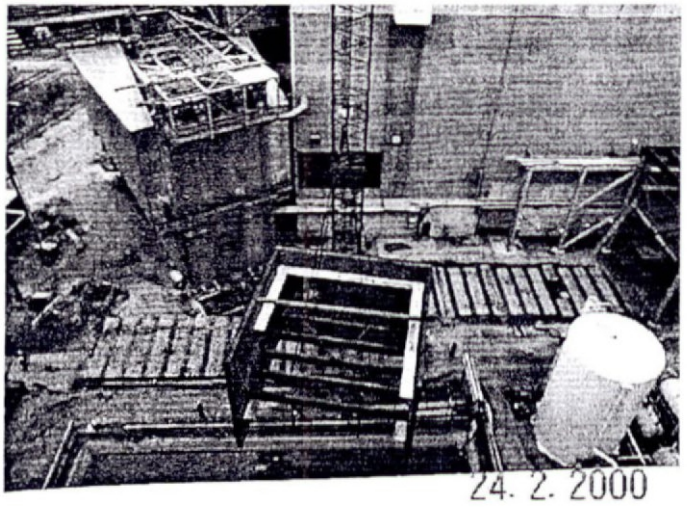
Canal Unit 1 SCR Construction



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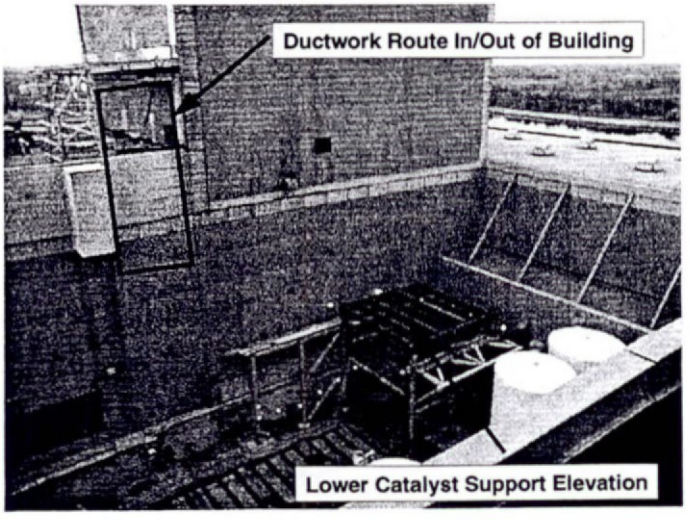
Canal Unit 1 SCR Construction



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Non-Regulated Project Example

Southern Energy Birchwood

- 250 MW Pulverized Coal Boiler
- Combination NOx Reduction Technologies
  - –TFS 2000 Low NOx Firing System
  - –Selective Catalytic Reduction
- Stack NOx Emission = 0.1 #/MBTU
- 5 ppm NH_3 Ammonia Slip
- ABB-CE Turnkey Contract for Plant
- Siemens Plate Catalyst
- Anhydrous Ammonia
- Year-Round Operation (Operation Since Nov 1996)

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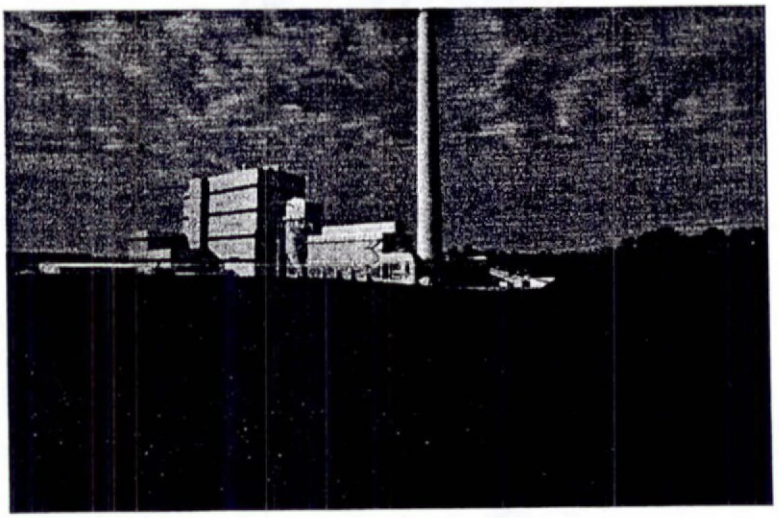
SEI Birchwood Plant



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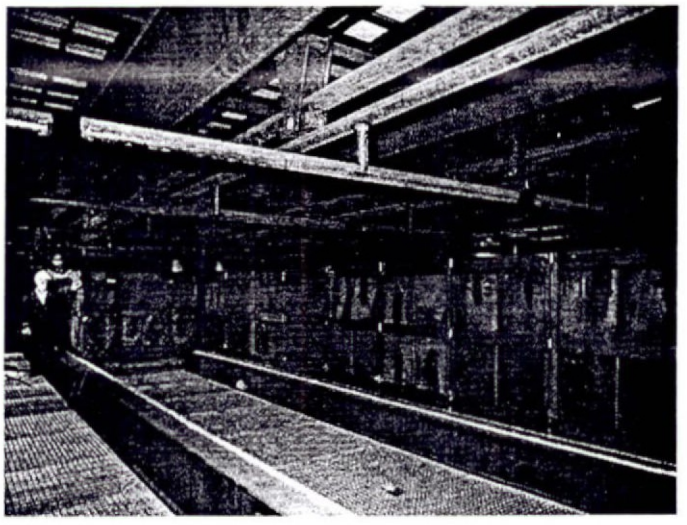
Birchwood Catalyst Module Installation



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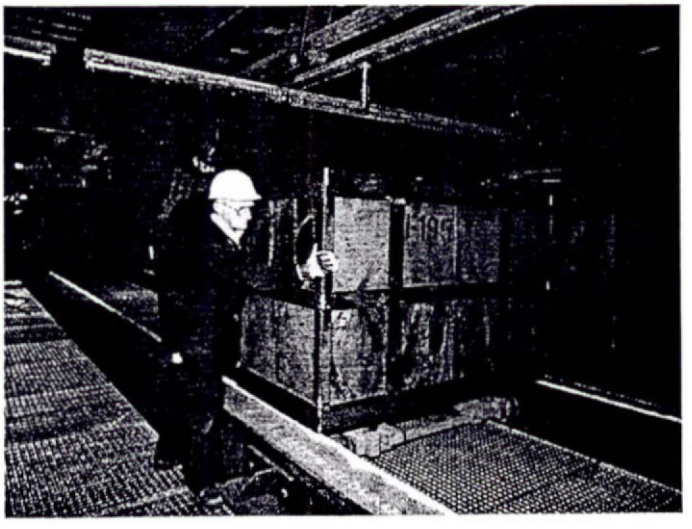
Birchwood Catalyst Module Installation



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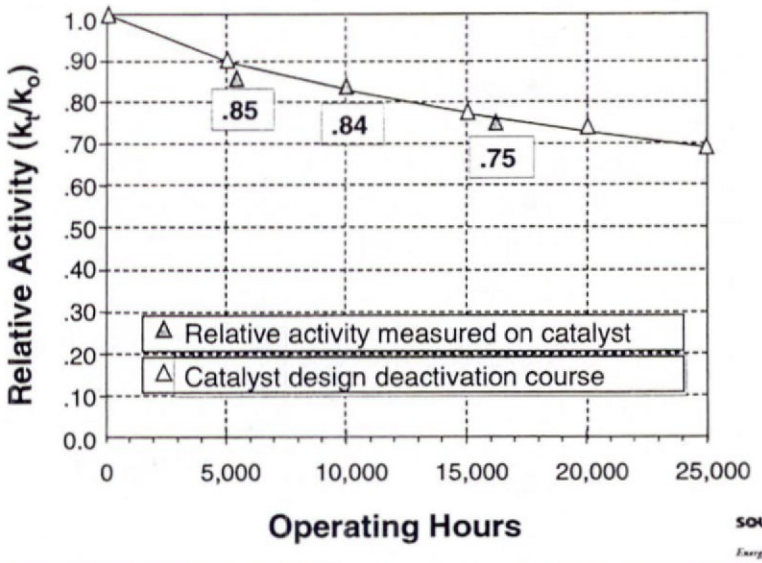
Birchwood Catalyst Reactivity History



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Summary of SCR Projects
(Regulated Business)

Plant	Size	New/Retrofit	Fuel	SCR System Supplier	Catalyst Supplier	Commercial Operation Date
Barry 6	500 MW	New	Natural Gas	Vogt / Hitachi	Hitachi	Jun 2000
Barry 7	500 MW	New	Natural Gas	Vogt / Hitachi	Hitachi	May 2001
Daniel 3	500 MW	New	Natural Gas	Vogt / Hitachi	Hitachi	May 2001
Daniel 4	500 MW	New	Natural Gas	Vogt / Hitachi	Hitachi	May 2001
Bowen 1	750 MW	Retrofit	Central App Coal	Southern Company	Cormetech	May 2001
Bowen 2	750 MW	Retrofit	Central App Coal	Southern Company	Cormetech	May 2001
Bowen 3	950 MW	Retrofit	Central App Coal	Southern Company	Cormetech	May 2003
Bowen 4	950 MW	Retrofit	Central App Coal	Southern Company	Cormetech	May 2003
Hammond 4	530 MW	Retrofit	Central App Coal	Turnkey (TBD)	TBD	May 2002
Gorgas 10	780 MW	Retrofit	Alabama Coal	Southern Company	Cormetech	May 2002
Wansley 1	935 MW	Retrofit	Central App Coal	Southern Company	Siemens	May 2003
Wansley 2	935 MW	Retrofit	Central App Coal	Southern Company	Siemens	May 2003
Wansley 6	500 MW	New	Natural Gas	Vogt / Hamon RC	Ceram/Frauenthal	Jun 2002
Wansley 7	500 MW	New	Natural Gas	Vogt / Hamon RC	Ceram/Frauenthal	Jun 2002
PRB Test	Pilot	Test	PRB Coal	Southern Company	Cormetech	July 2000
					Siemens	
					Haldor Topsoe	

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Summary of SCR Projects
(Non-Regulated Business)

Plant	Size	New/Retrofit	Fuel	SCR System Supplier	Catalyst Supplier	Commercial Operation Date
Birchwood	240 MW	New	Central App Coal	ABB/CE	Siemens	Nov 1996
Canal 1	600 MW	Retrofit	No. 6 Fuel Oil	ABBES	Cormetech	May 2000
Canal 2	600 MW	Retrofit	No. 6 Fuel Oil	ABBES	Cormetech	TBD
Contra Costa 6	340 MW	Retrofit	Natural Gas	TBD	TBD	Spring 2003
Contra Costa 7	340 MW	Retrofit	Natural Gas	B&W	TBD	Spring 2001
Contra Costa 8	600 MW	New	Natural Gas	TBD	TBD	Feb 2003
Pittsburgh 5	325 MW	Retrofit	Natural Gas	B&W	TBD	Spring 2002
Pittsburgh 6	325 MW	Retrofit	Natural Gas	B&W	TBD	Spring 2002
Pittsburgh 7	720 MW	Retrofit	Natural Gas	TBD	TBD	Spring 2003
Potrero 3	207 MW	Retrofit	Natural Gas	TBD	TBD	Spring 2004
Potrero 4	600 MW	New	Natural Gas	TBD	TBD	Feb 2003
Goat Rock 1	500 MW	New	Natural Gas	Vogt / Hamon RC	Ceram/Frauenthal	Jun 2002

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Implementation of SCR at Southern Company

Summary

- **Approximately 15,000 MW of SCR Projects**
  - 26 Active Projects, 15 Regulated, 11 Non-regulated
  - 9600 MW Regulated and 5,400 MW Non-regulated
  - 5000 MW New, 10,000 MW retrofit
  - 6800 MW coal, 1200 MW oil, 7000 MW gas
- **Diverse Catalyst Supply**
  - 4100 MW Plate, 7400 MW Honeycomb, 3500 MW TBD
  - Honeycomb Suppliers: Cormetech, Ceram/Frauenthal
  - Plate Suppliers: Siemens, Hitachi, Haldor-Topsoe

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Summary
(continued)

- **Multiple Contract Methods for Implementation**
  - Turnkey EPC
  - Subcontract to Major Equipment Supplier
  - Self Perform EP
  - Alliance (future)
- **No Regrets Strategy**
  - Variety of NOx Control Technologies Used
  - SCR Deployed on Large, High Capacity Units
  - Least Cost Compliance Utilizing Averaging Plans
  - Targeted Research to Lower Cost / Increase Performance

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Implementation of SCR at Southern Company

Summary
(continued)

- **SCR Implementation Must Consider Regulated and Non-Regulated Project Requirements**
- **Current NOx Research Work**
  - PRB Catalyst Testing
  - Advanced Catalyst Formulations
  - Alternate Reagents
  - Balance of Plant Assessment Studies
  - Next Generation Power Generation Technologies
  - Catalyst Regeneration
  - Horizon NOx Control Technologies
  - Combined Pollutant Technologies

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