ACT ADVANCED COMBUSTION TECHNOLOGY

NEW COAL BURNERS AND LOW NOx CONTROL TECHNOLOGIES

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Dalian, China

ACT

AGENDA □容安排

1. Company Information
2. NOx Control Philosophy
3. Capability (Layered Technology Approach)
    a) Combustion Optimization
    b) Low NOx Burner
    c) CFD
    d) OFA
    e) T-fired Boiler
    f) HERT
4. Experiences and Cases
5. ACT Layered Approach Summary

ACT

COMPANY INFORMATION
公司□介

- ACT: Headquarters in New Hampshire, USA; Offices in Baton Rouge (LA), Raleigh (NC), Oxnard (CA), Hamburg (NJ), and Marlborough (CT)
- ACT China: A subsidiary company of ACT；Offices in Baton Rouge (LA) and Nanjing, China
- Designs, supplies and installs low NOx combustion systems on utility and large industrial boilers
- Extensive combustion and emission control expertise and experience
- over 100 NOx control projects planned, designed, and implemented (25 to 1100 MW)
- Proprietary Low NOx Burner Hardware
- HERT - ACT Patented Technology

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NOx CONROL PHILOSOPHY

□□整体策略

- **Custom Solution**
  Design a plant-specific layered technical approach for NOx reduction tailored to client's specific needs

- **Minimize Operational Impact**
  Evaluate each layer of NOx reduction technology with minimal impact on unit operation and/or performance.

- **Lowest Cost Per Ton Ratio**
  Achieve the client's NOx emissions objectives at the lowest cost per ton ratio

- **Performance Guarantee**

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CAPABILITY 公司能力
(Layered Technology Approach)

- **Layer 1 - Boiler Optimization** □□□化
  - **Combustion Airflow Testing (CAT)** 燃□□流□□
  - **Coal Flow Balancing** 煤粉流□□
- **Layer 2 - Low NOx Burner Upgrades and New Low NOx Burner**
  燃□器改造或完全采用**ACT**的低**NOx**燃□器
- **Layer 3 - Over Fire Air (OFA)** 燃□□系□
- **Layer 4 - High Energy Reagent Technology (HERT)** 高能量反□□技□
  Advanced SNCR (Selective Non-Catalytic Reduction)
- **Computational Fluid Dynamics (CFD) Modeling** 流体□力□模□

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ACT Layered NOx Reduction System

ACT NOx分□控制系□

80%+NOx reduction at the lowest cost/ton

以最低价位□到**80%**以上□□率

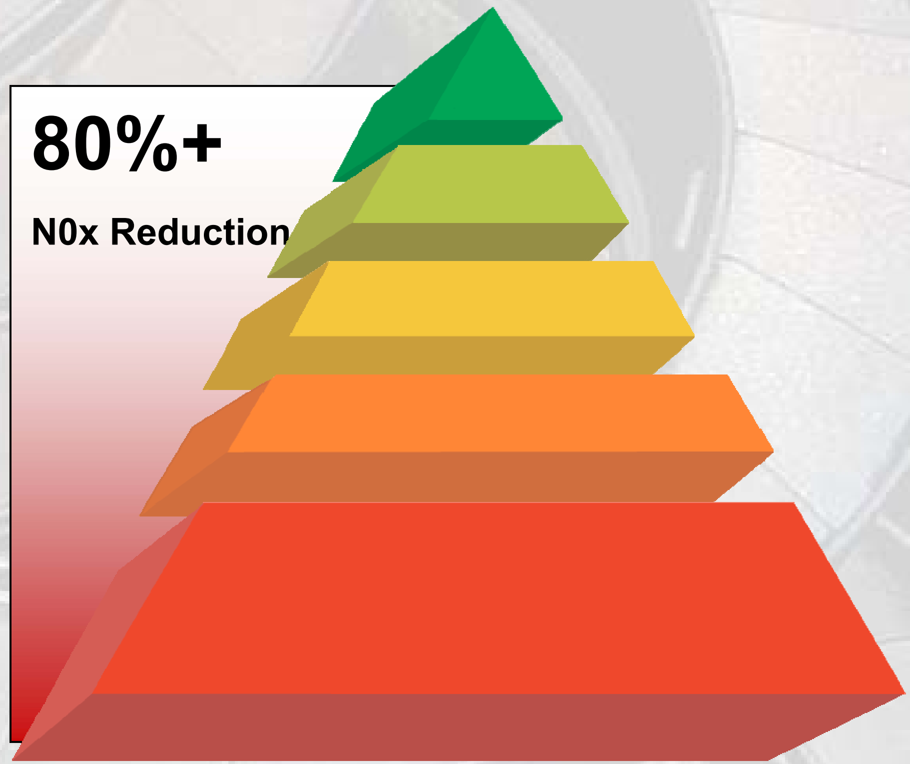
Layer 4 HERT System
第四□　高能量反□□技□

Layer 3 Overfire Air
第三□　燃□□系□

Layer 2B Low NOx Burner (LNB)
第二□ 低**NOx**燃□器

Layer 2A LNB Modification
第二□　燃□器改造

Layer 1 Boiler Optimization
第一□ □□□化



IMPACTS ON NOx

- **Burner zone heat release**
- **Outer zone secondary air to primary air velocity ratio (1.5 to 1.0)**
- **Primary air & coal velocity (75 to 80 ft/s)**
- **Burner throat diverging angle (30 deg)**
- **Throat diameter to diverging length ratio (4 to 1)**
- **Burner swirl number (0.6 to 0.7)**
- **Excess O_2 (impacted by coal fineness)**
- **Position of coal pipe in throat**

IMPACTS ON LOI

- **Burner zone heat release**
- **Excess O_2**
- **Position of coal pipe in burner**
- **Primary air velocity**
- **Coal fineness**
- **Burner swirl number**
- **% Ash in coal**

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COMBUSTION OPTIMIZATION

第一□ □□□化

COMBUSTION OPTIMIZATION

燃□□化

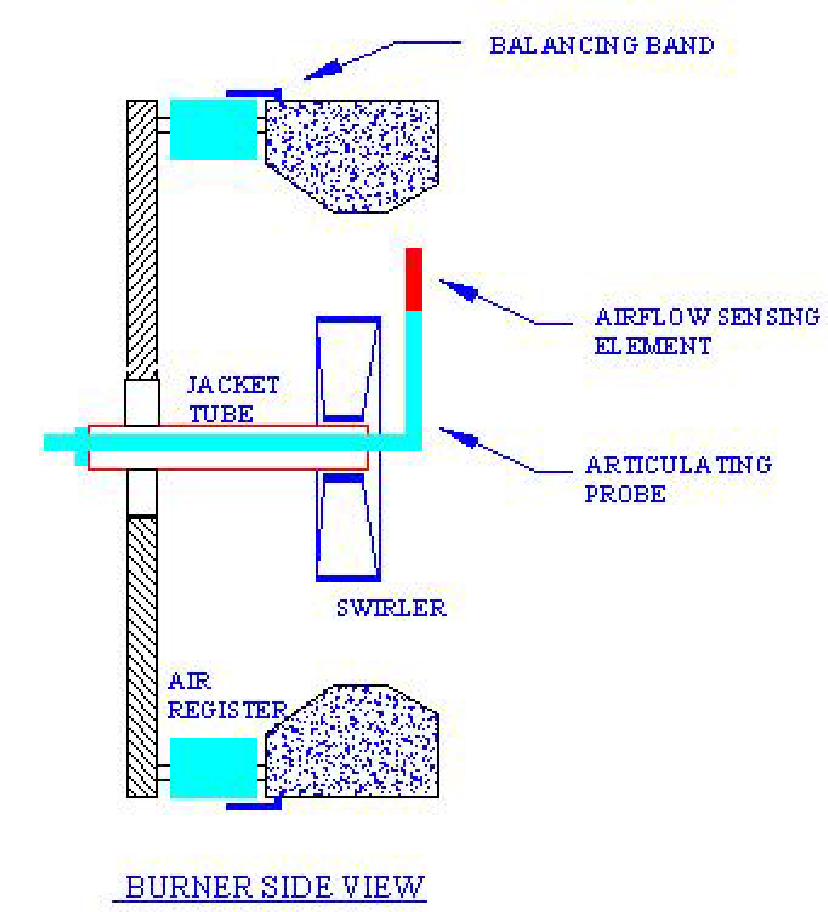
- Coal Flow Balancing
  - Rotor Or ASME Probe
  - Dirty Air Testing
- Secondary Airflow Balancing
  - Combustion Airflow Testing (CAT)

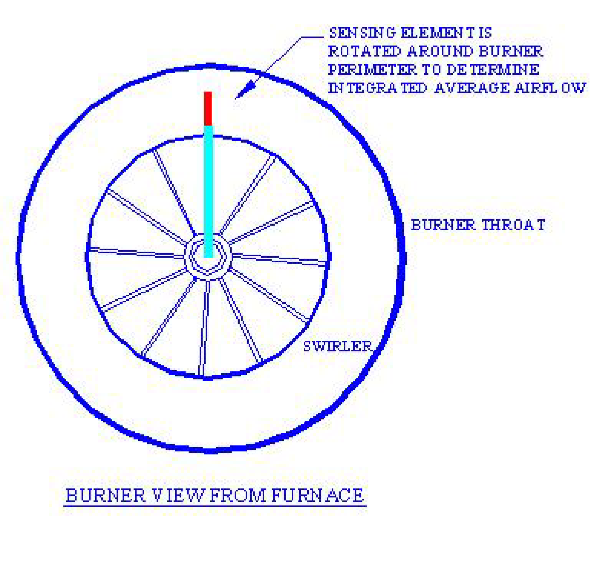
Combustion Air Test (CAT)

ACT

燃□□流□□和□□

A test probe is inserted along the burner centerline. A sensing element is raised up and rotated around the burner perimeter. Data is collected around the perimeter to determine the burner average and distribution. An average of all burners determines the boiler mean.



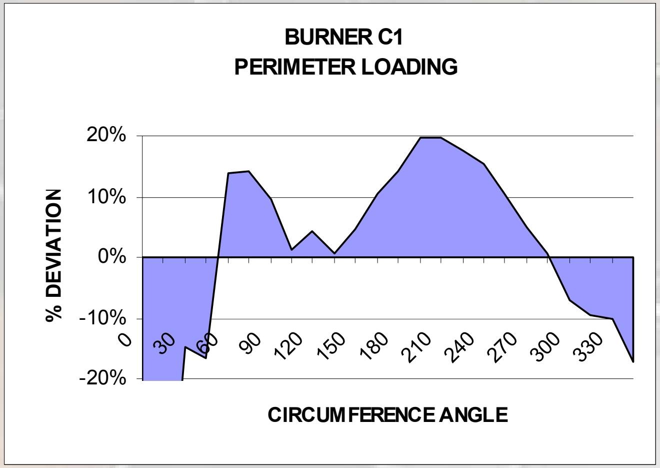


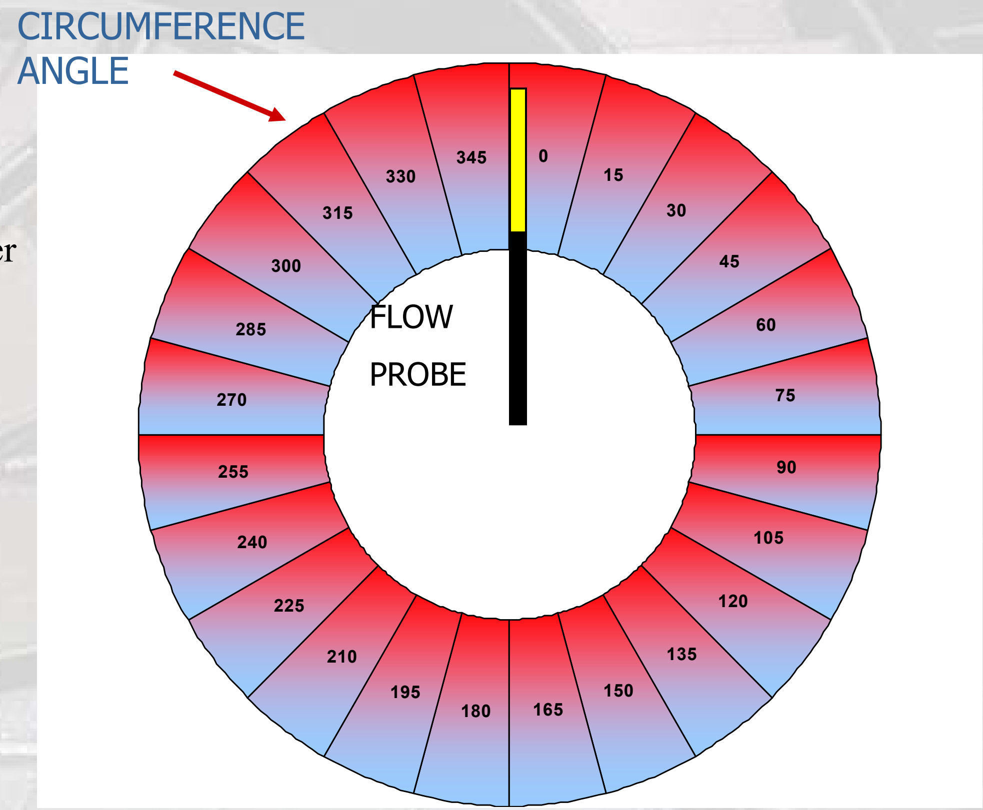
Burner Point Deviations

Large flow deviations around the burner can lead to burner instability and high CO, O2 and NOx emissions. These are caused by vortex flows in the windbox. Correcting this problem often requires CFD modeling.

This graph illustrates the point deviations from the burner mean around the CAT grid at the burner throat.

% DEVIATION FROM BURNER MEAN





TEST GRID AT BURNER THROAT

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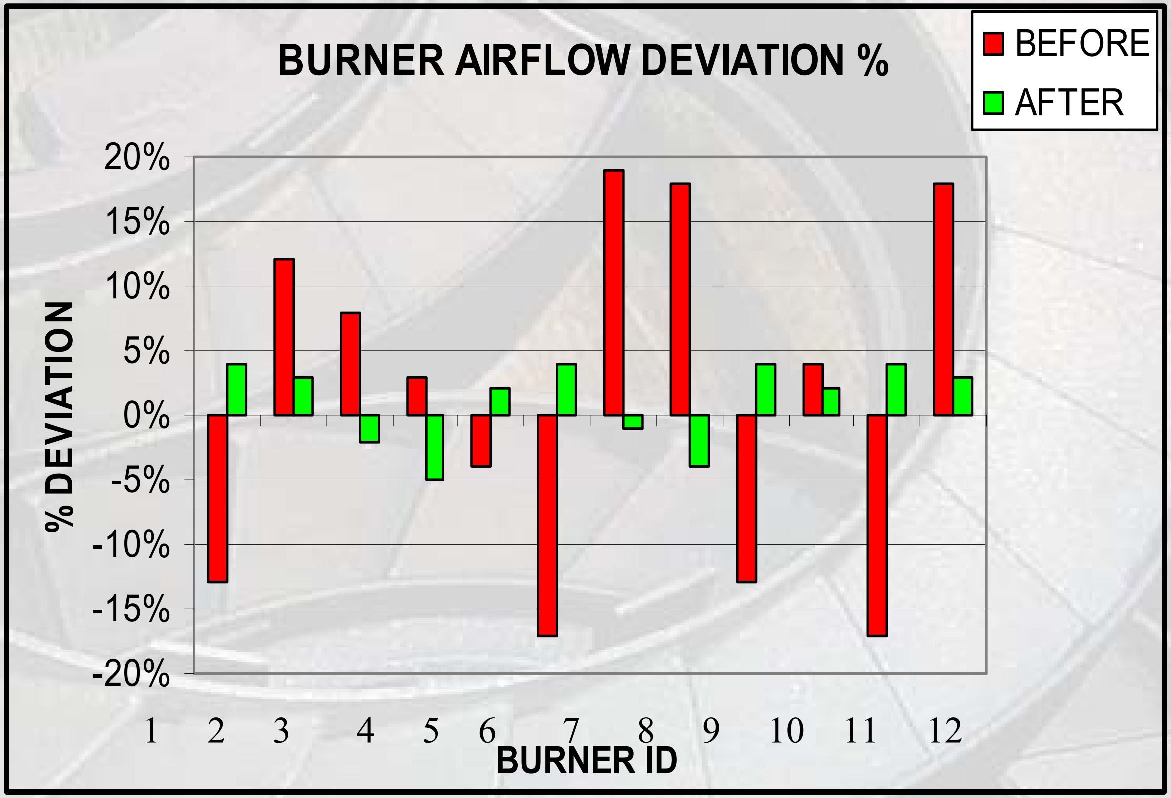
CAT Test Results

CAT□□□果

- Inlet register area of high flow burners is reduced to increase burner resistance. Airflow is forced from the high flow to the low flow burners.
- Testing is repeated to ensure the balance criteria is met.
- This graph illustrates baseline and post balancing testing of a 12 burner unit.



LOW NOx BURNER

第二□　低□燃□器

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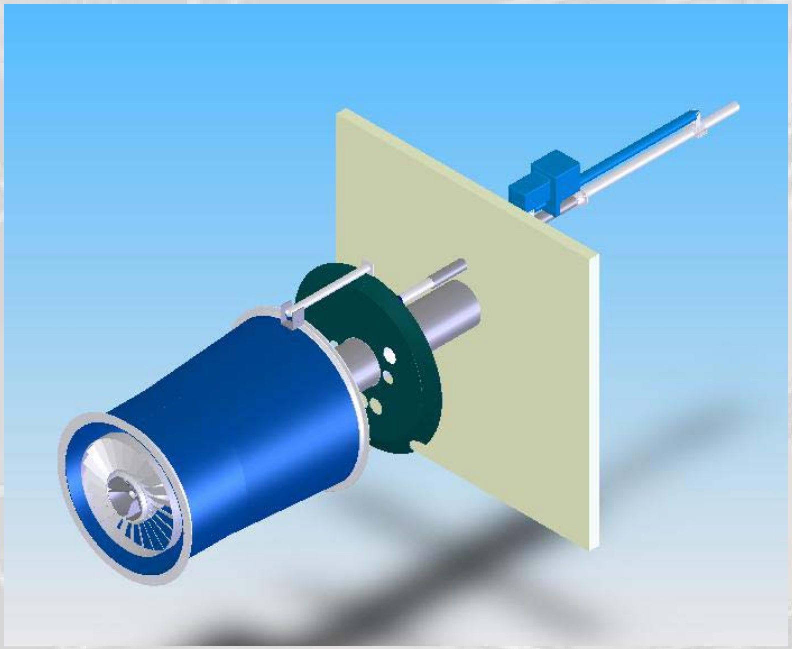
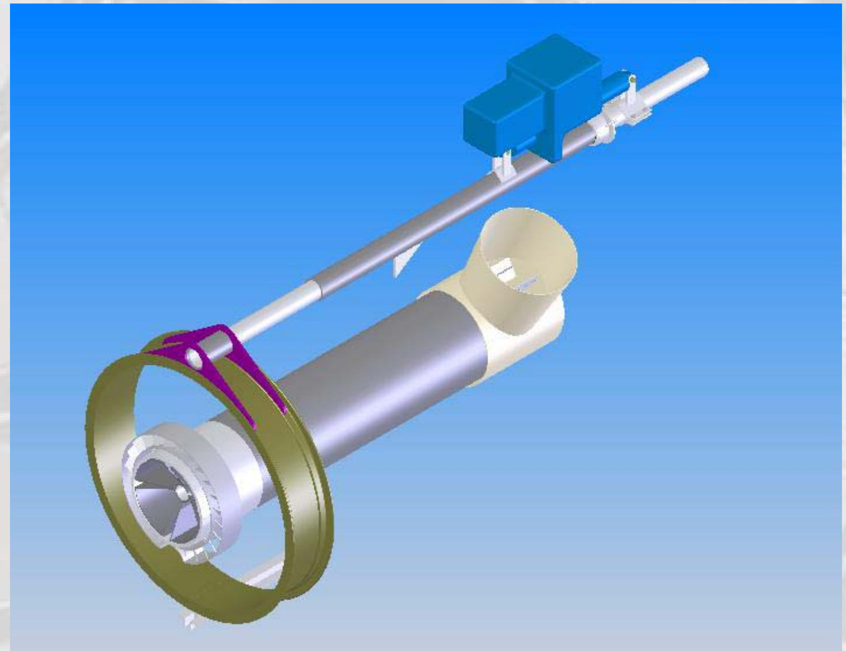
ACT Low NOx Burner Hardware

ACT低□燃□器硬件





VH600K LOW NOx BURNER

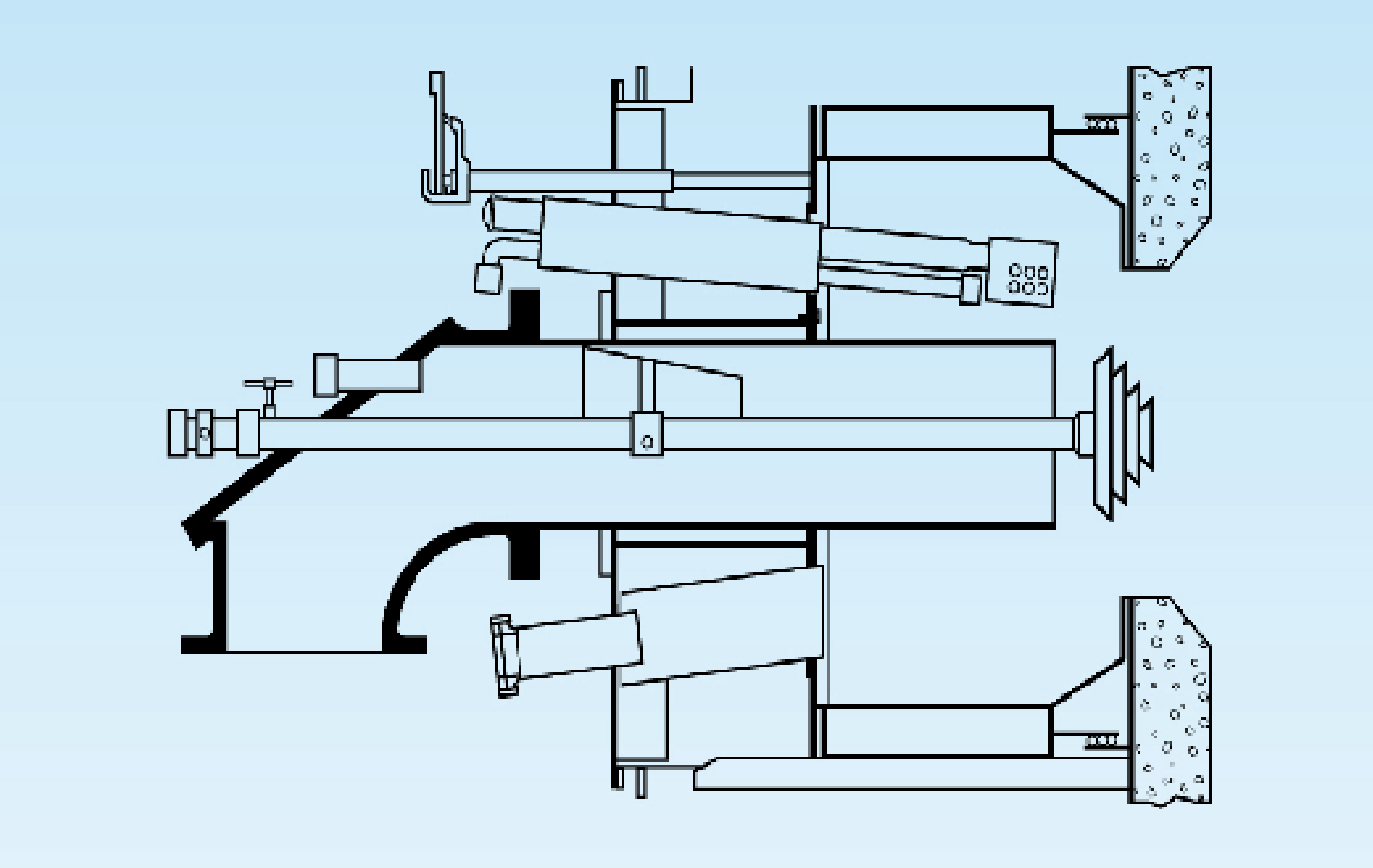
采用**ACT**□□完全替□**OEM**燃□器

BURNER UPGRADE COMPONENTS

□**OEM**提供的常□低□燃□器升□改造到**ACT**□□的低□燃□器, 用**ACT**的燃料□嘴□□替□**OEM**的□□.

Typical OEM Low NOx Burner

典型的OEM燃□器



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OEM Coal Burner Dynamics

OEM燃□器□力系□

Swirl Number (Sn), Swirl Effects & IRZ

TOO LITTLE SPIN

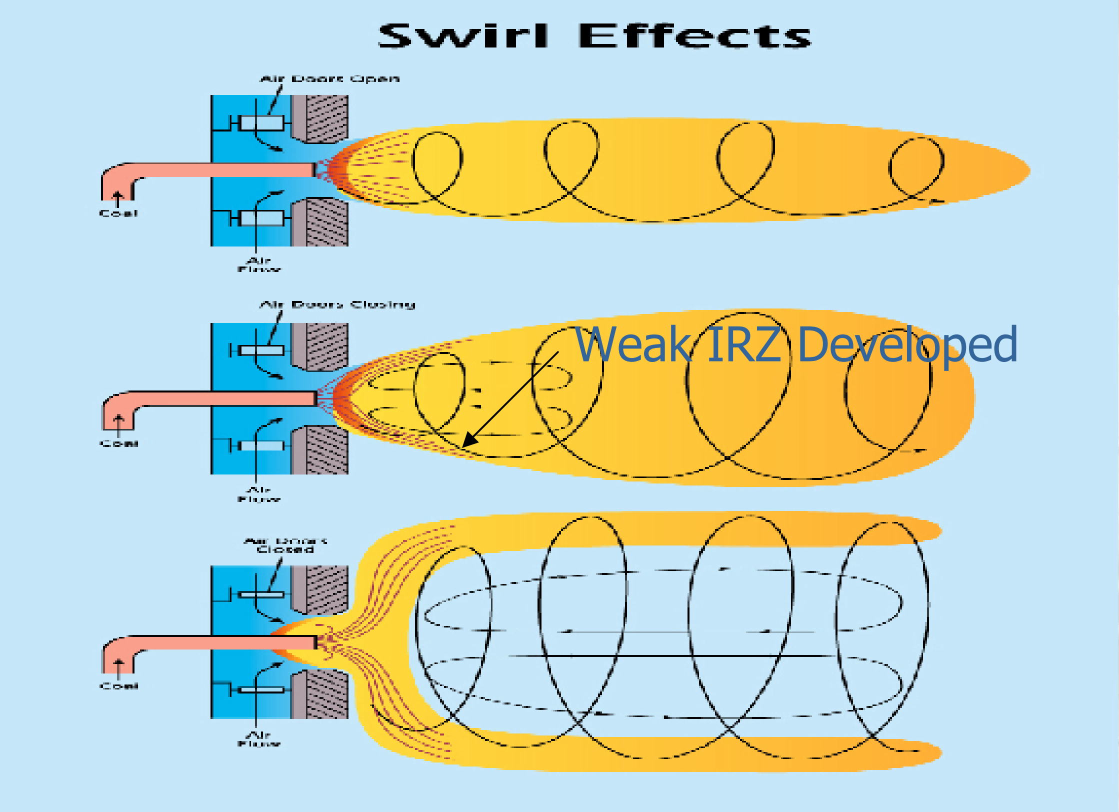
Sn 0.3

JUST RIGHT

Sn 0.6

TOO MUCH SPIN

Sn 0.9



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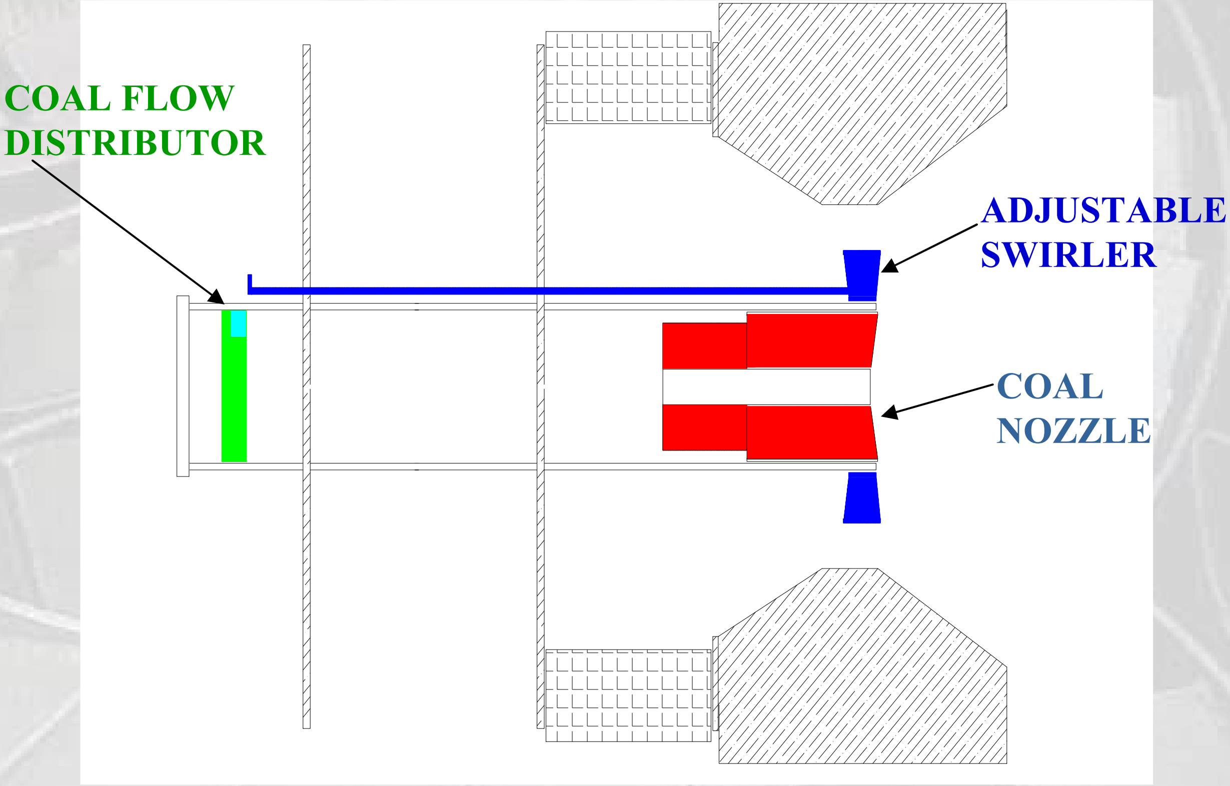
Typical OEM Low NOx Burner Upgrade To ACT Burner

OEM燃□器升□改造到ACT低□燃□器

ACT's low NOx swirler establishes a strong IRZ.

Coal is injected into the IRZ at the burner outlet to deeply stage combustion.

Airflow flowing around the swirler mixes downstream to complete combustion.



BURNER SIDE VIEW

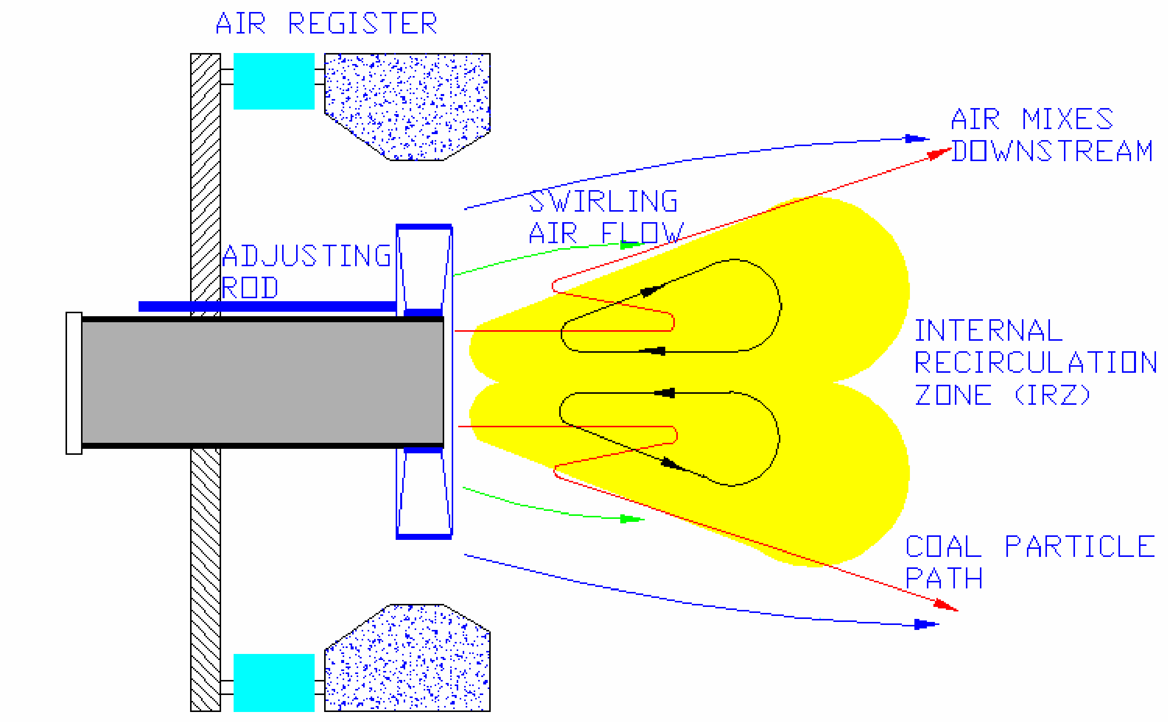
ACT Low NOx Burner Dynamics

ACT低□燃□器□力系□

IRZ, Coal Nozzle Position, Radial Staging

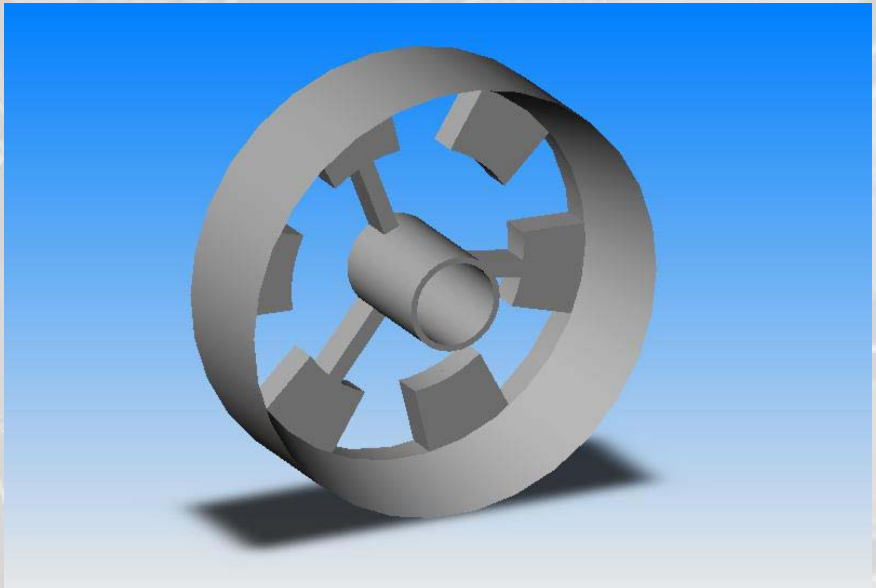
Swirling airflow from the swirler creates a strong IRZ at the burner outlet.

Air register is typically operated in the 40% to 60% to increase the strength of the IRZ.



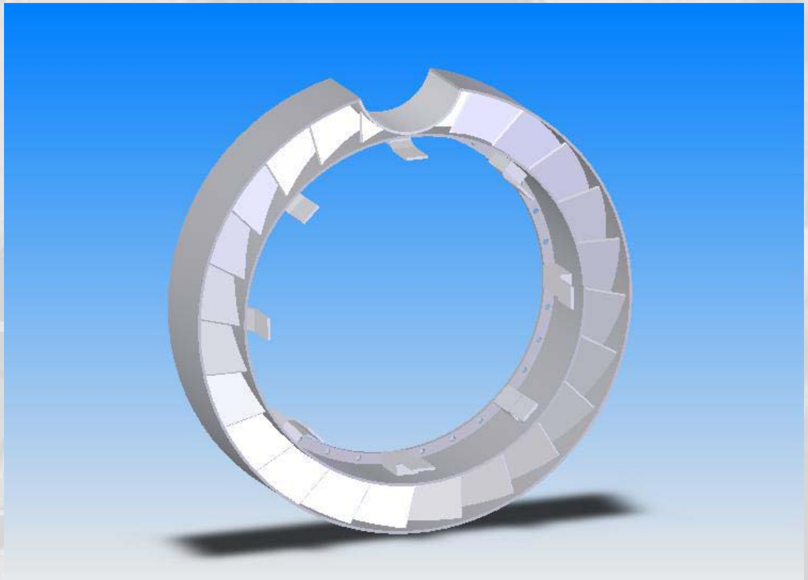
Coal Burner Upgrade Hardware

燃□器改造主要部件



Coal Distribution Disk

煤粉分布控制器



Low NOx Swirler

低**NOx**旋流器

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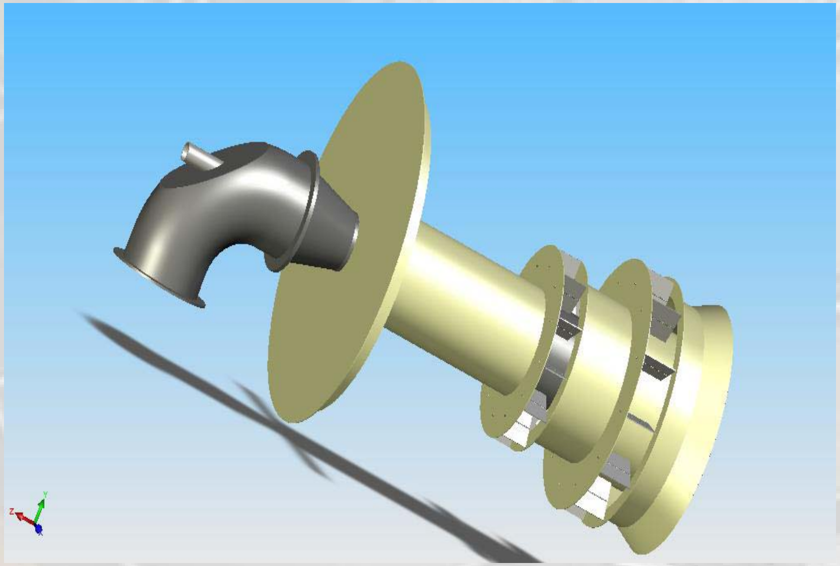
Low NOx Coal Nozzle □嘴

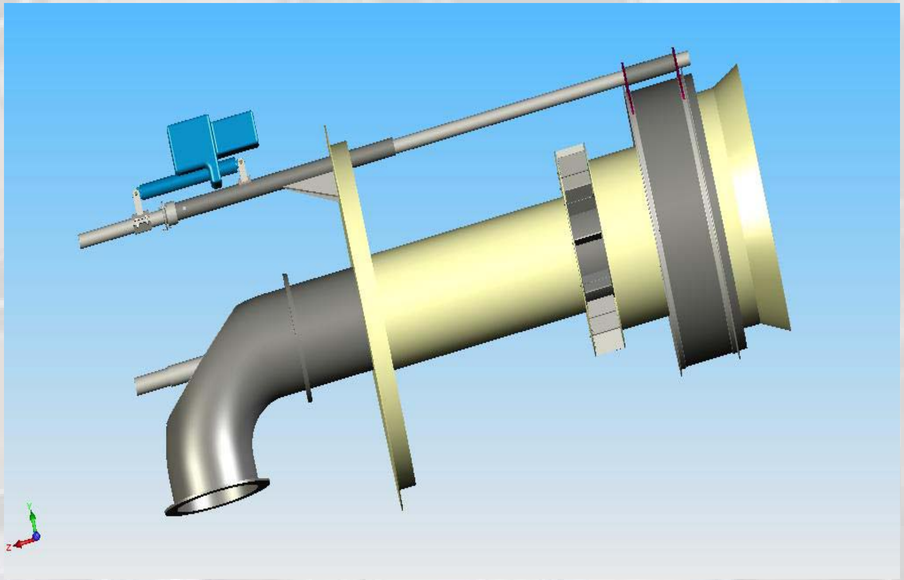
ACT's low NOx coal nozzle is manufactured from 309 SS with AR500 wear strips on the main wear surface. The nozzle ensures the primary air and coal stream is injected with a purely axial flow into the IRZ at the burner exit. Four small flame holders are positioned around the nozzle discharge for flame attachment. The nozzle is welded to the oil gun guide tube and can be adjusted from the burner front.

Low NOx Burner Upgrade

OEM Burner

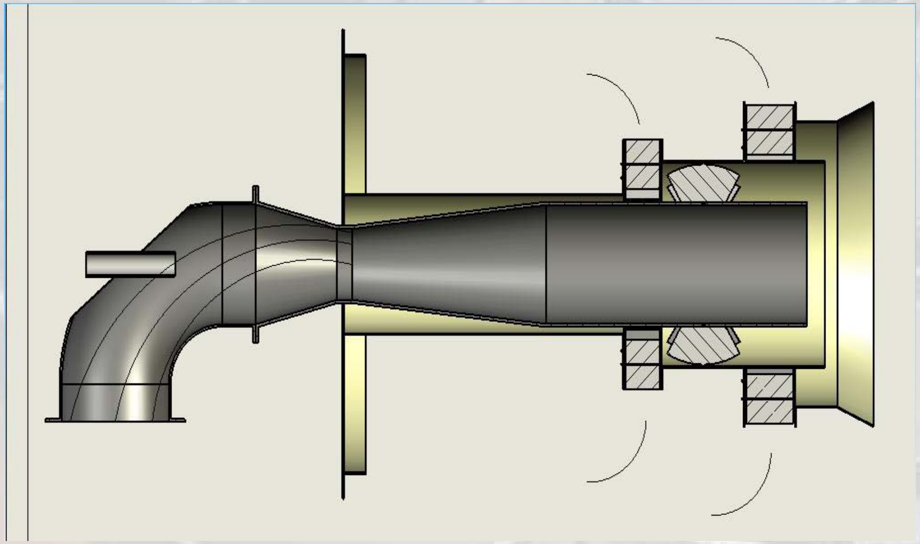


ACT Modified Burner

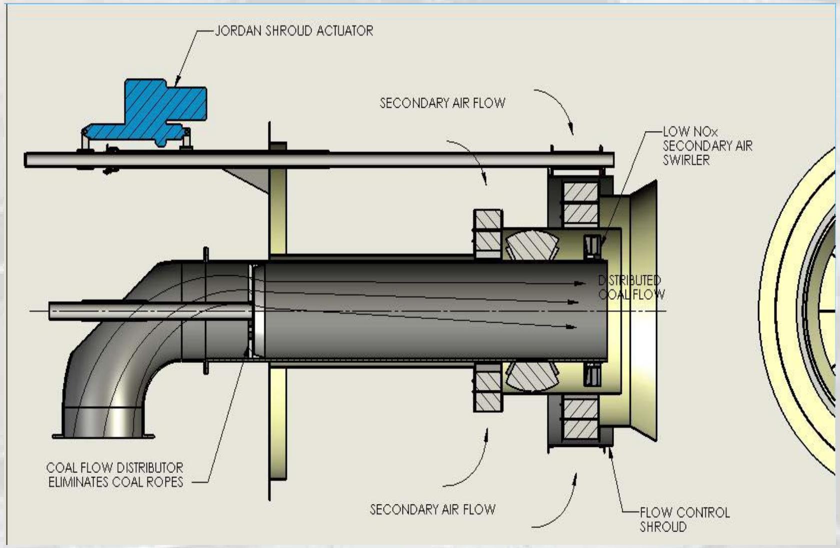


Low NOx Burner Upgrade

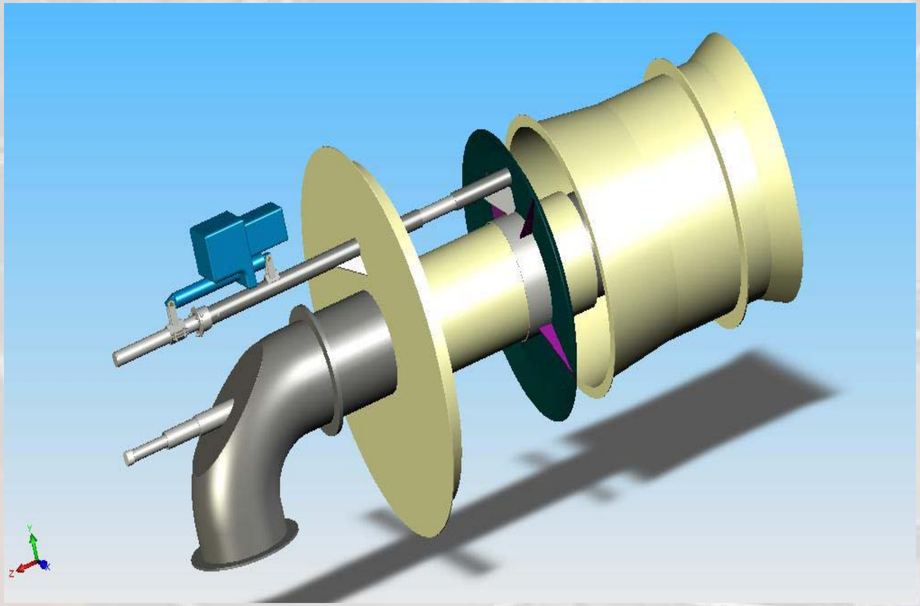
Existing OEM Burner Cut View

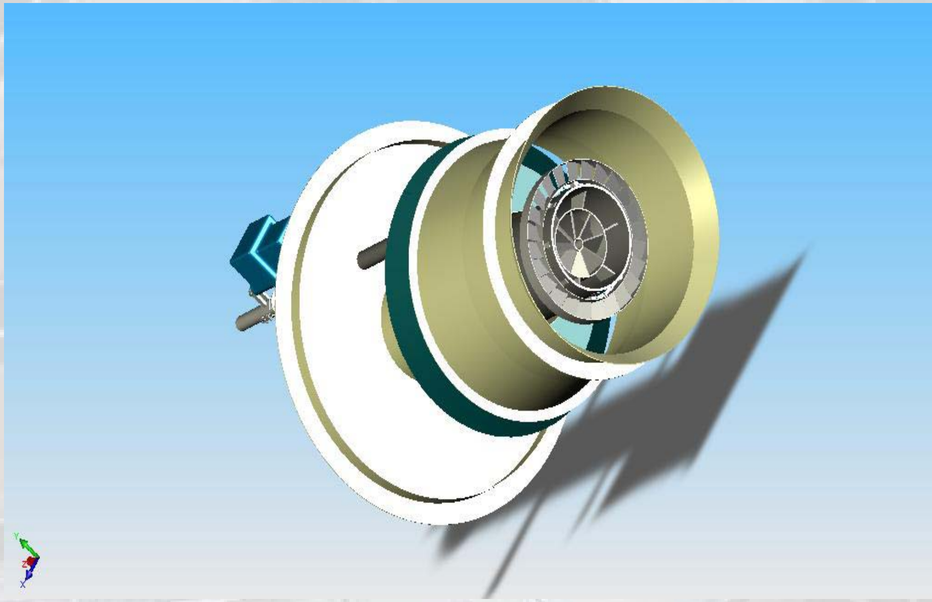


ACT Modified Burner Cut View



ACT New Burner





Low NOx Burner
□例

Baseline Burner

Upgraded Burner

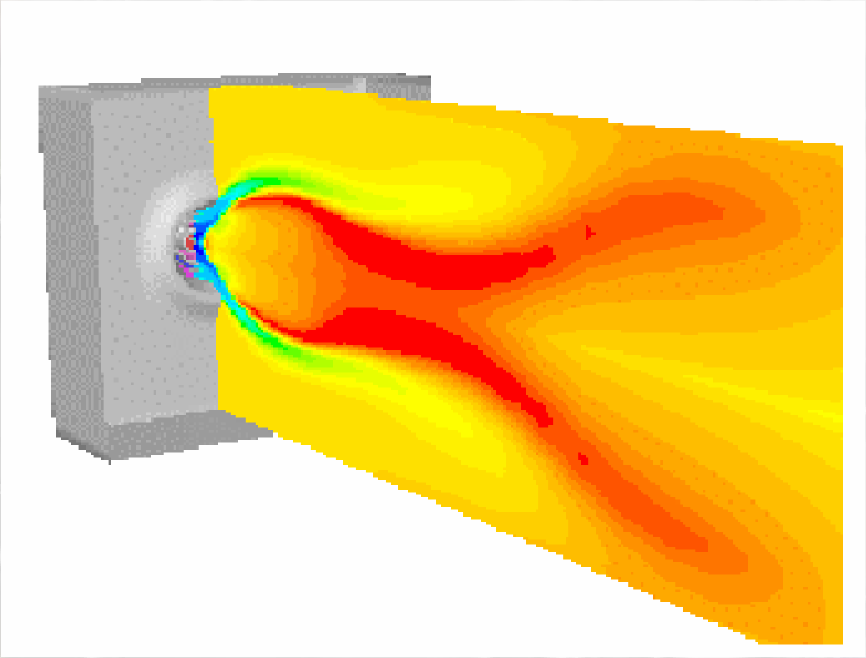
Upgraded Burner

Upgraded Burner

CFD MODELING

CFD MODELING & DESIGN PROCESS

(Seeing the Problem is half way to solving it)

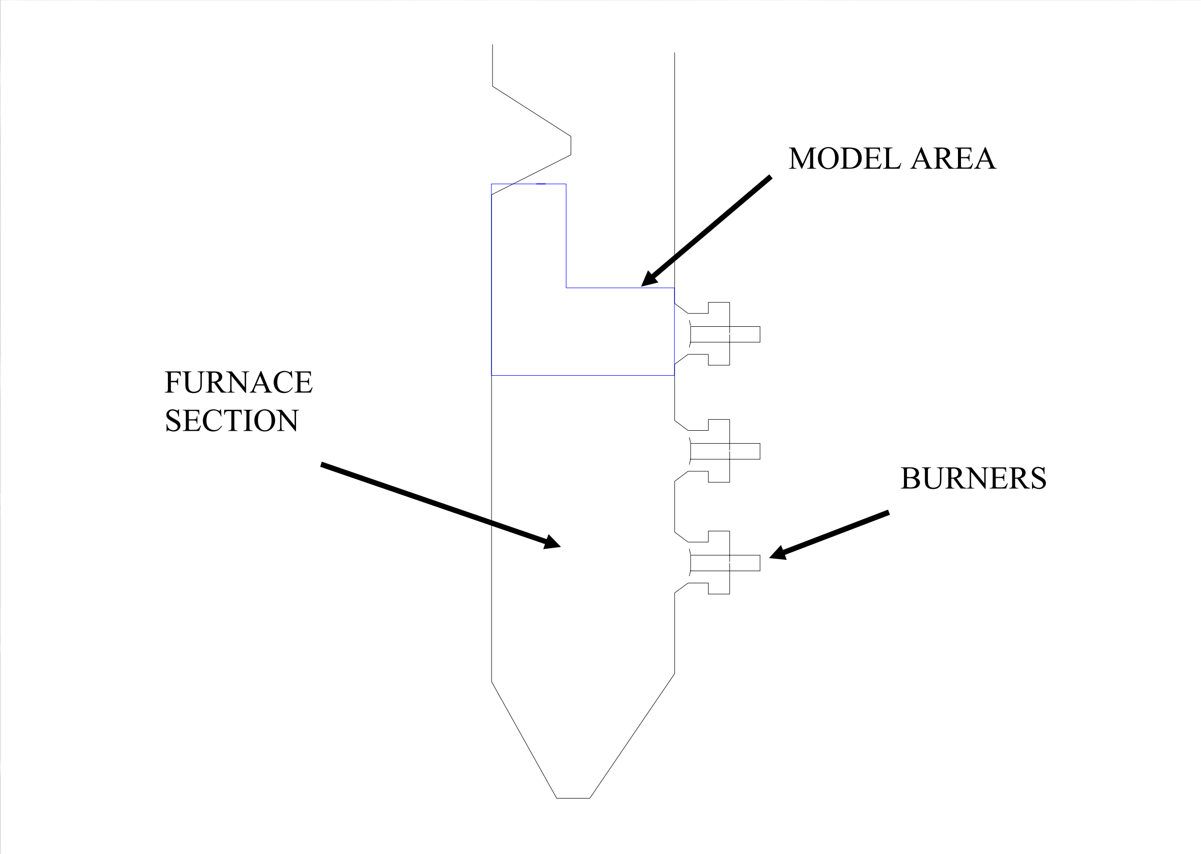


- COMPUTATIONAL FLUID DYNAMICS (CFD) MODEL OF BASELINE BURNER
  - BURNER DESIGN
  - FURNACE DESIGN
  - FUEL TYPE
- INCORPORATE NEW DESIGN INTO CFD MODEL
  - NOx
  - CO
  - O2
- REVIEW RESULTS AND MODIFY DESIGN AS REQUIRED

CFD MODELING IS USED TO VALIDATE ALL DESIGNS PRIOR TO MANUFACTURING

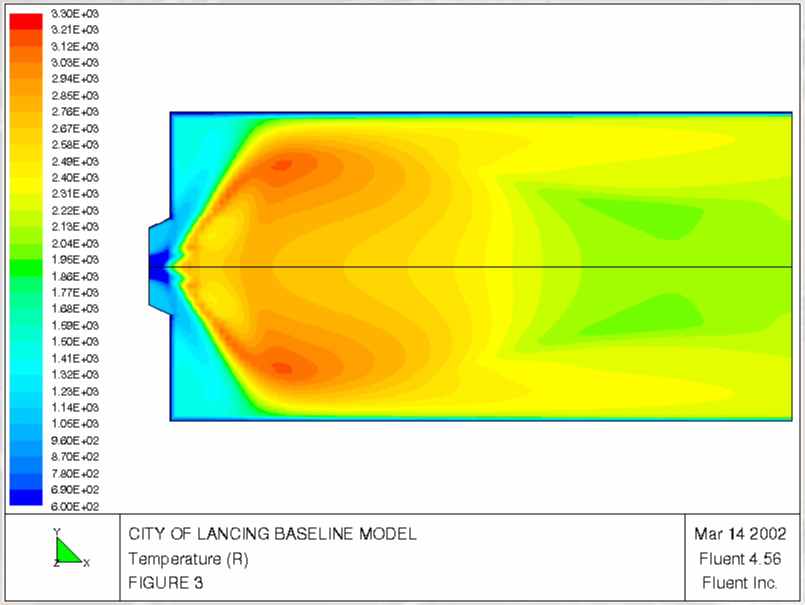
RELEASE DESIGN FOR FABRICATION

Furnace Section

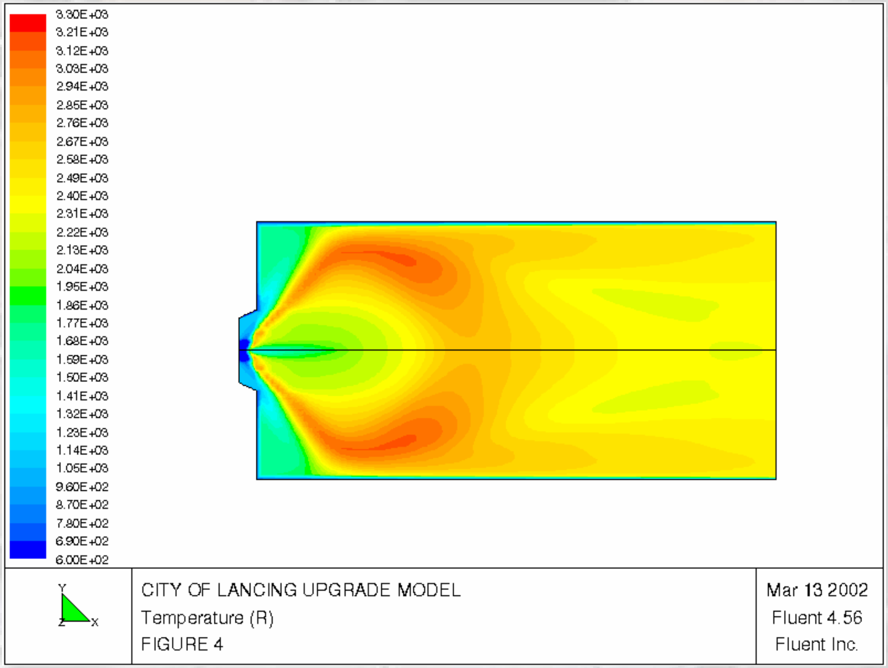


Temperature Contour

Baseline

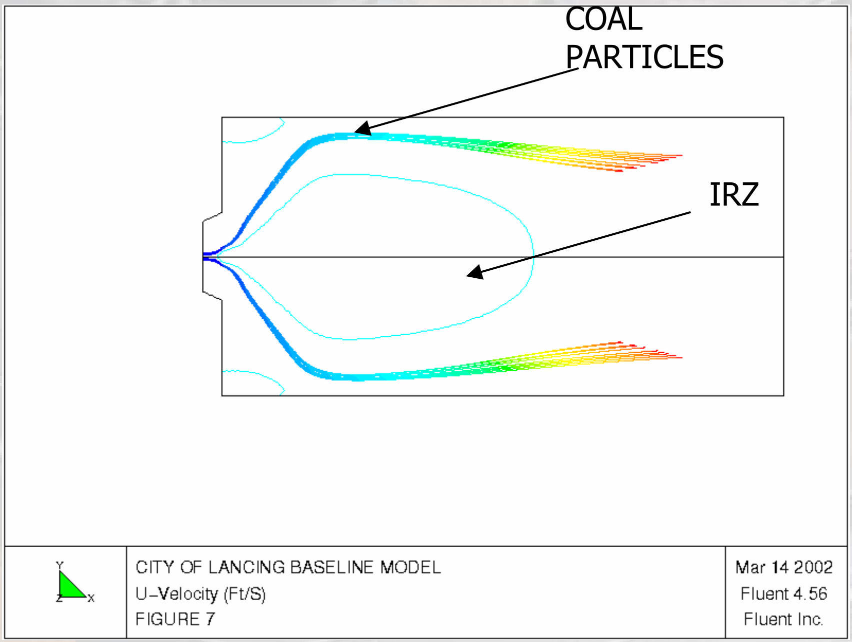


Upgraded

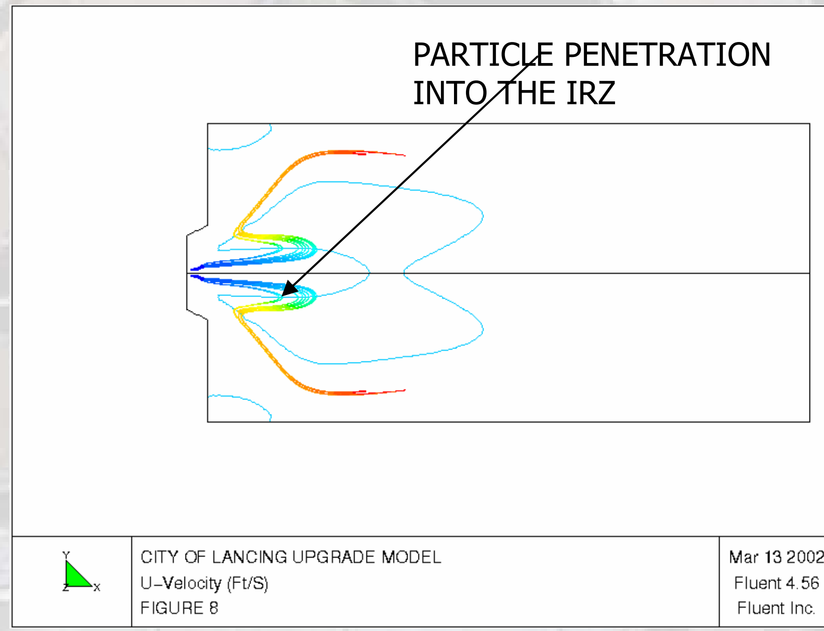


Coal Particle Path

Baseline



Upgrade



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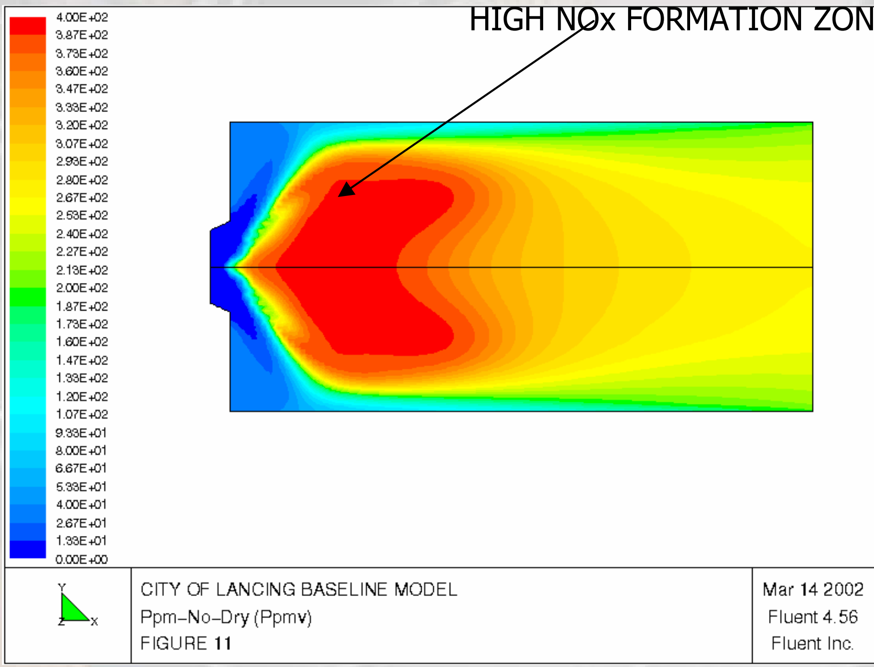
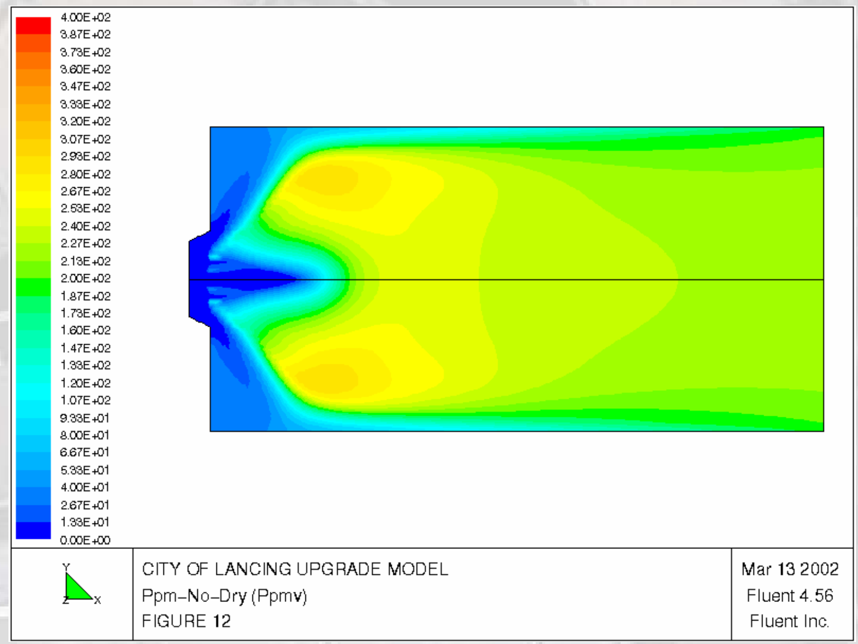
NOx Formation

Baseline Case



Upgrade Case



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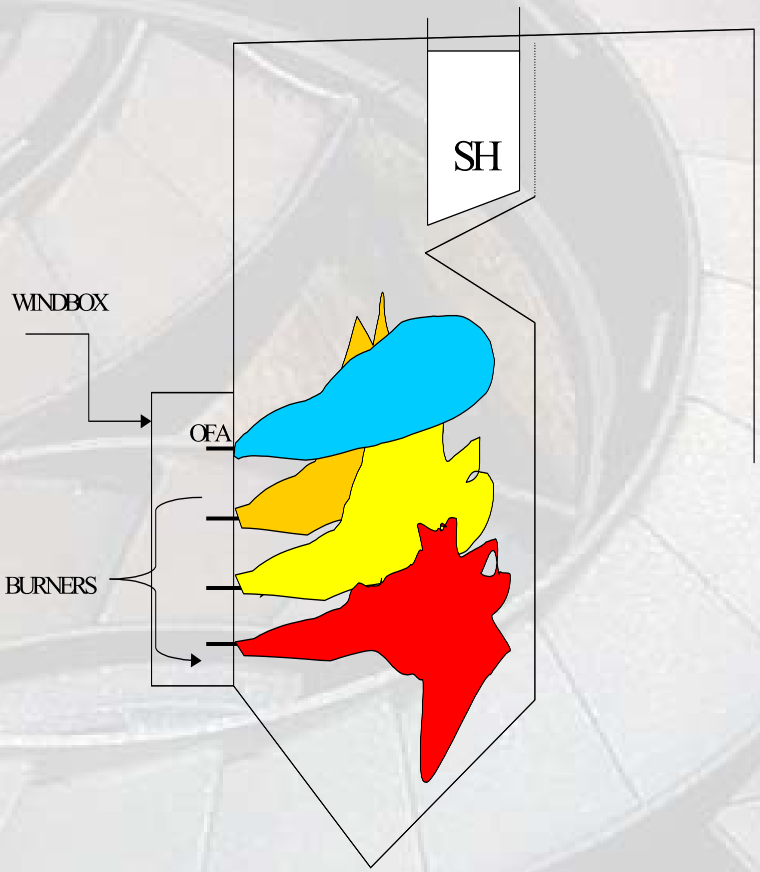
OVER-FIRE AIR (OFA)

第三□　燃□□系□

OVER-FIRE AIR (OFA) PROCESS

- Burner CFD model inputs into furnace model
- Mixing must be complete before the gases exit the furnace
- NOx reduction can be limited by LOI and CO



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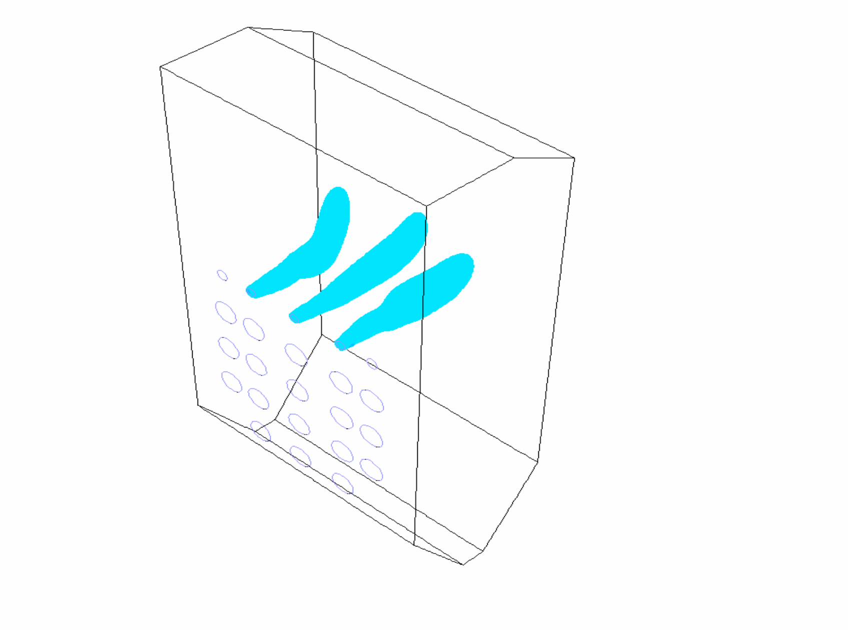
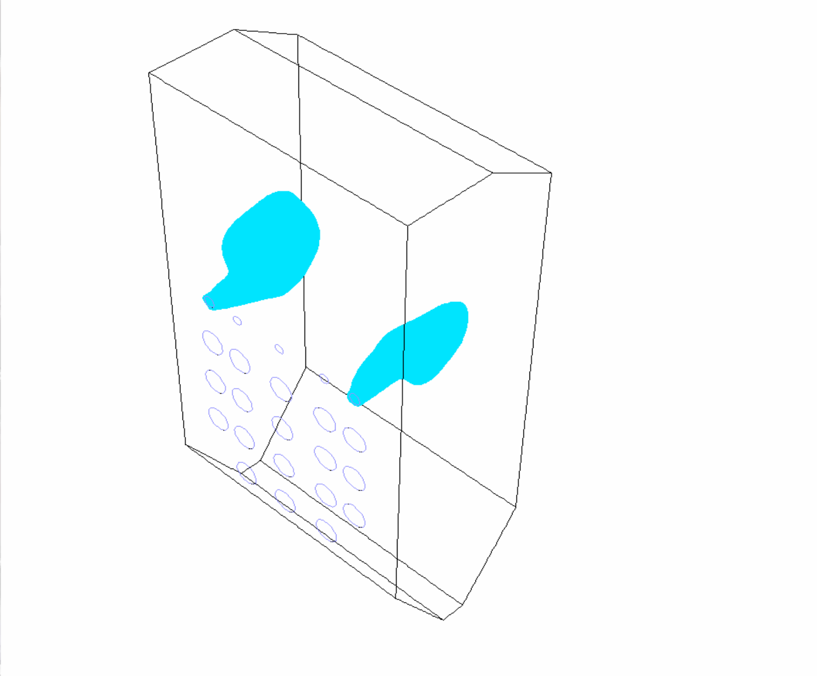
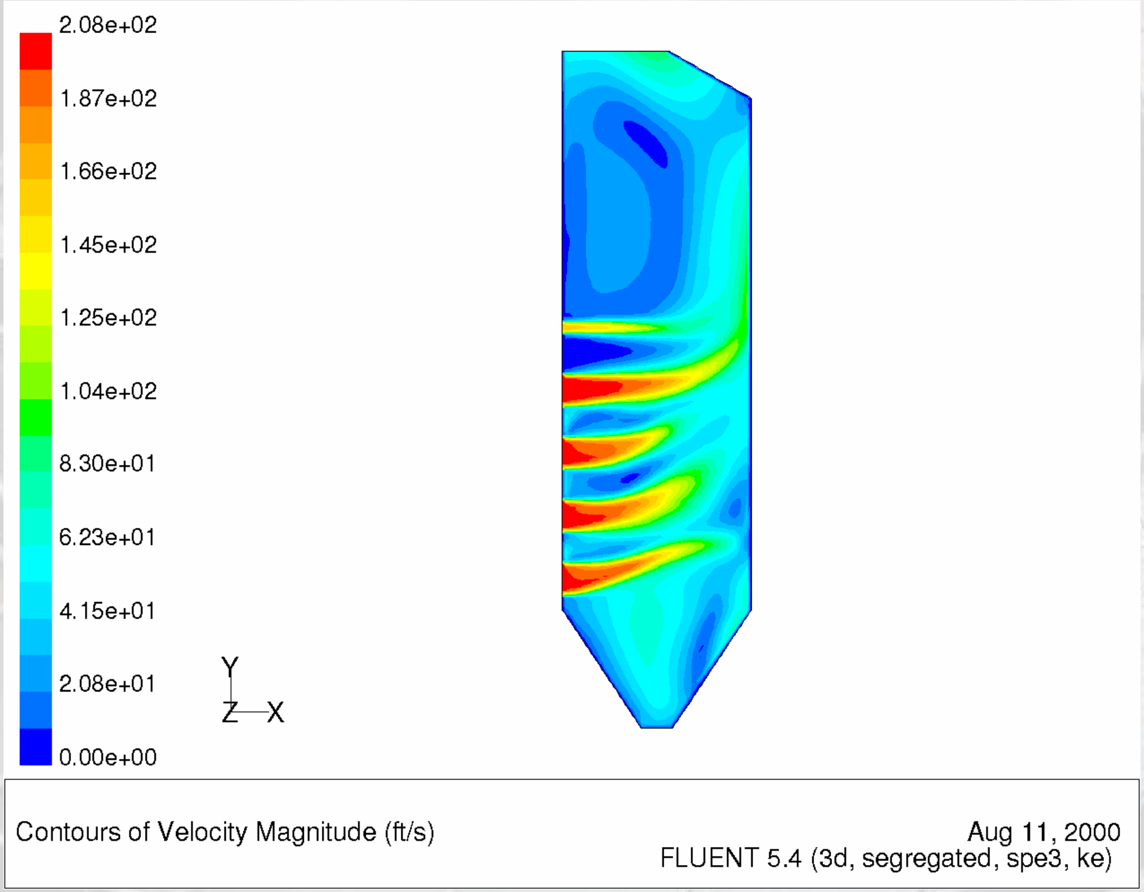
OFA Process





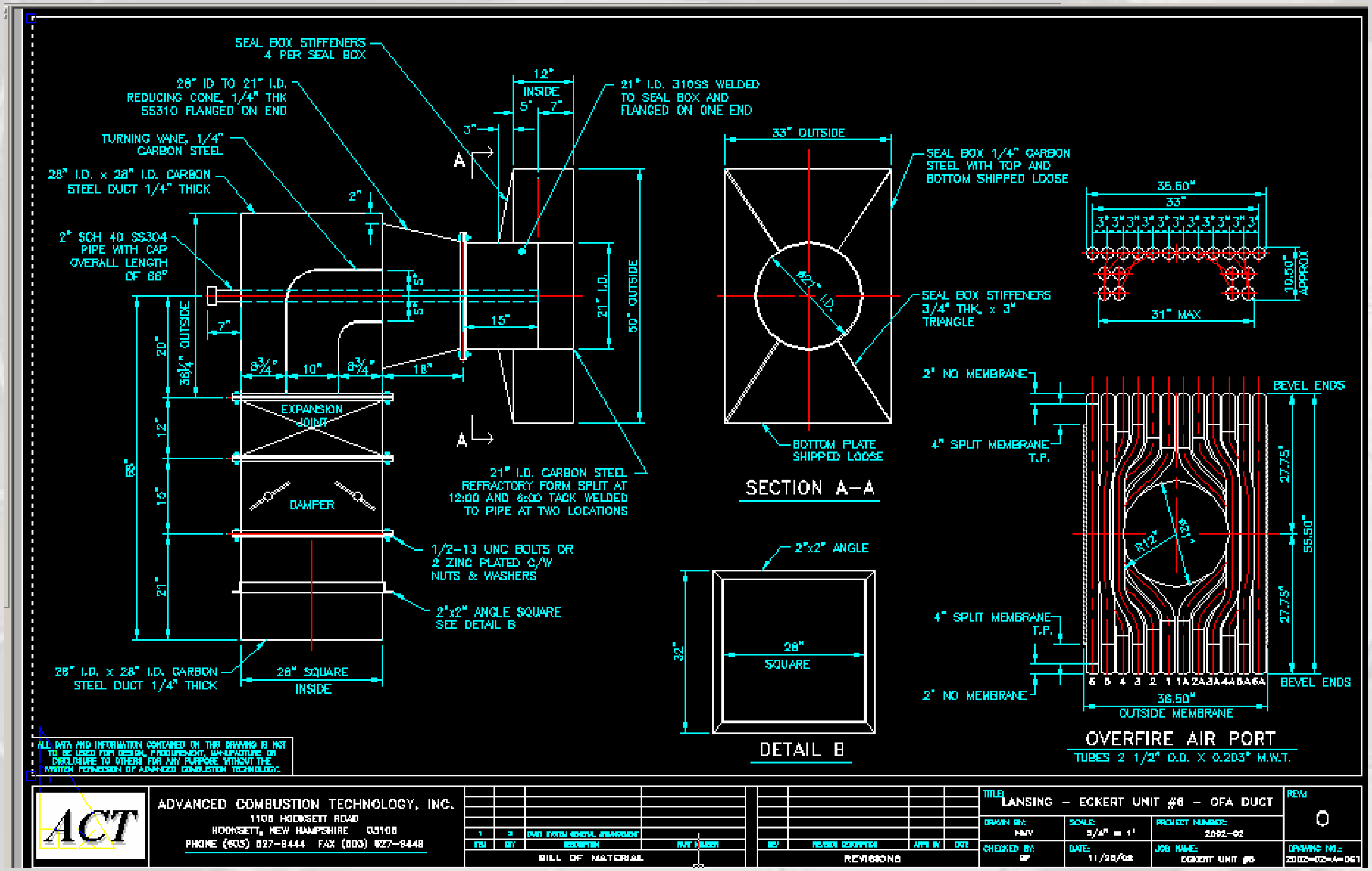
Penetration/Mixing Optimization

OFA Process



2.08e+02
1.87e+02
1.66e+02
1.45e+02
1.25e+02
1.04e+02
8.30e+01
6.23e+01
4.15e+01
2.08e+01
0.00e+00
Y
Z
X
Contours of Velocity Magnitude (ft/s)
Aug 11, 2000
FLUENT 5.4 (3d, segregated, spe3, ke)

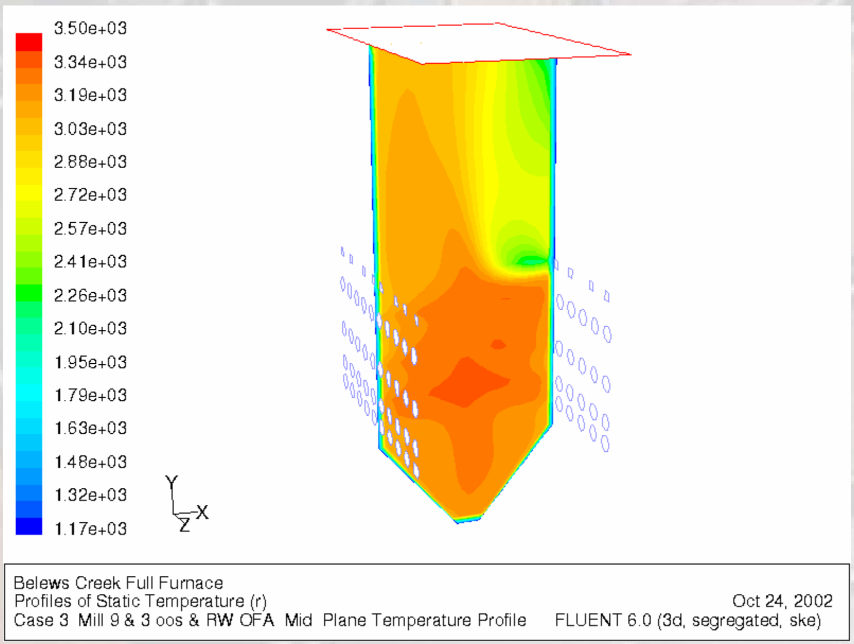
OFA Design

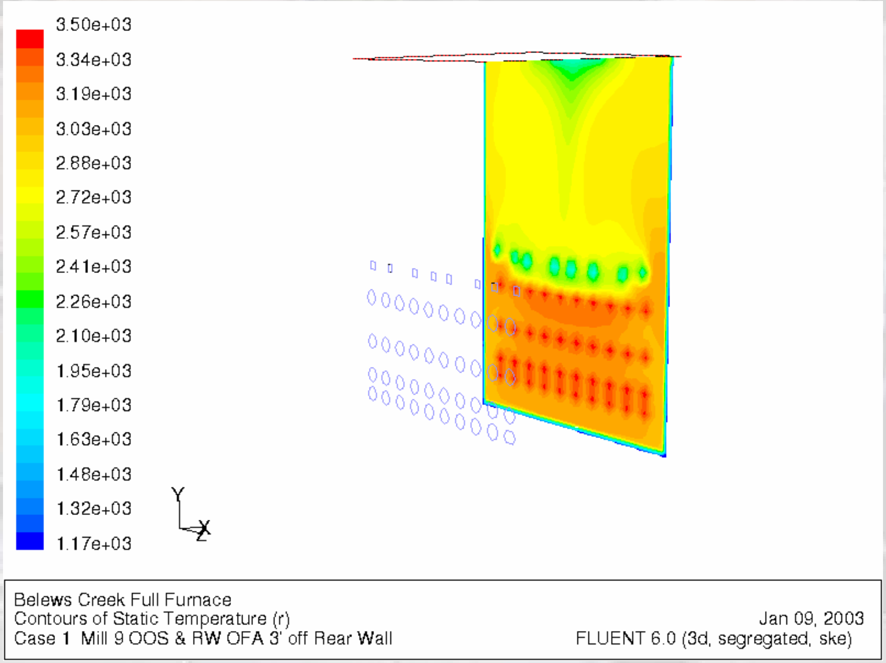

SEAL BOX STIFFENERS 4 PER SEAL BOX
28" ID TO 21" I.D. REDUCING CONE, 1/4" THK SS310 FLANGED ON END
TURNING VANE, 1/4" CARBON STEEL
28" I.D. x 28" I.D. CARBON STEEL DUCT 1/4" THICK
2" SCH 40 SS304 PIPE WITH CAP OVERALL LENGTH OF 86"
12" INSIDE
21" I.D. 310SS WELDED TO SEAL BOX AND FLANGED ON ONE END
21" I.D.
50" OUTSIDE
EXPANSION JOINT
DAMPER
21" I.D. CARBON STEEL REFRACTORY FORM SPLIT AT 12:00 AND 6:00 TACK WELDED TO PIPE AT TWO LOCATIONS
1/2-13 UNC BOLTS OR 2 ZINC PLATED C/W NUTS & WASHERS
2"x2" ANGLE SQUARE SEE DETAIL B
28" I.D. x 28" I.D. CARBON STEEL DUCT 1/4" THICK
28" SQUARE INSIDE
33" OUTSIDE
SEAL BOX 1/4" CARBON STEEL WITH TOP AND BOTTOM SHIPPED LOOSE
SEAL BOX STIFFENERS 3/4" THK. x 3" TRIANGLE
BOTTOM PLATE SHIPPED LOOSE
SECTION A-A
2"x2" ANGLE
28" SQUARE
DETAIL B
35.60"
33"
31" MAX
10.50" APPROX
2" NO MEMBRANE
4" SPLIT MEMBRANE T.P.
BEVEL ENDS
27.75"
55.50"
36.50" OUTSIDE MEMBRANE
OVERFIRE AIR PORT
TUBES 2 1/2" O.D. X 0.203" M.W.T.
ADVANCED COMBUSTION TECHNOLOGY, INC.
1108 HOOKSETT ROAD
HOOKSETT, NEW HAMPSHIRE 03106
BILL OF MATERIAL
REVISIONS
LANSING - ECKERT UNIT #6 - OFA DUCT

Furnace Model – OFA
□例

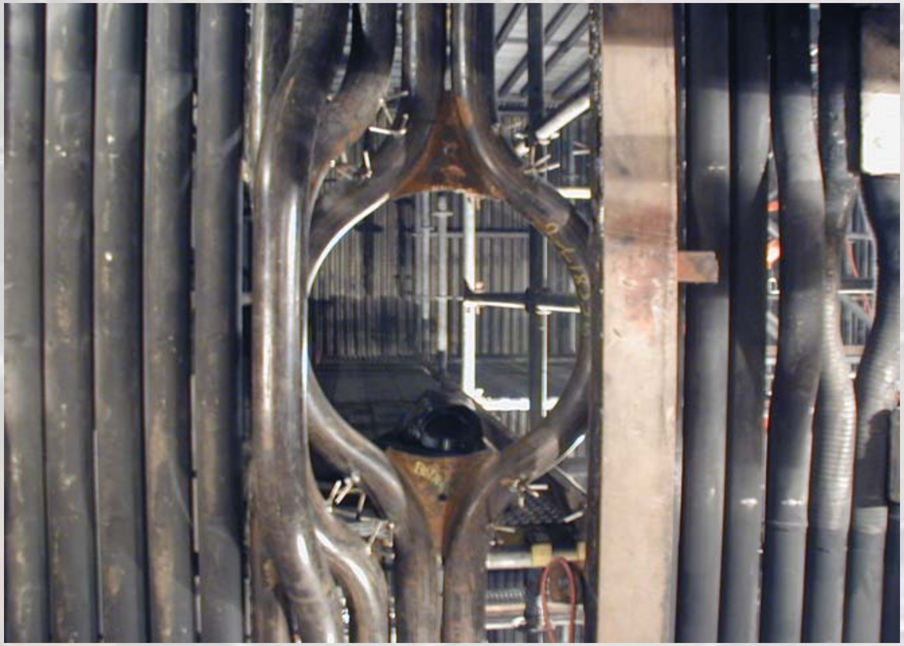
Before Modification

After Modification





OFA System Port Design



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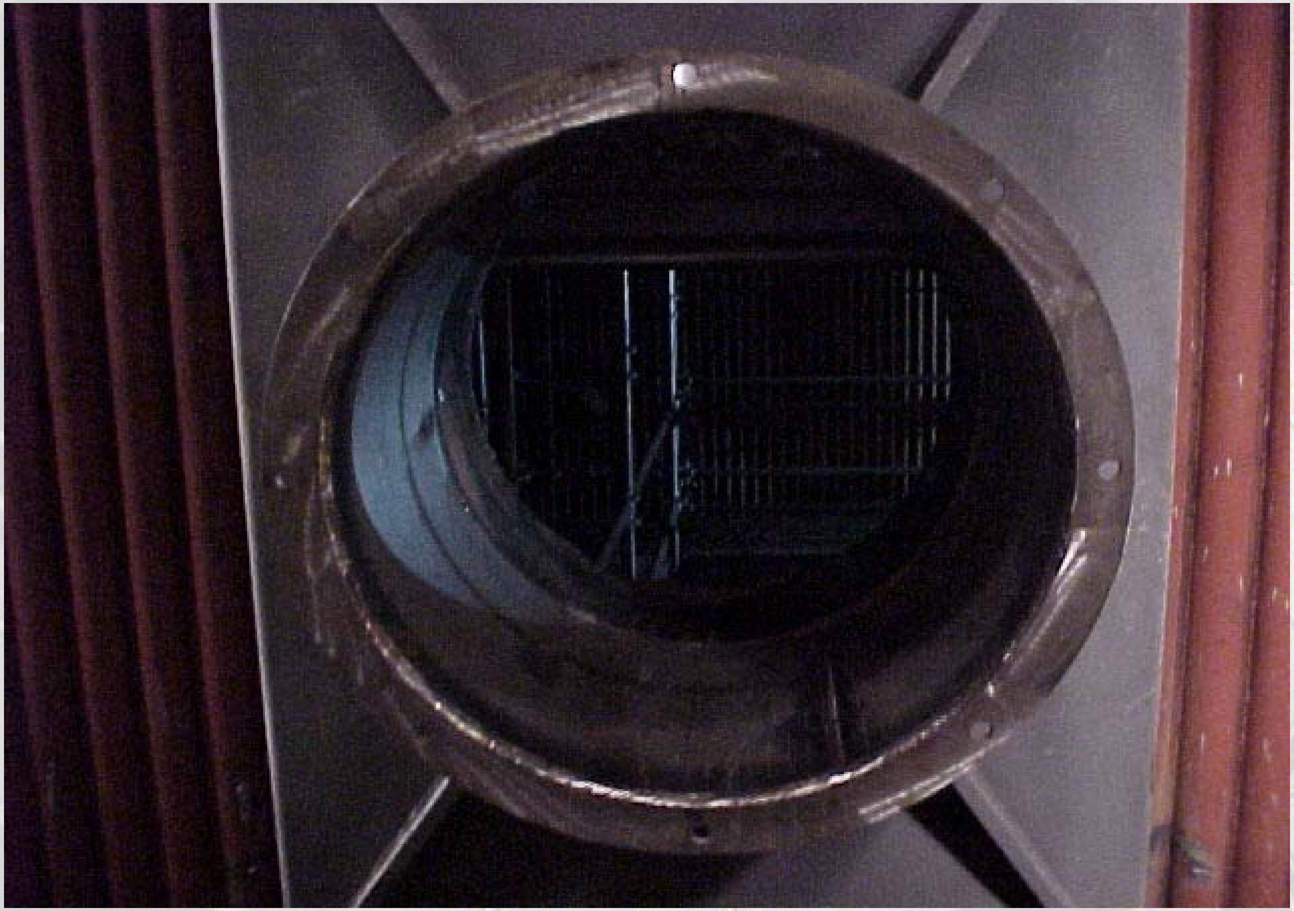
OFA System Port Design



OFA System

T-FIRED BOILER

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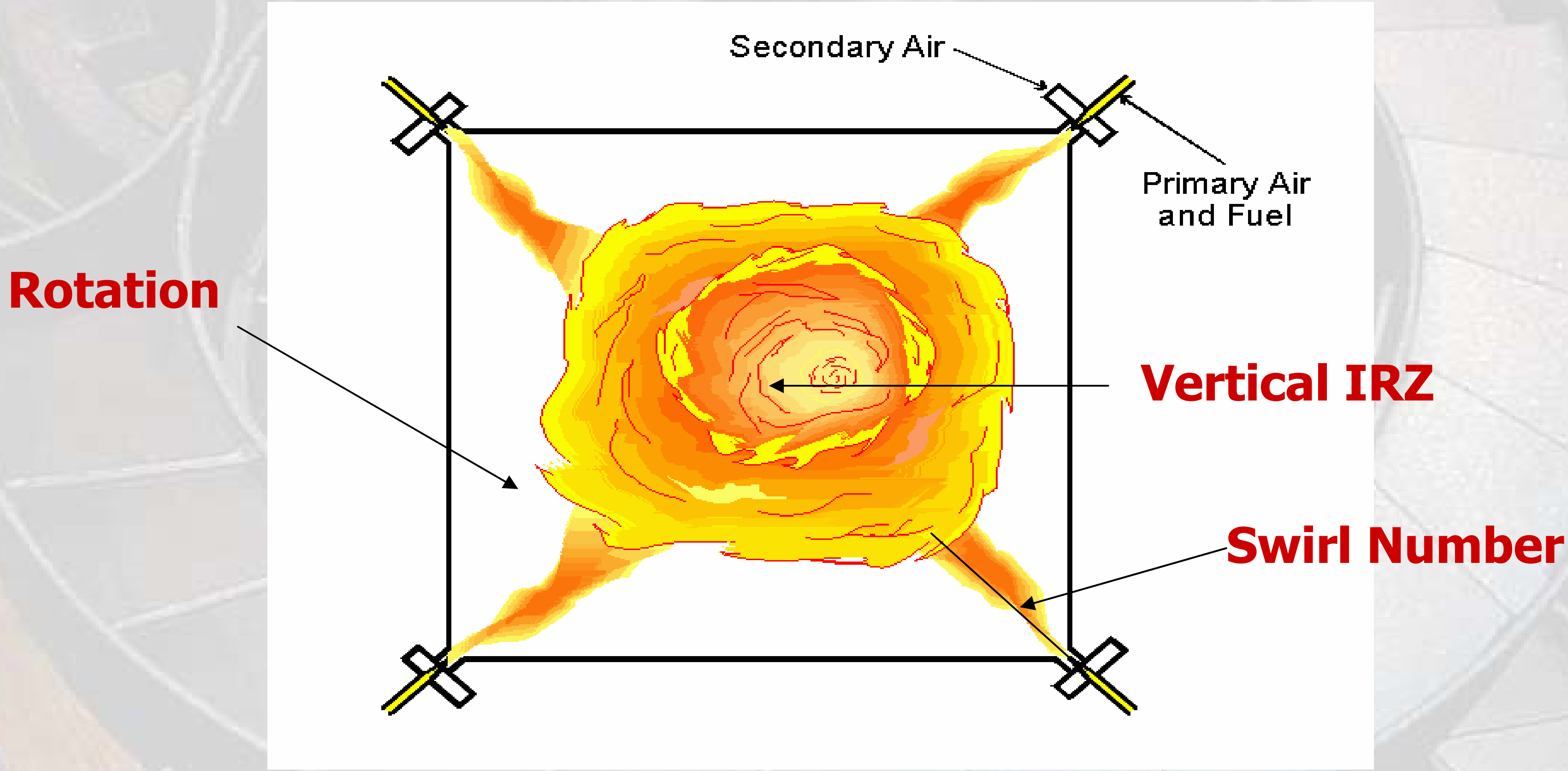
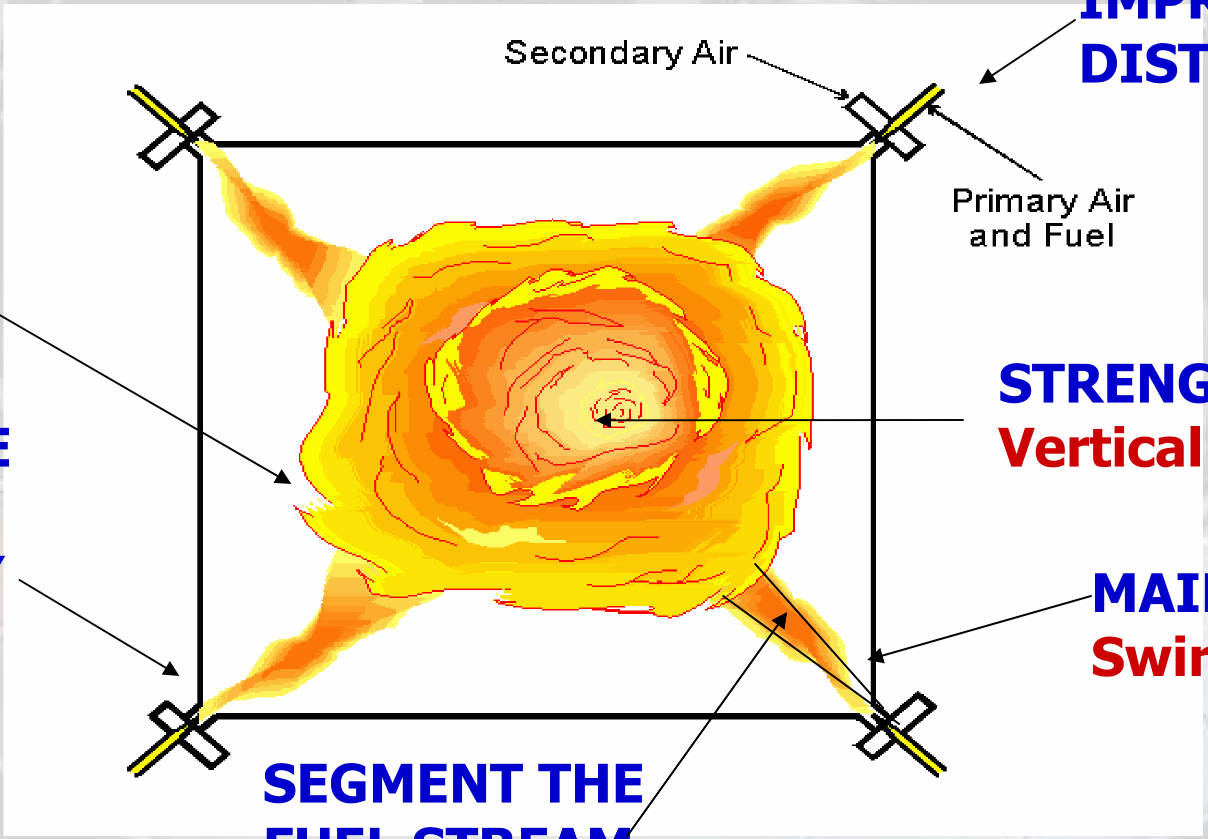
Coal Burner Dynamics

T-fired - Swirl Number (sn), Rotation & IRZ



Low NOx Dynamics

T-fired – NOx Reduction Techniques



IMPROVE COAL DISTRIBUTION

Rotation

STRENGTHEN Vertical IRZ

INCREASE COAL VELOCITY

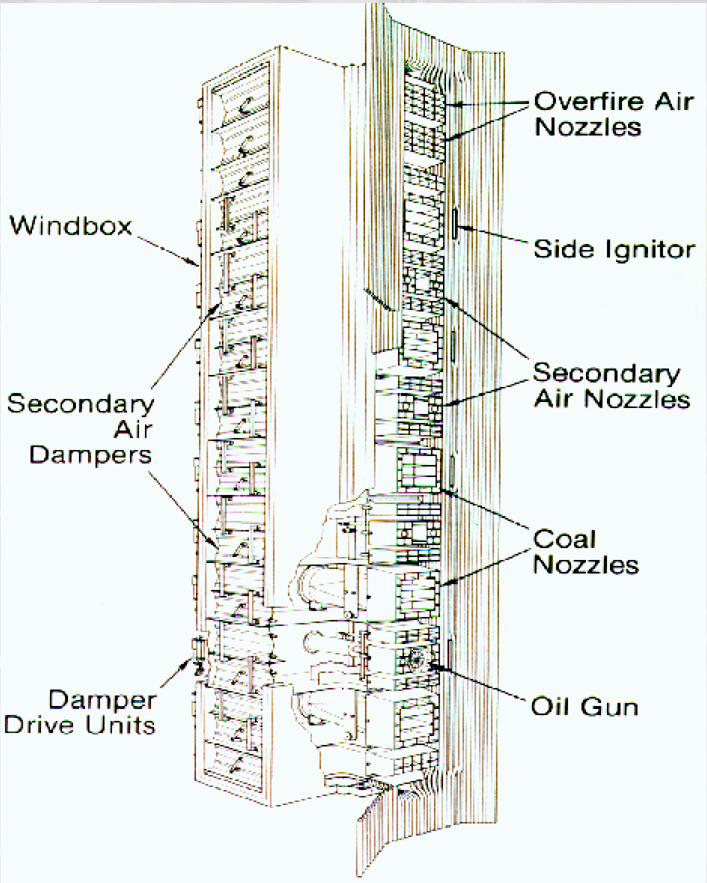
MAINTAIN Swirl Number

SEGMENT THE FUEL STREAM

ACT T-fired Boiler Burner Upgrade

- Coal Flow Distributor
- Coal Pipe Tip Insert
  - Increase Coal Injection Velocity
- New Fuel Bucket
  - Segmentation Of Fuel Stream

Typical T-fired Burner Corner

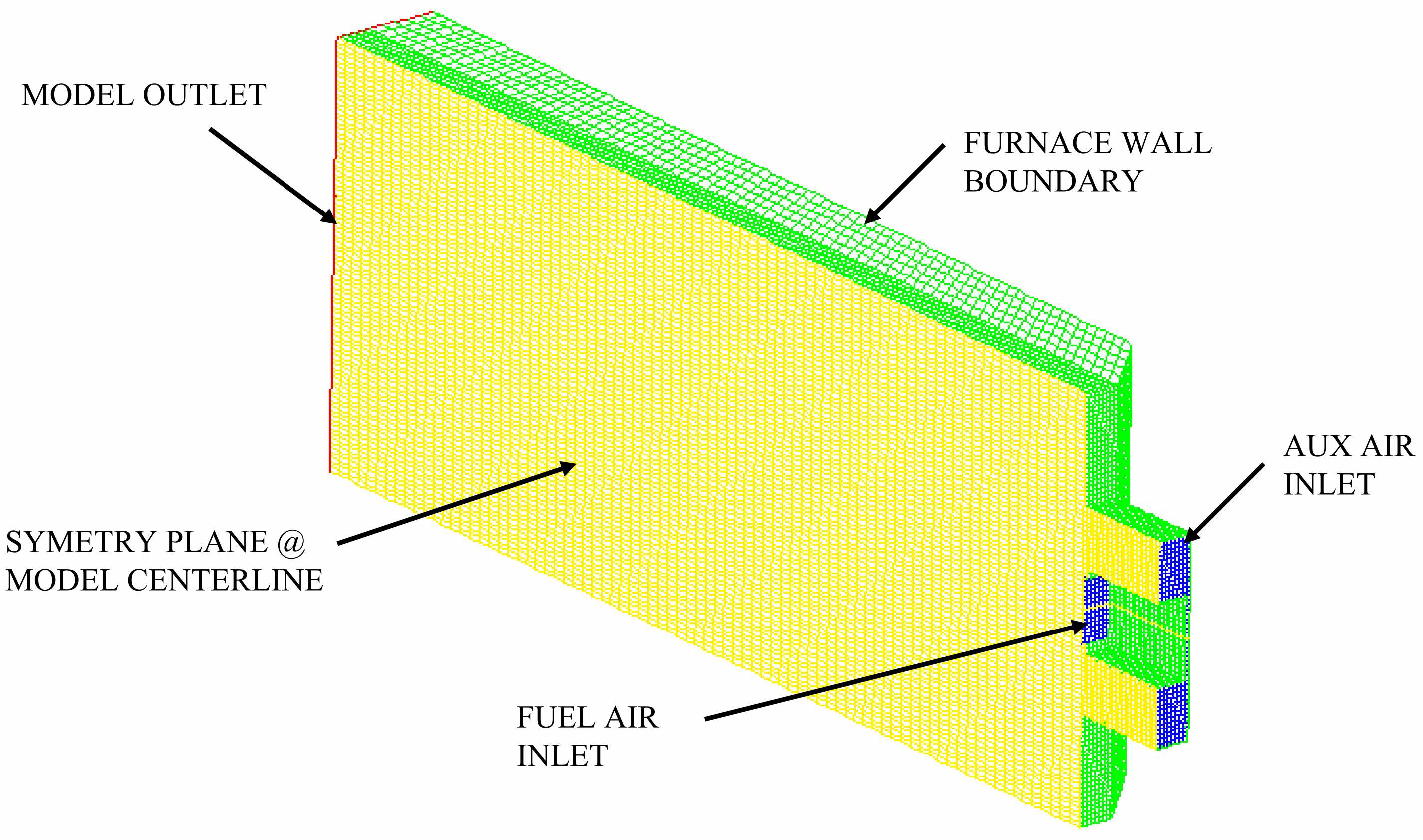


ACT T-fired Burner Upgrade & SOFA Addition

TYPICAL NOx REDUCTION

50 to 60% Burner Mods & OFA

Virtually No Change In LOI



	EAGLE VALLEY UNIT 4 BURNER MODEL Grid (14 X 47 X 105) FIGURE 2	Jan 05 2004 Fluent 4.56 Fluent Inc.

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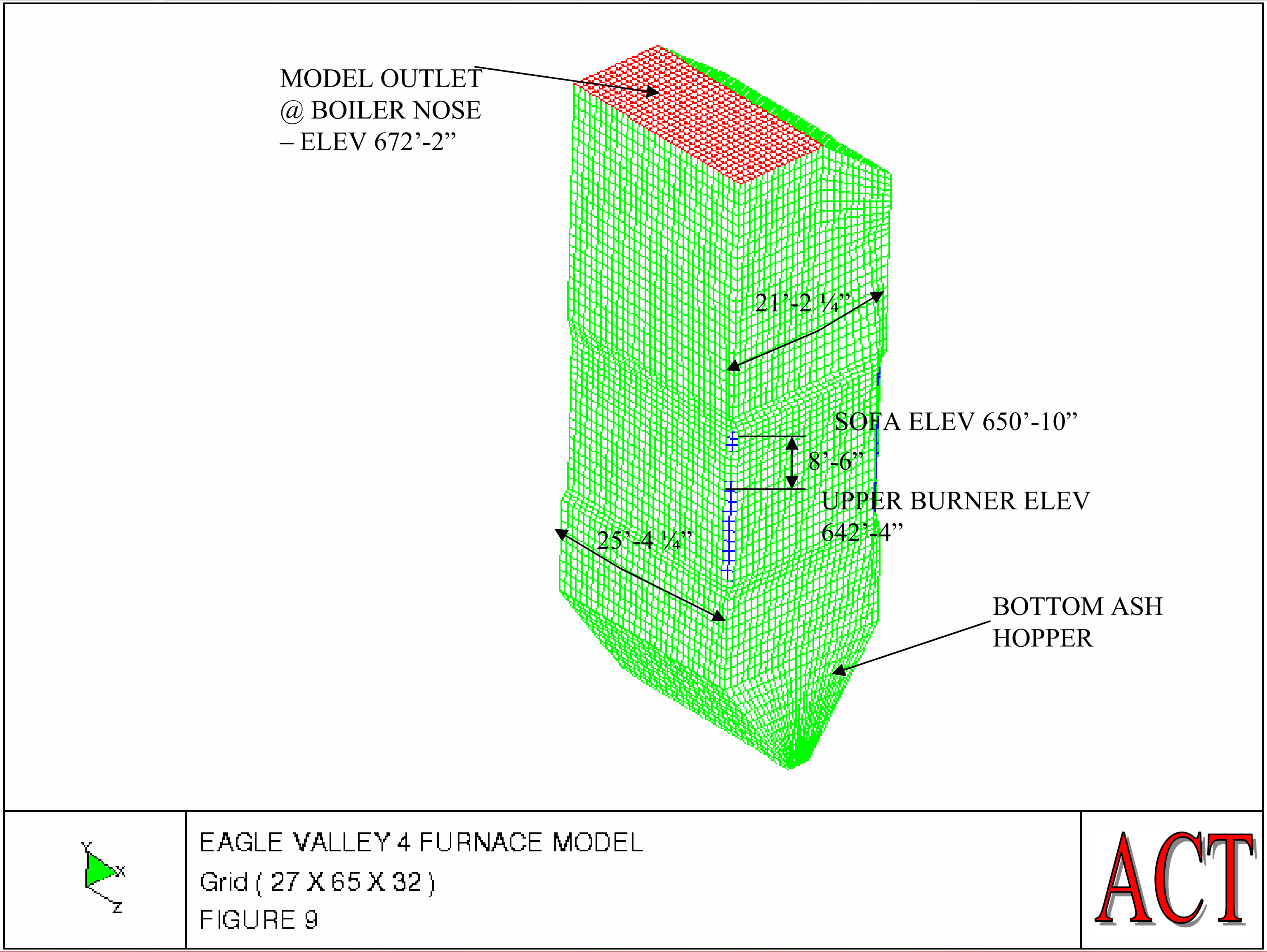
MODEL OUTLET
@ BOILER NOSE
– ELEV 672'-2"
21'-2 ¼"
SOFA ELEV 650'-10"
8'-6"
UPPER BURNER ELEV
642'-4"
25'-4 ¼"
BOTTOM ASH
HOPPER
Y
X
Z
EAGLE VALLEY 4 FURNACE MODEL
Grid (27 X 65 X 32)
FIGURE 9
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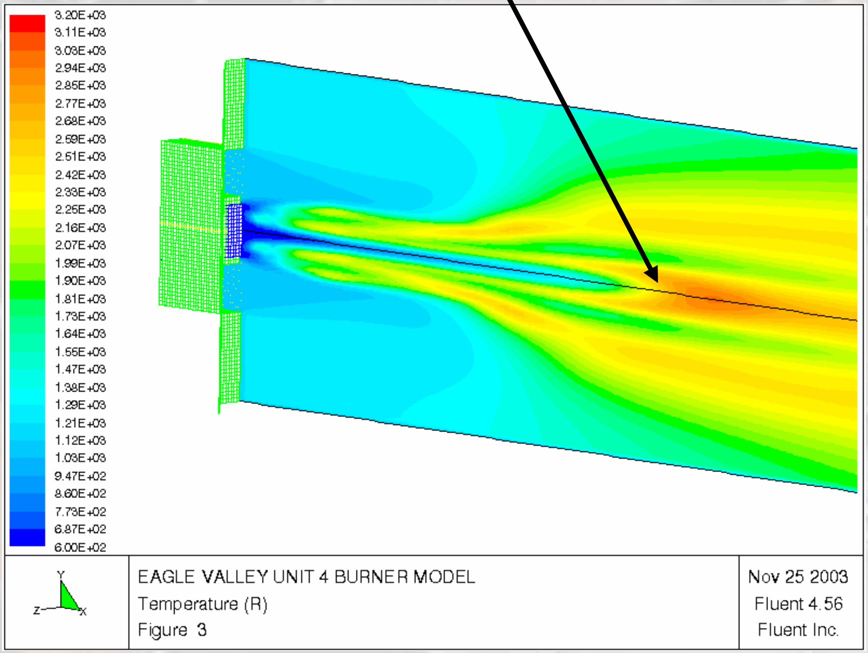
ACT

Temperature Contour

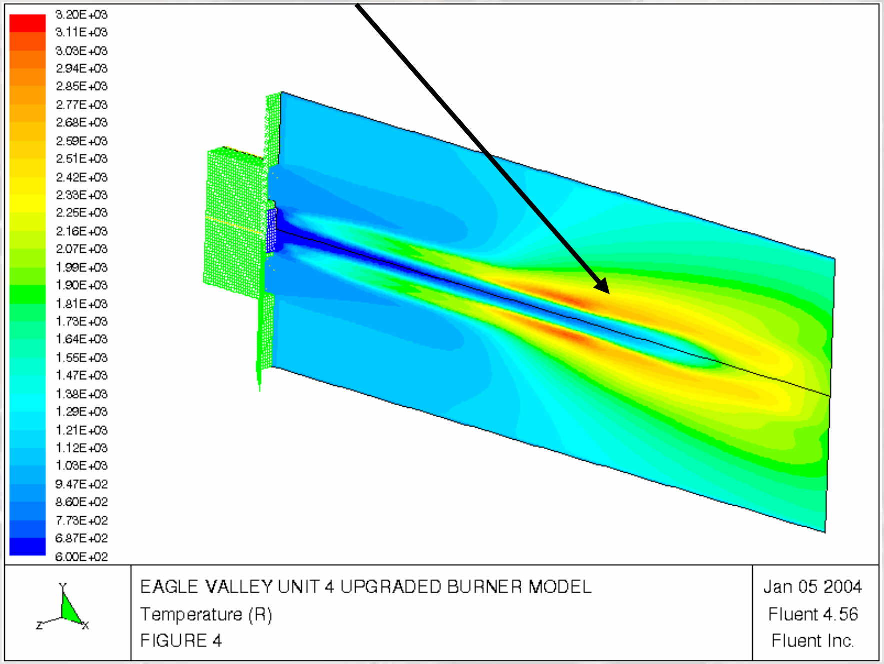
Baseline

PEAK TEMPERATURE ZONE



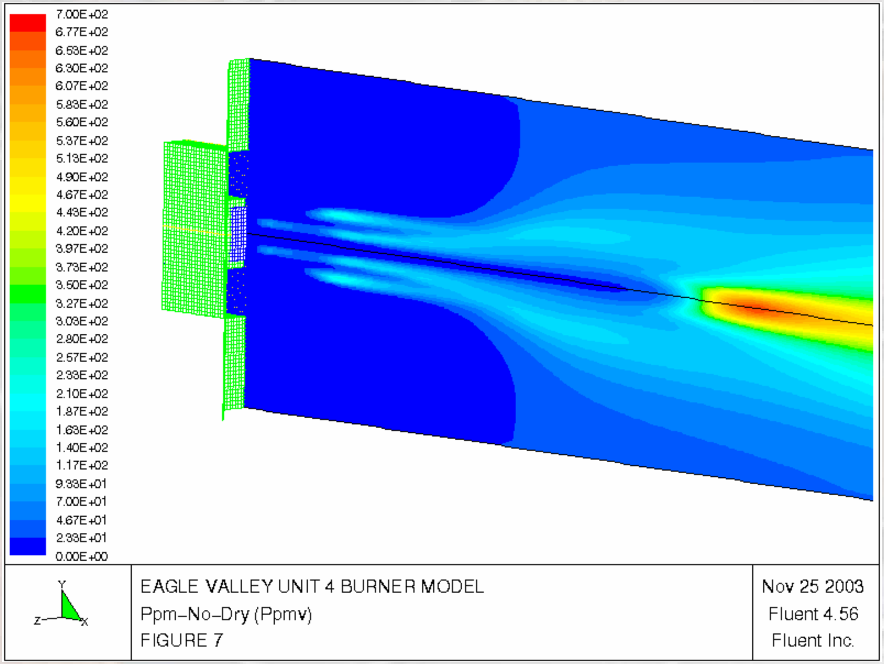
Upgraded

PEAK TEMPERATURE ZONE REDUCED

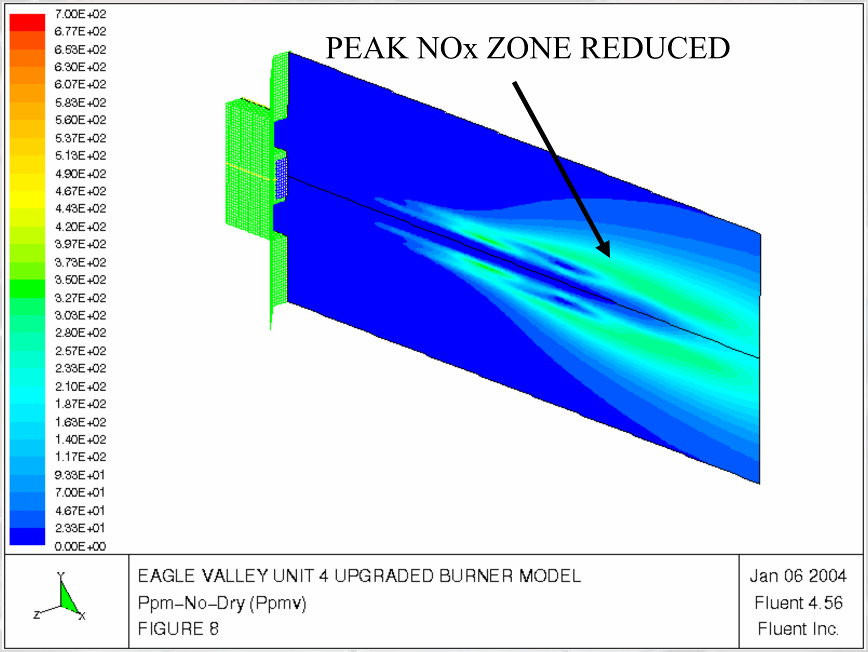


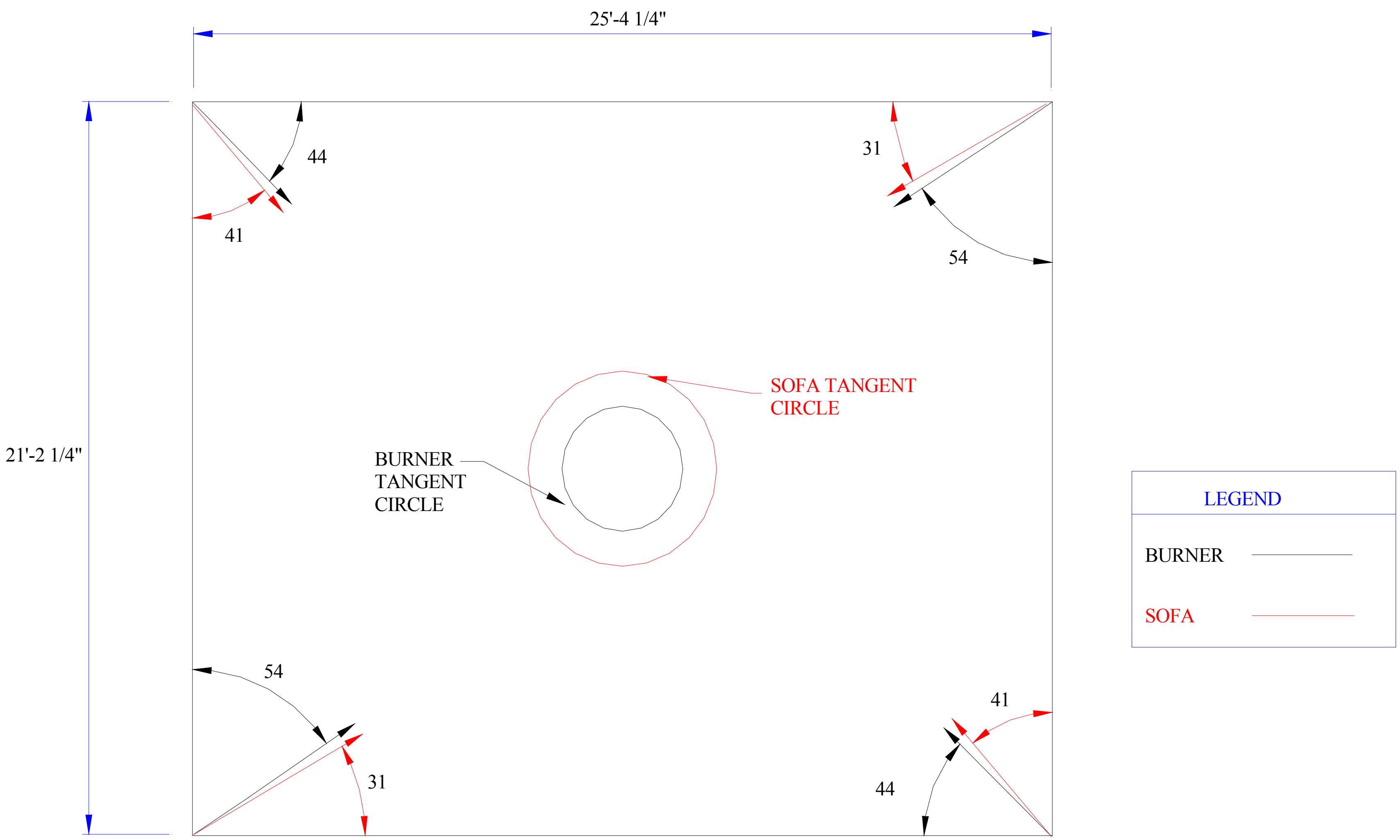
NOx Formation

Baseline Case



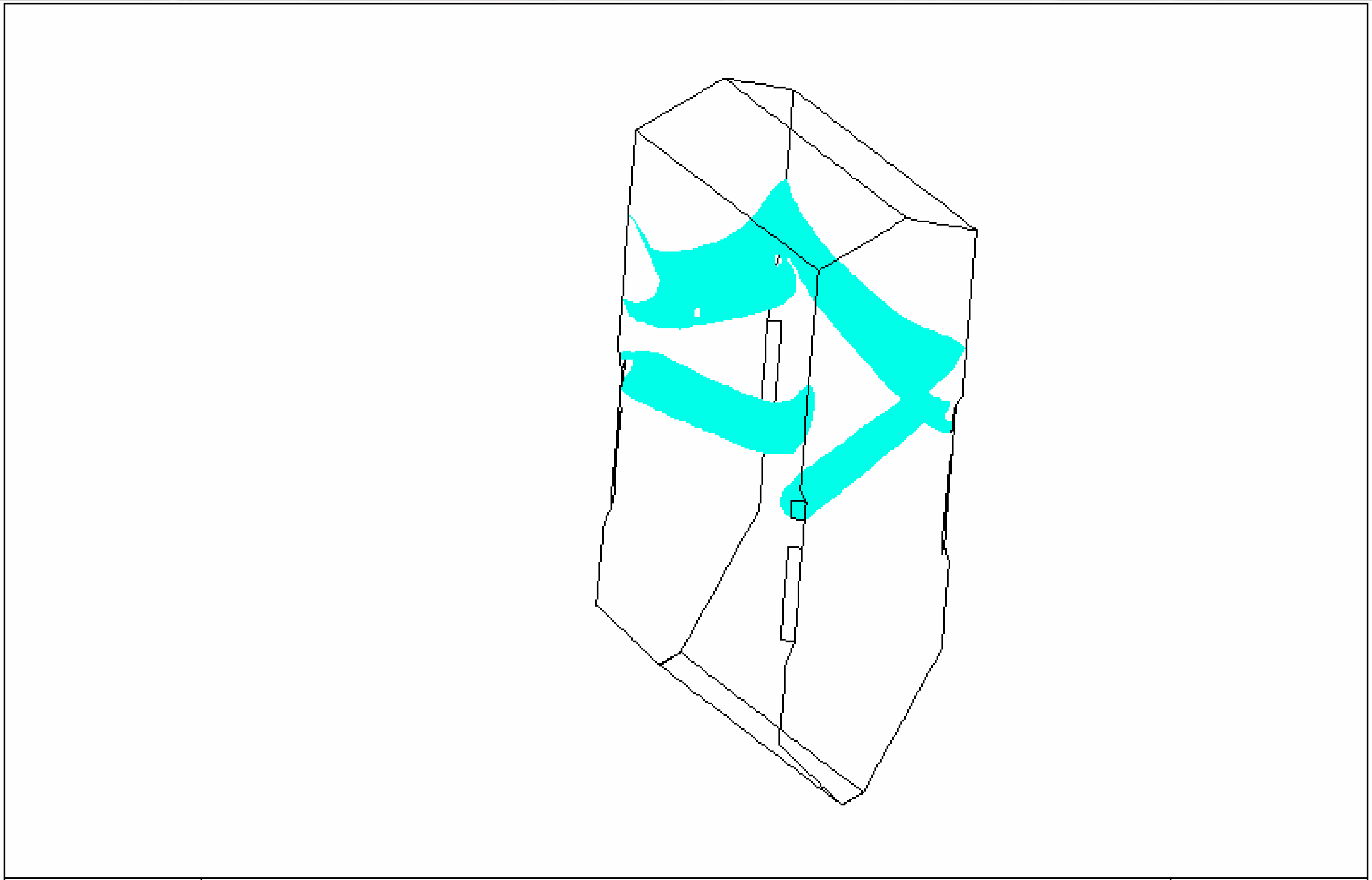
Upgrade Case





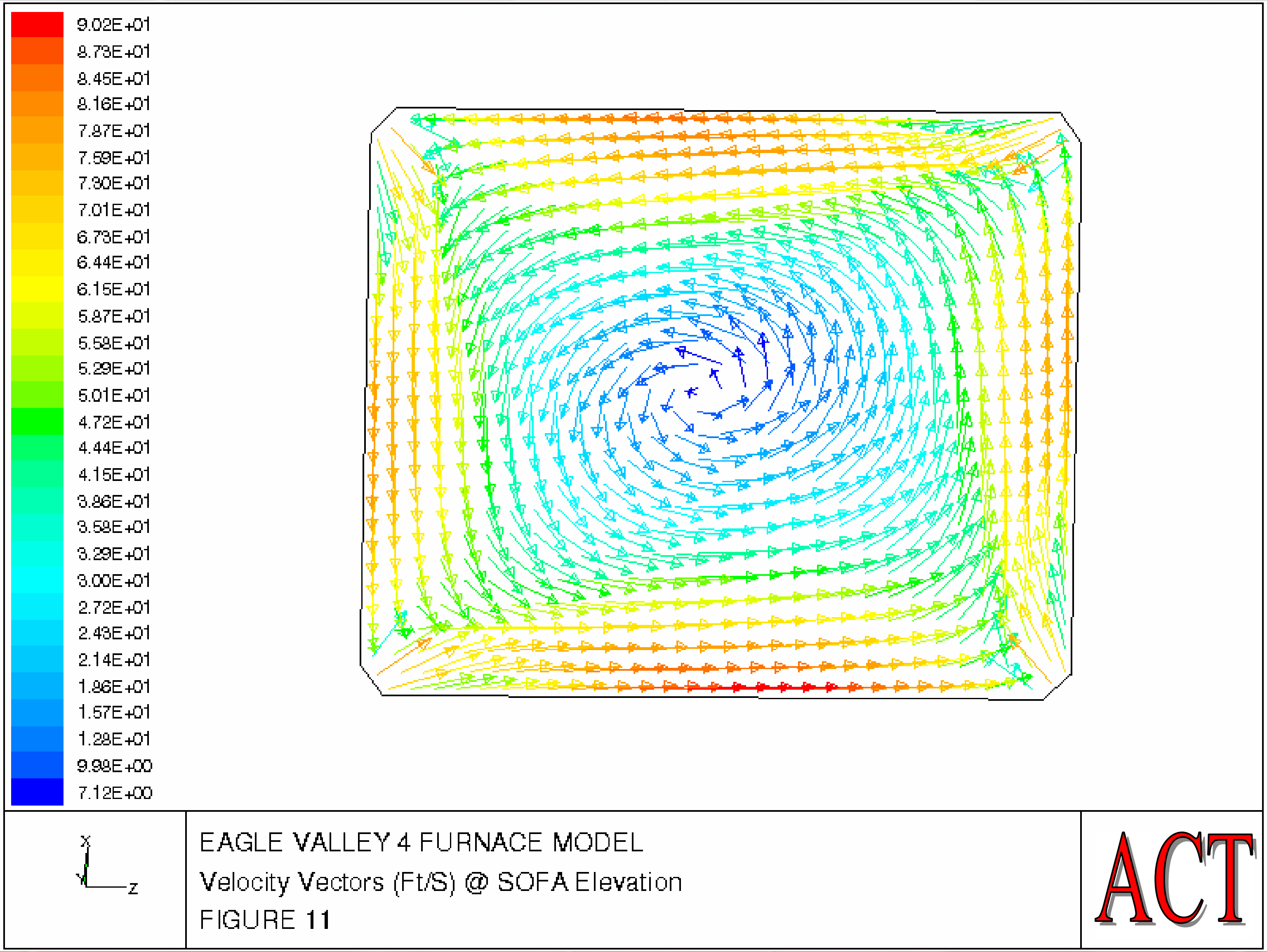
EAGLE VALLEY UNIT 4 FIRING CIRCLE

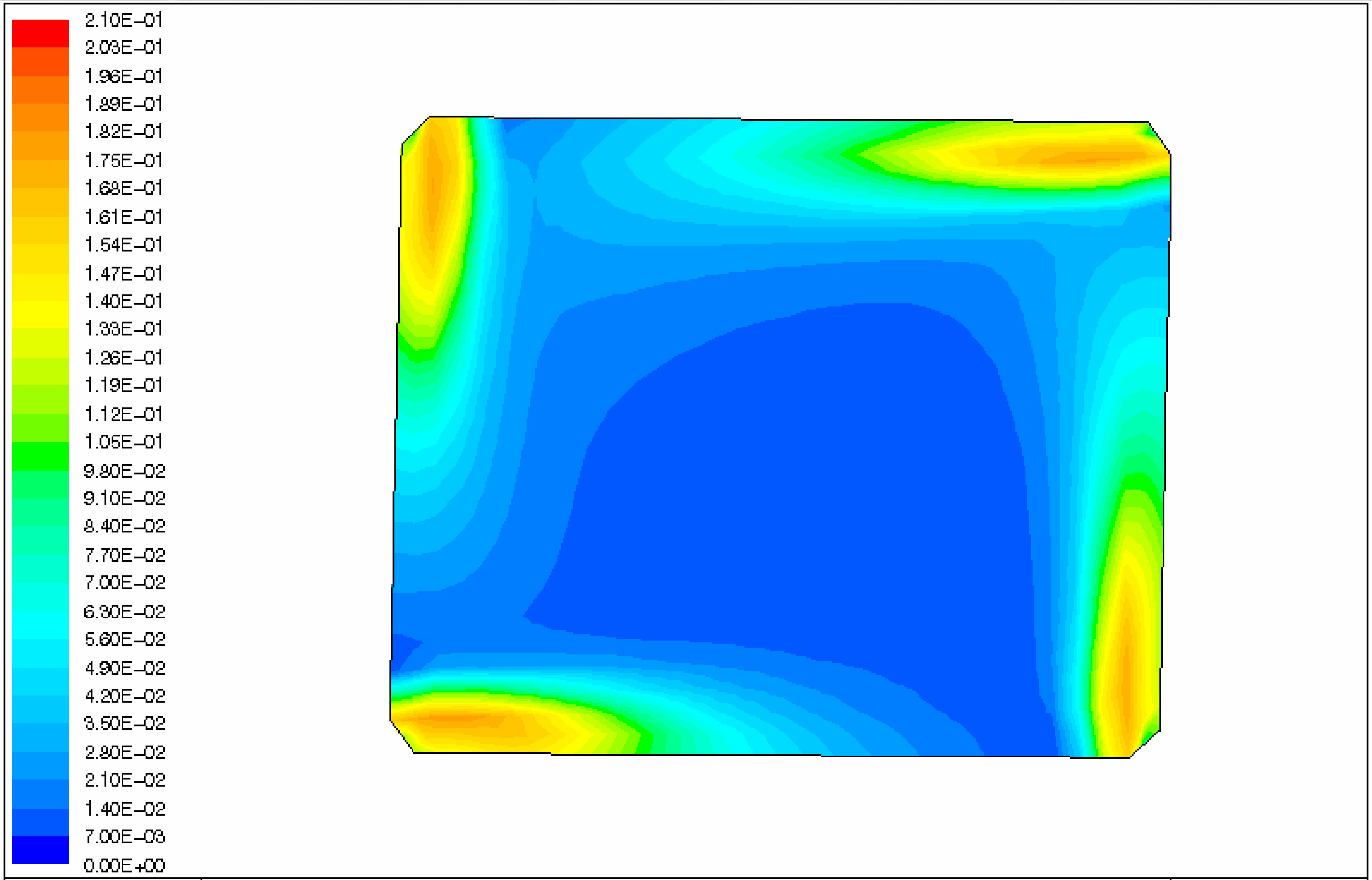
ACT



EAGLE VALLEY 4 FURNACE MODEL
Surface Of Constant 30% OFA Mole Fraction
FIGURE 10

ACT

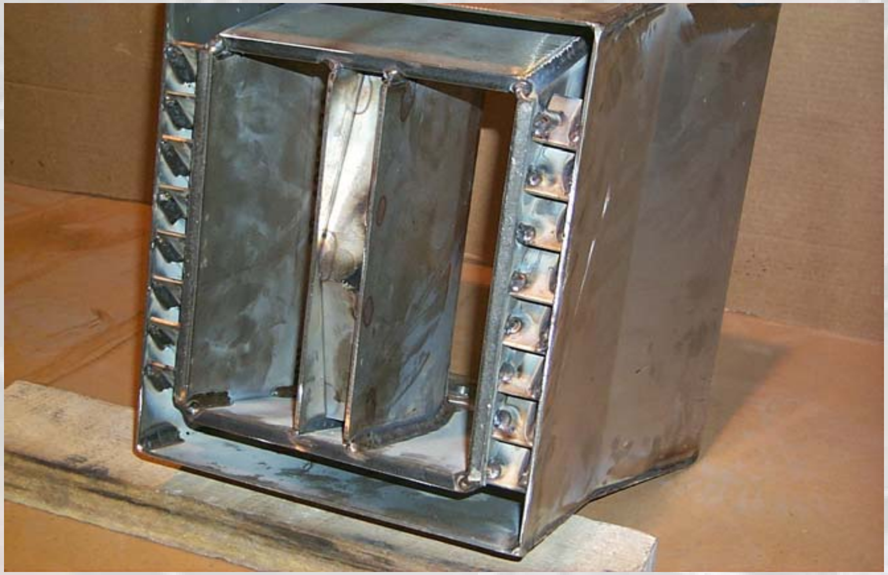

9.02E+01
8.73E+01
8.45E+01
8.16E+01
7.87E+01
7.59E+01
7.30E+01
7.01E+01
6.73E+01
6.44E+01
6.15E+01
5.87E+01
5.58E+01
5.29E+01
5.01E+01
4.72E+01
4.44E+01
4.15E+01
3.86E+01
3.58E+01
3.29E+01
3.00E+01
2.72E+01
2.43E+01
2.14E+01
1.86E+01
1.57E+01
1.28E+01
9.98E+00
7.12E+00
X
Y
Z
EAGLE VALLEY 4 FURNACE MODEL
Velocity Vectors (Ft/S) @ SOFA Elevation
FIGURE 11
ACT



EAGLE VALLEY 4 FURNACE MODEL
CONTOUR OF O2 MOLE FRACTION @ SOFA ELEVATION
FIGURE 12

ACT Low NOx T-Fired Fuel Bucket

Designed To Mate With Existing Coal Pipe And Sealing Arrangement



Coal Pipe

ACT Rope Breaker positioned inside existing coal pipe

ACT Coal Pipe Inserts positioned inside existing coal pipe

ACT Low NOx Burner Upgrade

ACT

Advanced Overfire Air

Advanced Overfire Air

OFA System Port Design

Advanced Overfire Air

OFA System Port Design

Advanced Overfire Air

OFA System Port Design

Typical NOx Reductions Coal Firing - Burner

- Wall Fired Boilers
  - 45% - 65%
- Opposed Fired Boilers
  - 40% - 55%
- Tangentially Fired Boilers
  - 45% - 60%

ACT

Low NOx Coal Burners
(Engineering and Design Summary)

- Baseline Testing
- CFD Modeling
- Hardware Design
- Hardware Manufacturing
- Hardware Installation
- Air And Coal Flow Testing
- Optimization

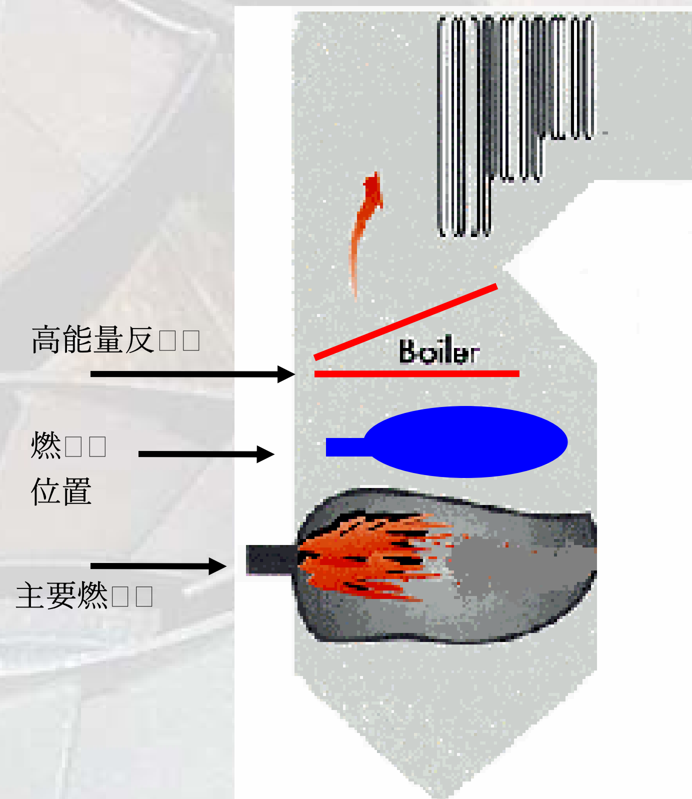
ACT

HIGH ENERGY REAGENT TECHNOLOGY (HERT)

第四□ 高能量反□□技□

HERT- ADVANCED SNCR

- Over Fire Air (OFA) is coupled with Urea or Ammonia injection to control nitrogen oxide emissions. Up to 65% NOx reductions achievable.
- OFA reduces NOx by staging combustion. Urea breaks down to NH_3 and reacts with NOx in the proper temperature window, 1600 F to 2100 F, to form H_2O and N_2. Multi-level injection scheme controls NH_3 slip below 5 ppm.
- Fewer injectors are required than a typical SNCR system.
- CFD modeling is used in conjunction with test data to design the OFA system and predict NOx reduction potential and NH_3 slip levels.



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HERT – Advanced SNCR

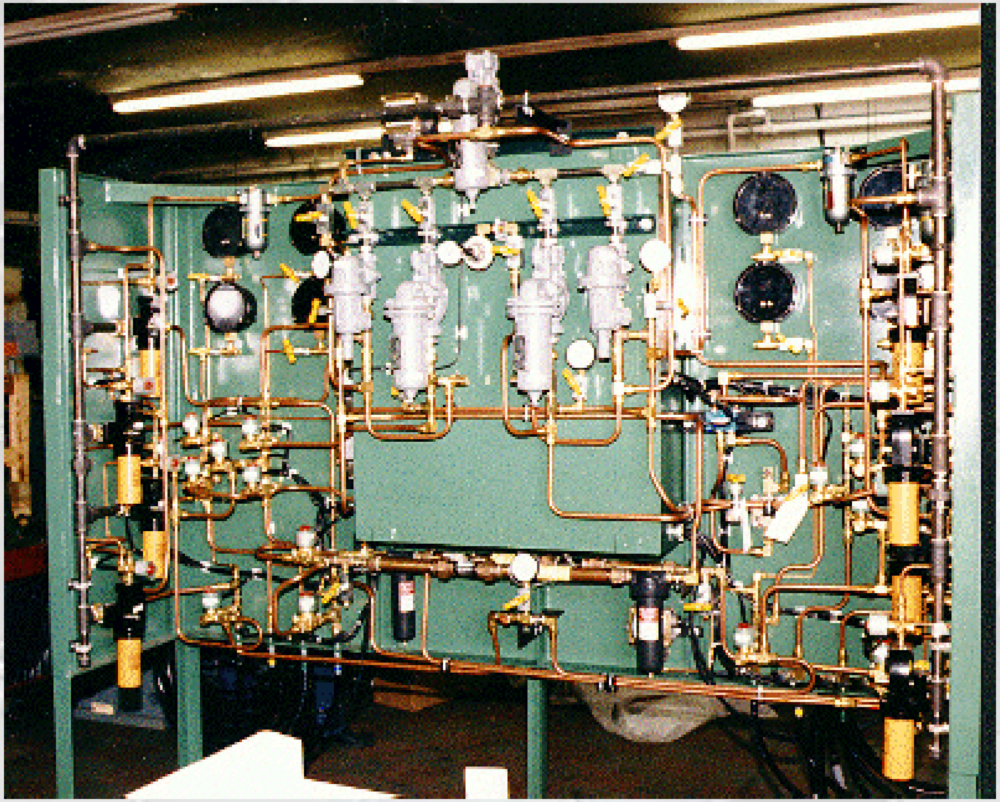
OFA Port & Wall Injector

Large wall injectors coupled with a high momentum OFA injection stage combustion and produce an optimum chemical agent coverage at the furnace outlet.

ACT

HERT – Advanced SNCR
Injection Skid

The skid mounted control system meters urea from storage tank to injectors throughout the load range. Optimum chemical usage with minimal ammonia slip is maintained.



EXPERIENCES AND CASES

EXPERIENCE SUMMARY

- Over 100 boilers (25 to 1100 MW) upgraded or replaced with new burners
- 45 coal fired boilers (36 coal fired boiler in the past four years)
- 24 OFA systems (17 OFA systems in the past four years)
- Over 1000 burners supplied
- Over 500 coal fired burners

Low NOx Upgrades & OFA Experience
Coal Fired Boilers (2001-2004)

Utility/Station Location	Boiler MFG	Firing	# of Burner	MW	Steam Flow Klb/hr	Baseline NOx lb/mmBtu	LNB NOx lb/mmBtu	OFA NOx lb/mmBtu
Project 1 Pekin, IL	CE	Front	6	30	300	0.8	0.32	---
Project 2 Austell, GA	B&W	Front	6	25	250	0.6	0.34	0.26
Project 3 Blue Asheville, NC	CE	Tang	12	40	400	0.7	0.48	0.28
Project 4 Tuscola, IL	CE	Front	4	20	200	0.90	0.40	0.30
Project 5 Hamilton, OH	CE	Tang	12	55	550	0.70	0.50	0.30
Project 6 Lansing, MI	B&W	Front	9	65	650	0.35	0.23	0.18
Project 7 Lansing, MI	B&W	Front	9	65	650	0.35	0.23	0.18
Project 8 Lansing, MI	CE	Tang	12	40	400	0.3	0.25	0.17
Project 9 Lansing, MI	B&W	Front	6	35	350	0.6	0.24	0.18
Project 10 Colorado Springs, CO	B&W	Front	12	150	1300	0.8	0.35	---
Project 11 Colorado Springs, CO	B&W	Front	9	90	750	0.8	0.35	---
Project 12 Colorado Springs, CO	B&W	Front	6	50	500	0.75	0.4	---
Project 13 Colorado Springs, CO	B&W	Opposed	21	300	2,100	0.65	0.25	---
Project 14 Litchfield, MI	B&W	Front	6	55	550	0.6	0.34	0.22

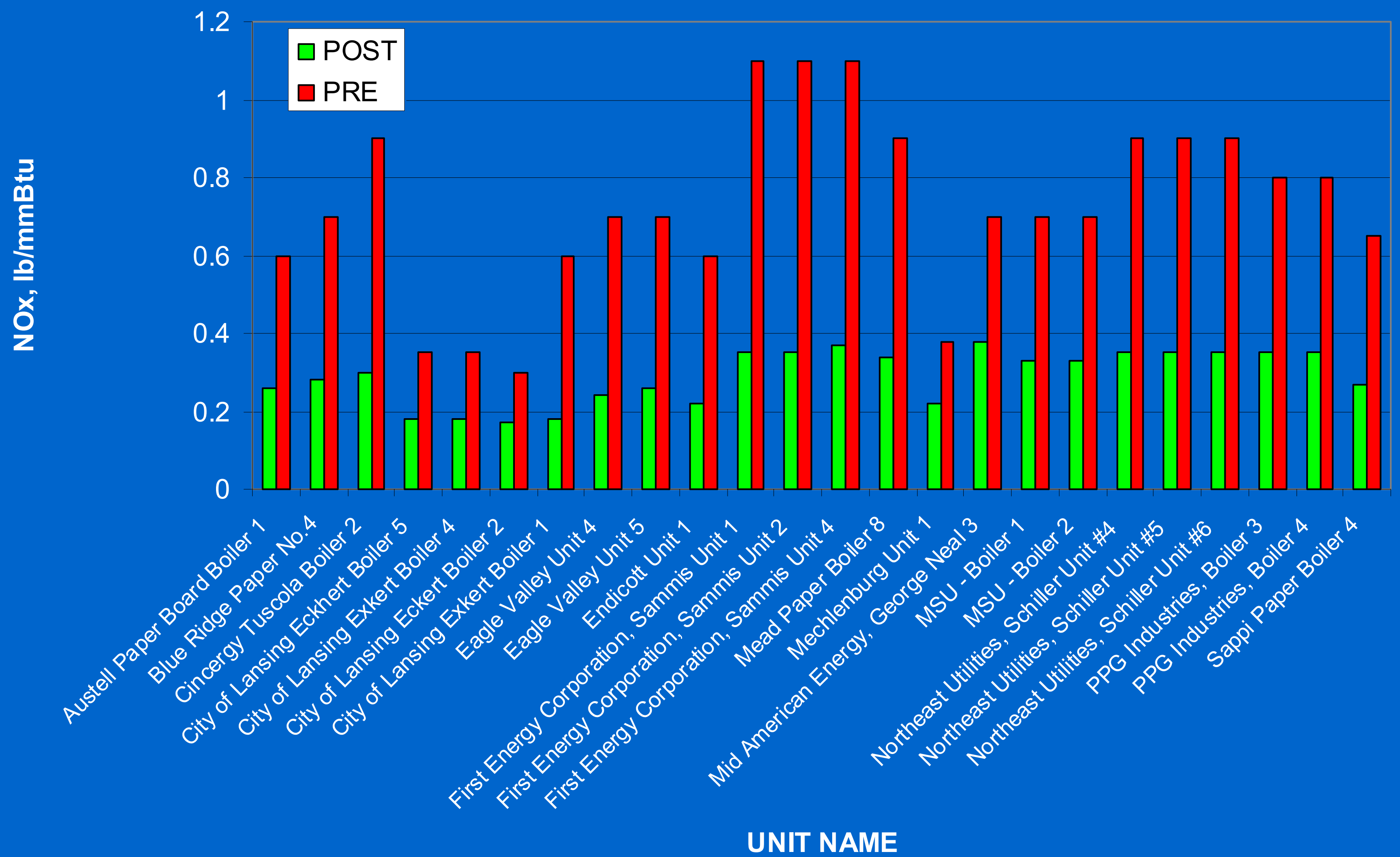
Low NOx Upgrades & OFA Experience
Coal Fired Boilers (2001-2004)

Utility/Station Location	Boiler MFG	Firing	# of Burner	MW	Steam Flow Klb/hr	Baseline NOx lb/mmBtu	LNB NOx lb/mmBtu	OFA NOx lb/mmBtu
Project 15 Stratton, OH	FW	Front	15	180	1,500	1.1	0.42	0.35
Project 16 Stratton, OH	FW	Front	15	180	1,500	1.1	0.42	0.37
Project 17 Martinsville, IN	CE	Tang	16	60	600	0.7	0.5	0.3
Project 18 Martinsville, IN	CE	Tang	16	60	600	0.7	0.5	0.3
Project 19 Chillicothe, OH	CE	Front	4	36	360	0.9	0.42	0.34
Project 20 Salix, IA	FW	Front	16	550	2,800	0.7	0.45	0.38
Project 21 Lansing, MI	Riley	Front	4	25	250	0.7	0.4	0.33
Project 22 Lansing, MI	Riley	Front	4	25	250	0.7	0.4	0.33
Project 23 Minneapolis, MN	B&W	Oppos ed	70	900	6,150	0.6	0.35	---
Project 24 Portsmouth, NH	FW	Front	6	40	400	0.90	0.42	0.35
Project 25 Portsmouth, NH	FW	Front	6	40	400	0.90	0.42	0.35
Project 26 Portsmouth, NH	FW	Front	6	40	400	0.90	0.42	0.35
Project 27 New Martinsville, WV	Riley	Front	6	20	200	0.80	0.42	0.35
Project 28 New Martinsville, WV	Riley	Front	6	35	350	0.80	0.45	0.35

Advanced Combustion Technology, Inc.
Low NOx Upgrades & OFA Experience
Coal Fired Boilers (2001-2004)

Utility/Station Location	Boiler MFG	Firing	# of Burner	MW	Steam Flow Klb/hr	Baseline NOx lb/mmBtu	LNB NOx lb/mmBtu	OFA NOx lb/mmBtu
Project 29 Muskegon, MI	CE	Tang	8	28	275	0.70	0.5	0.3
Project 30 Muskegon, MI	CE	Tang	12	35	350	0.50	0.4	0.28
Project 31 Syracuse, NY	B&W	Front	4	25	250	0.6	0.35	---
Project 32 Syracuse, NY	B&W	Front	4	25	250	0.6	0.35	---
Project 33 Syracuse, NY	B&W	Front	4	25	250	0.6	0.35	---
Project 34 Syracuse, NY	B&W	Front	4	25	250	0.6	0.35	---
Project 35 Syracuse, NY	B&W	Front	4	25	250	0.6	0.35	---
Project 36 Monticello, TX	B&W	Opposed	70	850	6500	0.29	0.19	0.16
Project 37 Toronto, Ontario	B&W	Front	24	300	2000	0.99	0.45	---
Project 38 Toronto, Ontario	B&W	Front	24	300	2000	0.99	0.45	---
Project 39 Toronto, Ontario	B&W	Front	18	300	2000	0.99	0.45	---
Project 40 Toronto, Ontario	B&W	Front	18	300	2000	0.99	0.45	---

ACT RECENT PROJECTS
PRE AND POST BURNER & OFA
NOx LEVELS



ACT

Case Example 1

Austell Coal Fired Boiler – Austell, GA

PROJECT SCOPE:

Engineer, model, supply and start-up burner upgrades and Overfire Air to reduce NOx emissions 53% to 0.26 lb/mmBtu.

DESCRIPTION AND PERFORMANCE:

•Secondary airflow was balanced utilizing ACT's combustion air testing technology. Burner upgrades included the addition of a Low NOx Swirler, Coal Nozzle, Coal Flow Distributor and Burner Barrel. Two (2) Over Fire Air ports (OFA), one (1) over each column of burners was added.

•NOx emissions were reduced to less than 0.36 lb/mmBtu at full load conditions with the burner upgrades and less than 0.26 lb/mmBtu with the OFA. Flyash Loss-On-Ignition, (LOI) decreased significantly from "Pre Upgrade" level of 37% to the "Post Upgrade" level of 15%.

ACT

Case Example 2

PLANT NAME: Michigan South Central Power Agency (MSCPA) – Boiler 1

APPLICATION: A 550,000 lb/hr Babcock & Wilcox Wall Fired Boiler required NOx reduction under the EPA Section 126 petition.

PROJECT SCOPE: Engineer, model, supply and start-up burner optimizations and modifications to reduce NOx emissions to 0.22 lb/mmBtu.

BOILER DATA

• Manufacturer	B&W
• Type	Natural Circulation Boiler
• Capacity	550,000lb/hr
• Steam Conditions	1,800 PSIG, 950 °F SH
• Fuels	Eastern Bituminous Coal
• Burners	8 B&W circular register
• Firing Arrangement	Front Fired 2 wide x 4 high
• Baseline NOx	0.65 lb/mmBtu
• Final NOx	0.22 lb/mmBtu

Case Example 2
Description And Performance

- MSCPA owns and operates a wall fired coal boiler. As part of Petition 126, they needed to reduce NOx to the lowest possible level. Baseline NOx was 0.65 lb/mmBtu with flyash LOI of 6%.

- The project was performed in two (2) stages. In the first stage ACT upgraded burners. NOx was reduced to less than 0.34 lb/mmBtu.

- ACT performed the OFA system addition in the second phase to reduce NOx to less than 0.22 lb/mmBtu. Flyash Loss-On-Ignition following the two (2) phases increased slightly to 8%.

- Burner upgrades included the addition of a Low NOx Swirler, Coal Nozzle, Coal Flow Distributor and Coal Barrel. The OFA system included, flow control dampers, ductwork, expansion joints, seal boxes and nozzles.

Case Example 3

PLANT NAME Monroe Unit 2 – Combustion Tuning - Post Burner Upgrade

APPLICATION 840 MWg boiler with 28 coal fired burners upgraded for enhanced NOx control.

PROJECT SCOPE Tune upgraded burners for optimum combustion and Low NOx performance

BOILER DATA

Manufacturer	Babcock & Wilcox
Type	UP Boiler
Capacity	5,900,000 lb/hr
Steam Conditions	3,500 psig and 1,000 F
Fuels	Coal Blend with Opportunity Fuels
Burners	28 Cell Burners
Baseline NOx	0.55 lb/mmBtu
Final NOx	0.35 lb/mmBtu
CO, ppm	<200 ppm
Opacity	14% - 16%
Upper NOx Ports - % Open (N-S)	100/100/50 50/100/100
Lower NOx Ports 5-4, 7-1, 1-1	100/100/40

DESCRIPTION AND PERFORMANCE

DTE's Monroe Unit 2 was upgraded with ACT low NOx burner components. Tuning was performed to optimize combustion and reduce NOx to the lowest possible level. A third party test crew to determine the emission performance conducted testing. An initial setup was performed for low NOx performance. CO emission was maintained below 200 ppm.

Table 1
Monroe Unit 2
Low NOx Test Run
(750 MWn, 60/40 Coal Blend)

Parameter	North Duct	South Duct	Unit Average
NOx, lb/mmBtu	.37	.31	.34
CO, ppm	129	124	127

Tuning was conducted to reduce CO to the lowest possible level and maintain acceptable NOx emissions. These results are illustrated in Table 2.

Table 2
Monroe Unit 2
Low CO Test Run
(700 MWn, 65/35 Coal Blend)

Parameter	North Duct	South Duct	Unit Average
NOx, lb/mmBtu	.37	.34	.355
CO, ppm	16	7	12

Case Example 4

CLIENT ***COLORADO***

PLANT NAME Unit 1

APPLICATION One (1) 2,000,000 lb/hr Babcock and Wilcox Coal Fired Boiler

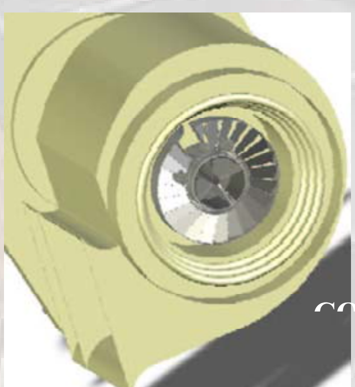
PROJECT SCOPE Engineer, model, supply and start-up ACT designed Low NOx burners to reduce NOx emissions from 0.40 lb/mmBtu to less than 0.26 lb/mmBtu

BOILER DATA

Manufacturer	Babcock & Wilcox
Type	Natural Circulation Boiler
Capacity	2,000,000 lb/hr
Steam Conditions	1800 PSIG, 950°F SH
Fuels	Western Sub Bit Coal
Burners	21 opposed fired circular register
Baseline NOx	0.40 lb/mmBtu
Final NOx	0.25 lb/mmBtu

DESCRIPTION AND PERFORMANCE

CSU owns and operates Nixon Boiler 1, in order to operate the Front Range combined cycle unit NOx needed to be reduced. The boiler was retrofitted several years earlier with Eagle Air burners. Following the retrofit NOx was 0.40 lb/mmBtu with high CO and severe slagging. To further reduce NOx, ACT's low NOx burners were selected as the most cost effective technology. Baseline testing determined the flyash LOI was 2% at the full load condition. The design was required to limit flyash to less than 2% with no impact on unit opacity.



Secondary airflow was balanced utilizing ACT's combustion air testing technology. The existing secondary air dampers were set to balance airflow to each burner to within +-5% of boiler mean.

NOx emissions were reduced to less than 0.25 lb/mmBtu at full load conditions. Flyash LOI was less than 2.0% and Opacity was not impacted

ACT

HERT (ADVANCED SNCR) EXPERIENCE

Utility/Station Location	Boiler MFG	Firing	# of Burner	MW	Steam Flow Klb/hr	Baseline NOx lb/mmBtu	LNB NOx lb/mmBtu	OFA NOx lb/mmBtu	HERT NOx lb/mmBtu	Total NOx Reduction (%)
Project 1 Asheville, NC	CE	Tang	12	40	400	0.7	0.48	0.28	0.12	83%
Project 2 Litchfield, MI	B&W	Front	6	55	550	0.6	0.34	0.22	0.15	75%
Project 3 Stratton, OH	FW	Front	15	180	1,500	1.1	0.42	0.35	0.21	81%
Project 4 Stratton, OH	FW	Front	15	180	1,500	1.1	0.42	0.35	0.25	77%
Project 5 Stratton, OH	FW	Front	15	180	1,500	1.1	0.42	0.37	0.22	80%
Project 6 Portsmouth, NH	FW	Front	6	40	400	0.90	0.42	0.35	0.25	72%
Project 7 West Pittsburg, PA	B&W	Front	16	135	1,350	0.83	0.45	0.38	0.26	69%

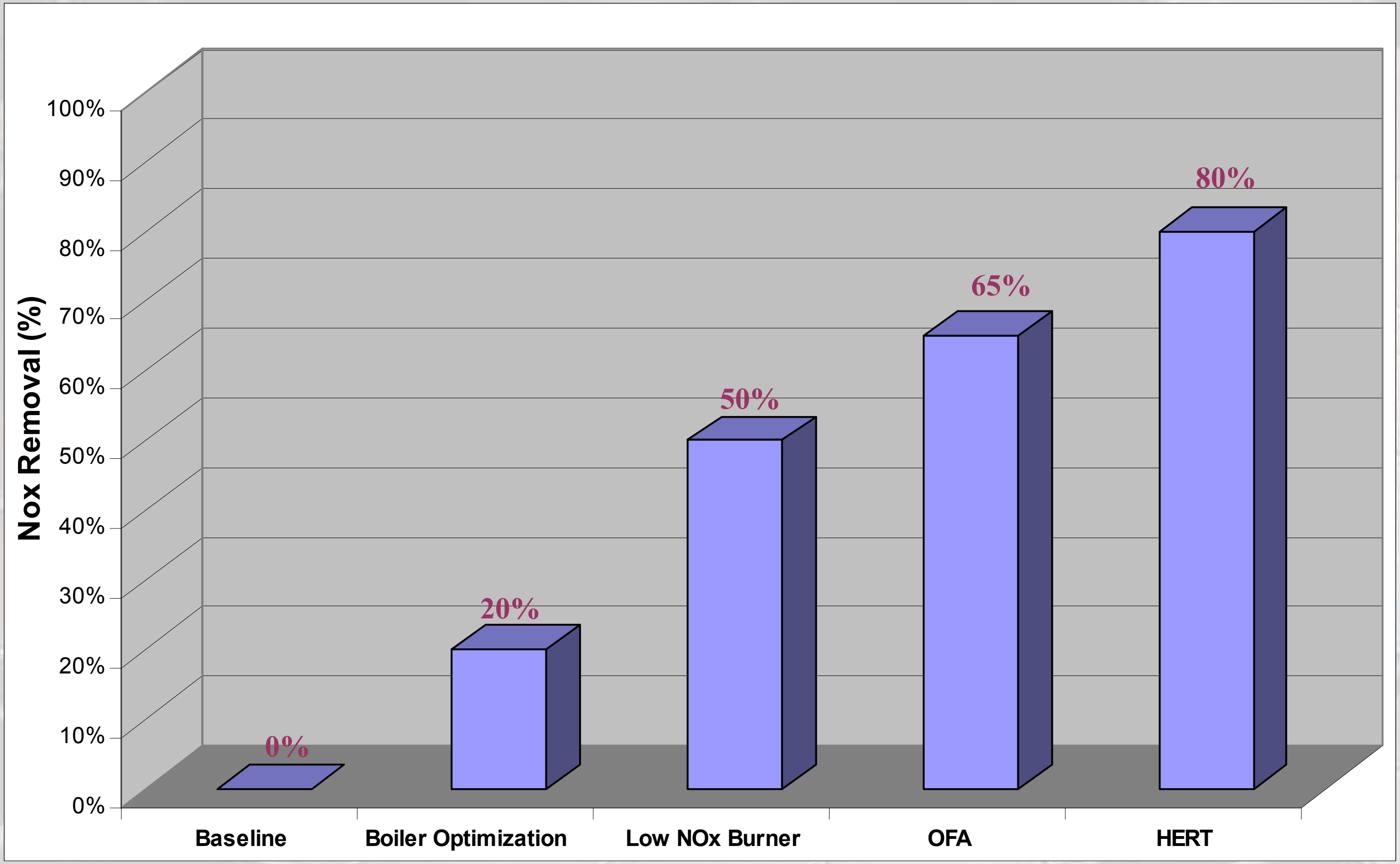
ACT

ACT LAYERED APPROCH SUMMARY

Layer	Technologies	NOx Reduction (%)
Layer 1	Combustion Optimization	10-20%
Layer 2	Low NOx Burner	45%-60%
Layer 3	Over Fire Air (OFA)	25-40%
Layer 4	HERT (Advanced SNCR)	35-50%
Layer 2+3	Low NOx Burner + OFA	55-65%
Layer 3+4	OFA + HERT	65%
Layer 2+3+4	Low NOx Burner + OFA + HERT	80%

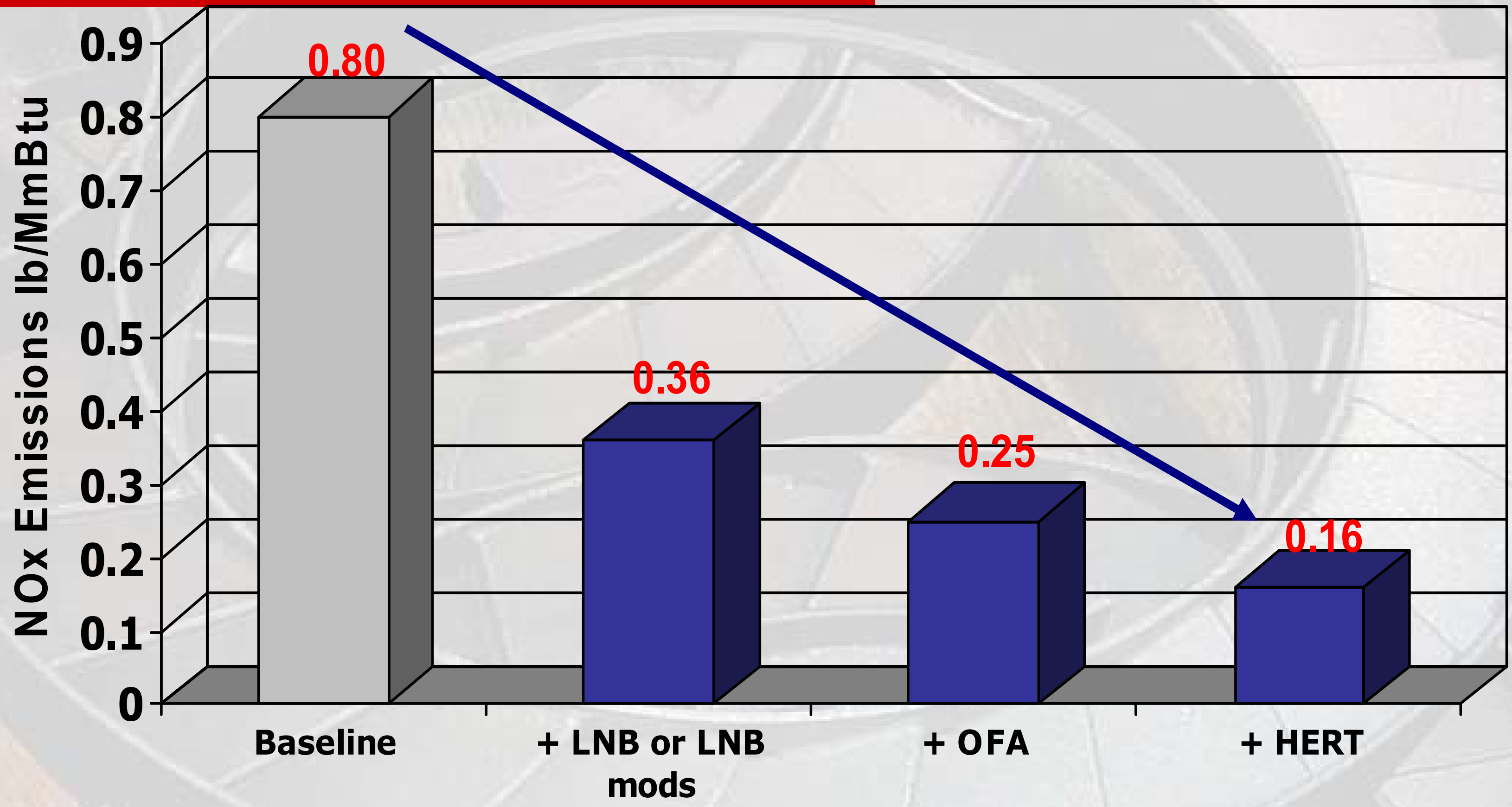
ACT Layered NOx Reduction Approach

80%+NOx reduction at the lowest cost/ton (以最低价位□到80%以上□□率)



ACT

ACT's Layered NOx Reduction Process



ACT

WHAT ARE YOU LOOKING FOR?

		NOx Reduction	Cost (□用)
ACT NOx 分□控制系□	Boiler Optimization? Modified Burners? New Low NOx Burners? Overfire Air? HERT (Advanced–SNCR)?	80%＋	Low（低）
	Traditional SNCR?	35%	High（高）
	SCR?	90%	Extremely High（很高）

ANSWER：
ACT Best Value NOx Reduction

ACT

HERE IS YOUR SOLUTION

- Custom Fit
- Minimize Operational Impact （Shorter Plant Outages）
- Lowest Urea Consumption
- No Catalyst Required
- Select Only the Performance You Need （Flexibility)
- Lower Capital Cost
- Lowest O&M Cost

The ACT Layered NOx Reduction Process
80%+NOx reduction at the lowest cost/ton
(以最低价位□到80%以上□□率)

THANK YOU