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Use of Numerical Modeling in Air System Design and Analysis

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Advanced Combustion Engineering Research Center
February 27-28, 2007, Provo, Utah

Modeling Boilers and Related Equipment

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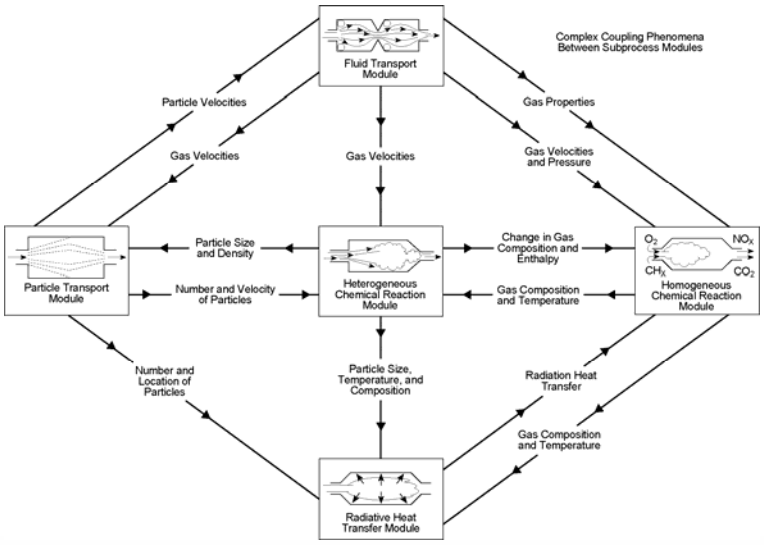
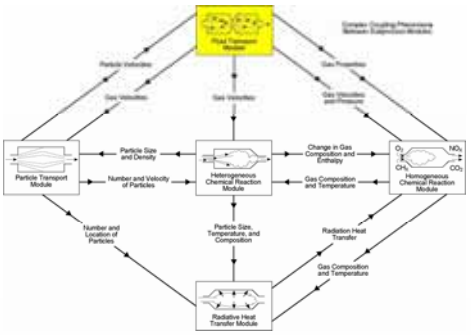
Coal Combustion Modeling



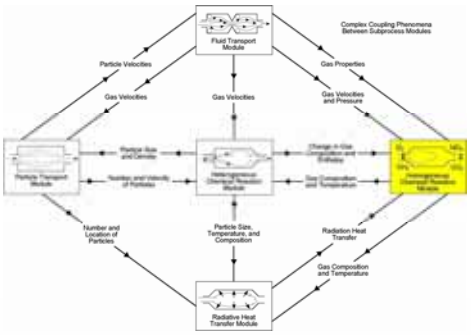
Fluid Transport

- *Time Averaged Transport Equations*
- *Steady State*
- *k-ε Turbulence Model*
- *Energy Transport*
- *Species Transport*



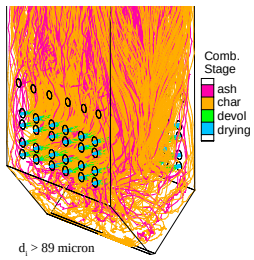
Homogeneous Combustion

- *EDM and EDC Combustion models*
- *Chemical Kinetics*
- *Turbulent Interactions*
- *Multiply Species and Steps*

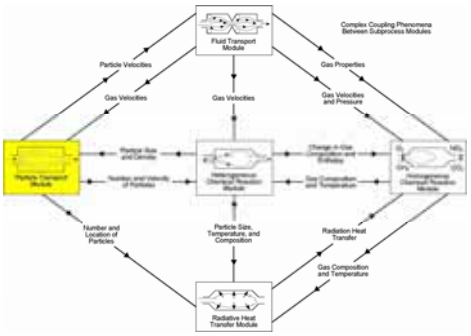


Particle Transport

- *Flow, Heat Transfer and Combustion*
- *Lagrangian-Turbulent Particle Dispersion*
- *Eulerian-Advection with Turbulent diffusion*
- *Hybrid (Lag. and Eul.)*



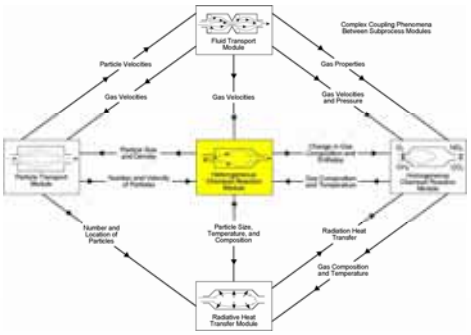
d_i > 89 micron



Heterogeneous Combustion

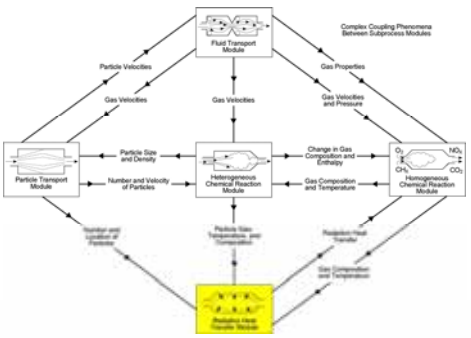
- *Drying*
- *Devolatilization*
- *Char Oxidation*
- *Inorganic Transformations*
- *Surface Reactions*

Combustion Stage	Coal	Oil	Wood	Black Liquor
Drying / Evap	X	X	X	X
Devolatilization	X		X	X
Char Burning	X	X	X	X
Inorganic Transformations				X



Radiative Heat Transfer

- *Gray or Spectral Radiation*
- *Absorption and Scattering*
- *Thermal and Radiative Properties*
  - Gases
  - Particles
  - Deposits



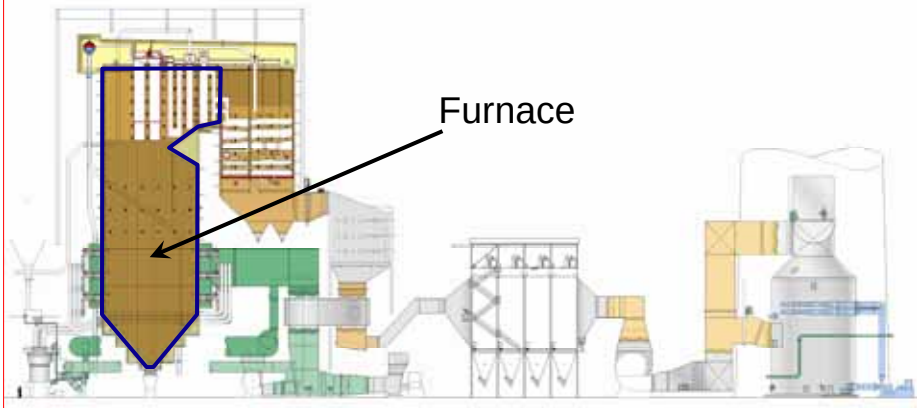
Background and Objective

- *775 MW Coal Fired Boiler*
- *Reduce NOx Emissions*
- *New Low-NOx Burners*
- *New Over-Fire Air System*

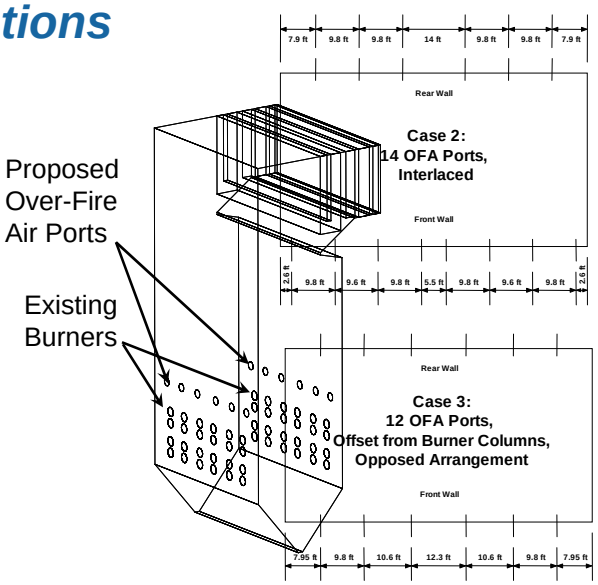
Determine Best Over-Fire Air Design Option

- *CO emissions*
- *Flow Uniformity*

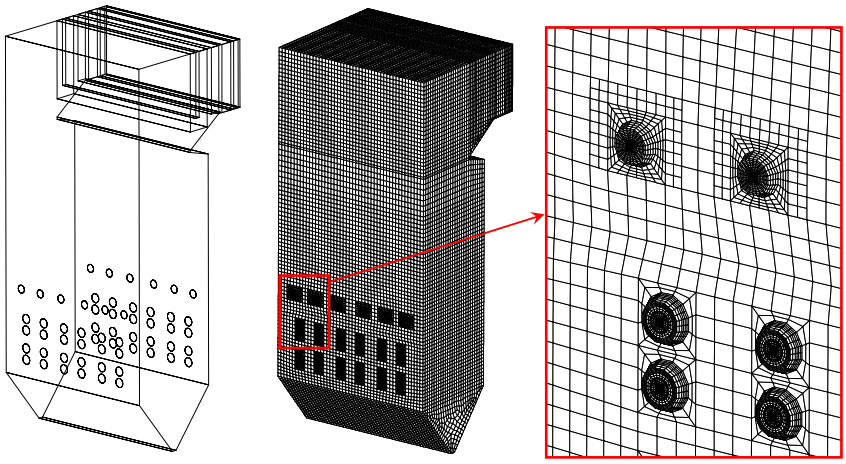
Over-Fire Air System Design



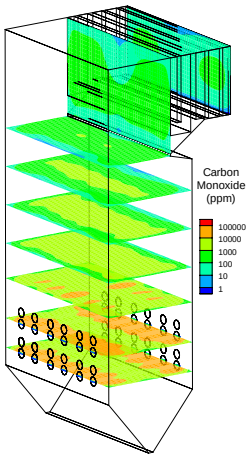
Design Options



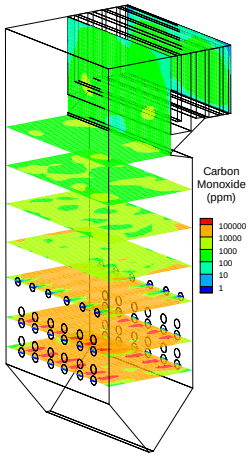
Furnace Mesh



Study Results

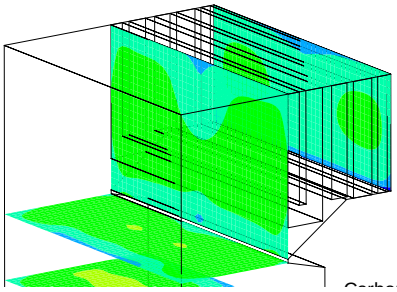


Before

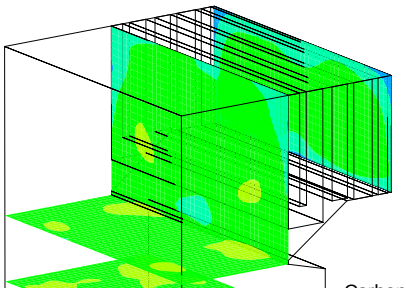


After

Study Results



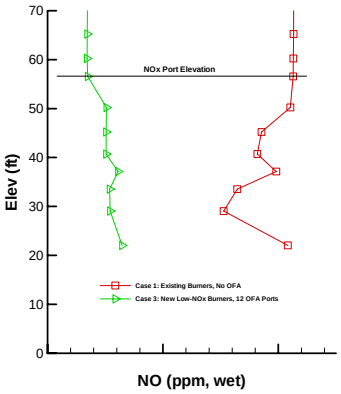
Before

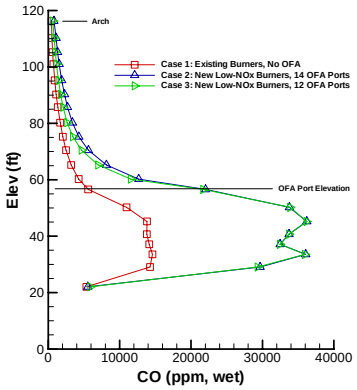


After

Case No.	*CO* (ppm dry @ 3% O2)
1	*179*
2	*417*
3	*380*

Study Results





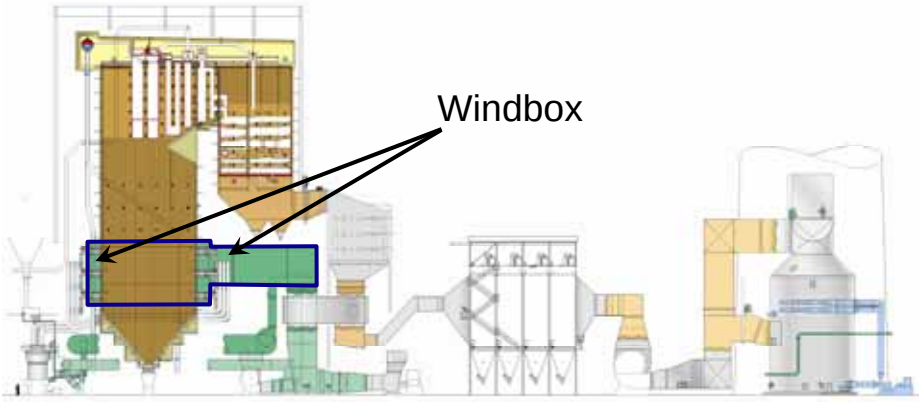
Study Background and Objective

- *1100 MW Coal Fired Boiler*
- *80 (40/wall) Individual Burners*
- *Improve Burner Performance/Balance*

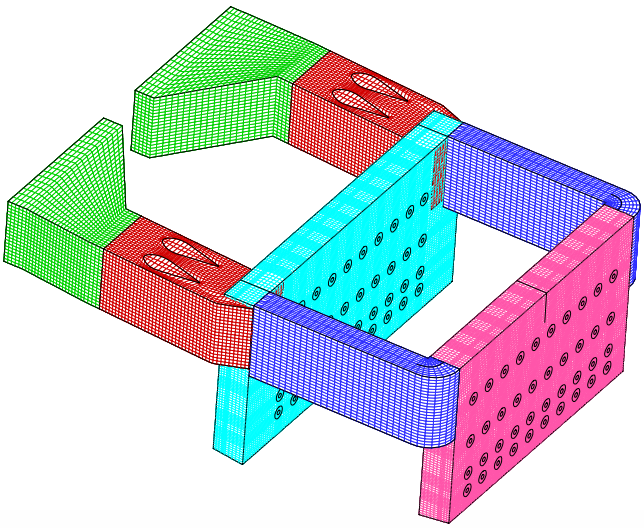
Optimize Windbox Design

- *Burner-to-Burner Air Imbalance*
- *Wall-to-Wall Imbalance*
- *Cost*

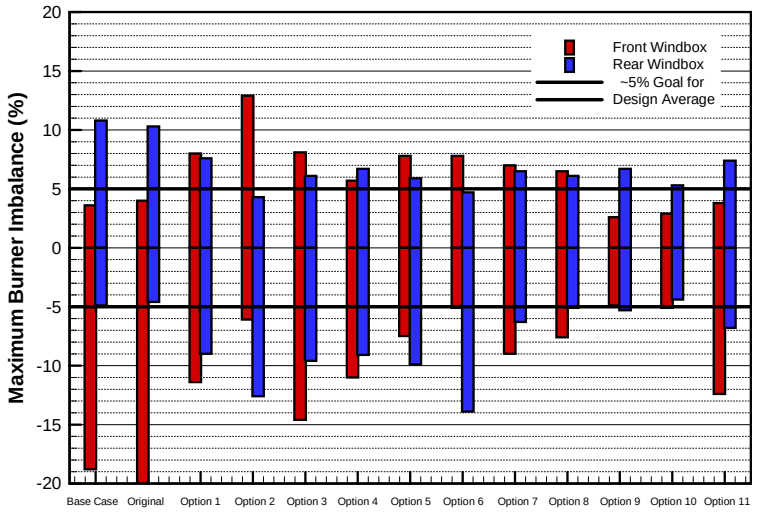
Windbox Optimization



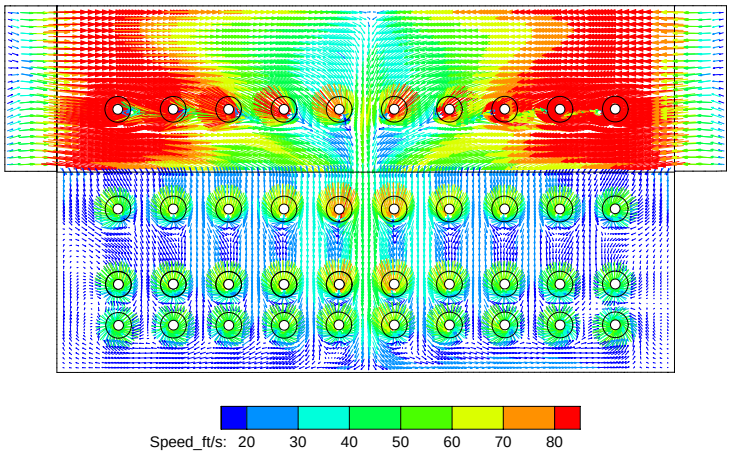
Windbox Mesh



Results



Original Configuration



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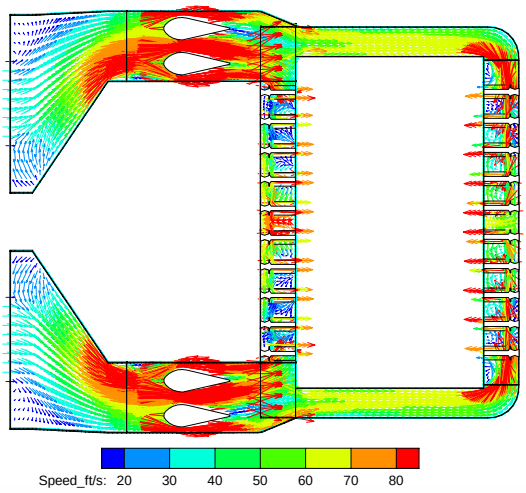
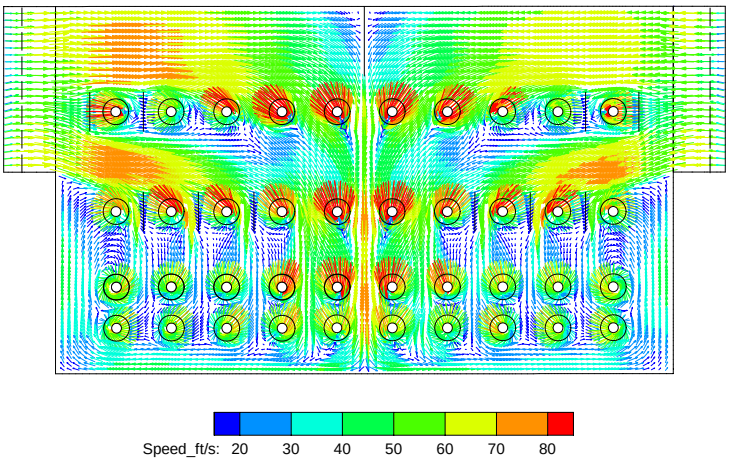
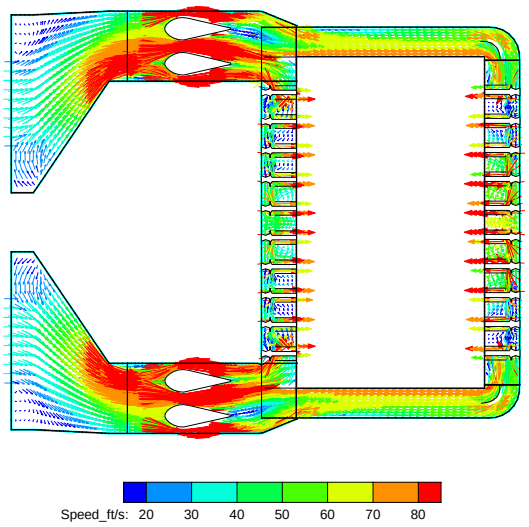


Optimum Configuration



Optimum Configuration



Summary

- ***Boiler Combustion Model of Over-Fire Air System***
  - **Design Evaluation**
  - **Mixing**
  - **NOx Emission Reduction**
- ***Windbox Flow Model***
  - **Design Optimization**
  - **Flow Imbalances**

Questions