Worldwide Pollution Control Association

WPCA/TVA

Coal & Gas Seminar

August 24, 2016

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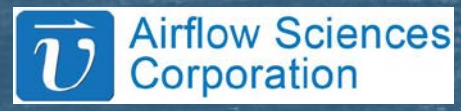
Gas Turbines SCR, and Ammonia Injection Systems

WPCA Seminar
August 24, 2016



Agenda

- Introduction
- Gas Turbine Design Objectives
  - Flow
  - Temperature
  - Ammonia
  - Pressure Drop
- Gas Turbine Troubleshooting / Optimization
  - AIG Tuning
  - Velocity Testing
  - Maintenance
- Conclusions

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Introduction

- Gas turbines come in many sizes and flavors
  - Simple cycle
  - Combined cycle / HRSG
  - With / without CO catalyst
  - With / without tempering air
  - Footprint
  - Site arrangement
- Performance is a combination of competing goals
  - Power / steam output
  - Emissions
  - Pressure drop
  - Ammonia consumption
  - O&M costs

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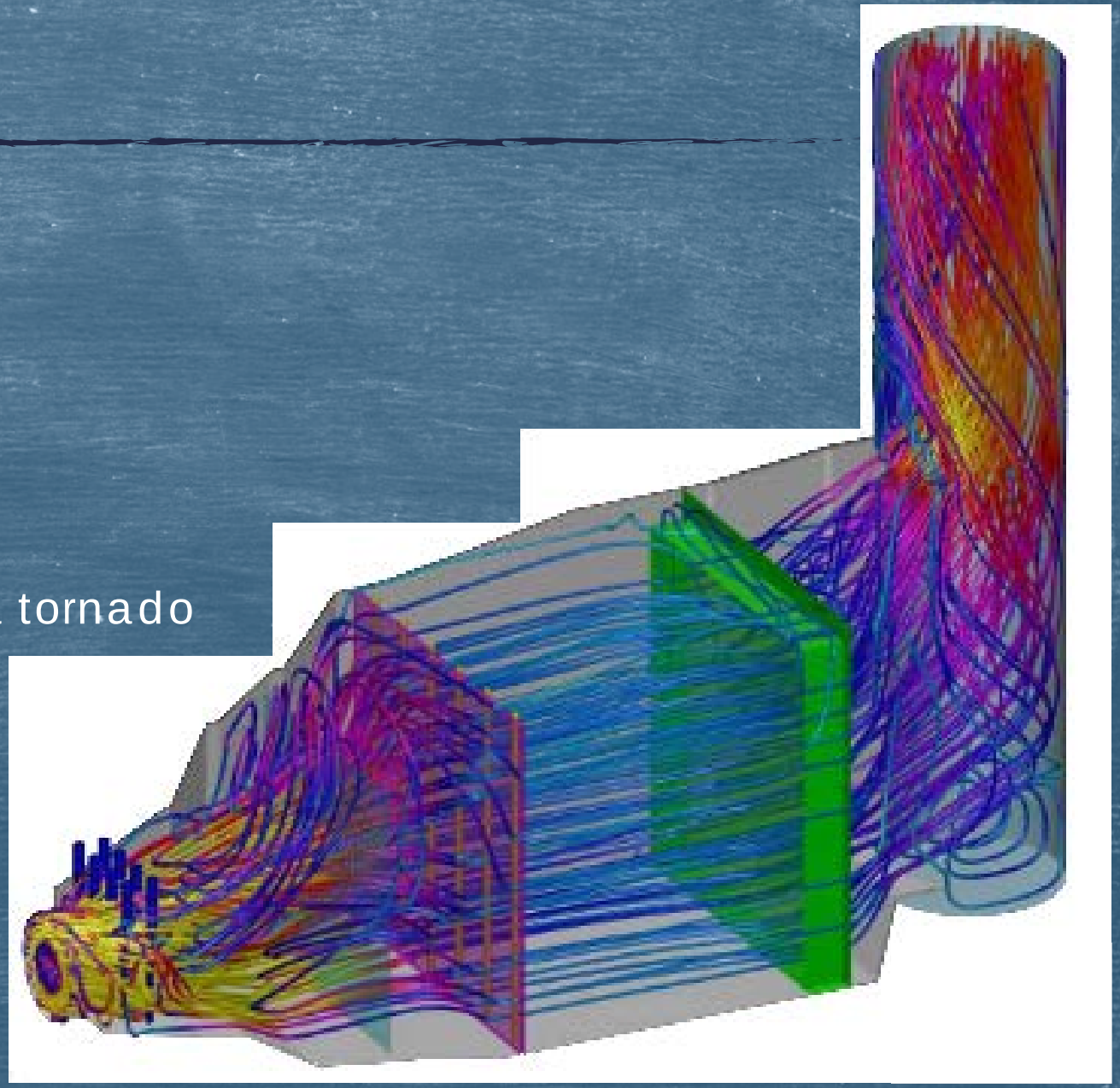
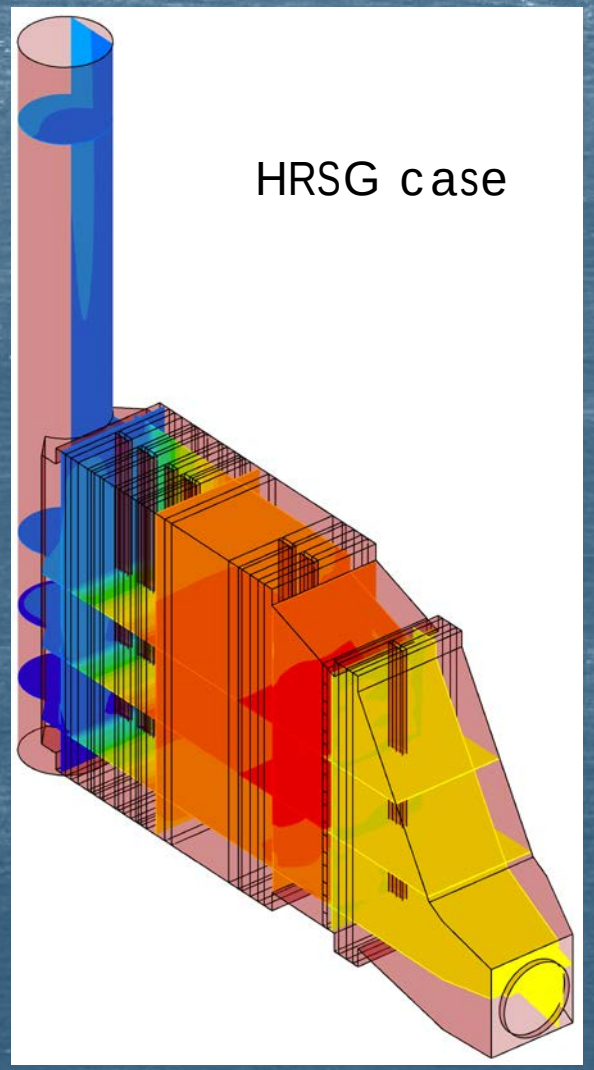
Design Objectives

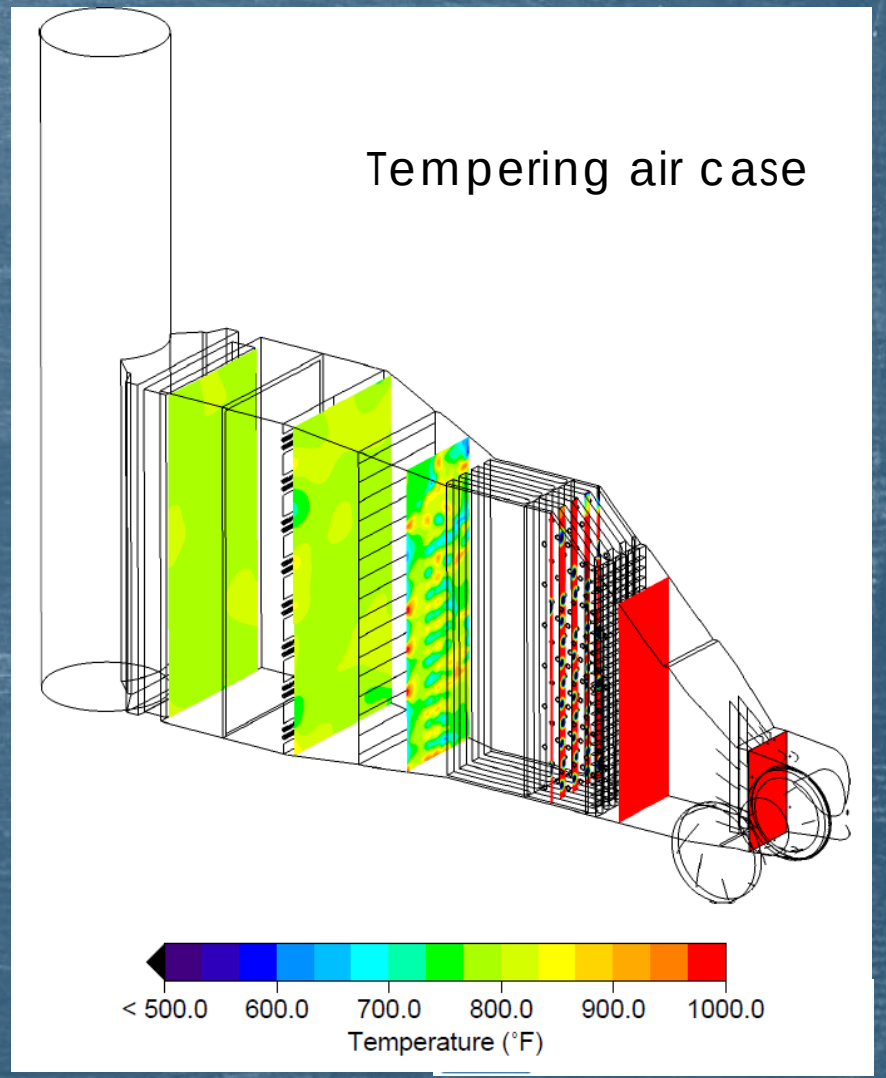
- Flow
  - Uniform velocity profile (15% RMS) at
    - CO catalyst
    - AIG
    - SCR catalyst
    - Tube banks
    - Stack CEMs
  - Not easy given the inlet condition is a tornado
  - Requires intricate design of devices
    - Baffles
    - Straighteners
    - Perforated plates



Design Objectives

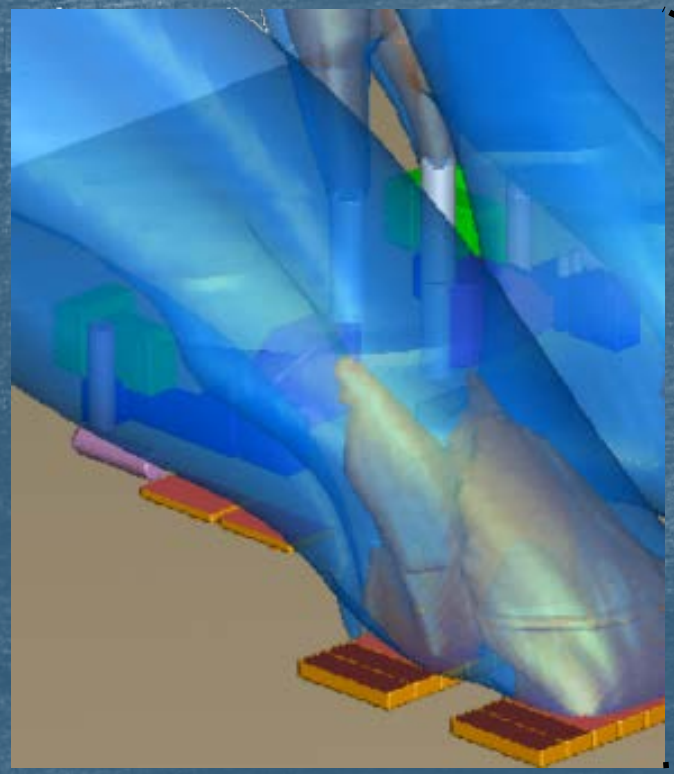
- Gas Temperature
  - Heat transfer to tube banks / HRSG important
  - Uniformity at catalyst (CO, NOx) affects performance
    - Typical goal +/-50 F
    - Can be challenging if significant amount of tempering air
    - Temperature is not necessarily uniform exiting the turbine

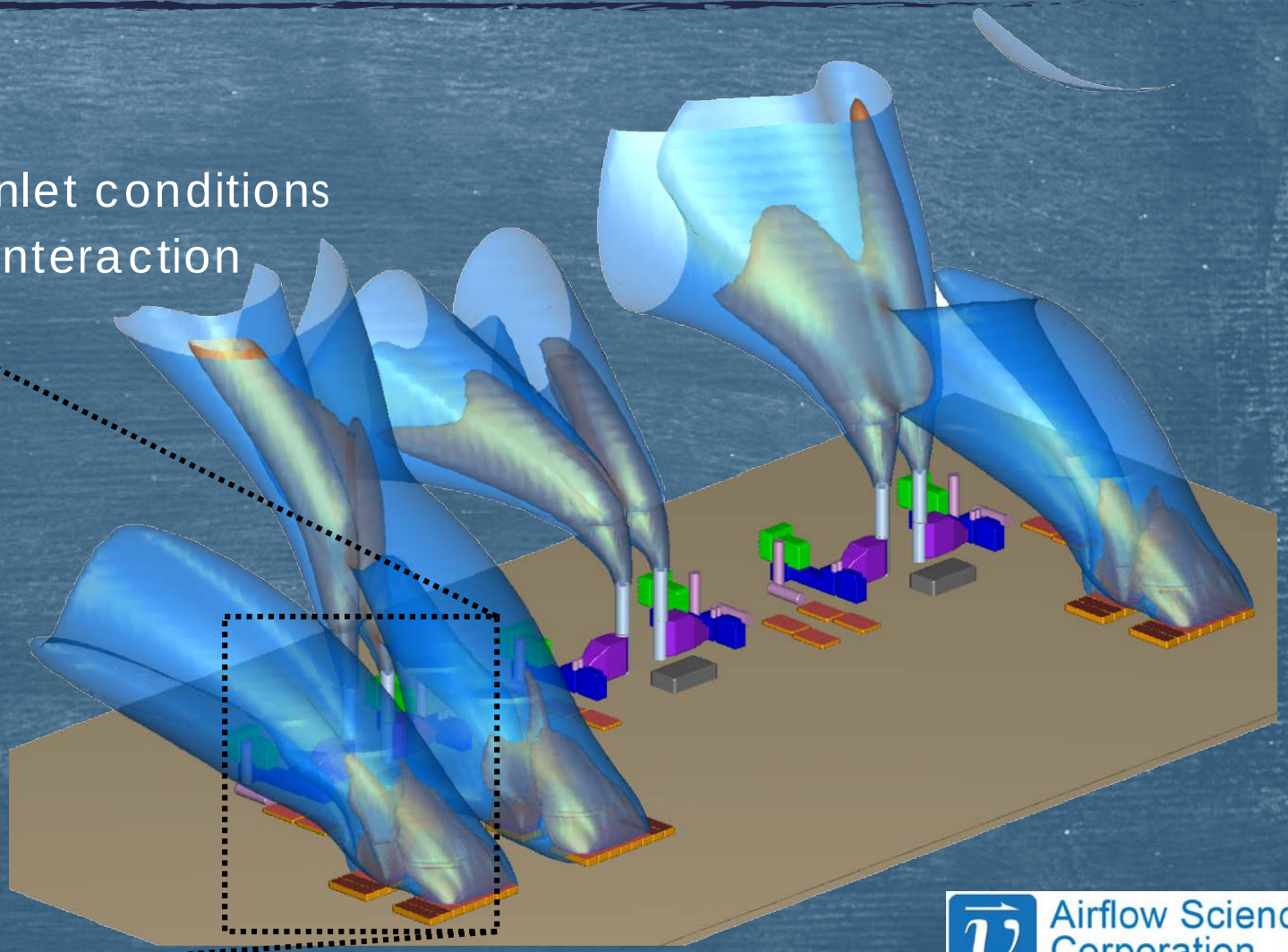




Design Objectives

- Turbine Inlet Conditions
  - Can have inlet cooling systems
  - Plant layout can affect turbine inlet conditions
  - Condenser and exhaust plume interaction





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Design Objectives

- Ammonia Injection
  - The key factor in deNOx performance and ammonia slip
  - Goal is uniform concentration (ammonia-to-NOx ratio) at SCR catalyst
  - General target is 5% RMS or better
  - Optimization requires balance of competing goals
    - Velocity profile at AIG
    - Uniform injection from AIG nozzles
    - Mixing effectiveness
    - Pressure drop
  - AIG design is not straight-forward
    - Mixing can be limited
    - Temperature heat up can affect distribution
    - Updated design practices have led to advances
    - Older systems likely have room for improvement

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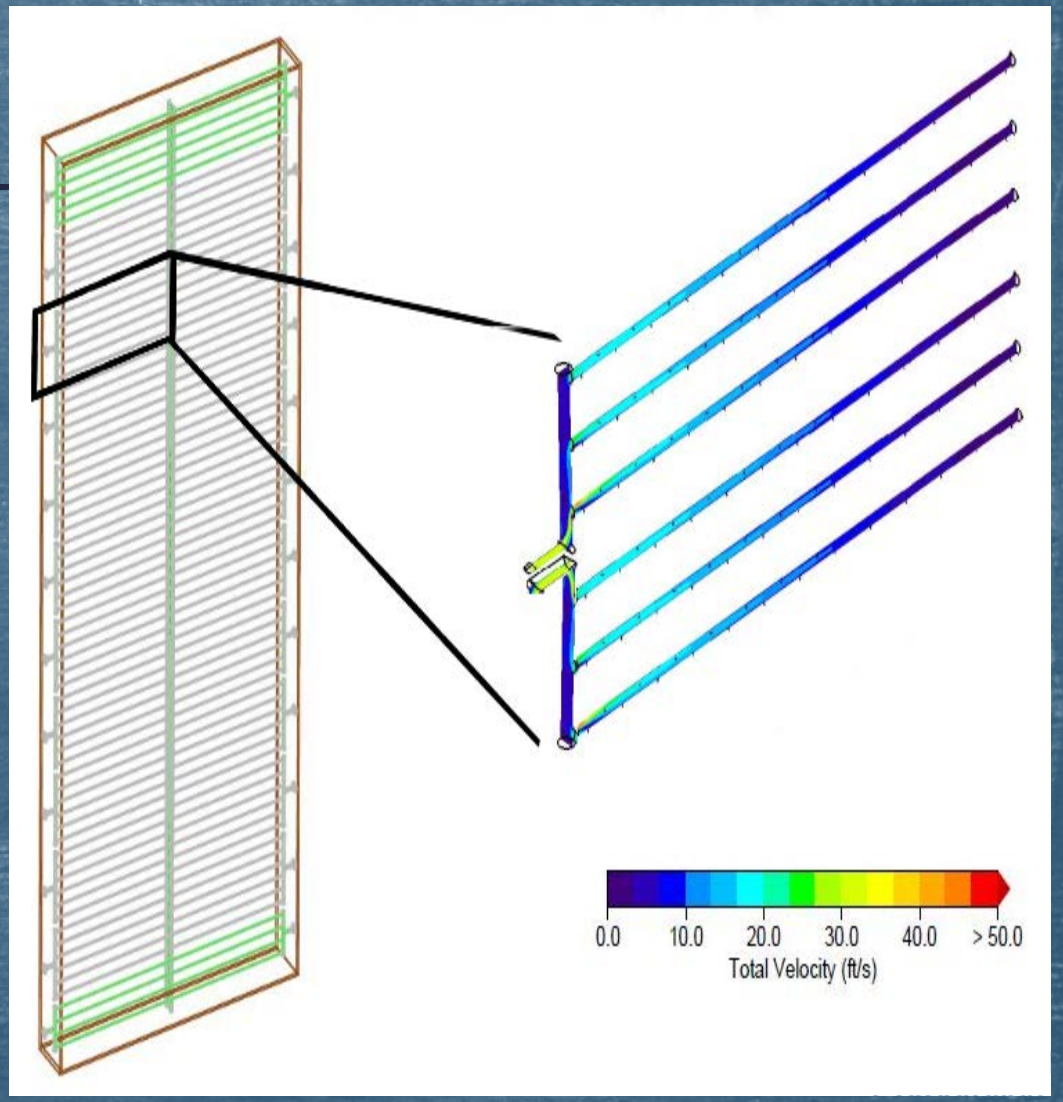
Design Objectives

- Ammonia Injection Grid
  - General goal is to inject equal ammonia from each nozzle to within 2% or better
  - Correct sizing of header ID, lance ID, and nozzle diameters is important
  - May need to consider heat transfer from gas side to the internal pipe flow; this can influence the balance between nozzles
  - The presence of tuning valves cannot always fix a poor design



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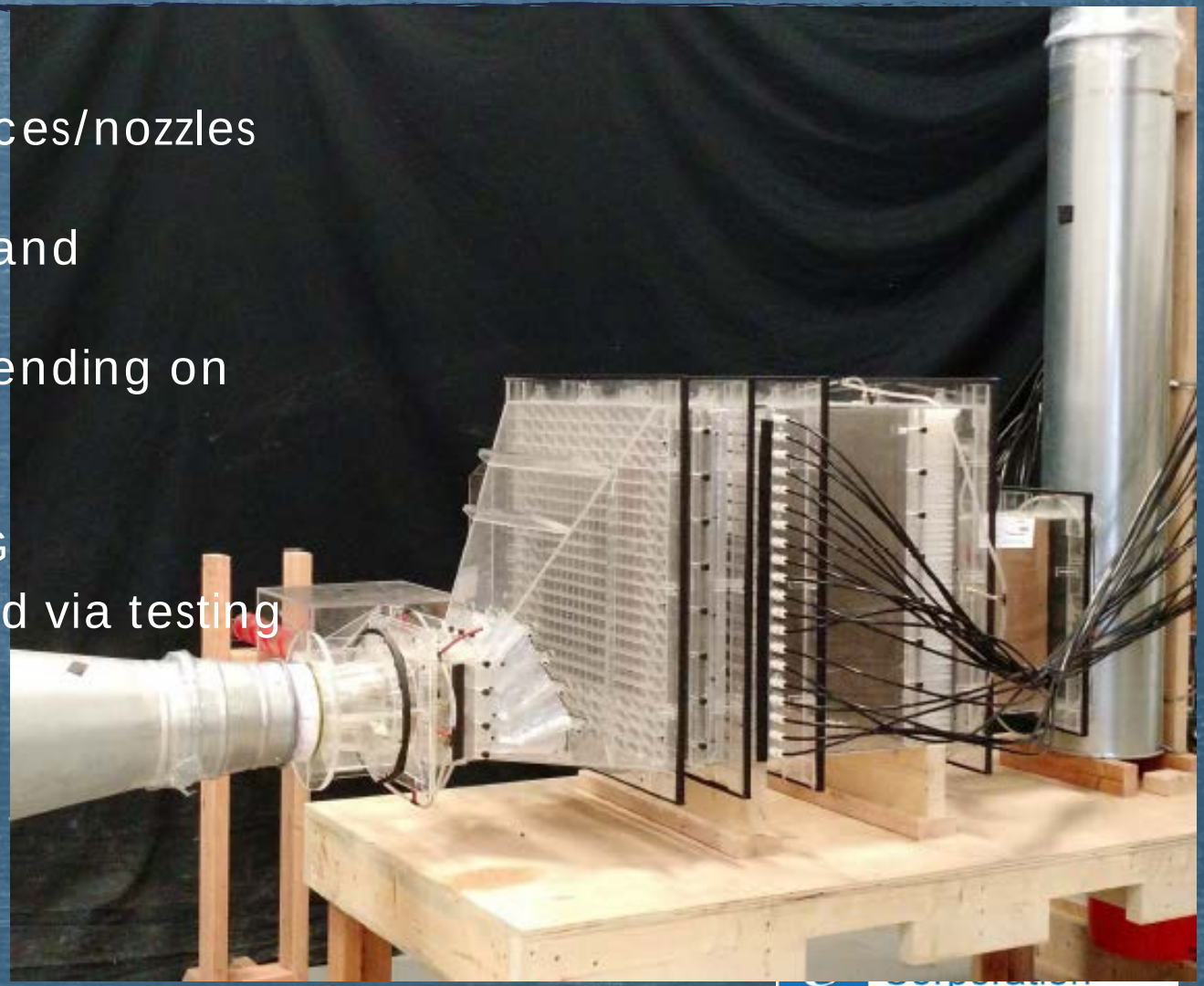
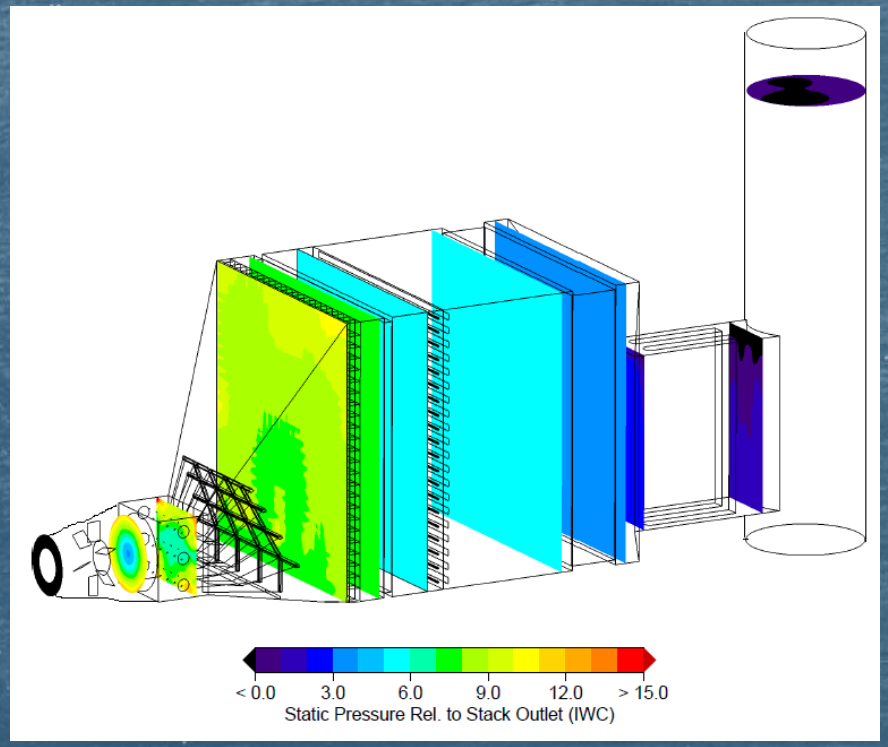
Design Objectives

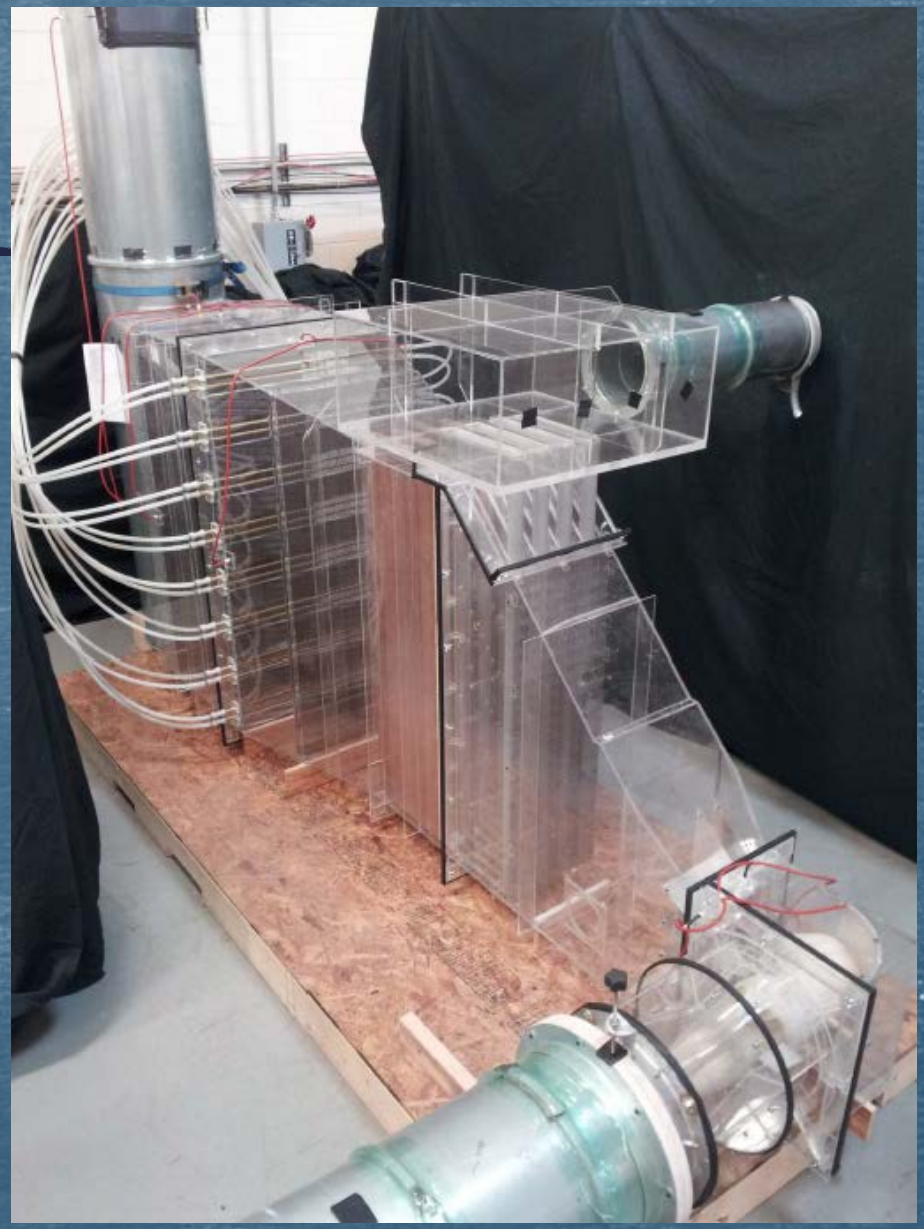
- Ammonia Distribution at SCR
  - Need to ensure sufficient number of lances/nozzles to cover the cross section
  - Depends on residence time to catalyst and turbulence intensity
  - Additional mixing may be required depending on geometry details
    - Static mixer after AIG
    - Turbulence generators integrated with AIG
  - Determined through modeling, validated via testing



Design Objectives

- Pressure Drop
  - Minimize
  - This goal competes with all the other goals
  - Balancing act is needed





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Gas Turbine Optimization

- AIG tuning
  - Perform periodically
  - Fixed gas sampling grid

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Gas Turbine Troubleshooting

- Velocity testing
  - EPA Method 2F using 3D pitot probe
  - Standard or water-cooled probe depending on location

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Conclusions

- There are many parameters that affect gas turbine and SCR performance
- Need optimized design at beginning, and design improvements over time
- AIG tuning should be done regularly
- Good maintenance practices for SCR and seals

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Questions

- Thank you

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