

Nuts and Bolts Guide to Simple Cycle SCR Systems



Presented at:



June 23, 2025

Presented By:

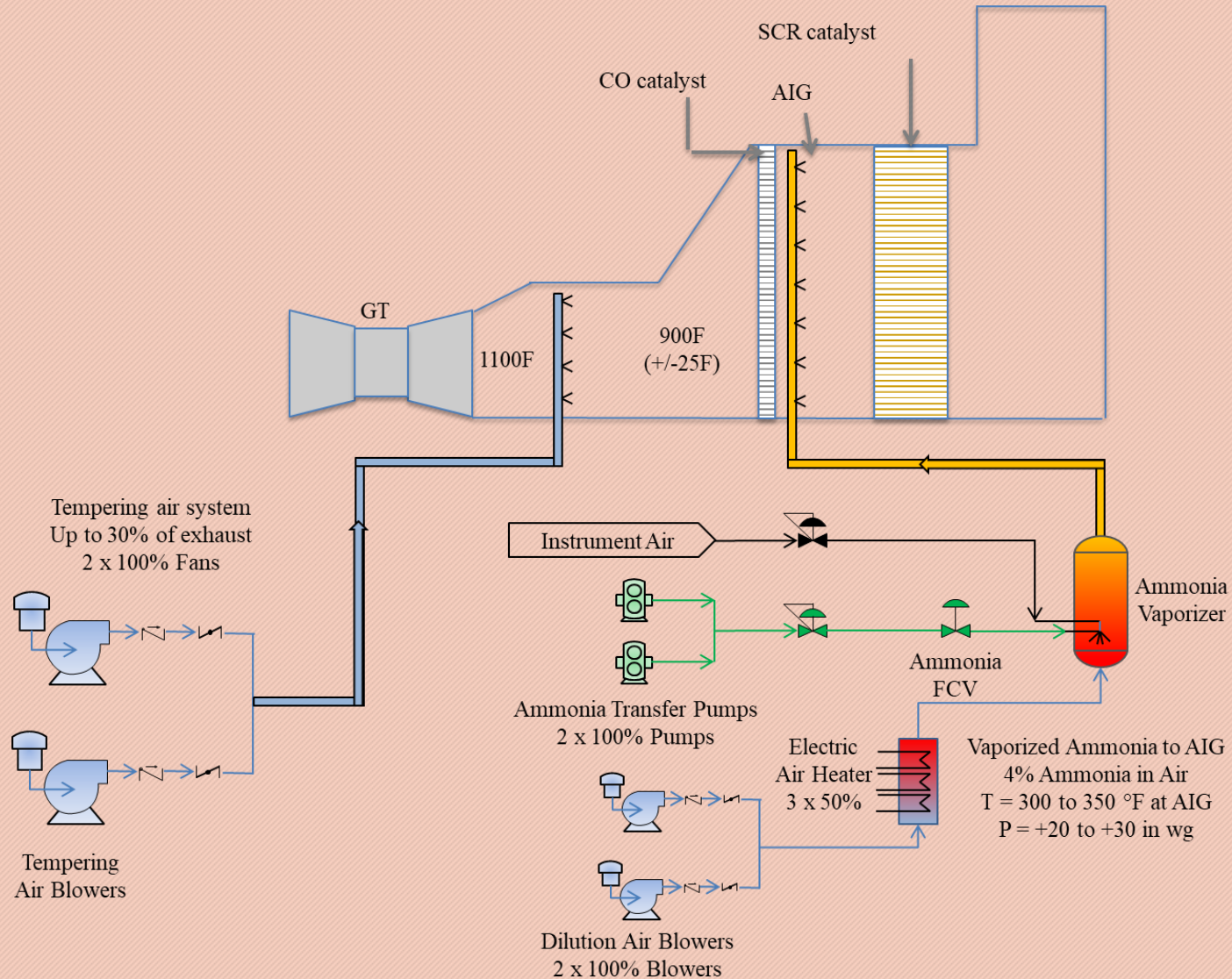
Dan Ott

Environex, Inc.

Malvern, PA 19355
(484) 320-8608

Environex.com

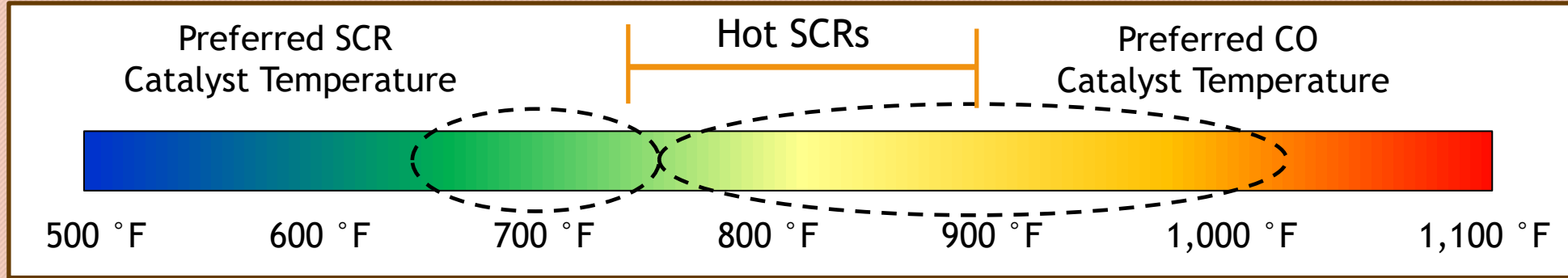
Hot SCR Process



Key Design Features

- Steep Transition Angle
- High Temp SCR Catalyst
- Tempering Air Blowers
- Thermal Stress
- Cycling
- Turbulence

SCR/CO Catalysts



CO Catalyst

Good



Bad



Typical SCR/CO
Design Temperature

SCR Catalyst

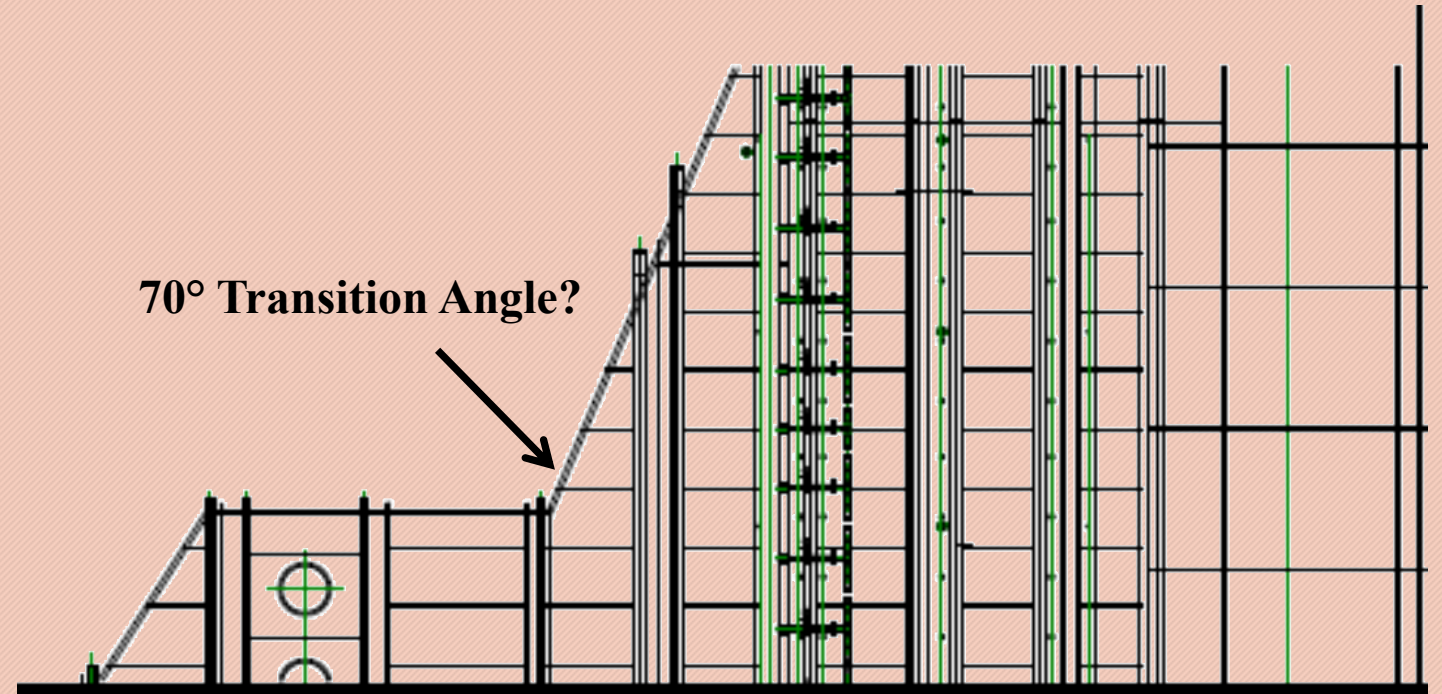
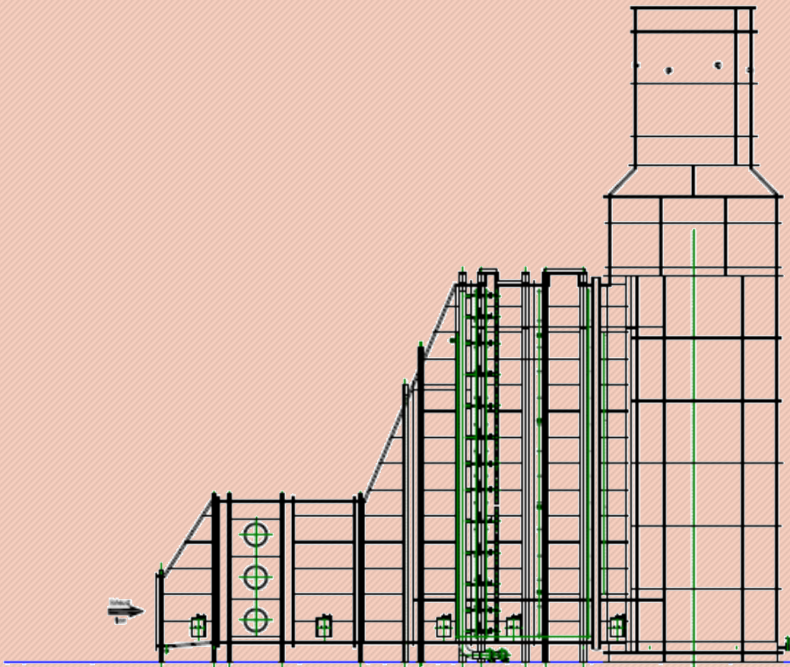
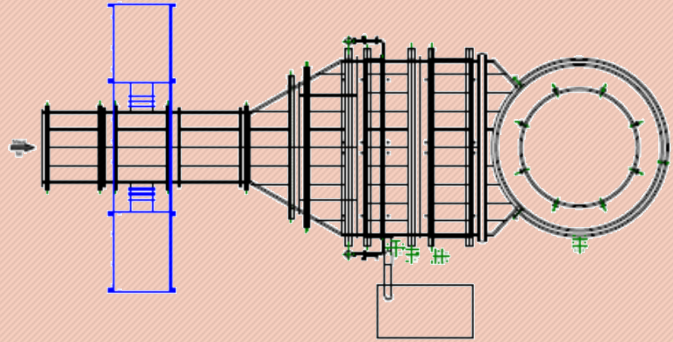
Good



Bad

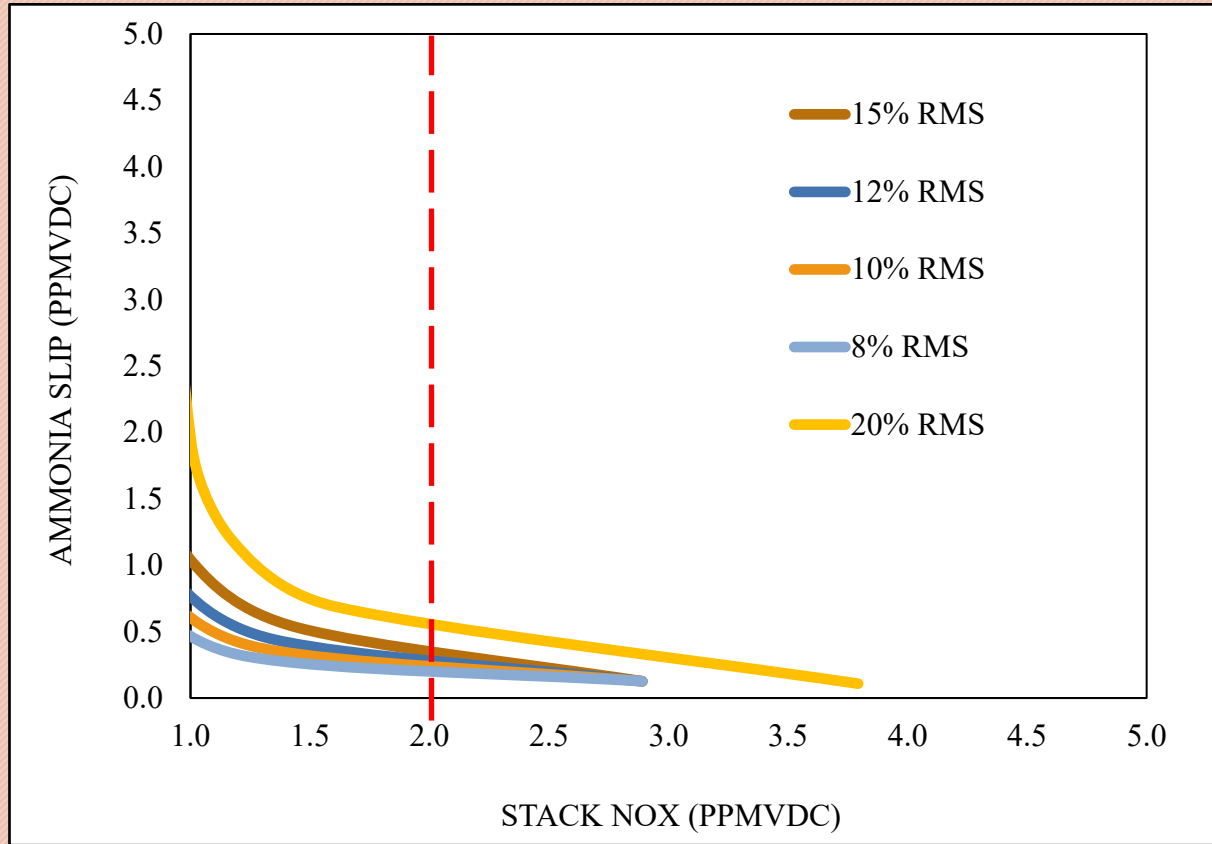


Step Transition Angle

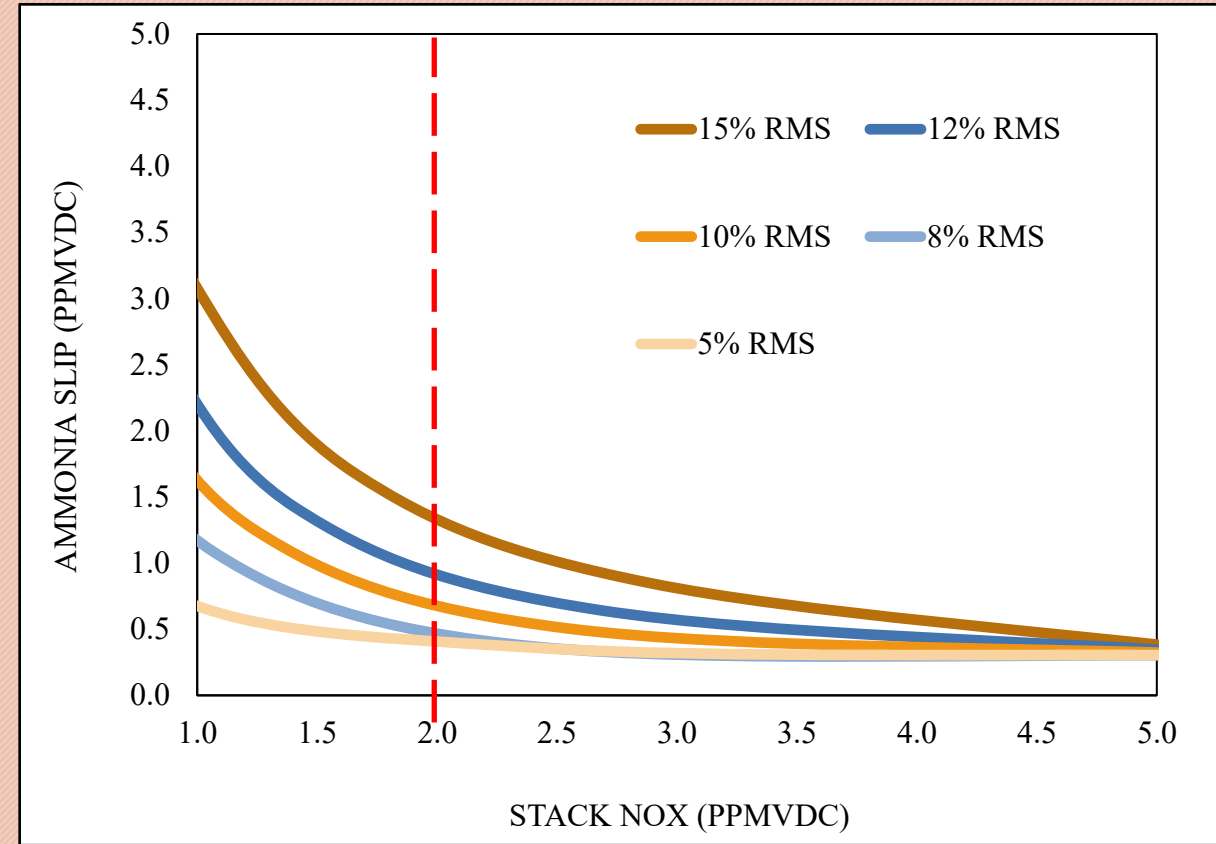


Step Transition = Poor Flow and Ammonia Distribution

Ammonia to NOx Variation on System Performance



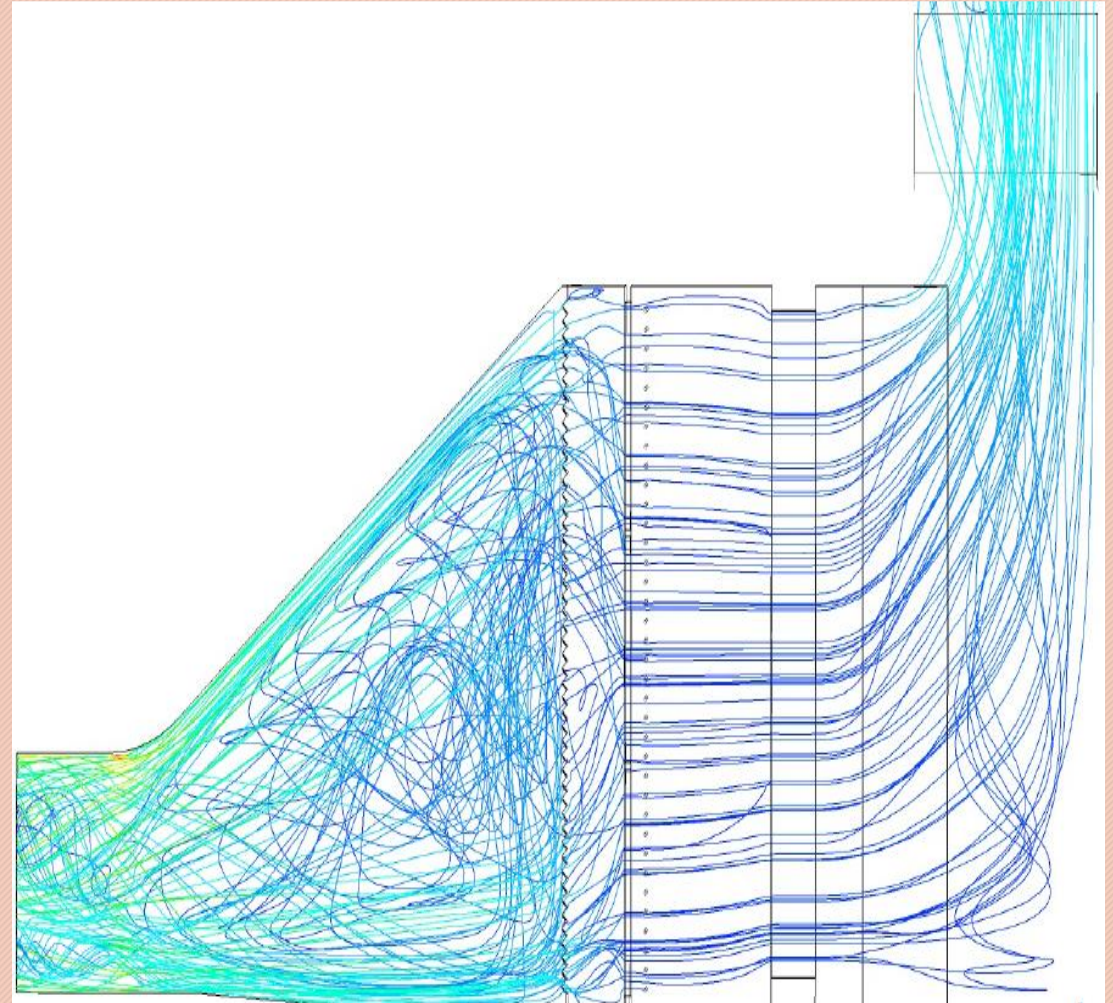
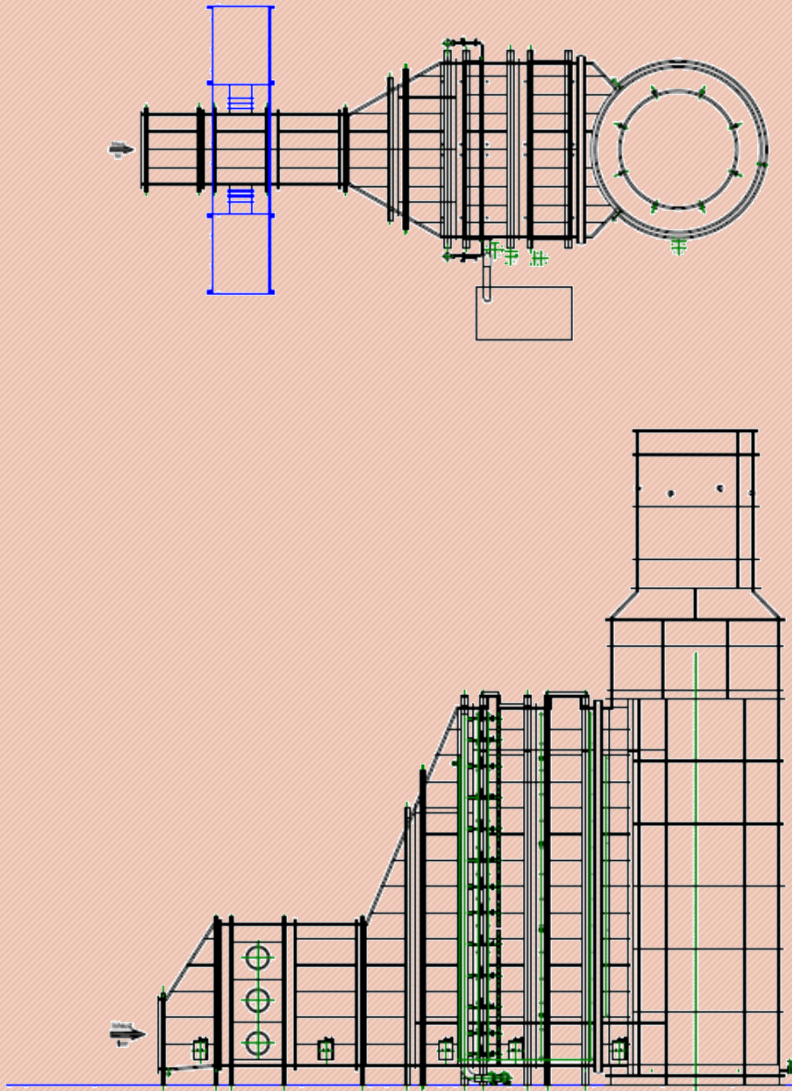
GE Frame 7F or 501F ULN – 9 ppm Inlet NOx



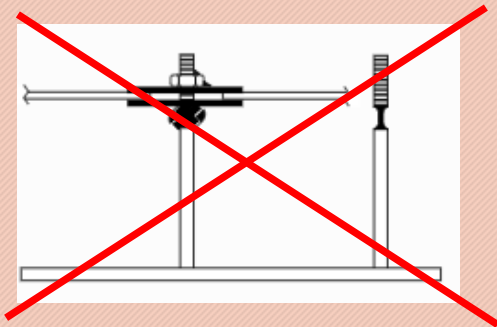
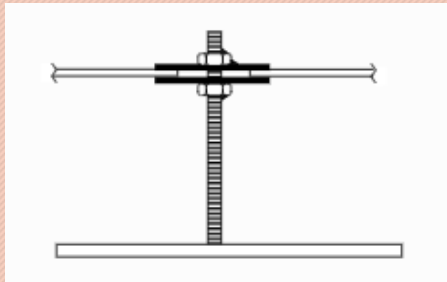
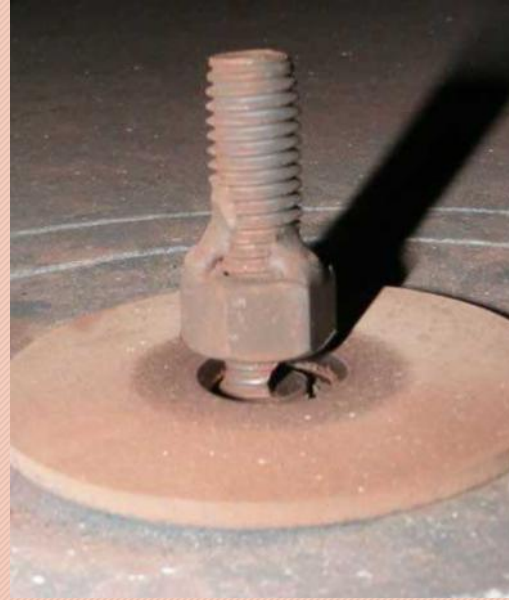
501G – 20 ppm Inlet NOx

Turbulence in the Transition Duct

Much more Vibration and Velocity Variation than HRSGs



Liner Plates



Good Design Practices

- 11 to 12” stud spacing
- 12 to 14 gauge solid liner
- No crimped studs
- Tack the Washers
- Studs centered in holes
- Cycling
- More Turbulence
- More Vibration
- Higher Velocity?

Hot SCR Liner Plate Lessons Learned

Shingled
("Post-It")



Expanded
Metal



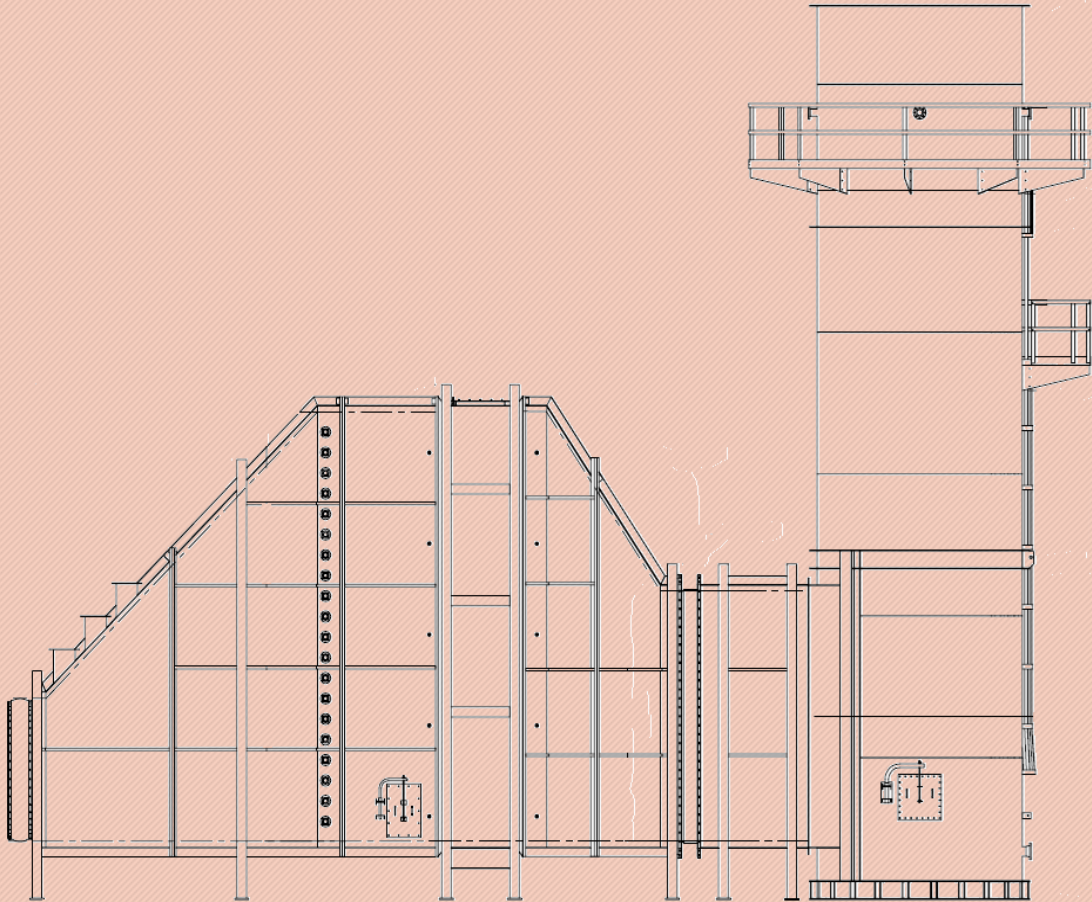
Too
Thin



Alkaline Earth Silicate
AES Insulation

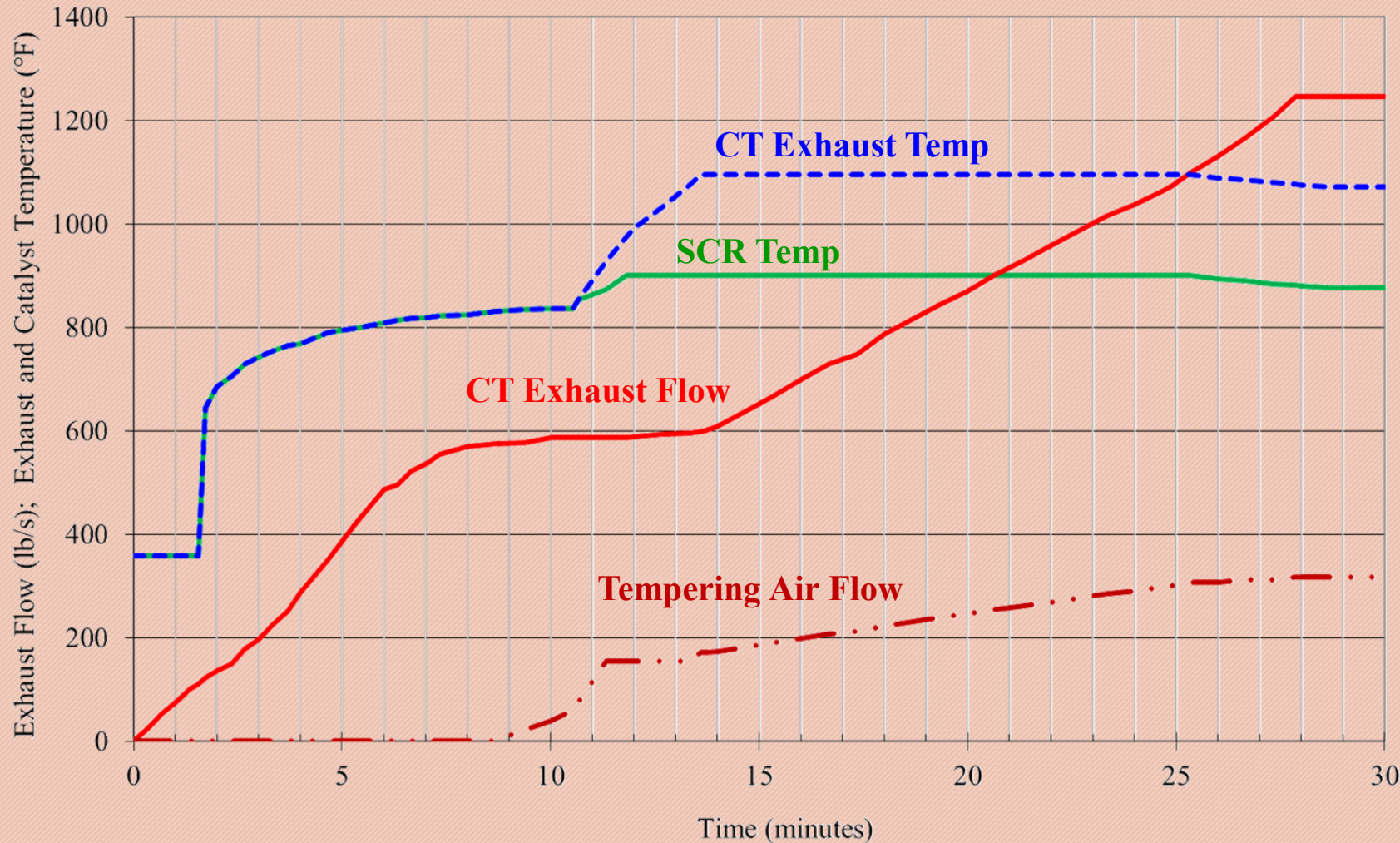


How Far Do We Trust CFD?



Tempering Air – How Big is the Fan?

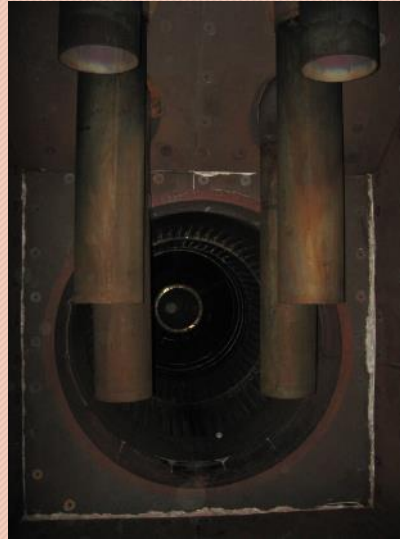
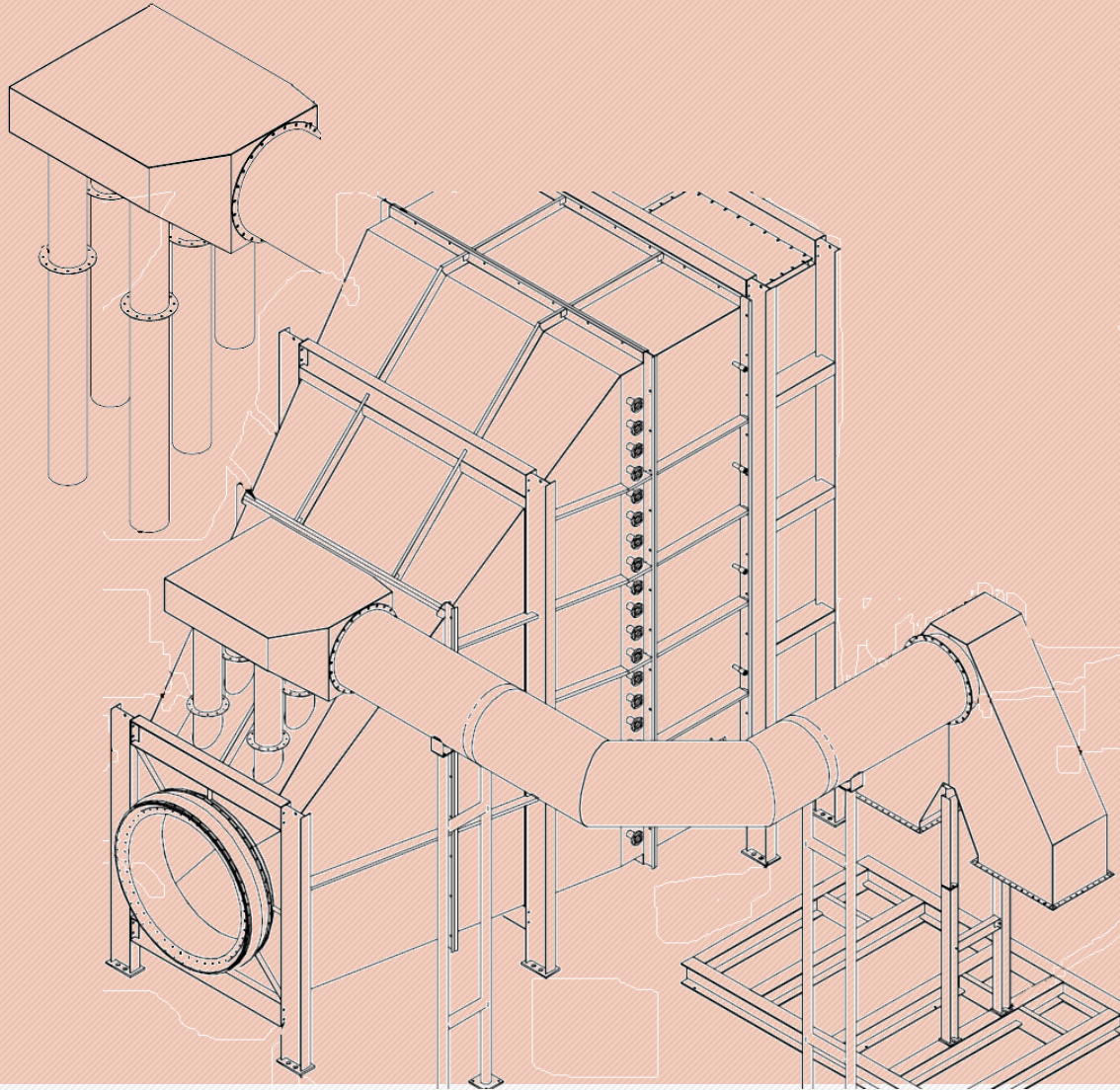
Case Study – SGT6-5000F – 30 Minute Startup



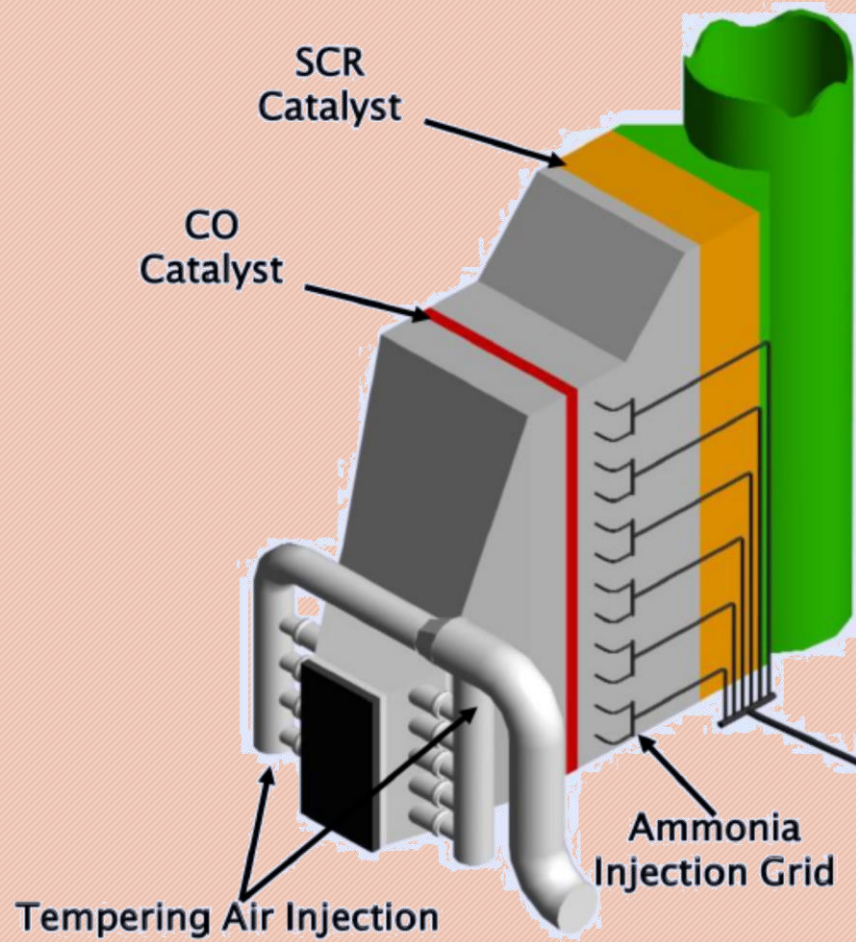
Case Study – SGT6-5000F

- 232 MW
- Flow 4.4 Mlb/hr (1,250 lb/s)
- Exhaust Temp 1,076 °F
- Design SCR Temp 875 °F
- Fan Size
 - 2,800 hp
 - 1,180 rpm
 - 550k ACFM
 - DW, Arrangement 3

Tempering Air Manifold Design – Lessons Learned

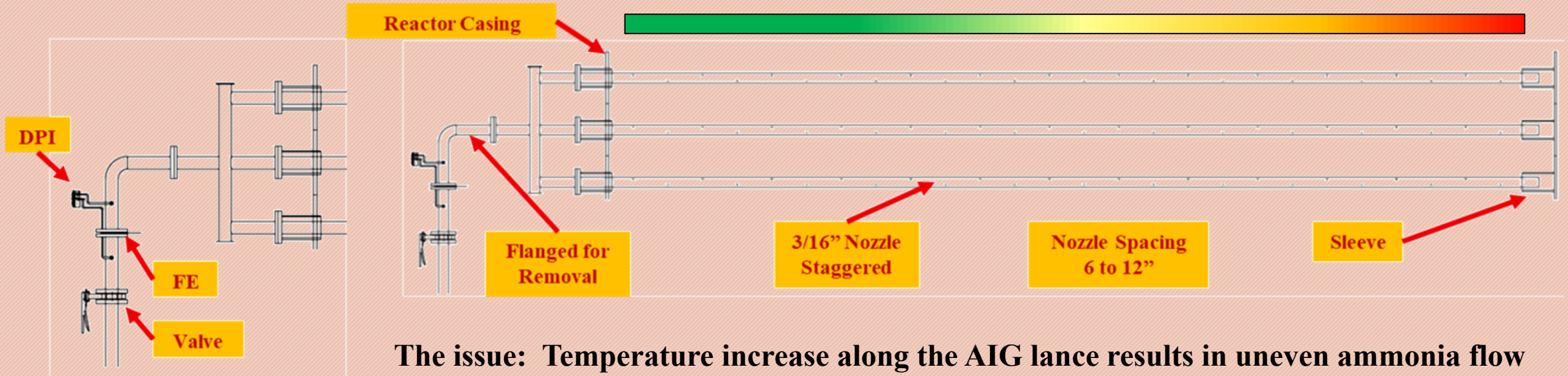


Tempering Air Manifold Design – Lessons Learned



Support the Tempering Air Lances

Ammonia Injection Grid Design



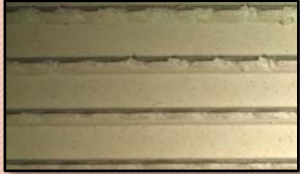
The issue: Temperature increase along the AIG lance results in uneven ammonia flow

Minimize the impact by:

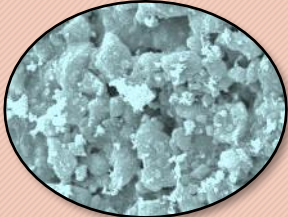
- **Keep AIG pipe diameter small (2.5 to 3")**
- **Minimize wetted components**
- **20:1 pressure ratio**
- **Nozzle size 3/16" (not too small)**
- **Adequate dilution air flow**



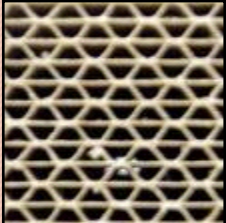
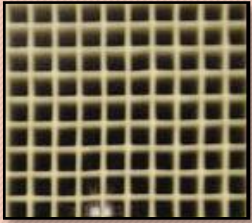
SCR Catalysts



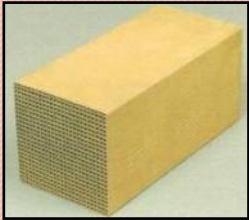
Channel Wall



Catalyst Surface



Channel



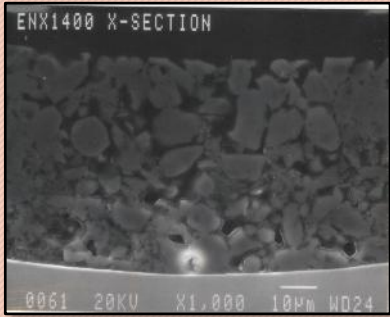
Brick/Element



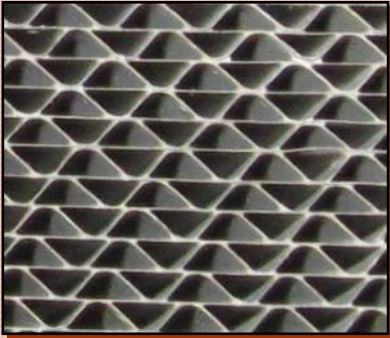
Module



CO Catalyst



Washcoat



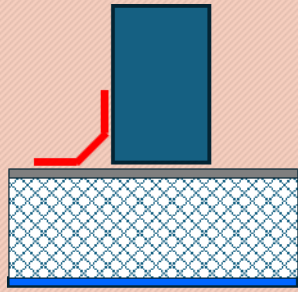
Channel



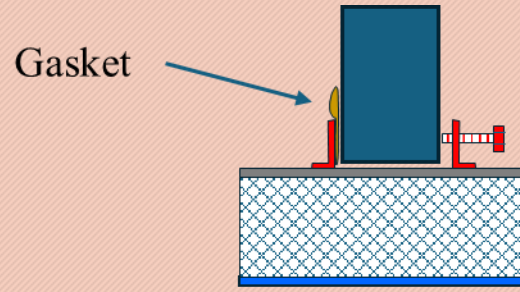
Element/Radiator



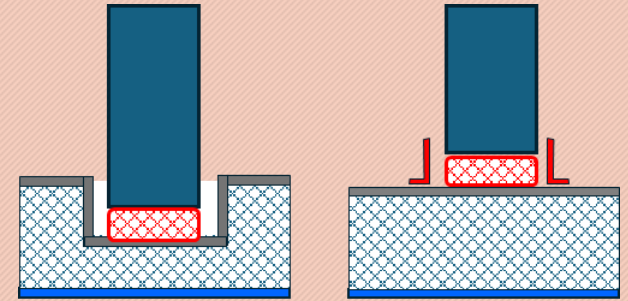
Catalyst Side Seals



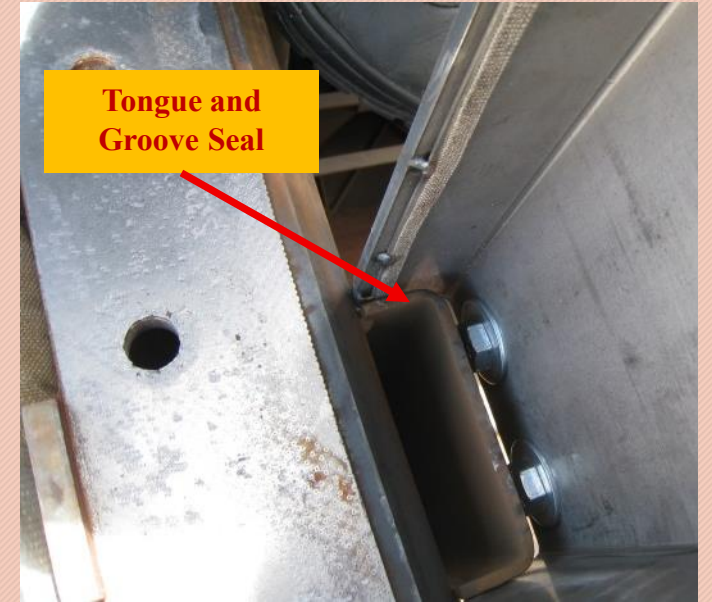
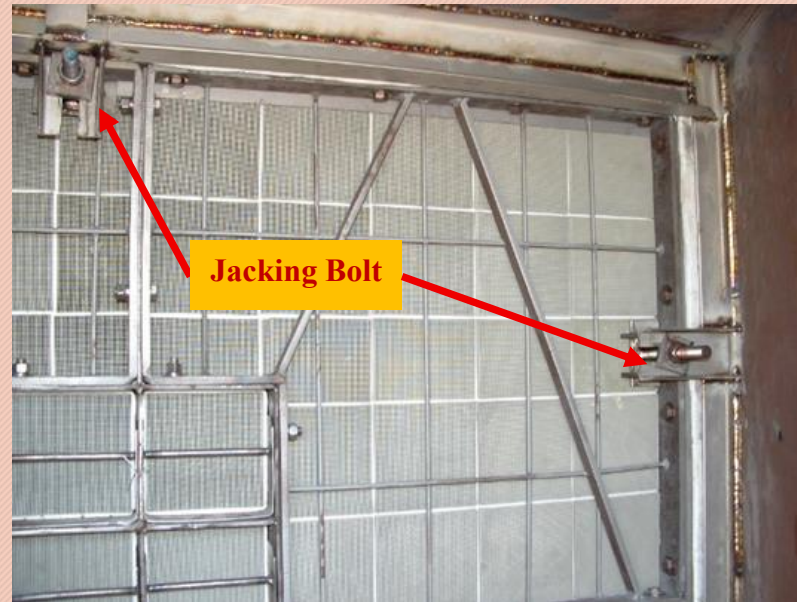
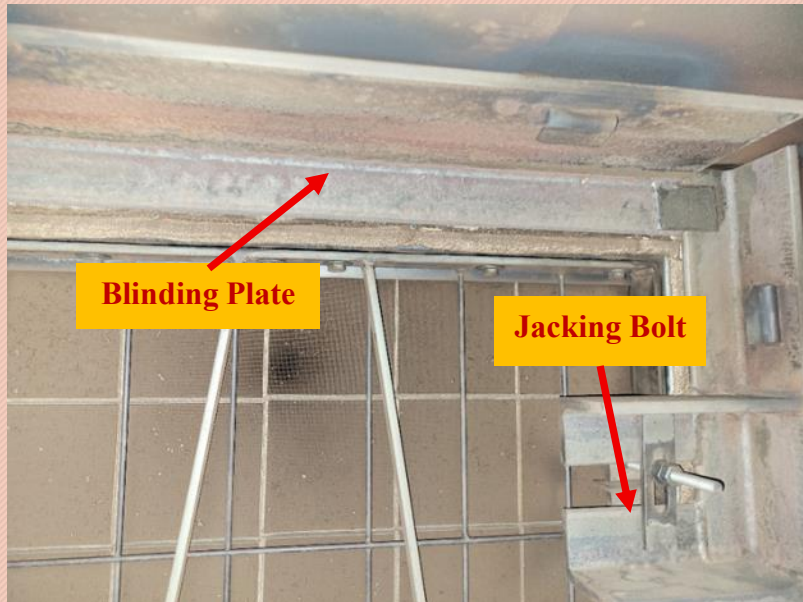
Blinding Plate



Jacking Bolt



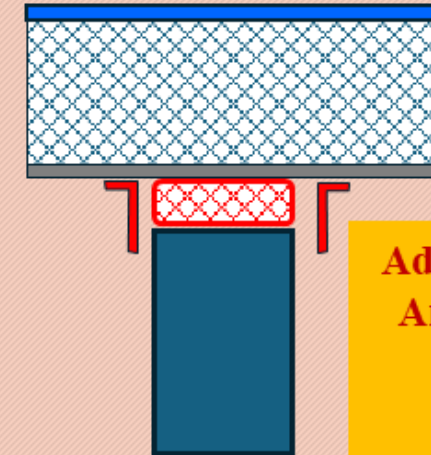
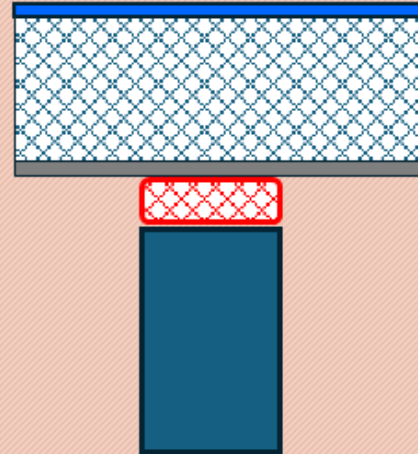
Tongue and Groove



Catalyst Top Seals



Not Recommended

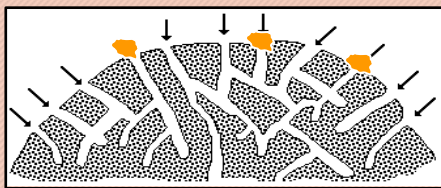
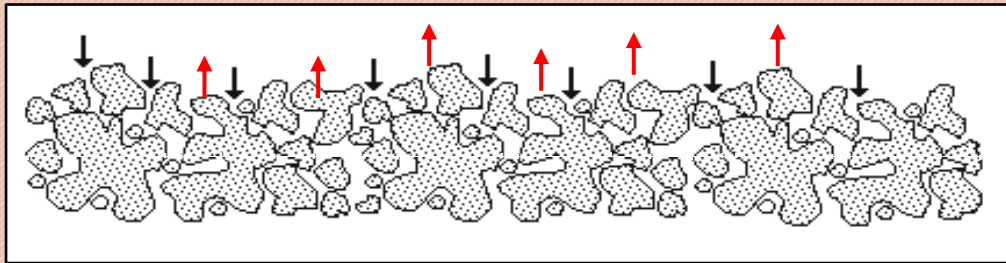


**Adding Channel or
Angles to Protect
the Pillow is
Preferred**

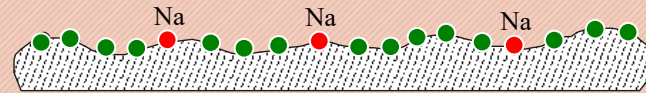
Common Problems in Hot SCRs

Catalyst Performance Loss

Physical/Chemical Damage



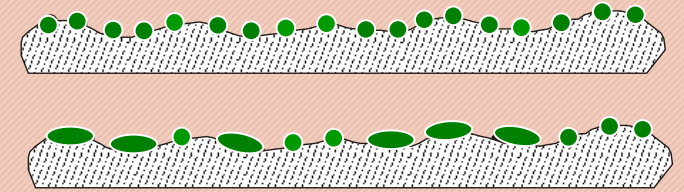
Fouling Blocks Mass Transfer



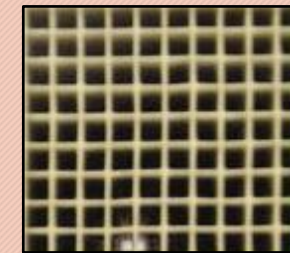
Poisoning Eliminates Active Sites

Thermal Damage

Sintering Eliminates Active Sites From High Temperature Exposure



Thermal Phase Change
Total Collapse of Catalyst Structure (above 850 °F)

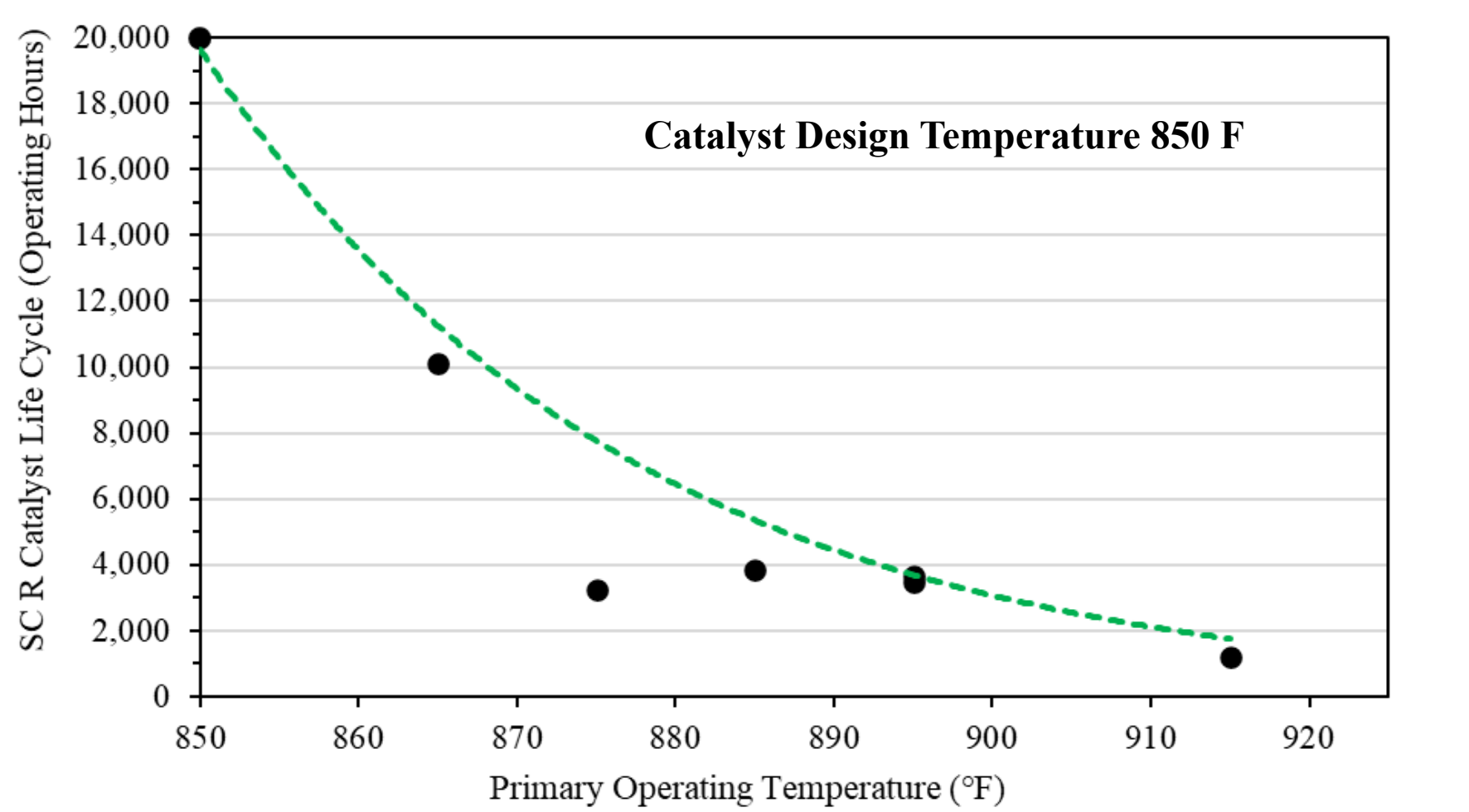


Fresh



Overheated

Over-Temperature Impact on Life Cycle

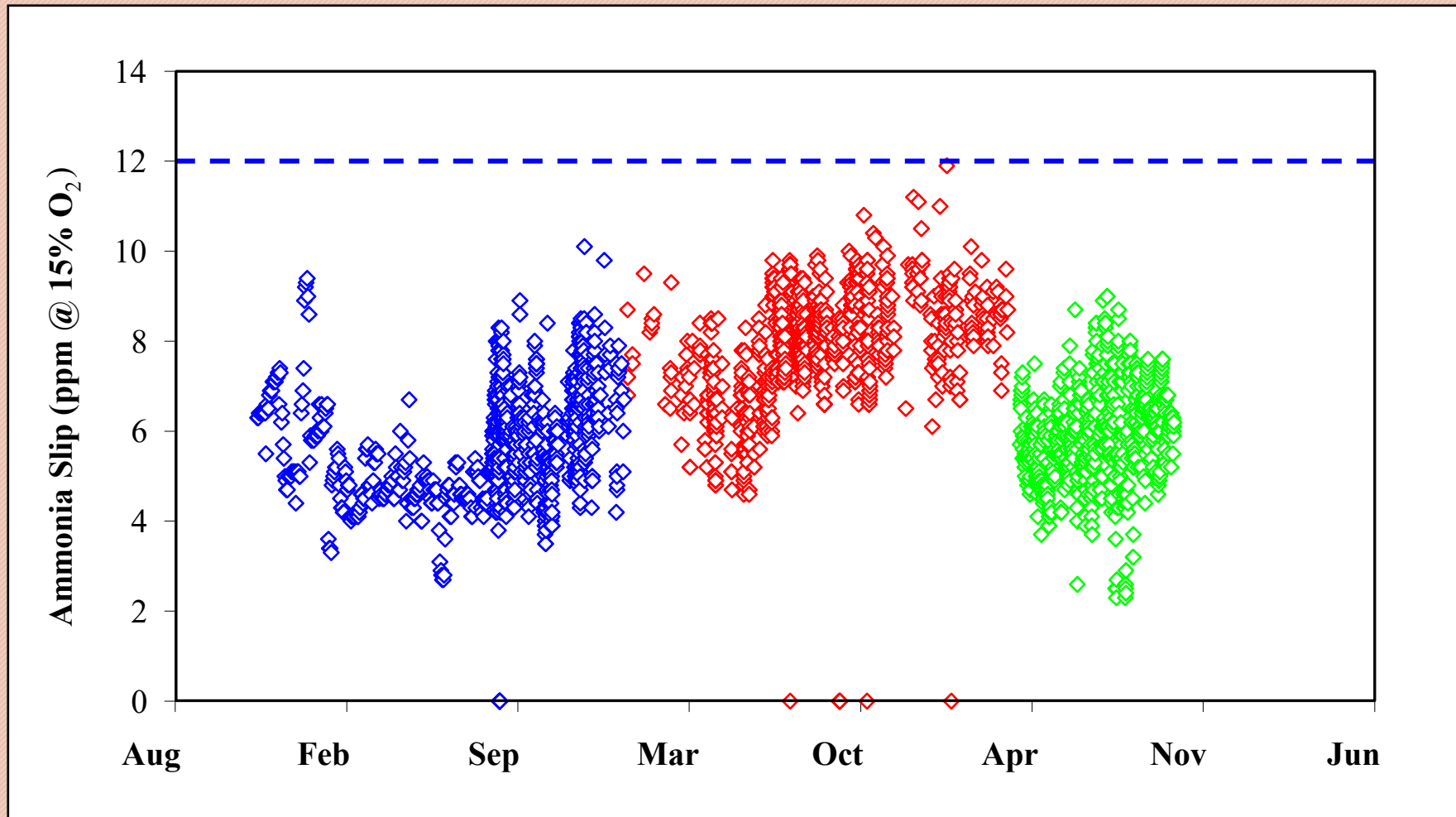


CO Catalyst Plugging



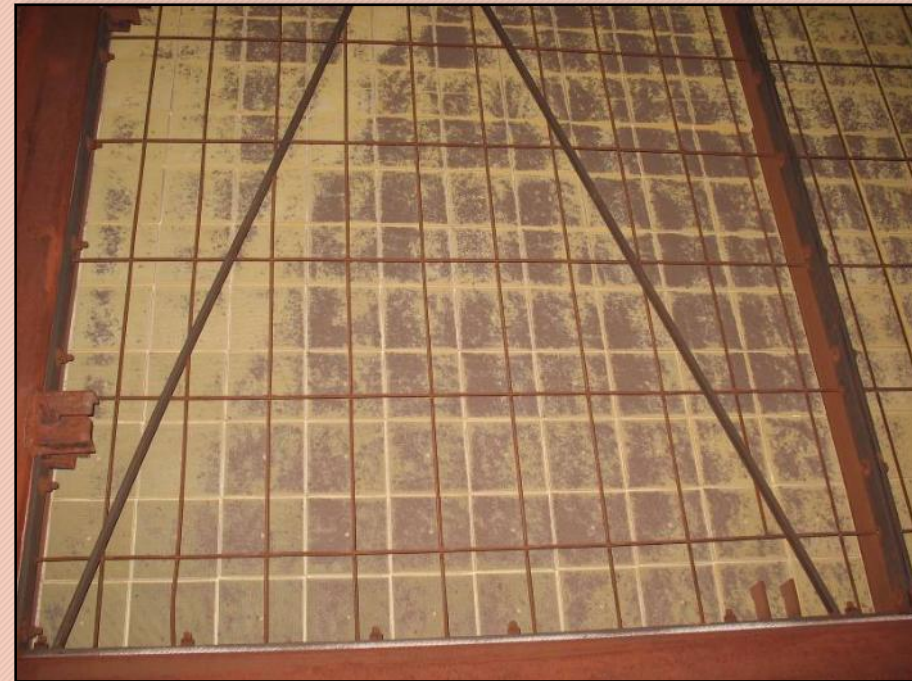
- Biased ammonia flow can lead to high NO_x and high ammonia slip.
- Poorly tuned AIGs, plugged nozzles, and CO catalyst plugging can all cause ammonia maldistribution.

CO Catalyst Cleaning SCR Performance Results



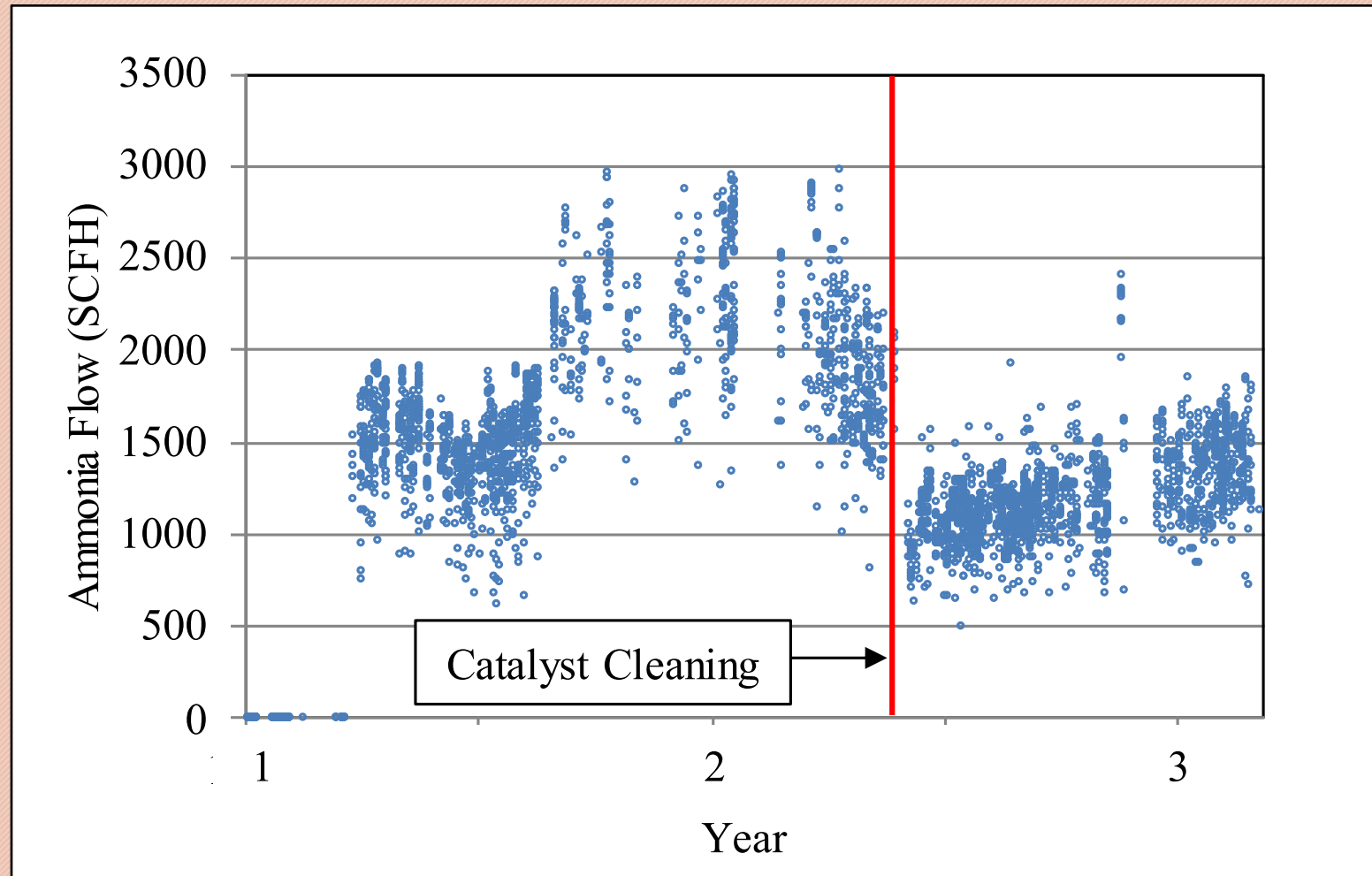
Cleaning the CO catalyst in this case lowered the Ammonia Slip at the stack by 2-3 ppm.

Catalyst Plugging



- Common with all catalyst types
- Source of increased backpressure
- Regular maintenance recommended to remove build-up by vacuuming
- If left untreated catalyst performance loss due to fouling will occur
- Can cause shift of catalyst due to high backpressure

SCR Catalyst Cleaning Results



Ammonia Injection Grid Deposits

Clean Grid



Plugged Grid



Clean Nozzles

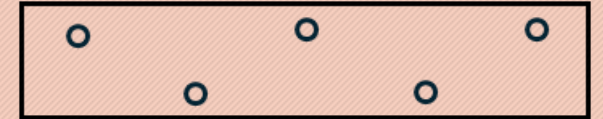


Plugged Nozzles

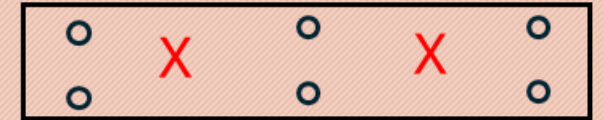


Boroscope of Plugged Lance

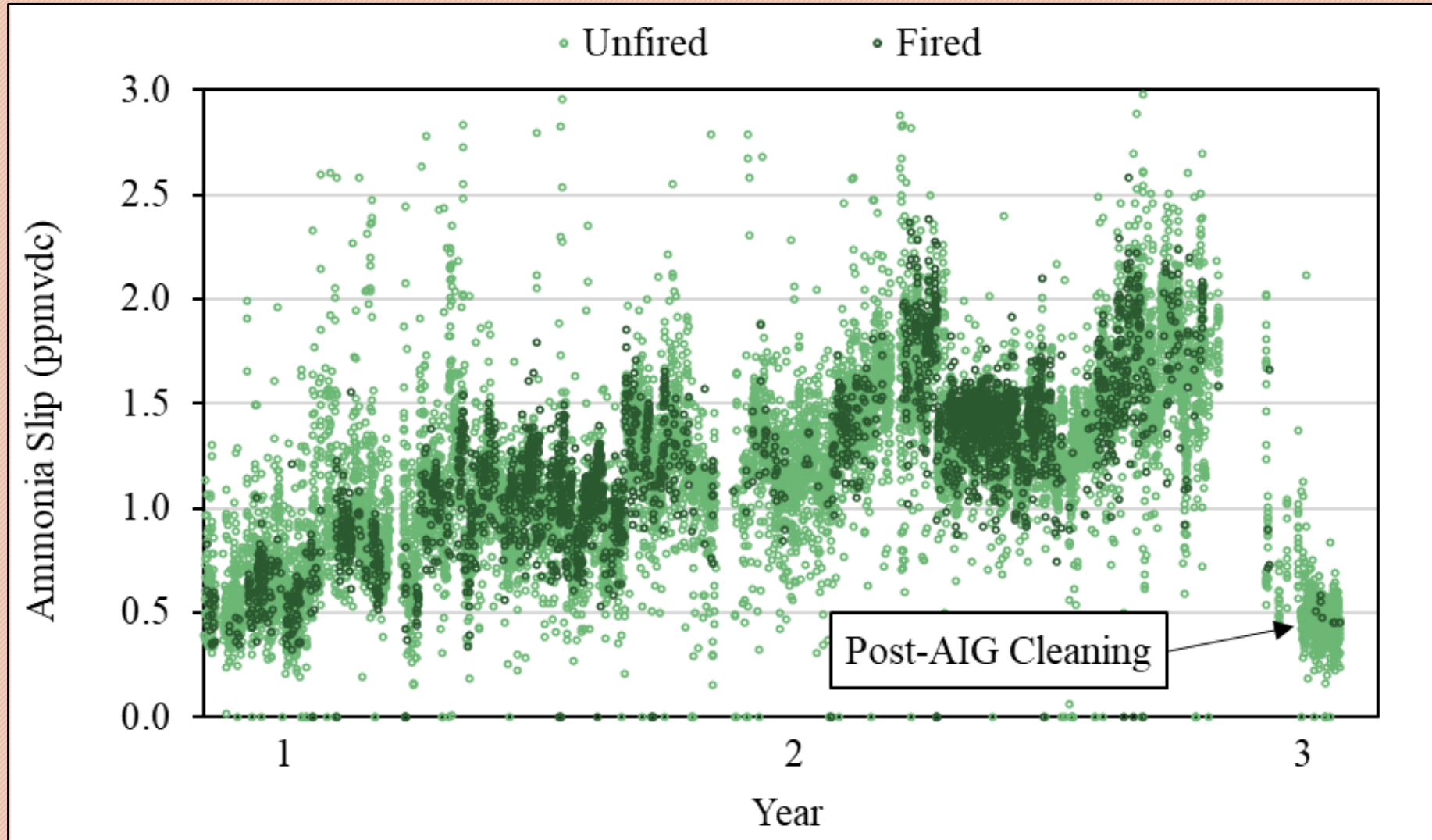
3/16" Staggered Nozzle Preferred



In-Line Nozzle Not Recommended



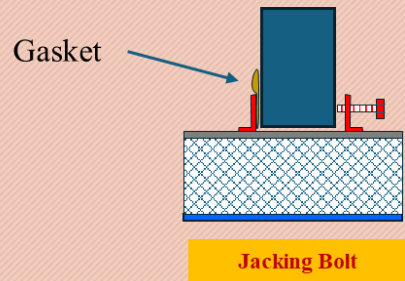
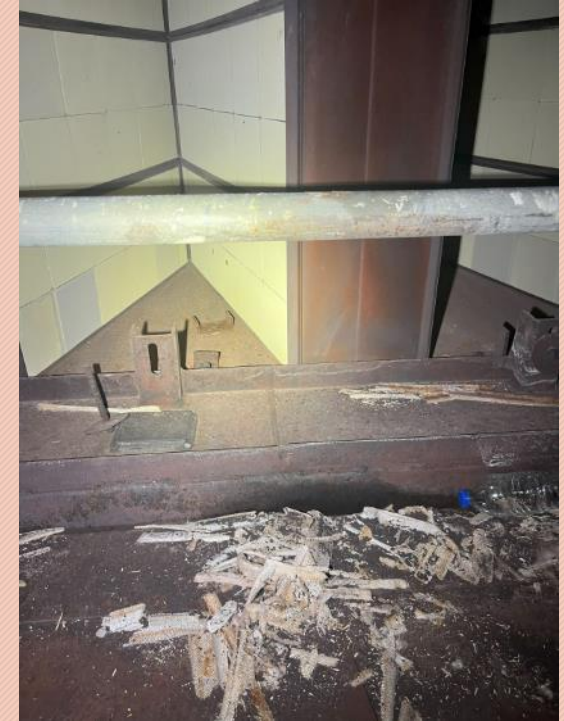
AIG Cleaning SCR Performance Results



Catalyst Seals - Bypass



Insufficient Allowance for Thermal Expansion



Insufficient Allowance for Thermal Expansion

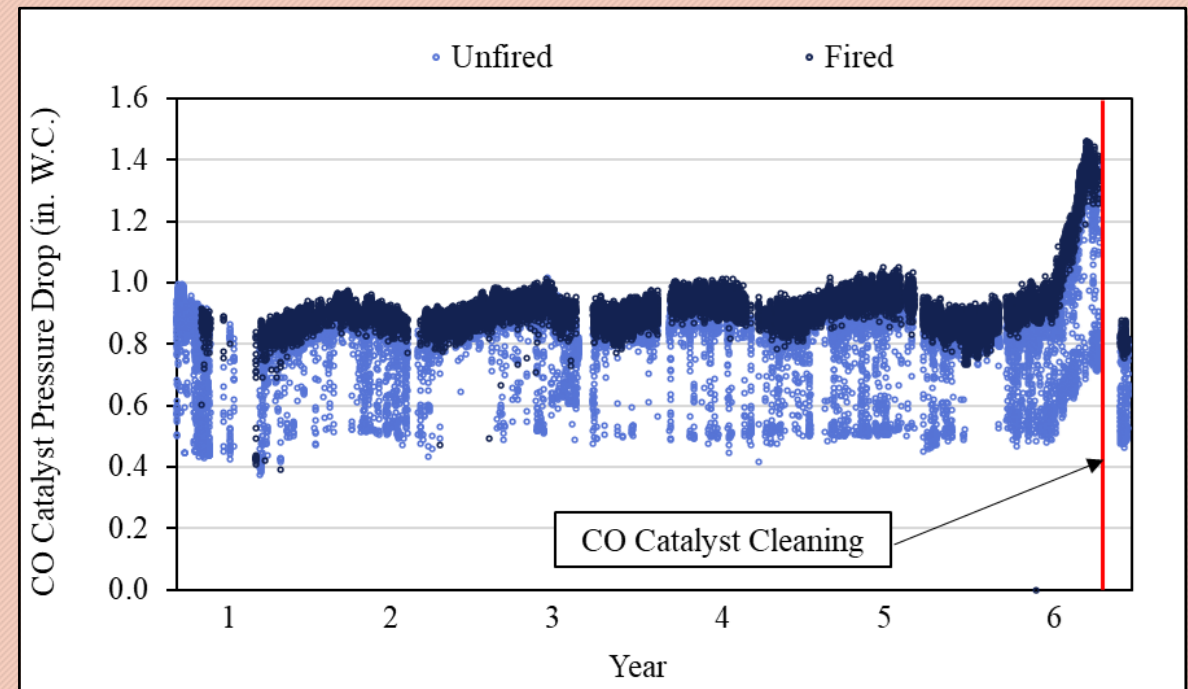
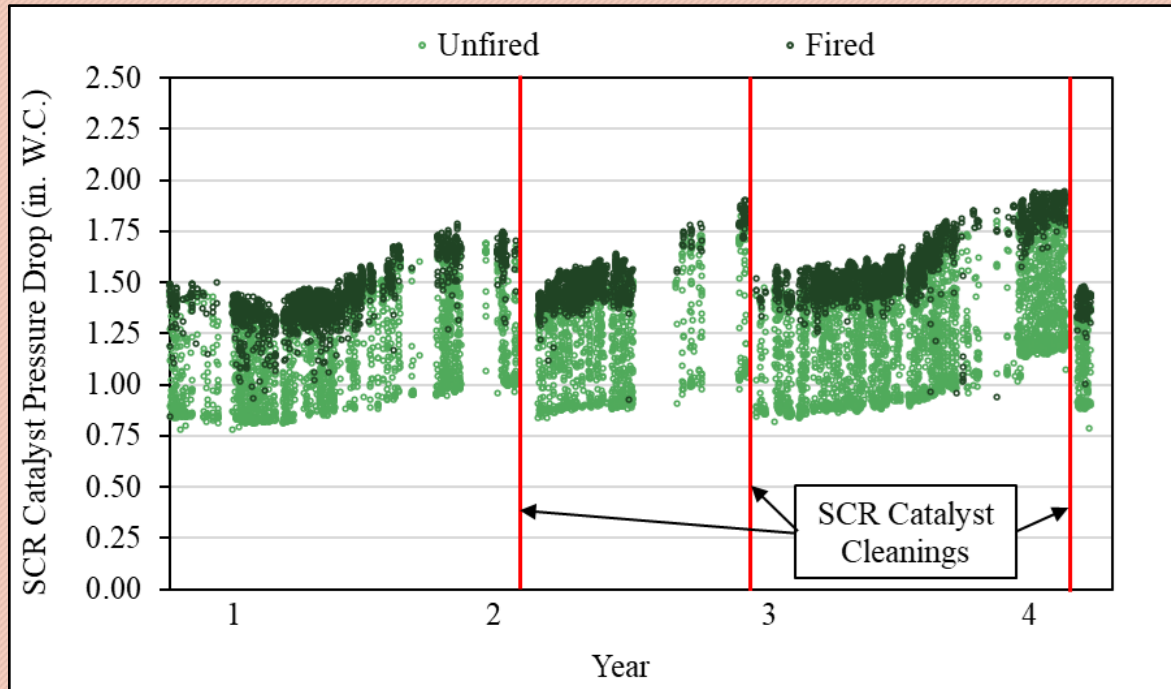


Catalyst Brick Shifting



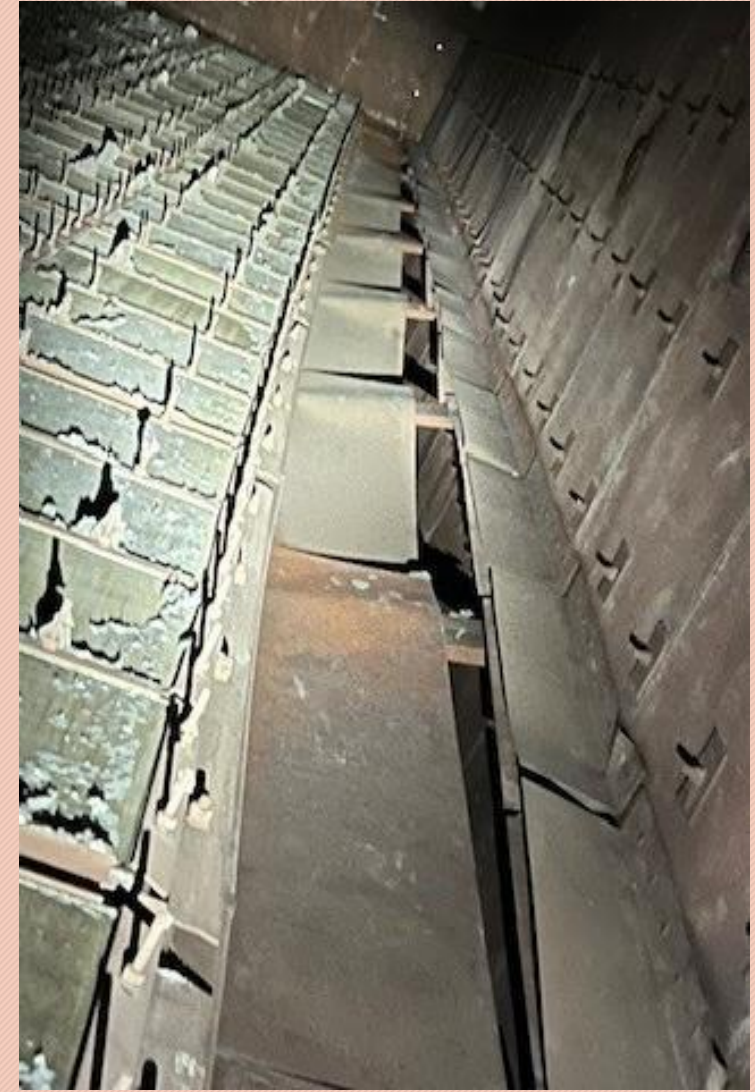
- Common with extruded and washcoated ceramic catalysts
- Most common with catalyst length < 12 inches
- Regular maintenance recommended to minimize shifting
- Repack insulation during outages
- If left untreated, gas bypass around the catalyst, performance loss and structural failure may occur

Catalyst Cleaning Decreases Total Backpressure



- Backpressure increase can be gradual or sudden
- 50% increase in backpressure, action required

Catalyst Frame Deformations



Thank You!!

Dan Ott

ott@environex.com