

**World Pollution Control Association
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SCR Design and O&M Best Practices

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SCR Design and O&M Best Practices

SCR Design

- Flow Modeling Criteria
- Flow Distribution
- Layout in Flues
- Minimize Internal Structure
- Ash Guards
- Catalyst Pitch

SCR O&M

- PRB Ash Accumulation
- Outage Layup
- Reactor Inspections
- On-line Cleaning – Horns, Ash Sweepers, Sootblowers
- Outage Cleaning – Vacuum, Air Lance, DIB, Vibratory
- Inspections & Monitoring – Operating trends, NH3 slip, Catalyst tests, Rx Inspections, Tuning, Cat life modeling.

LaCygne SCR Operation Comparison

	LaCygne 1	LaCygne 2
Gross Load	815 MW	715 MW
Boiler Burners	Cyclone	PC LNB
OFA	OFA	OFA
Boiler Outlet NO _x	0.64-lb/MBtu	0.26-lb/Mbtu
SCR Outlet NO _x	0.09-lb/MBtu	0.10-lb/MBtu
Catalyst Layers	4 + 0	3 + 1
Catalyst Type	2x 5.7 x 625-740 PL	2x 6.7 x 700 Plate
Catalyst Layout	2 x 8 x 13	2 x 8 x 12
NO _x removal cost	\$200 per ton	\$300 per ton

SCR Design – Flow Modeling Criteria

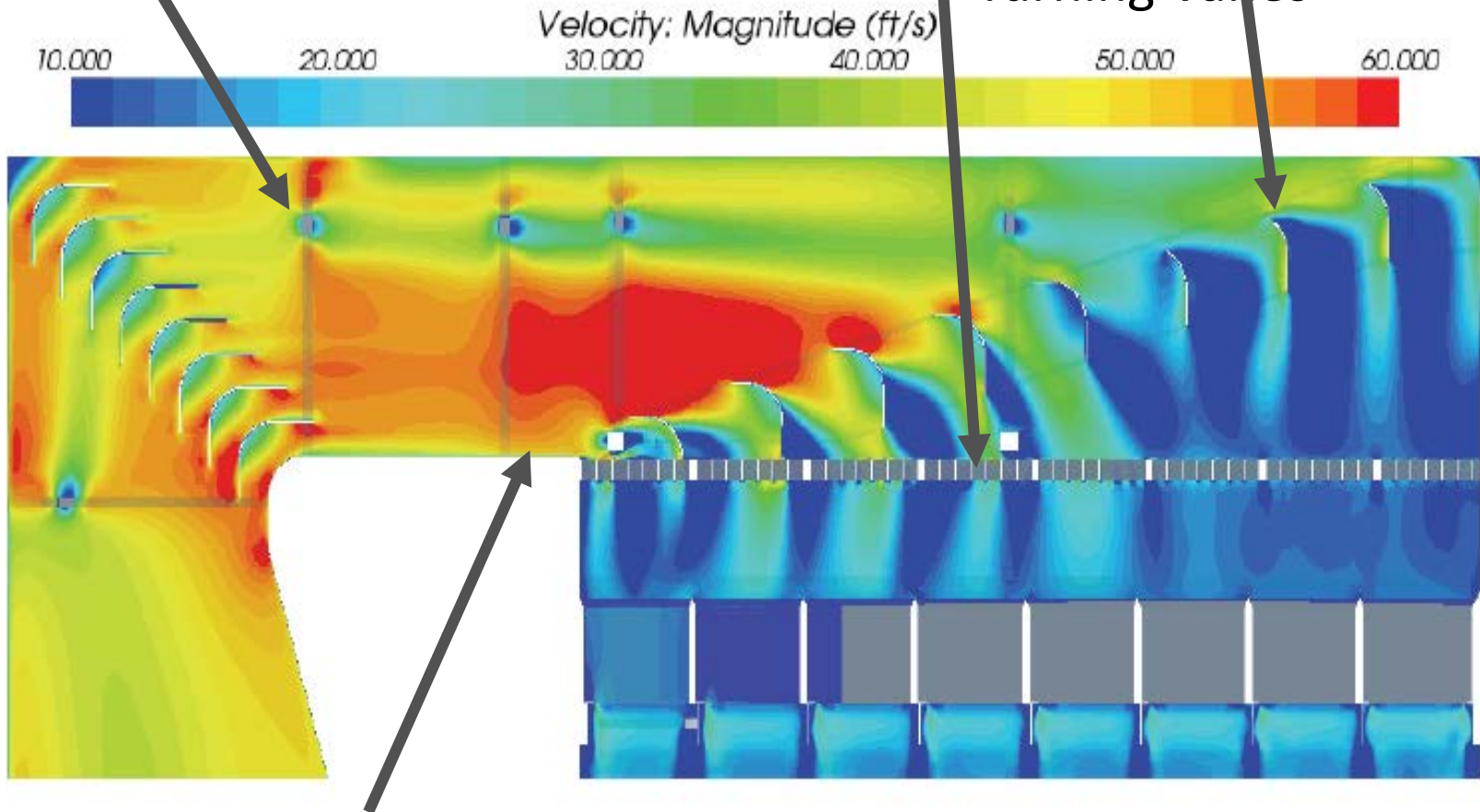
	LaCygne 1	LaCygne 2
NH3:NOx Distrib	+/-5% Mean	+/-5% Mean
Temp Distribution	+/- 20 F	+/- 20 F
Velocity Distribution	100% in 15% RMS (~30% Mean)	85% in 10% Mean 100% in 15% Mean Phy Model 40 pts
Minimize Flow Recirc in Hood	-	Mutual Agreement
CFD model criteria	Hood = 2M cells	Model all flow obstructions. Hood > 5M cells
Phy model criteria	Model flow device	Model all > 6"

SCR Flow Distribution – Lac1 CFD 17.5% RMS

STRUCTURE:
Truss & Gussets

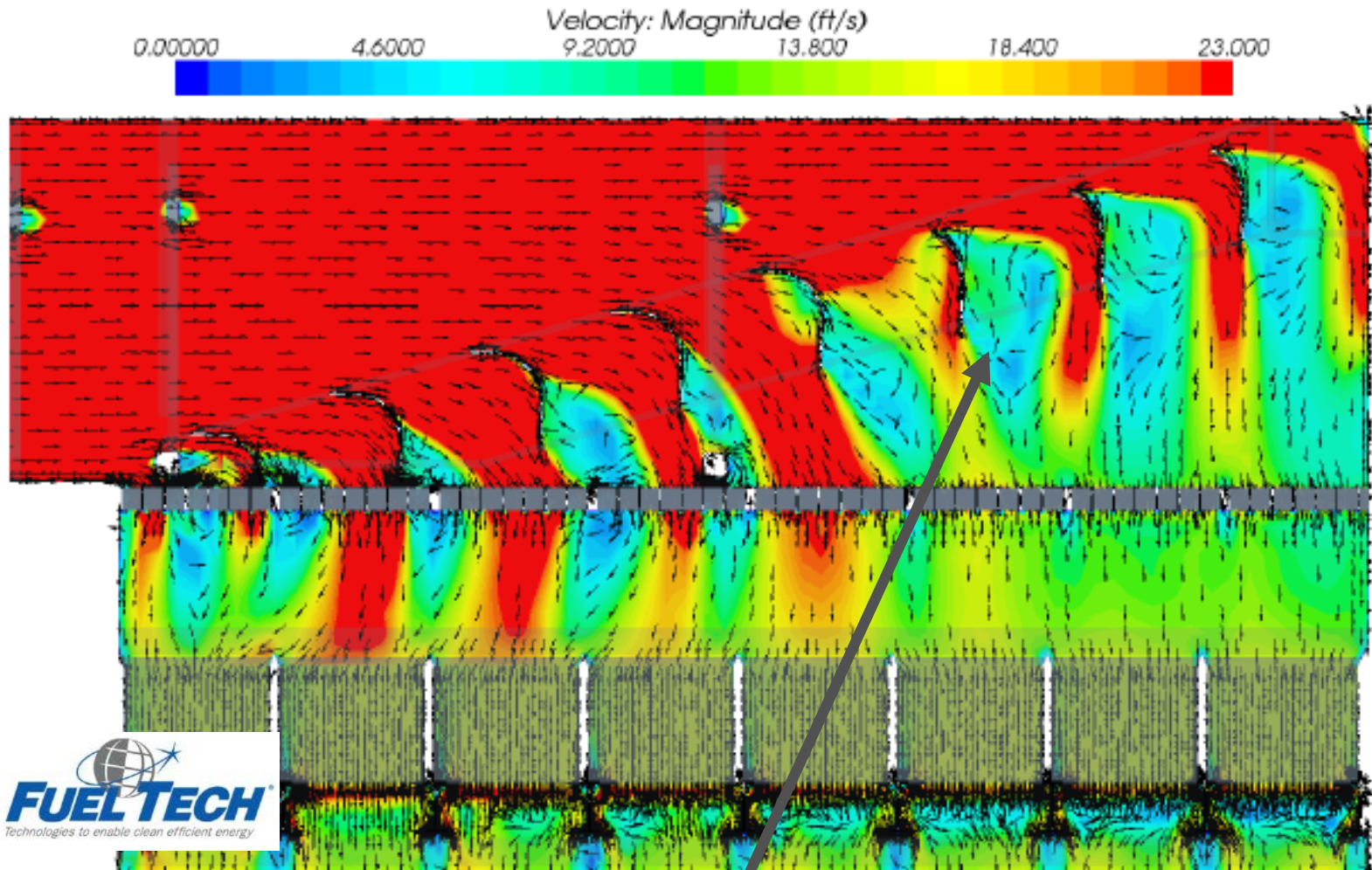
Egg Crate & Perforated Plate

Turning Vanes



Inlet transition, Truss & Gussets create high flow

SCR Flow Distribution – Lac1 Flow Recirculation



Vectors near vanes show recirculation areas where potential ash fallout can occur.

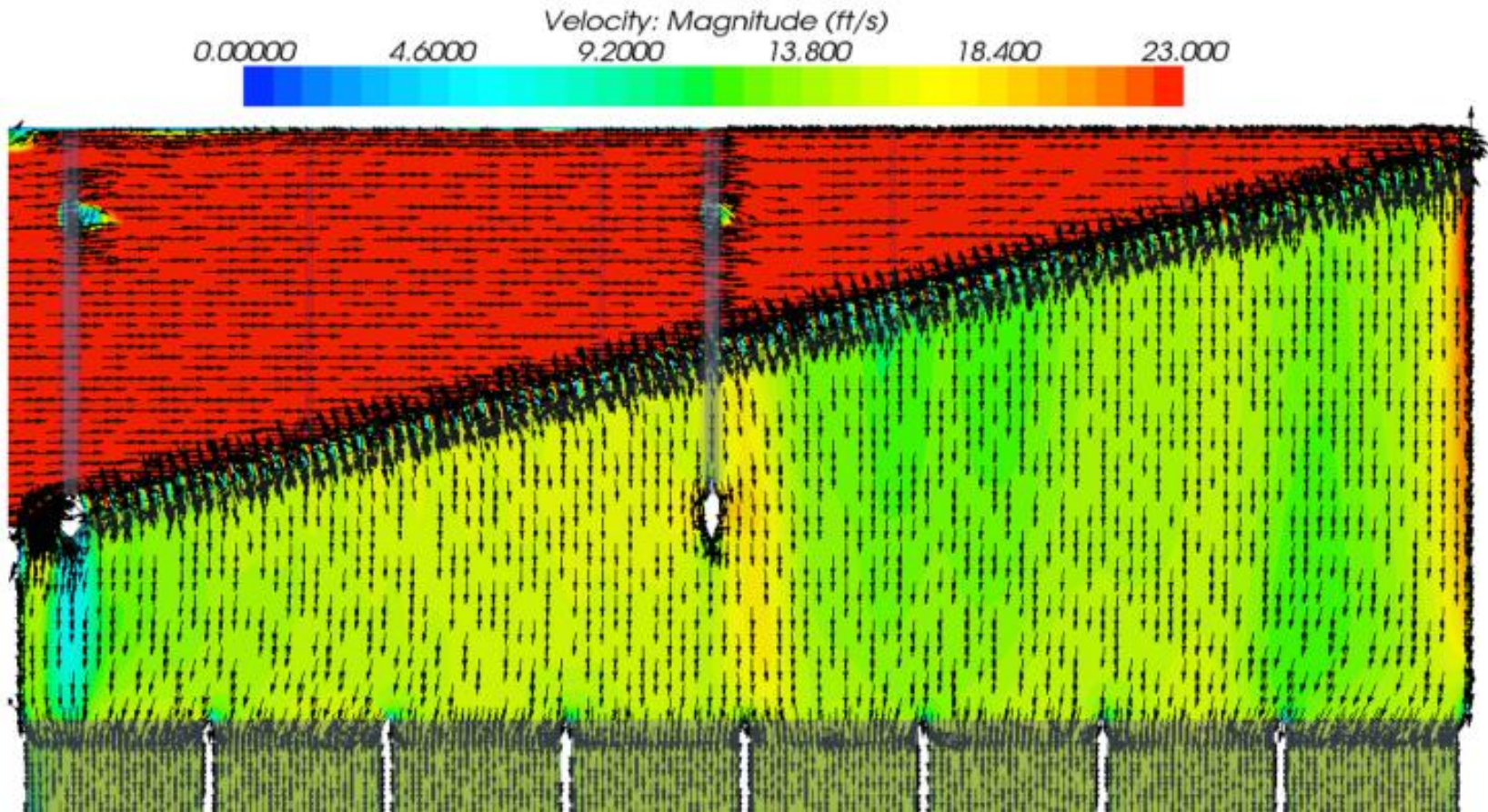
SCR Flow Distribution – Lac1 Ash Pluggage

Excess Flyash Pluggage – Layer 2 2nd Seal Strip



SCR Flow Distribution – Lac1 Hood GSG Mod

Vectors show very good straight flow in the hood.



- Graduated Straightening Grid (GSG) with variable perforated plate - uniform, vertical, non-recirc flow
- Egg Crate structural members removed

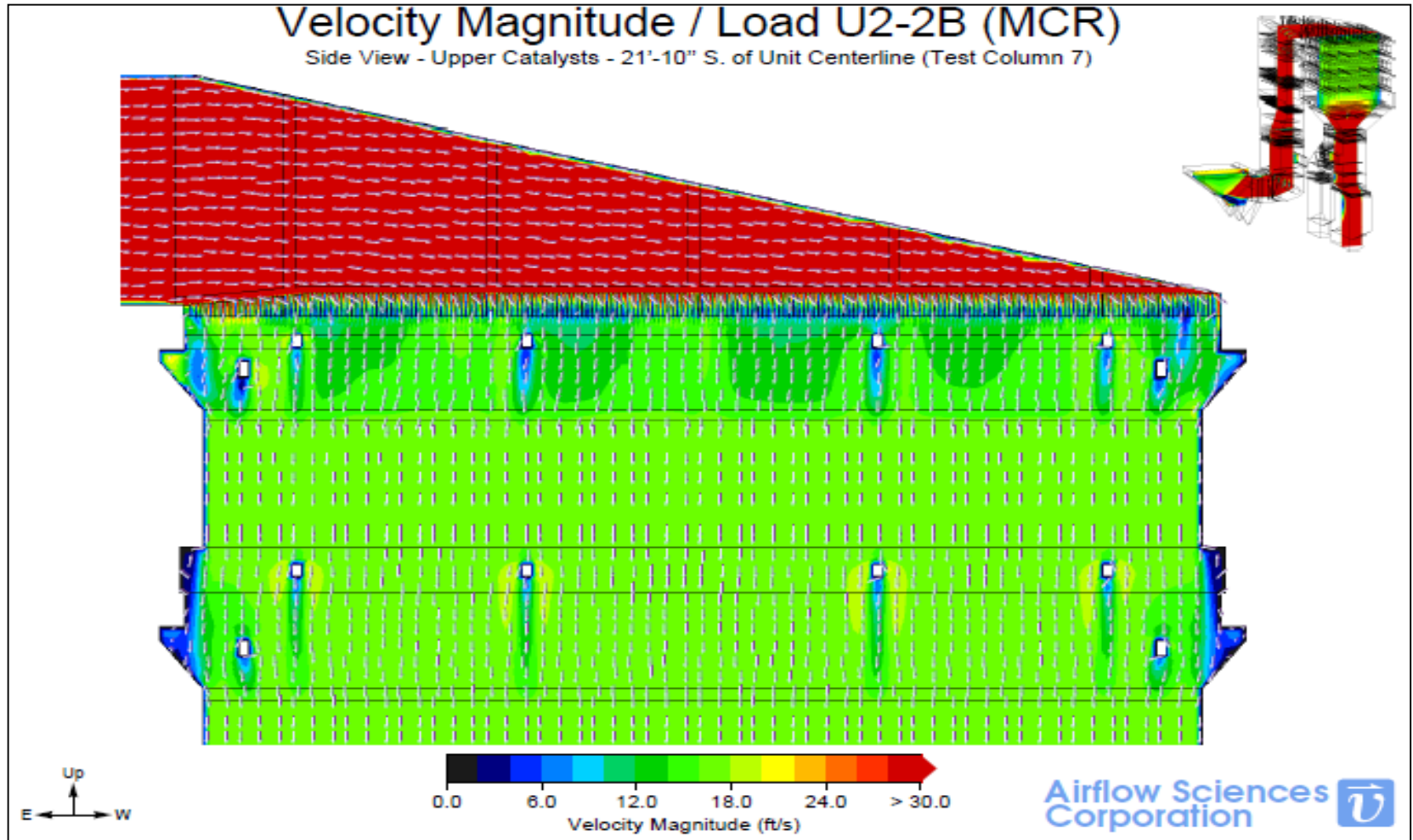
SCR Flow Distribution – Lac1 GSG CFD

CFD Flow Modeling Shows GSG Benefits

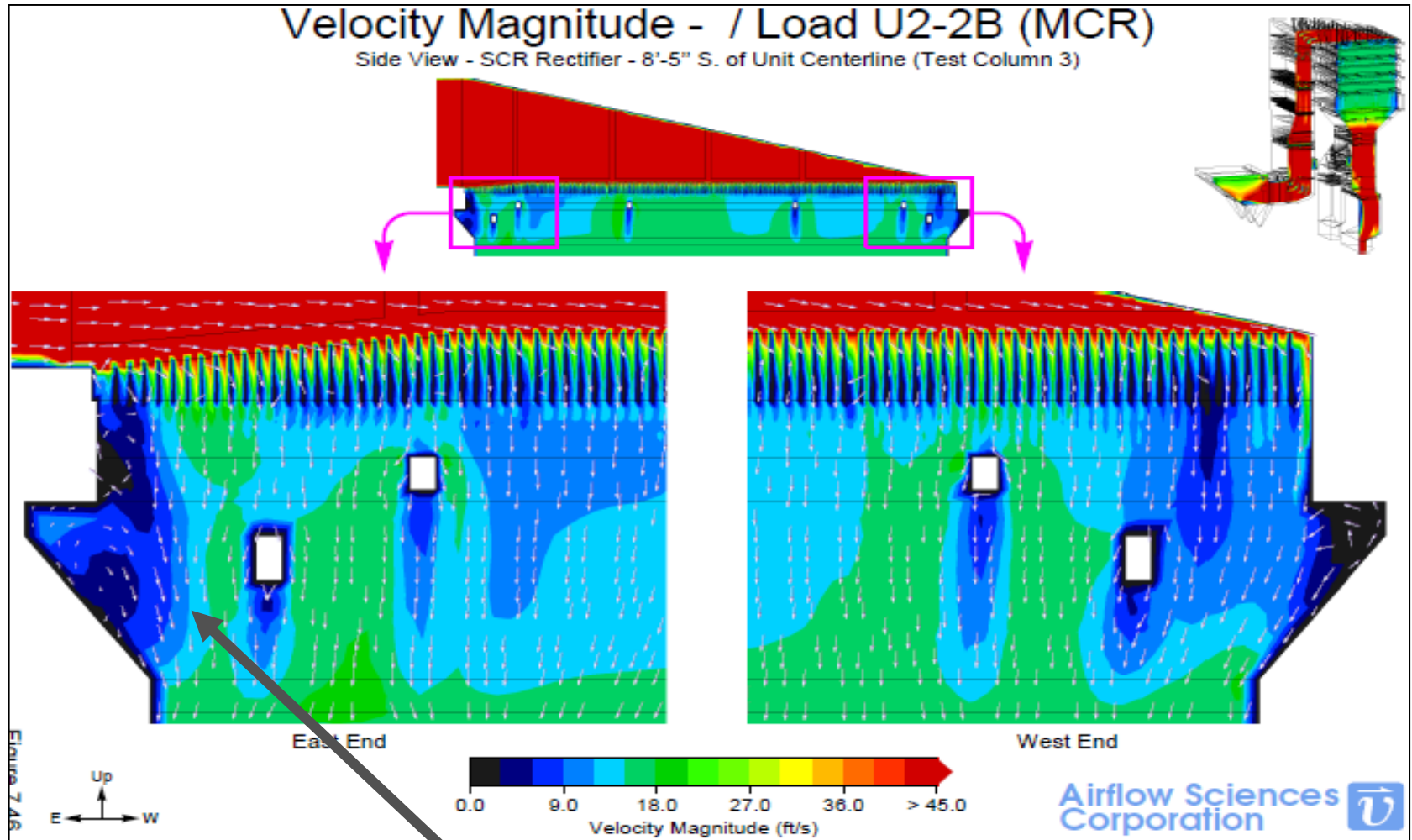
	Baseline	GSG	Desired
Flow +/- 15%	58%	91%	100%
Flow +/- 30%	94%	99%	Not Used
RMS	17.5%	9.5%	Not Used

SCR Flow Distribution – Lac2 CFD

Uniform, vertical, non-recirc flow. CFD & Physical Model agree. Improved model acceptance criteria.



SCR Flow Distribution – Lac2 CFD



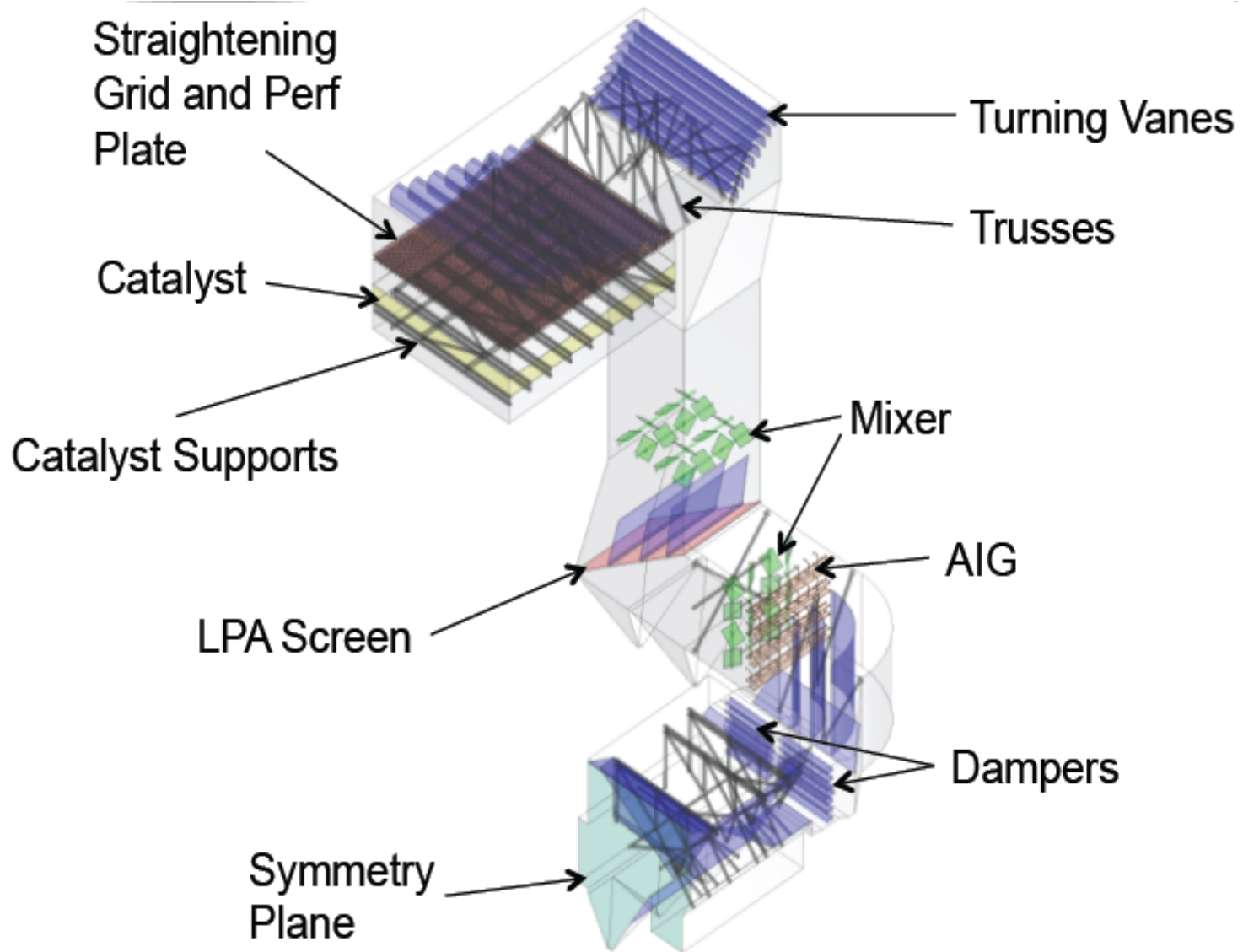
Flow recirculation at catalyst wall seals

SCR Flow Distribution – Lac2 CFD

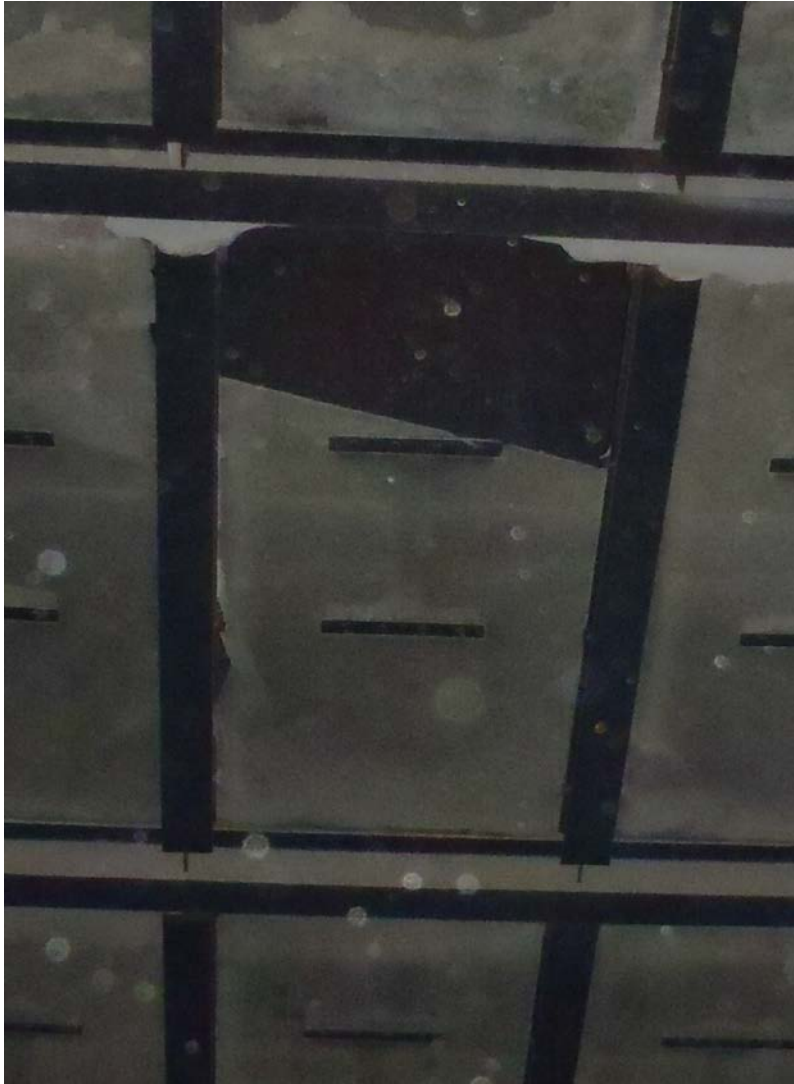


Flow recirculation at catalyst wall seals.
Minimize internal structure.

SCR Design Flue Layout – Lac1



Lac1 Flue Layout – LPA, NH3, Mixers

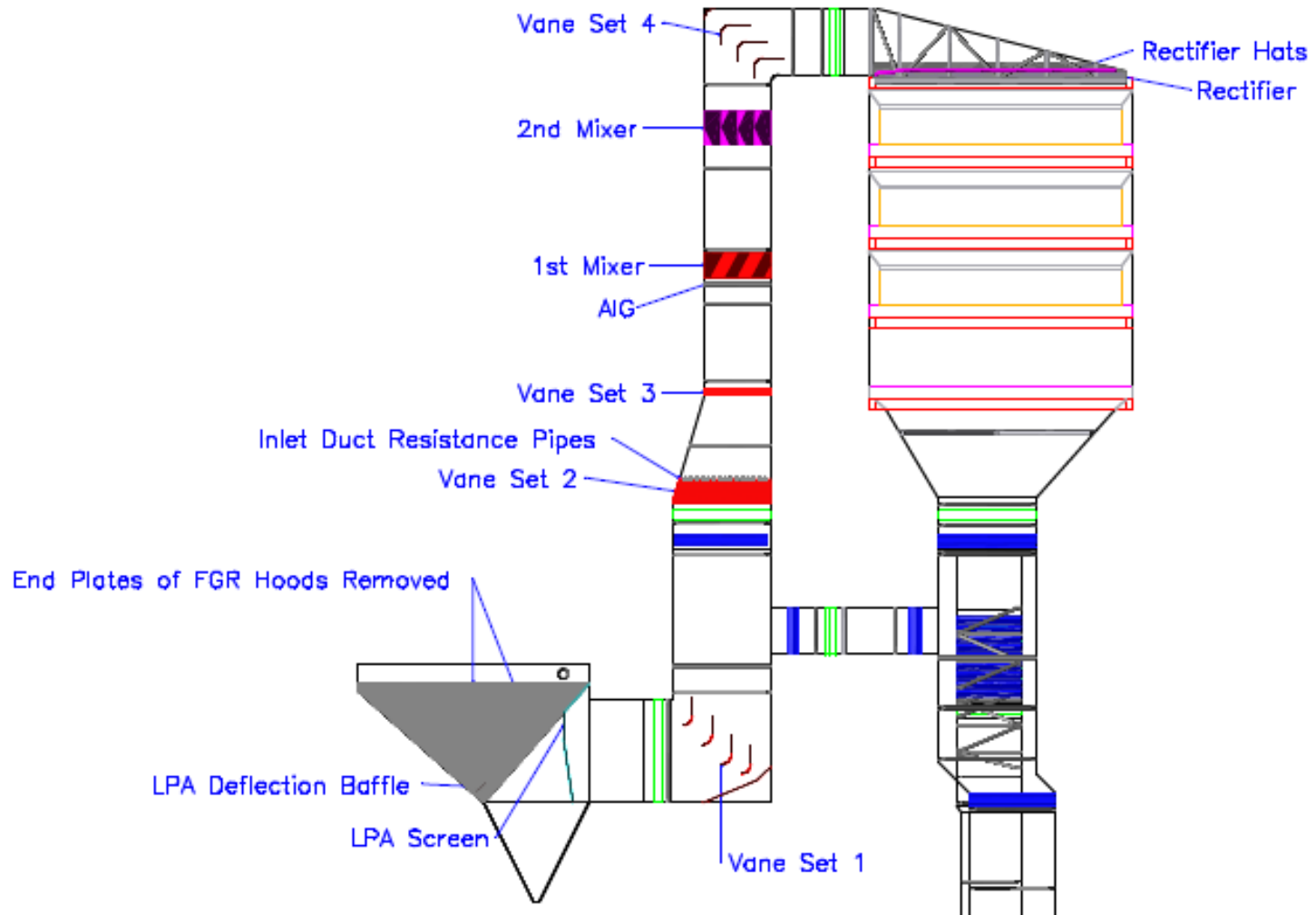


LPA Screen damaged by falling ash clumps

SCR Design Flue Layout - Lac2

Recommended Flow Control Devices

Overview of Flow Control Devices

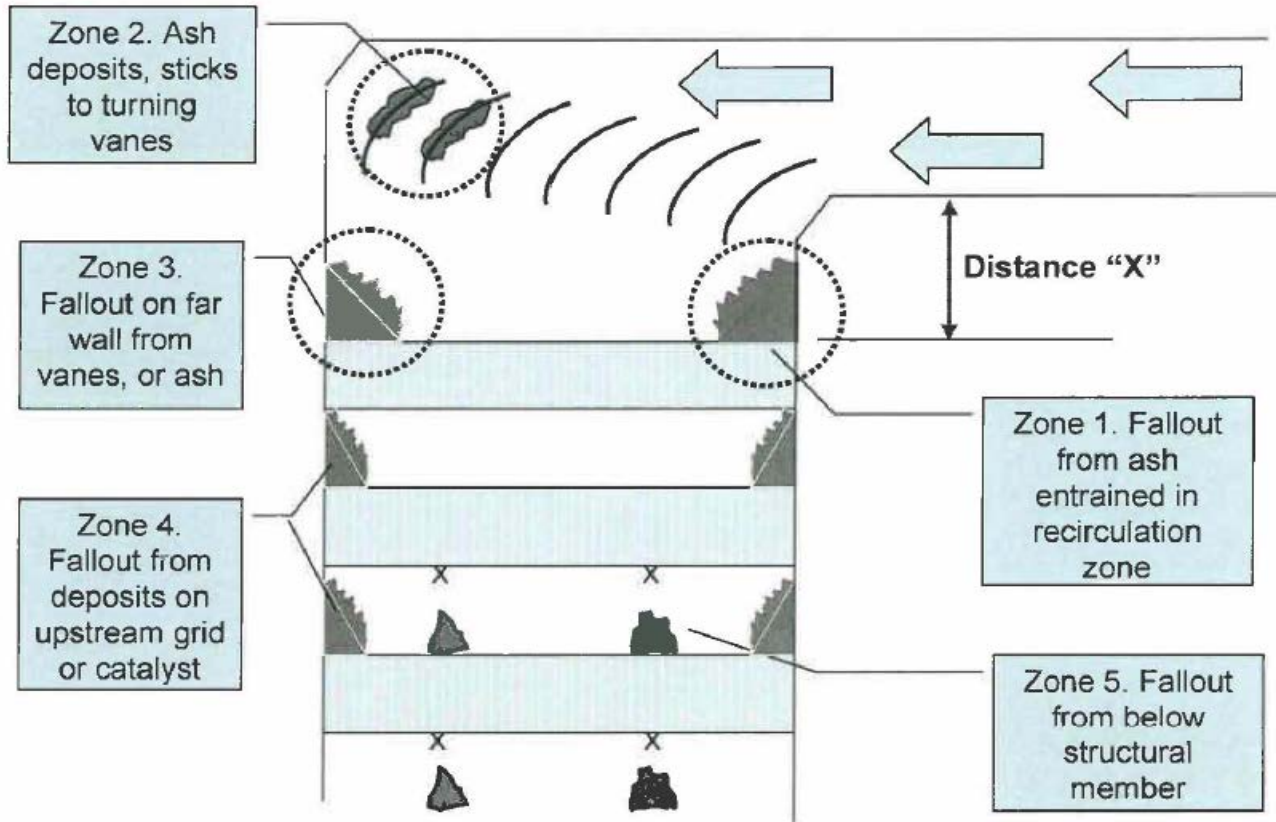


Minimize Internal Structure



Rectifier plugs below Top Hat flow recirculation

Minimize Internal Structure



Minimize Internal Structure

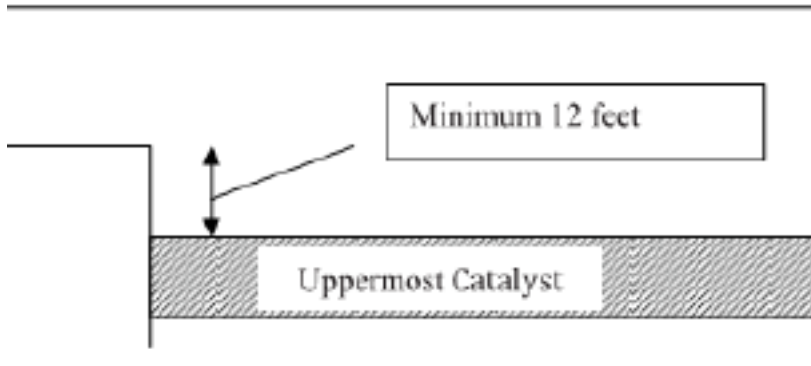
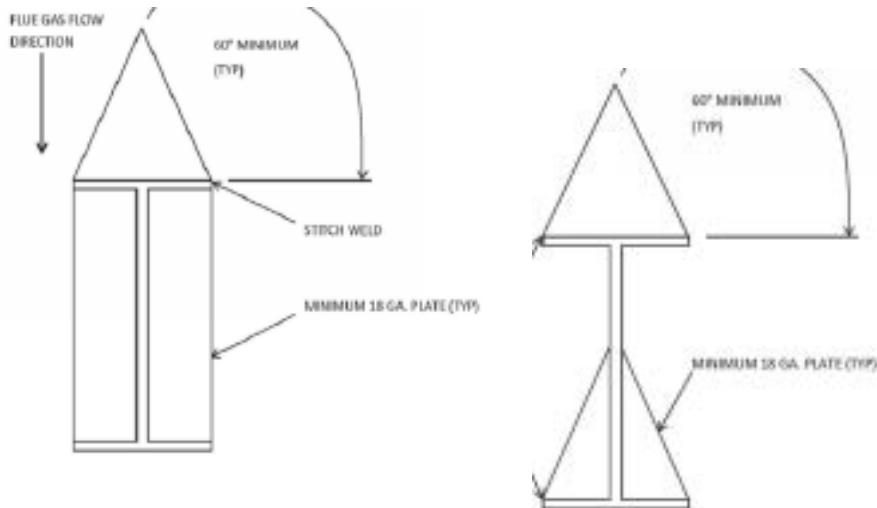
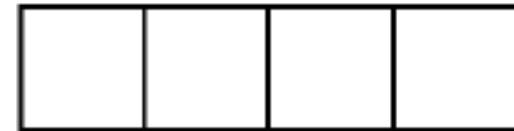


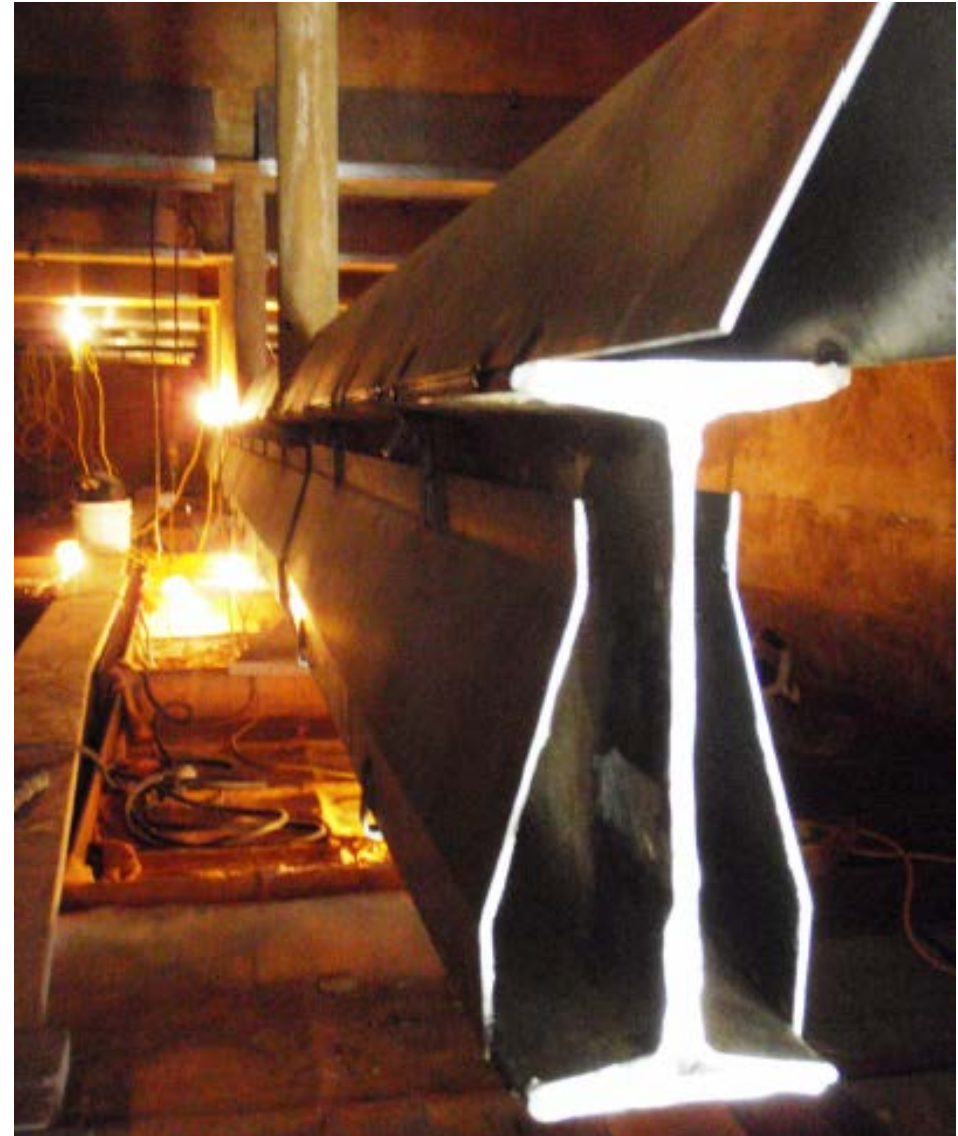
Figure 4 – Minimum Distance to First Catalyst Layer



Above not allowed within 1.5 x hydraulic diameter of SCR inlet



Lac1 I-Beam Ash Guards

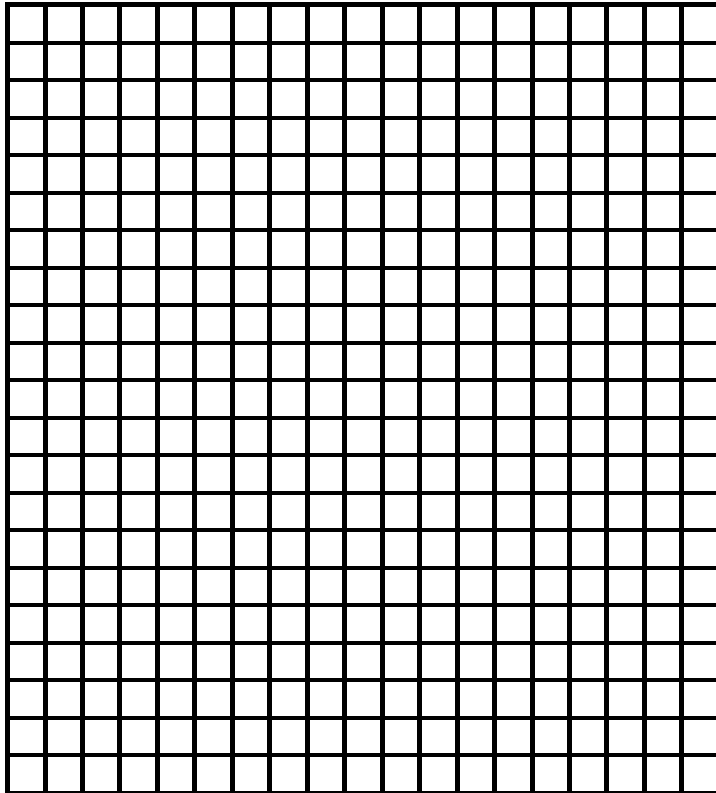


Lac2 I-Beam Ash Guard



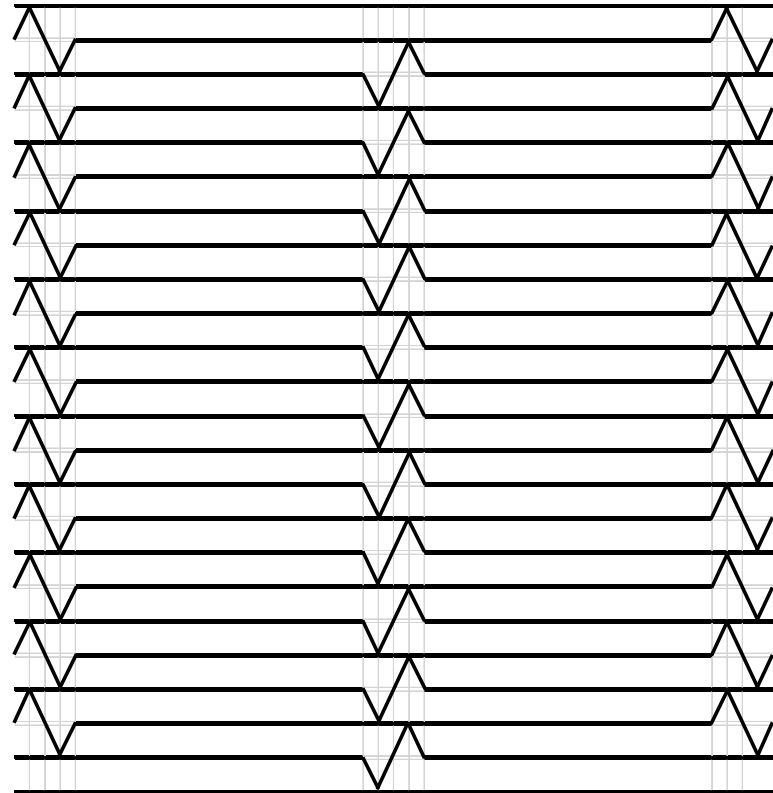
Catalyst Pitch

8.2 mm Pitch Honeycomb



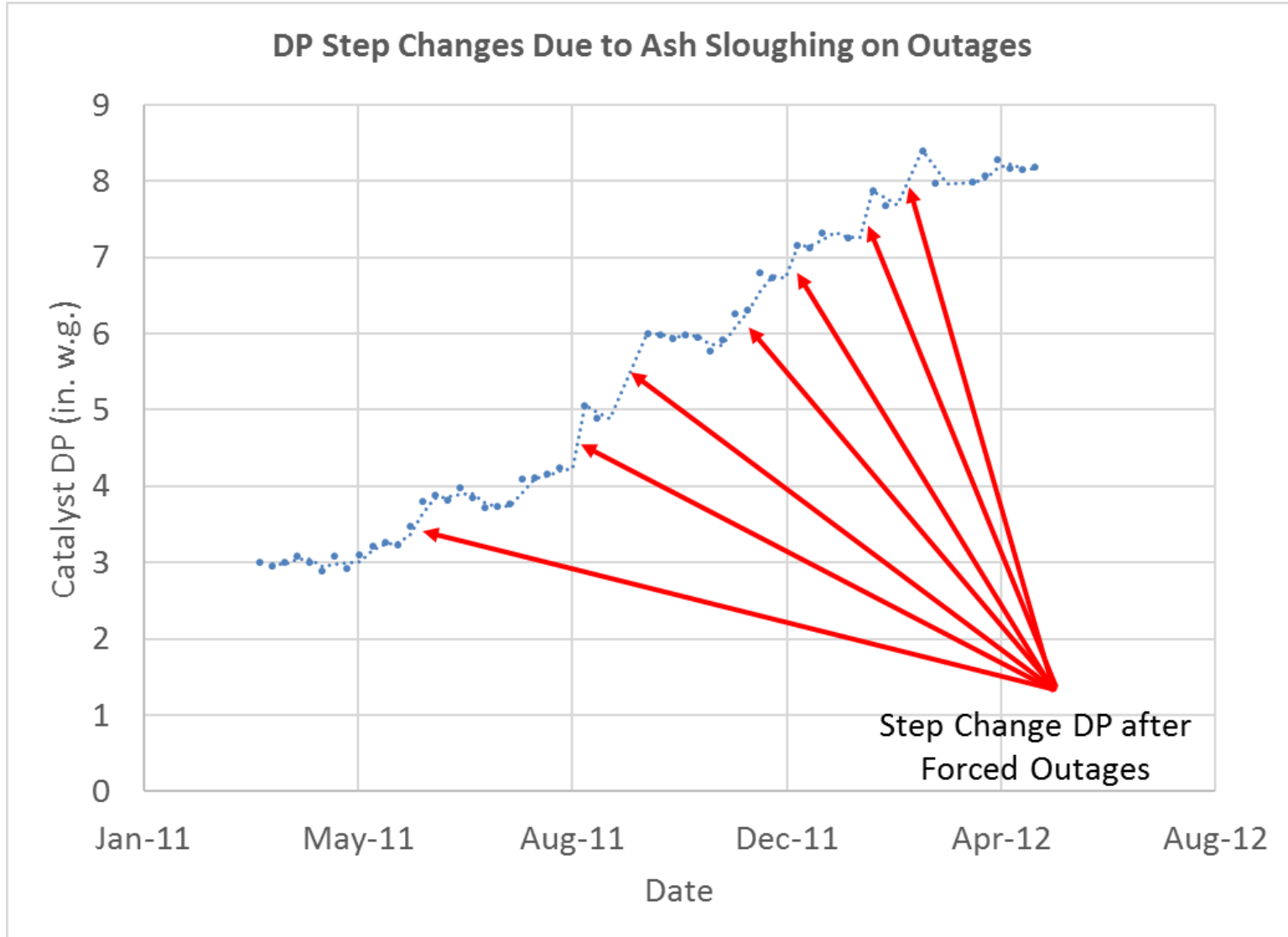
- 7.4 mm hydraulic opening
- 79% open area
- 426 m²/m³ specific SA

5.7 mm Pitch Plate

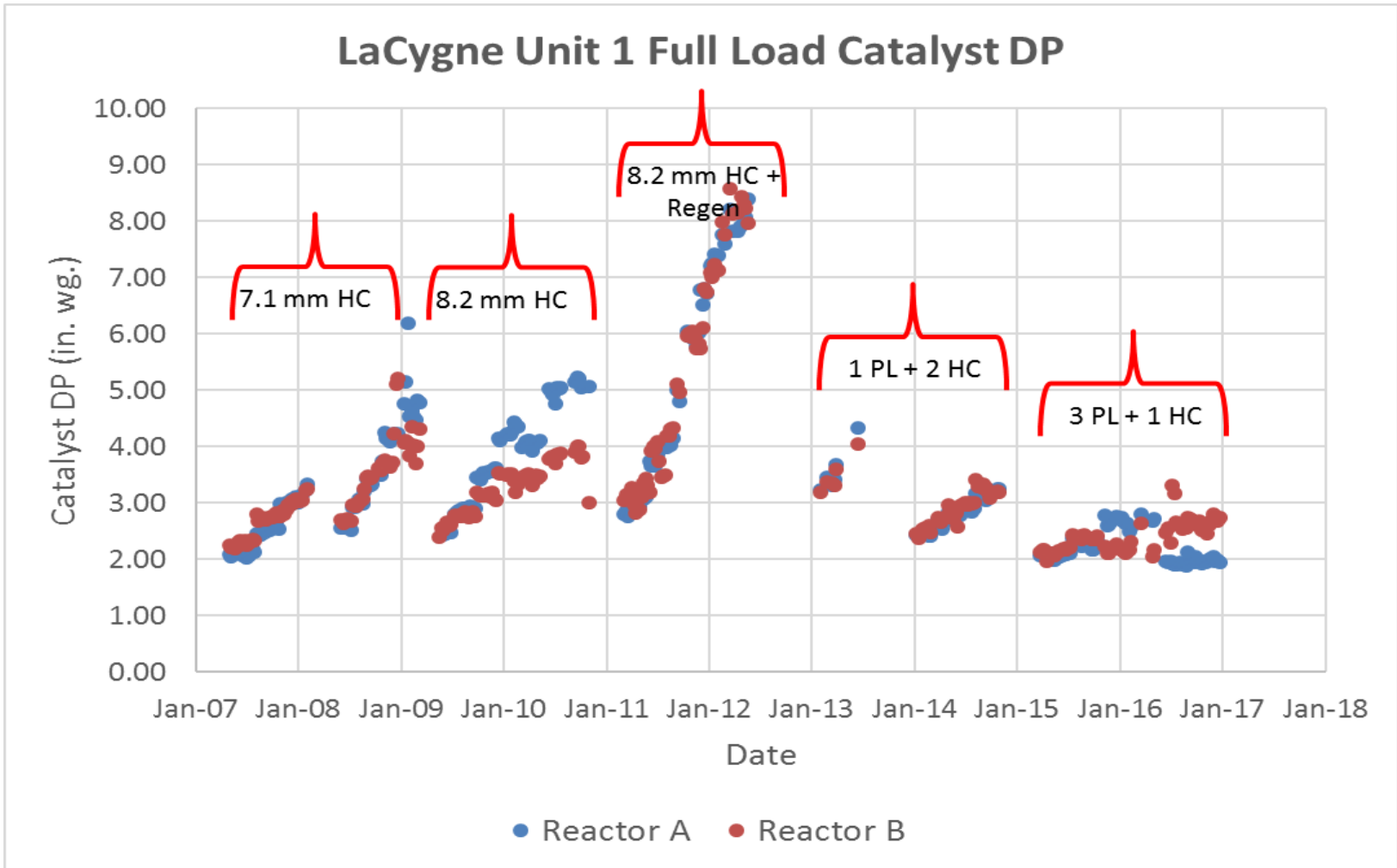


- 9.25 mm hydraulic opening
- 85% open area
- 351 m²/m³ specific SA

SCR O&M – PRB Ash Accumulation

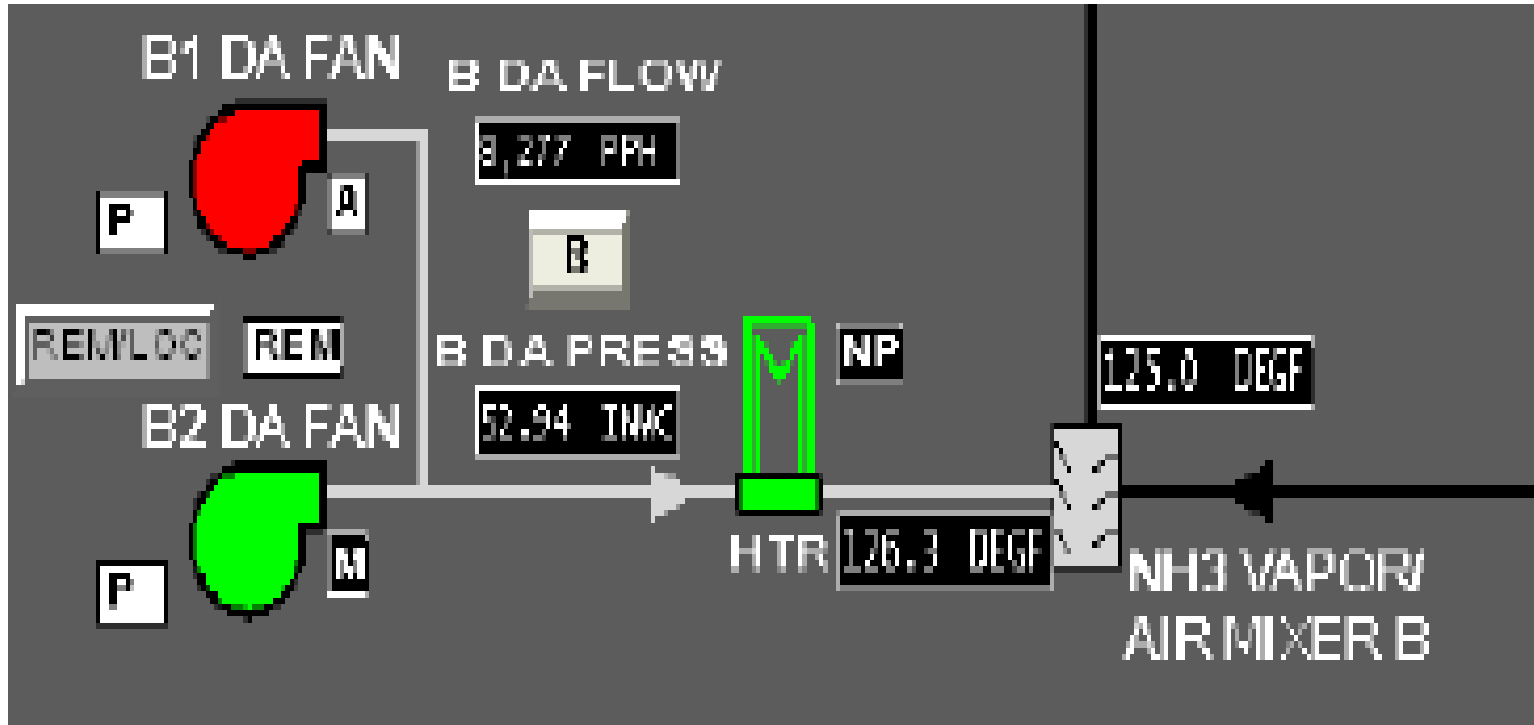


PRB Ash Accumulation



Lac1 GSG, Ash Guards, outage Dry-Ice Blast cleaning

SCR O&M – Outage Layup Heaters



- Catalyst outage layup heaters lower the air relative humidity and prevent ash solidification.
- Can also set up temp heat piped to doors/sonic horns

SCR Inspections - Catalyst Erosion



- Ash accumulation causes increased Rx flows
- Ash piles can redirect flow off of vertical
- Also inspect for dark sintering from high heat (LOI burns)

SCR Inspections - Catalyst Erosion



- Honeycomb catalyst erosion

SCR Inspect - Wall Seal Damage Causing Bypass



Wall seal damage

SCR Inspections – Ash Pluggage

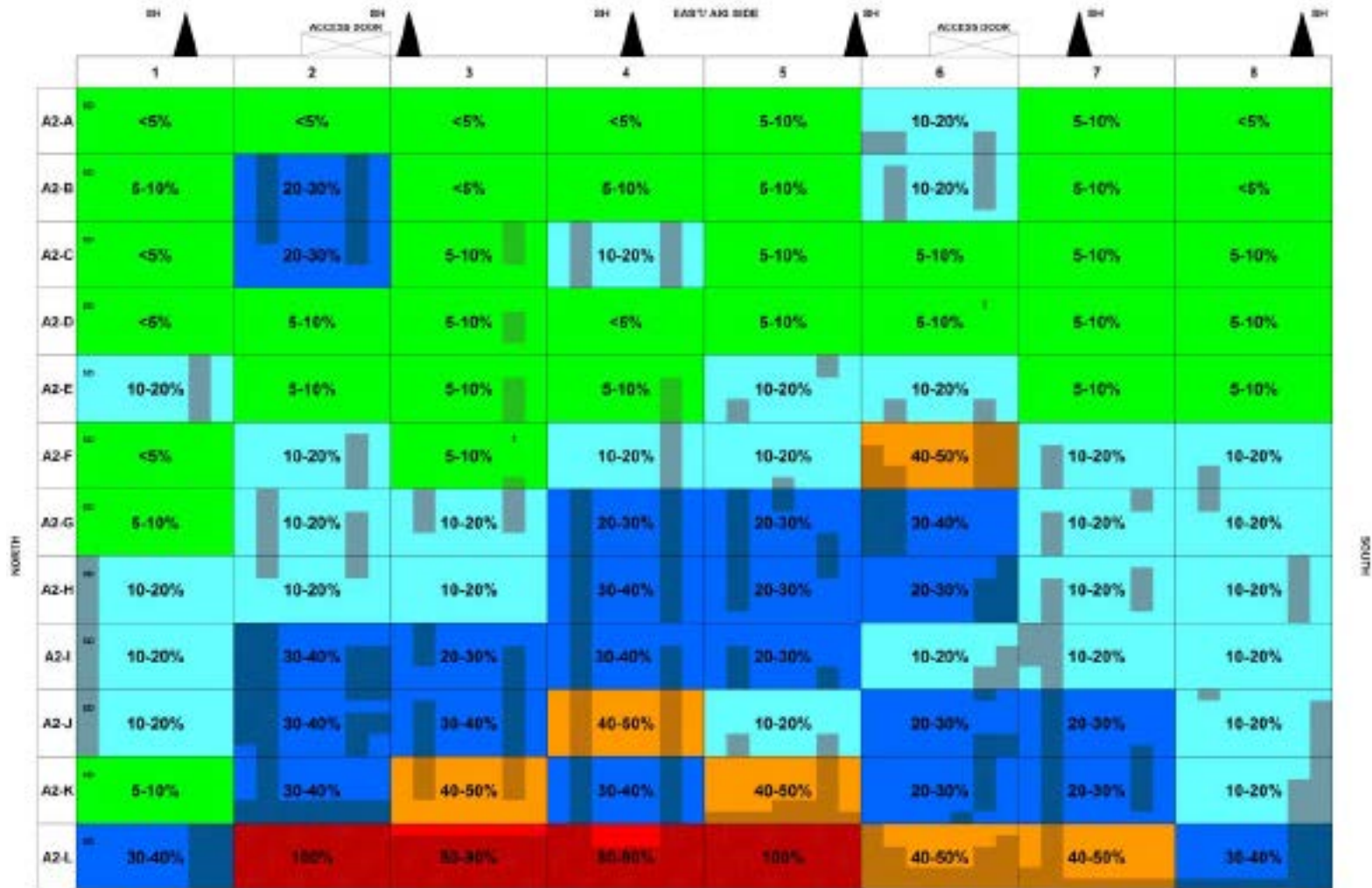


- Ash sloughs show areas needing ash guards.



- Inspect for water leakage in Roof & Expan Joints
Water carries ash poisons to Catalyst

SCR Inspections – Ash Pluggage Charts



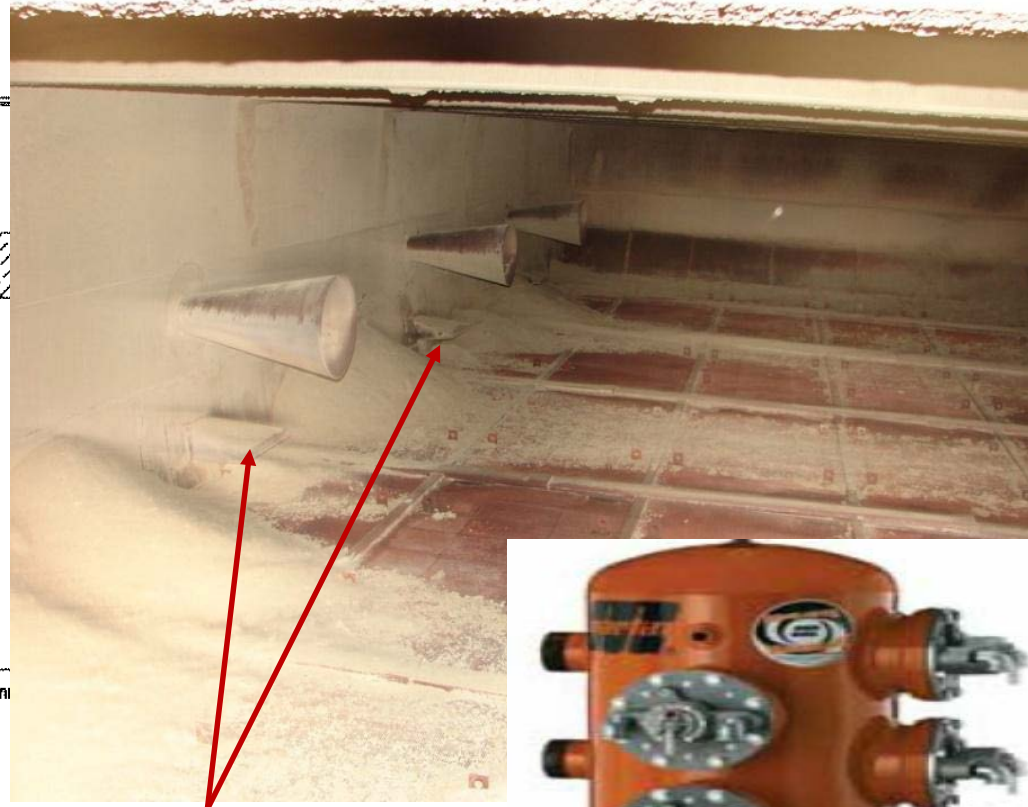
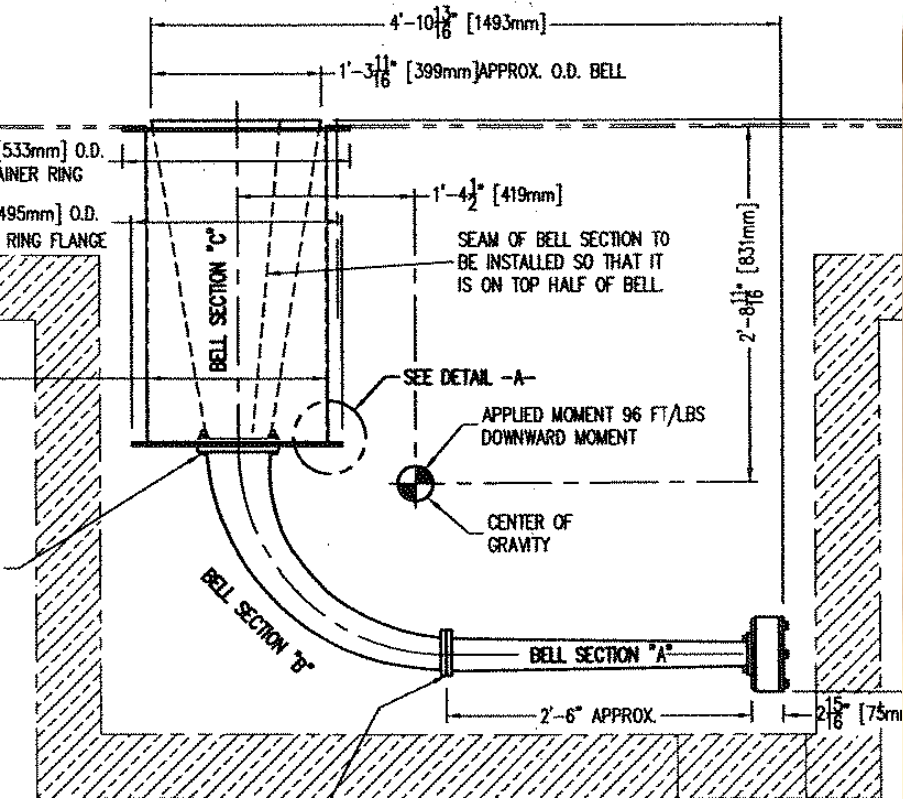
- Ash pluggage charts map problem areas.
- Pluggage percentage used in Catalyst life models.

SCR Inspections



- LPA Screen
- Ammonia Injection Grid
- Vanes & Mixers
- Reactor structure – erosion or member failure
- Sonic Horns

SCR On-Line Cleaning

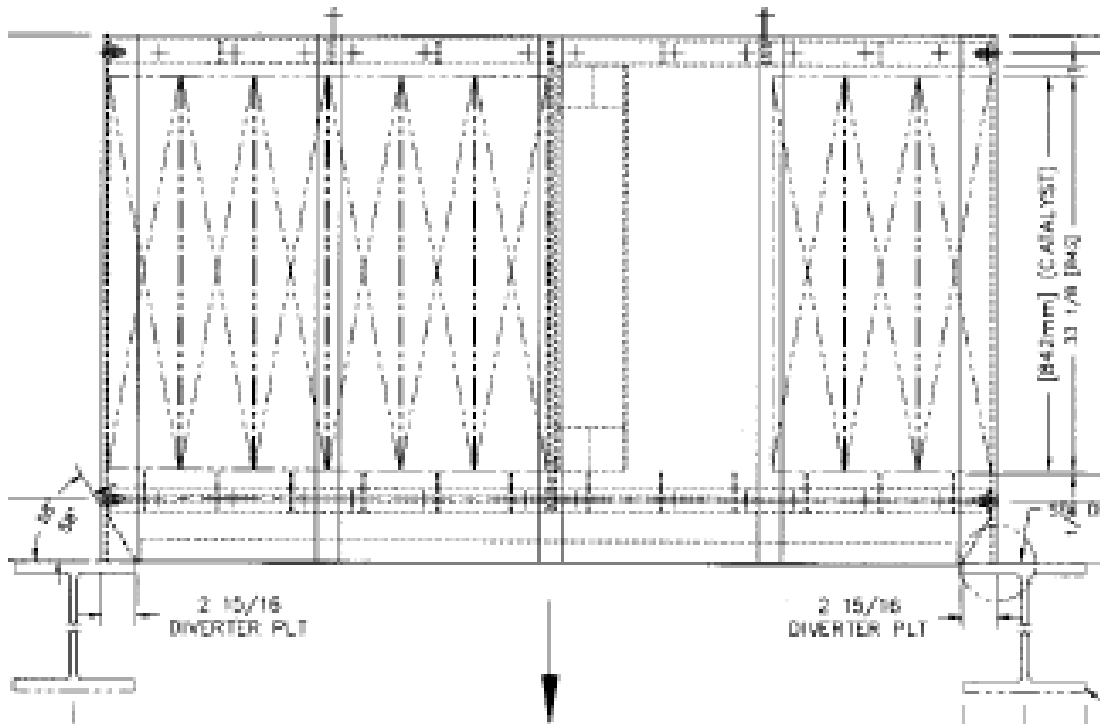


Fan Jet nozzles



On-line cleaning –
Sootblowers \neq Minimize Structure
Sonic Horns, Ash Sweepers

SCR Outage Cleaning



- Experienced Catalyst vacuum services crews
- Vacuum to Cover Screen
- Vacuum to Catalyst Face
 - Quickly after screen
- Vacuum, Air Lance, Vibratory typically gain 10-15% pluggage

- Air Lance, Dry-Ice Blast or Vibratory to reopen catalyst flow
- Dry-Ice Blast can return catalyst to <5% plugged (Not for LPA)
- Vacuum best on low %plug

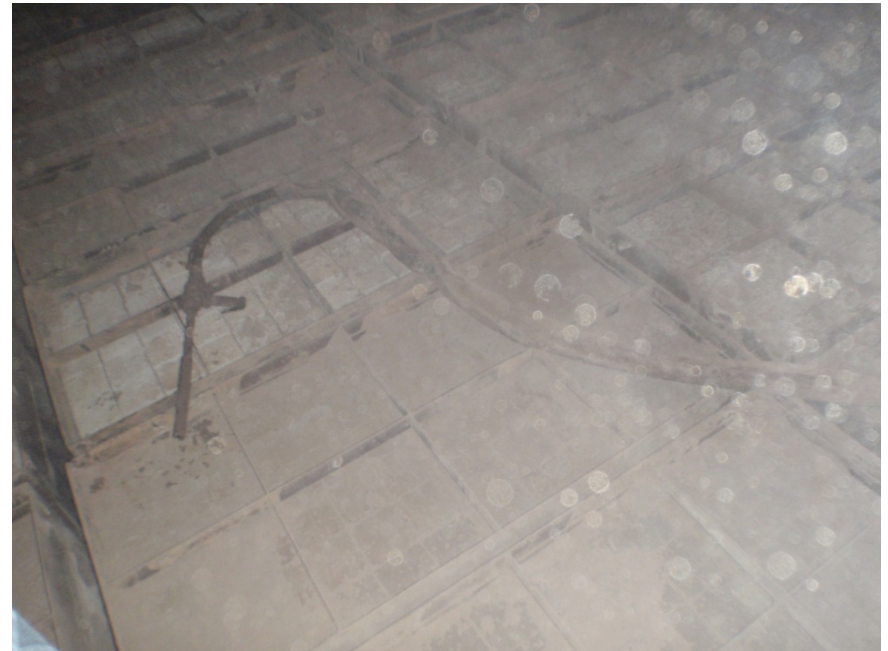
- DIB best on high %plug
- Catalyst Rejuvenation
- Catalyst Regeneration

SCR DIB Cleaning



Dry Ice Blast Cleaning

- First Performed in December 2013
- Approximately 45% of modules cleaned
- Reduced average pluggage from 29% to 9%
- Used again in future outages on modules >20% plugged



Questions?

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