



SCR & LPA Screen Efficiency: Case Study and Results

APS Four Corners

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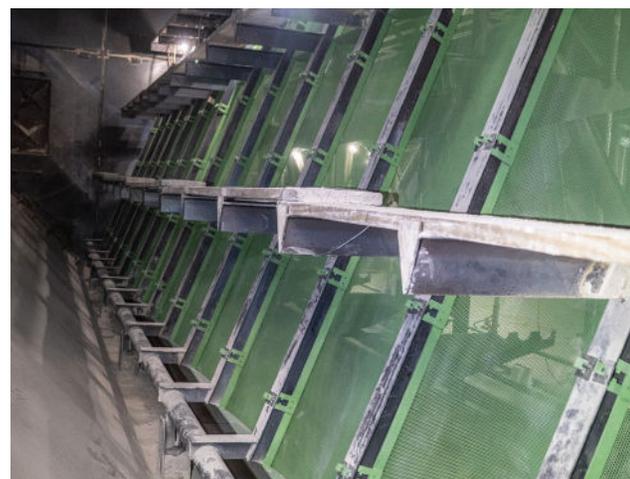
1. Background

Efficiency and productivity of Selective Catalytic Reduction reactors, or SCR reactors, are critical components of all plants that must meet modern NOx emission requirements. Four Corners Generating Station, a 1,540 MW coal-fired plant near Fruitland, New Mexico, understood the challenges associated with SCR optimization and took the necessary steps to combat these obstacles. This plant, owned by Arizona Public Service Company (APS), utilized the expertise of Riley Power, who served as the OEM for the SCR installation, before looking to Integrated Global Services (IGS) to provide the original SCR cleaning systems.

Upon the design and installation of the Riley Power SCR systems on Units 4 and 5, commissioned in Spring and Fall of 2018 respectively, the plant underwent a period of operational success experiencing proper DeNOx performance, while meeting or exceeding the designed efficiency values. However, over time, the SCR systems experienced reliability and efficiency issues from natural wear and tear and lack of maintenance. This, in turn, indicated the need for system upgrades, and IGS was once more called on to administer these improvements.



APS Four Corners



IGS LPA Screens





2. Diagnosing the Problems

After roughly six years of SCR operation, the SCR began experiencing significant ash piling issues resulting in high system pressure drops, plant derates, excessive vacuuming costs, and shortened catalyst life. The system had been getting progressively worse over the prior 4 years. Upon inspection, it was clear the air cannon system was no longer fully operational and LPA had reached the SCR.

3. LPA Screen Summary

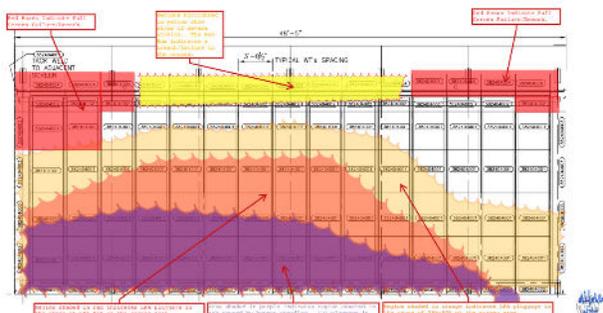
The LPA screen hopper screw conveyor in the original system, which was not supplied or specified by IGS, proved to be a challenge to keep operational and effective. The screw conveyor stopped operating in approximately 2020. In 2023-2024 the site added vacuum ports to the hoppers below the LPA screens to remove ash while the system was online, in an attempt to mitigate ash piling on the LPA screen. Even with these modifications, the LPA hoppers suffered from excessive ash piling around the LPA screens, yielding the screens approximately 50% plugged or blocked. The increased velocity through the remaining open screen areas caused severe premature erosion on the original LPA Screen panels, reducing their life span to about five years of operation. Previous inspection reports of the LPA screen system predicted this premature failure due to the increased velocities, and the screens actually lasted longer under these circumstances than anticipated.



LPA Found in SCR



LPA Erosion due to Increased Velocities



Inspection Map Showing Ash Piling



Ash Piling on LPA Screens





4. Verification of LPA in SCR

According to the LPA analysis performed at the IGS Technology Solutions laboratory, it was proven that all samples of LPA at Four Corners exhibited characteristics of slag and ash LPA types with a porous, sintered matrix surrounded by fly ash agglomerates.

These structures, combined with the high melting points of possible eutectic compounds, confirmed that the ash samples were formed in high temperature regions close to the burners in the furnace.



Erosion on LPA Screens Caused by Increased Flue Gas Velocities



LPA Screen Ash Piling

5. Short-Term Solution

Due to the LPA Screen failures, this LPA was allowed to reach the SCR, and was a significant contributor to the fly ash piling experienced in the SCR. This combined with limited functionality of the SCR air cannon system, along with an isolated maintenance event where steam was released into the SCR cementing the buildup, led to SCR buildup becoming a major concern.

Since Unit 5 had operated for a longer period than Unit 4, it was determined that buildup in the Unit 5 SCR was an even greater concern that had arisen during its final year of operation.

IGS identified these problems and predicted the various issues before supplying LPA patch material to affected regions. This allowed the plant time to formulate a more permanent solution but only provided temporary relief from an otherwise larger problem.





6. SCR Air Cannon Summary

Positive pressure also became an issue for the supporting equipment as it took its toll on the SCR air cannons, discharge piping, and firing assemblies. The air cannons were operating ASME pressure vessels, but appeared to have suffered significant interior corrosion.



Many air cannons were found to have pinhole leaks in their tanks and discharge piping, and some had even fallen off of the SCR wall due to piping structural failures. Not only did this impact cleaning performance, but this was a significant safety concern. All air cannons would have to be replaced prior the expected end of the plant life of 2031.

Additionally, the connecting thermal safety shields were leaking due to the positive pressure system. The thermal safety shields were functional gate valves used to isolate individual cannons for maintenance, but they were not air tight. They were constructed with Sch. 40 carbon steel pipe, that had been threaded.

The thin threaded carbon steel metal was corroding quickly due to the exposure to atmosphere, allowing the air cannons to break off the unit during a discharge. These findings were significant safety concerns and the maintenance became intensive and difficult, which limited the overall effectiveness of the system. The most cost effective solution was to replace the entire system as soon as possible.



Piling due to Inoperable Air Cannons



Failure of Air Cannon Discharge due to Corrosion

The site also had increased the SCR from a 3 layer system to a 4 layer system. This increased the rate of sulfuric acid formation, a side reaction of NO_x Reduction Catalyst. Sticky sulfuric acid was forming in the preheater, allowing the ash to further plug, increasing the back pressure through out the system.





7. Financial Implications

With all these compounding issues, the booster fans were struggling to perform and overcome the system back pressure. This resulted in more maintenance costs for the fans, SCR, and baghouse. The site also saw a reduction in MW produced during the summer run due to inability to reach full load because of this high pressure drop.

The financial implications of these various issues also proved to be a significant factor for the plant due to production derates and pressure drops.

Although APS is not able to share specific financial information, it has been documented in similar sized units for 1 inWC of excess pressure drop to equate to 1 MW or more consumed by the ID fan, which is still a relatively small number when compared to the lost generation and revenue due to limited plant capacity.

Manual vacuuming of the SCR also became expensive, and if allowed to go unchecked and unchallenged, these losses could have become catastrophic for the plant.

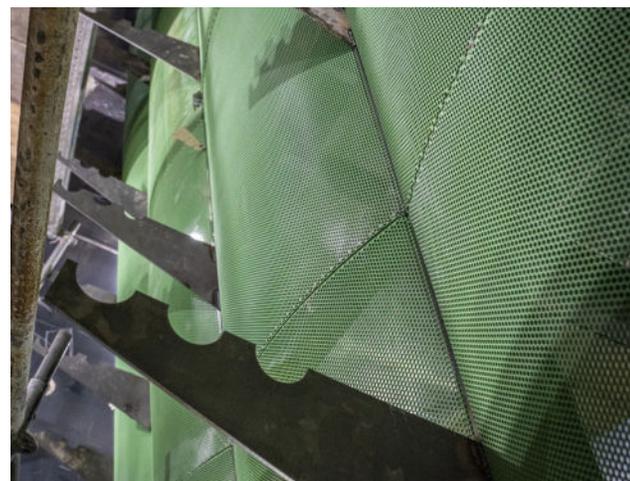
8. Corrective Actions and Implementation: LPA Screen Improvements

After diagnosing the issues surrounding the LPA screens, online cleaning systems, and buildup around the SCR, IGS strongly recommended the LPA screens and SCR air cannons in Unit 4 and Unit 5 be replaced before further damage could be done to the catalyst. Due to the system's highly erosive state and elevated velocities through the screen, ash piling and flue gas acceleration had increased dramatically and escalated the need for early screen replacement.

The LPA screen panels were completely replaced in both Units 4 and 5. The coating material was upgraded to the IGS Two-Stage coating to provide additional erosion protection, but more importantly allow for a quick visual inspection for future maintenance.



Replaced LPA Screens with Bolt in Scaffold Brackets



New LPA Screen Panels with Upgraded Two-Stage Coating





9. LPA Screen Cleaning System

IGS recommended repairing the hopper screw conveyor, however APS decided to not fix this system. Therefore, IGS was instructed to optimize the LPA screen cleaning system to help mitigate the impacts of the ash piling, as well as improve the effectiveness of the hopper vacuuming ports.

To accommodate, IGS recommended and replacing the outdated rapper cleaning system with an LPA screen air cannon cleaning system. This system was better suited to handle the upset flow conditions caused by potential ash piling, and was also able to help re-entrain and redistribute the fly ash pile, helping to slow its growth and improve the effectiveness of the hopper vacuuming ports.



Air Cannon Header Nozzle on Screen



Air Cannon Multipliers

This air cannon system was designed and installed, allowing for the removal of the rapper system structure, also improving flue gas flow. An IGS air cannon monitoring system was also installed to verify proper operation of the air cannon system, reducing the need for physical inspections, and alerting personnel of any potential issues to allow them to be addressed quickly, keeping the system operational.

10. SCR System Improvements

The original SCR air cannon system worked well initially, but its design was not adequate for the positive pressure application, resulting in excessive maintenance requirements and safety issues. The result ultimately was many of the air cannon units were removed from service over time, exposing the SCR to fly ash accumulation.





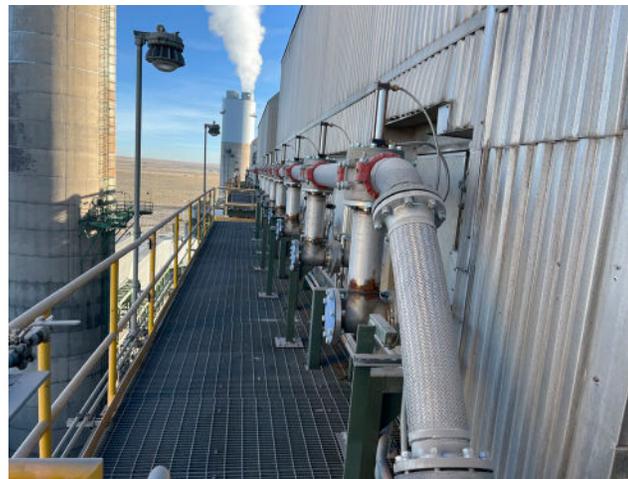
10. SCR System Improvements: IGS Air Cannons

IGS designed and supplied an air cannon system specifically designed for positive pressure SCR units on both Units 4 & 5. Firstly, IGS moved to the IGS Multiplier system, which reduced the ASME pressure tanks from 32 per unit to 4 per unit. This also distanced the critical pressure air cannon components away from the process and the multiplier system added a protective layer between the process and the air cannon itself. This dramatically reduced the maintenance requirements while also making the system more resilient the challenges of a positive pressure unit.

Next, IGS upgraded the discharge configuration and materials of the discharge piping. By routing the discharge piping in such a way that the multiplier was above and a certain distance away from the nozzle penetration, this minimizes corrosion and clogging of the system. This discharge piping after the multiplier was also upgraded to a stainless steel.



Upgraded SCR 8" Big Blue Air Cannon



Air Cannon Multipliers

To improve cleaning performance, the system was upgraded from 150L 4 inch air cannons to an 300L 8 inch air cannon. This dramatically increasing cleaning power and distance in the reactor. Additionally, the nozzles were changed from a narrow blast to a more powerful yet wider spreading blast.

Lastly, an air cannon monitoring system was installed on the SCR as well. This system provides feedback to the DCS, alerting personnel if there is a fault with the air cannon system. This reduces the need for physical inspection, and more importantly, allows for a quick repair of the system the event there is a fault. This prevents damage to the system while also preventing a long period of non-operation which could allow for catalyst plugging.



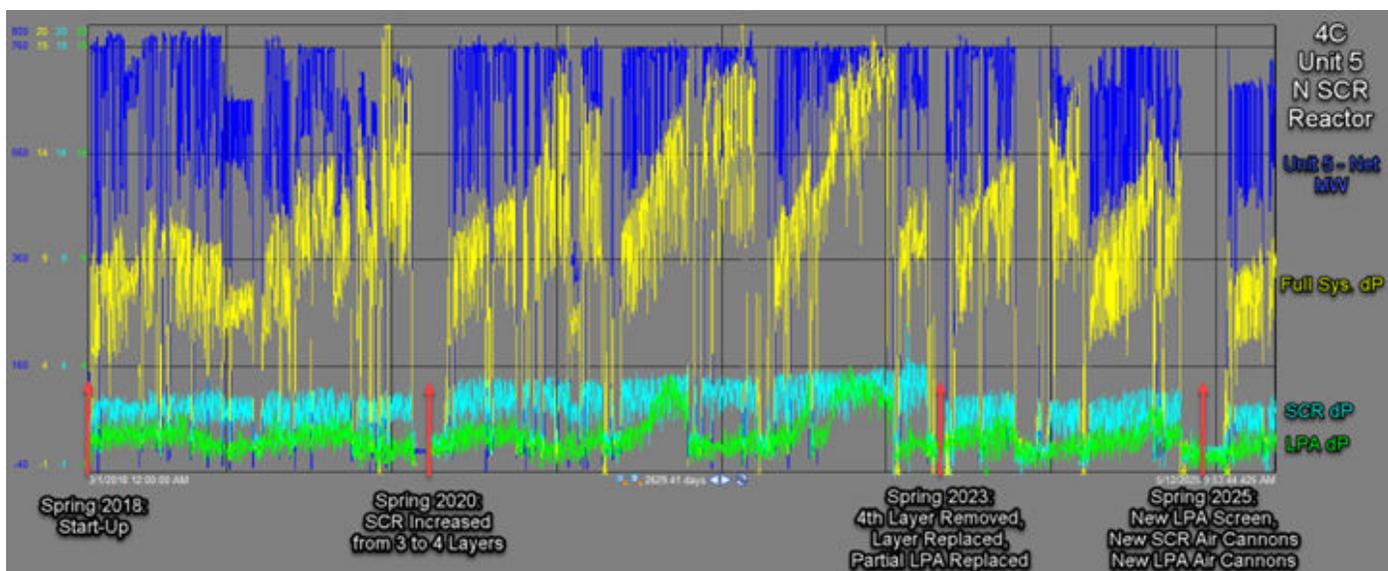
11. Results

After installing and operating the upgraded LPA screen system, SCR Big Blue air cannons, a new catalyst layer on Unit 5, and some improvements to the Air Preheater, the plant reviewed the relevant data to examine the full system back pressure (dP). The preliminary results indicated a promising outcome from the installation. After 100 days of operation, the plant experienced a 30% - 60% improvement in back pressure, which APS designated as a “huge” improvement. This has eliminated the risk of system derates due to pressure drop in the SCR and LPA screen and restored the catalyst life. Unit 4 is showing similar promising results after operating approximately 50 days.

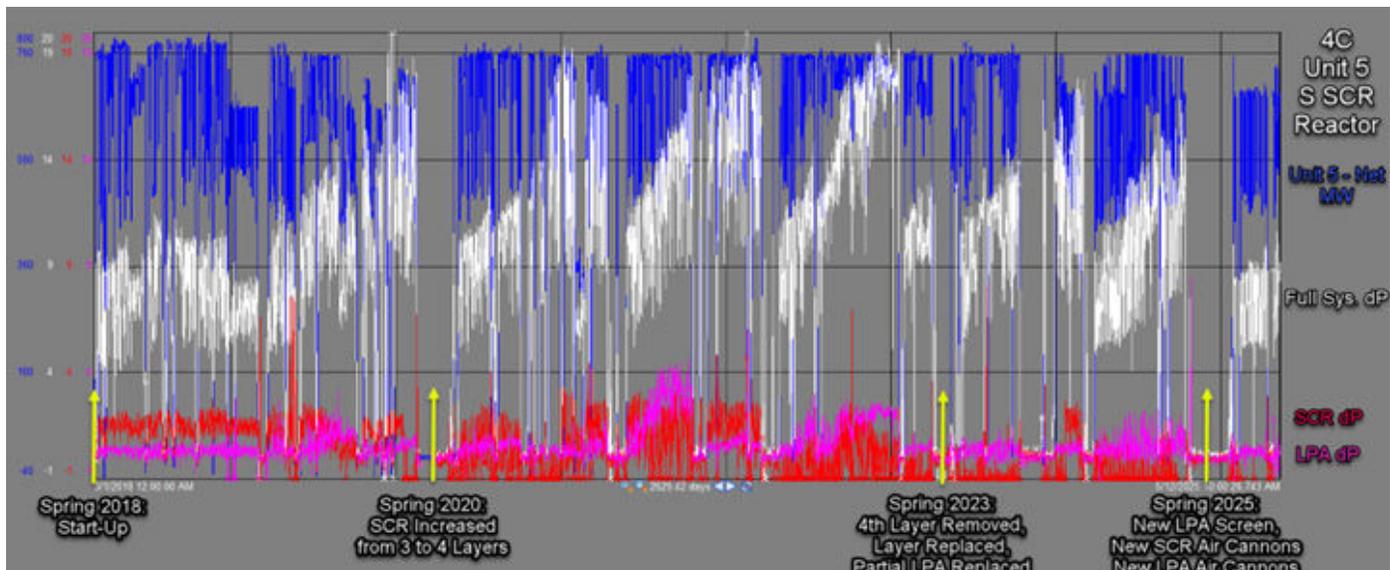
On average, the rate of plugging was reduced by about 30-60% (28% in Unit 5 North and 33% in Unit 5 South) while maintaining low dP at the LPA screen, as predicted. Thus, the whole system saw significantly less buildup, resulting in cost savings, energy savings, extension of the catalyst life, and improved maintenance. Plant engineers described the system design to be “working as intended” with performance capabilities meeting expectations.

Historically, Unit 5, which was a major area of concern and had run for around 8% longer than Unit 4, had approximately 12-13 in-H₂O of dP at 675 MW. After the LPA screen and online cleaning improvements, the plant experienced an operation closer to 9.5-10.5 in-H₂O of dP. They also expect that after 200 days of operation, which will be re-analyzed in June 2025, Unit 5 will recover approximately 2-6 in-H₂O, or 2-6 MW of losses or more.

Below is an illustration of pressure drops of Unit 5 North and South from initial startup in March 2018 all the way to the present-day data of April 2025. Marked improvements can be seen in LPA dP, SCR dP, and full system dP, especially after the implementation of upgraded systems in Fall 2024.



System Pressure Drop Data Before and After Installation



System Pressure Drop Data Before and After Installation

12. Conclusion

After a combination of improvements made on the LPA screen system, SCR system, and baghouse, APS Four Corners Units 4 and 5 were able to return to full load and operate more efficiently. The system pressure drop was reduced by up to 40%, SCR catalyst life was extended by 2 years, safety was improved while maintenance costs were reduced, deNO_x remained in compliance, and pressure drop related derates were eliminated.

The total cost of the improvements was approximately \$3M per unit, and while elimination of derates alone justified the project, this project eliminated 2 catalyst layer change outs per unit assuming an end of life of 2031 for the plant. This added another \$2.2M in ROI per unit towards the project data.

The improvements at Four Corners and other plants who have underwent similar installations foreshadow a potential shift in market sentiment surrounding updated SCR cleaning techniques. Plants can now utilize technological advancements to improve production, satisfy environmental regulations, and ensure their SCRs run safely and effectively. Adopting such technological improvements are crucial for coal fired powerplants to remain competitive and relevant in today's energy markets.



13. Before & After Photos

LPA Screens



LPA Piling



IGS LPA Screen Prevents Piling



LPA Found in SCR



Clean SCR Guarantee



13. Before & After Photos

Air Cannons



Inoperable Air Cannons



IGS Big Blue Air Cannon



Multiple Air Cannons



Air Cannon Multiplier System

