

Technical Paper

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Intelligent Heat Transfer Management through Individual Sootblowing Optimization

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Introduction

This paper highlights the successful application of individual sootblowing optimization with Babcock & Wilcox Power Generation Group, Inc.'s (B&W PGG) Powerclean[®] intelligent sootblowing system on a coal-fired utility boiler in the United States. The boiler operated with the sequenced-based version of Powerclean since 2009 and in June 2013, upgraded to the latest version, Powerclean NX with individual sootblowing. The boiler is a supercritical, B&W PGG universal pressure (UP[®]) boiler rated at 1200 MW (Figure 1).

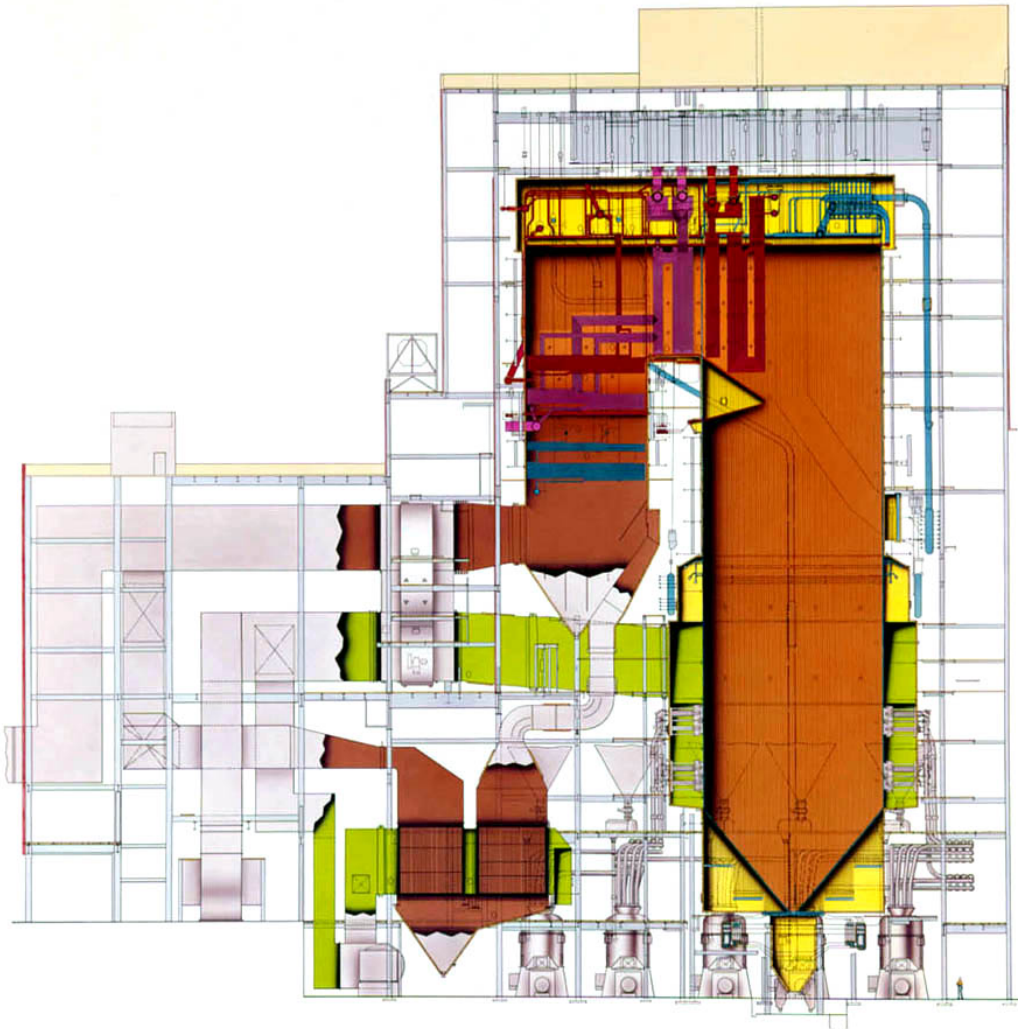


Figure 1: B&W PGG UP[®] Boiler

Cleaning Equipment

The unit is equipped with 60 Diamond Power[®] IK retractable sootblowers in the convection pass using steam as the sootblowing medium. The furnace contains 32 Diamond Power IR retractable sootblowers also with steam as the sootblowing medium. The sootblowing controls are contained in an Emerson Ovation[™] distributed control system (DCS).

Operating History

Before the Powerclean system was installed in 2009, the sootblowers were operated manually. A set sequence, based on previous experience and industry expertise, was operated continuously while the unit was at full load. The sequence would essentially run through the entire convection pass, operating all of the sootblowers, regardless of whether the area needed cleaning. Visual inspections through view ports were also used to identify areas in which spot blowing was required to remove slag deposits. Overall, the cleaning approach was inefficient and, in some areas of the boiler, it led to premature failing of tubes due to sootblower erosion from over cleaning.

Prior to installation of the Powerclean intelligent sootblowing system, the plant suffered from extended outages in which significant slag deposits required removal. In the first few months of operation, the customer was concerned with operating the system in automatic mode due to fears of over cleaning and tube damage. These fears subsided when a forced outage found pluggage in the convection pass. The Powerclean boiler model indicated these same areas to have severely reduced heat transfer leading up to the outage. Following the outage, there was much more confidence in the system and it was allowed to operate in automatic mode more than 90% of the time.

There were also some areas of the boiler that were not cleaned frequently enough. Based on visual inspections, areas of the economizer were only allowed to clean once per week to reduce the potential for sootblower erosion. This was also one of the areas that experienced significant fouling.

Powerclean[®] Intelligent Heat Transfer Management

The Powerclean software was installed in 2009 and implemented to help improve cleaning operations as well as heat transfer performance. The software makes use of the boiler model developed by B&W PGG used to design the boiler. The model is included in B&W PGG's Heat Transfer Manager[™] program which is incorporated into the Powerclean optimization system. The model is an accurate representation of the boiler and is responsive to changes in unit performance. The B&W PGG boiler model includes a detailed furnace performance model that can assess whether the furnace is performing as expected given current operating conditions. Maintaining furnace performance close to expected performance is a key part of overall unit performance.

Some key aspects of the system include:

- Uses an accurate and responsive boiler performance model for system monitoring and feedback
- Does not require furnace exit gas temperature probes
- Does not require heat flux sensors to be installed in the furnace to effectively control furnace water cleaning
- Has the ability to control a variety of cleaning devices including retractable sootblowers, wall blowers, waterlances and across-the-furnace water cleaning devices such as the Diamond Power HydroJet[®] system
- Is straightforward and easy for the plant operators and engineers to understand and use
- Prioritizes sootblowing based on calculated blower effectiveness

Sequenced Versus Individual Sootblowing

The original version of Powerclean was limited to only run sequences of blowers. While a sequence might consist of 1 to as many as 16 blowers, this operation does not optimize sootblower performance. Sequence-driven sootblowing often leads to the possibility of over cleaning. For example, if a sequence contained 8 sootblowers, and if half way through the sequence the boiler component affected attained an appropriate level of cleanliness, the sequence would still continue to run until all of the sootblowers operated. While the sequences were designed to limit the amount of over sootblowing, the potential for over cleaning was still present. This also led to more setup and configuration time and expense to properly develop the most effective sequences of sootblowers.

With the advent of the next generation Powerclean NX intelligent sootblowing system came the ability to not only operate sootblowers in sequences, but to operate them on an individual basis as well. This individual-based philosophy allows for more accurate and targeted sootblowing to the areas that need it most. It also allowed for sootblower effectiveness to be calculated for every blower, enabling the Powerclean system to focus on operating the sootblowers which are most effective at increasing heat transfer efficiency, leading to a reduction in the number of sootblowing cycles.

The ultimate goal with individual blowing is to reduce the number of sootblowing operations while maintaining effective boiler heat transfer in all of the components. This is achieved through developing a cleaning strategy that constantly monitors the sootblowing process and holding or stopping sootblowing when the desired heat transfer is achieved. This saves on maintenance costs as well as sootblowing medium usage. Heat rate improvements are also realized because the primary goal of the Powerclean system is to improve heat transfer, and thus reduce fuel costs.

Sootblowing Cycle Reduction

Since this unit started with the sequence-based version of Powerclean, which already brought major improvements to boiler heat transfer, it was easy to compare the gains made by implementing individual sootblowing with Powerclean NX. Data was gathered for sequence operation for the 3-month period, March to May 2013, prior to the implementation of individual sootblowing and compared to the first 3-month period following, June to August 2013. The unit was online during the entire 6-month period and operating at full load.

The results are shown in Figure 2. Each heat transfer component correlates to the different cleanliness factors calculated by Powerclean's Heat Transfer Manager system. The bars represent the average number of daily sootblower operations for each component. As can be seen, the number of sootblower operations was much higher with sequenced-based operation as compared to individual sootblowing. The largest reduction was in the secondary superheater.

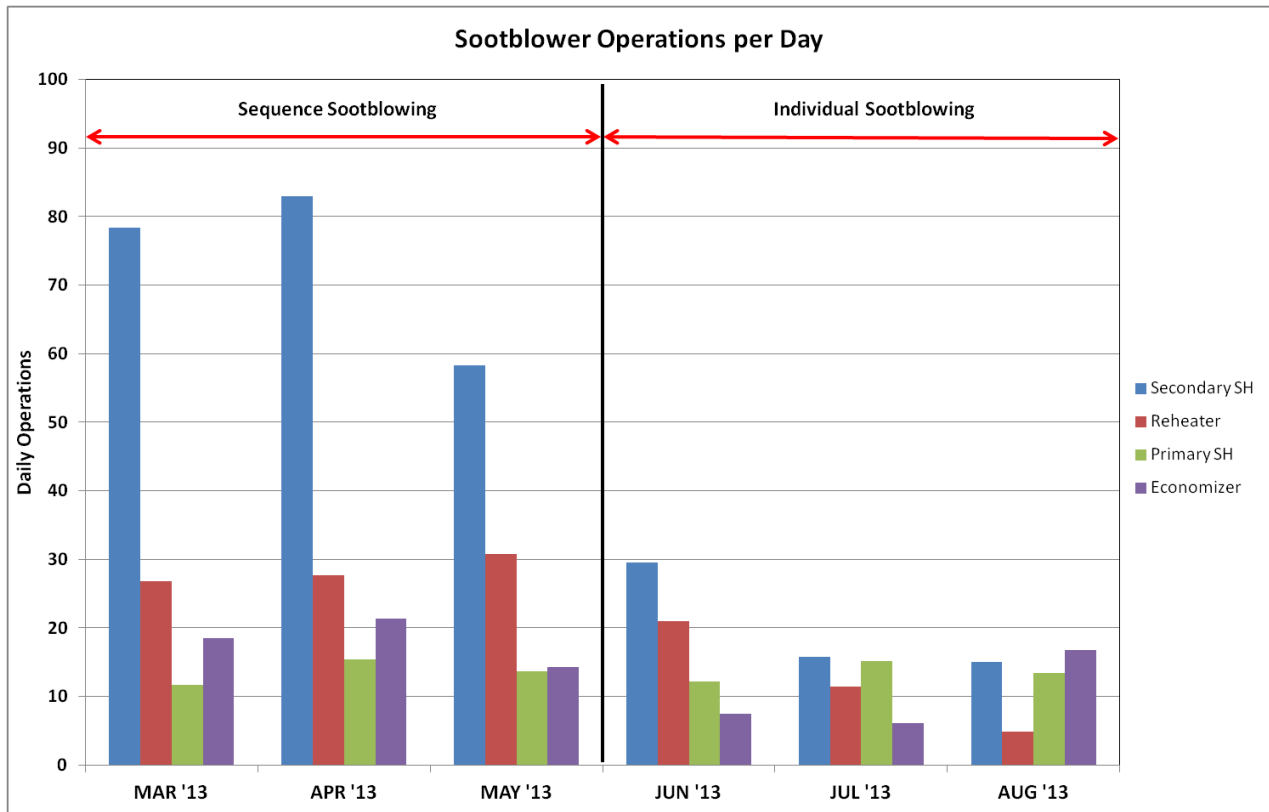


Figure 2: Sequence Sootblowing vs. Individual Sootblowing

Figure 3 shows the total number of sootblower cycles by component based on sequenced sootblowing versus individual sootblowing. Most of the areas (secondary superheater, reheater and economizer) experienced a reduction in sootblowing cycles, while the primary superheater stayed the same and the furnace saw a slight increase. This shows the dynamic ability of the Powerclean software to target the areas that need cleaned based on heat transfer performance and adjust sootblowing as needed.

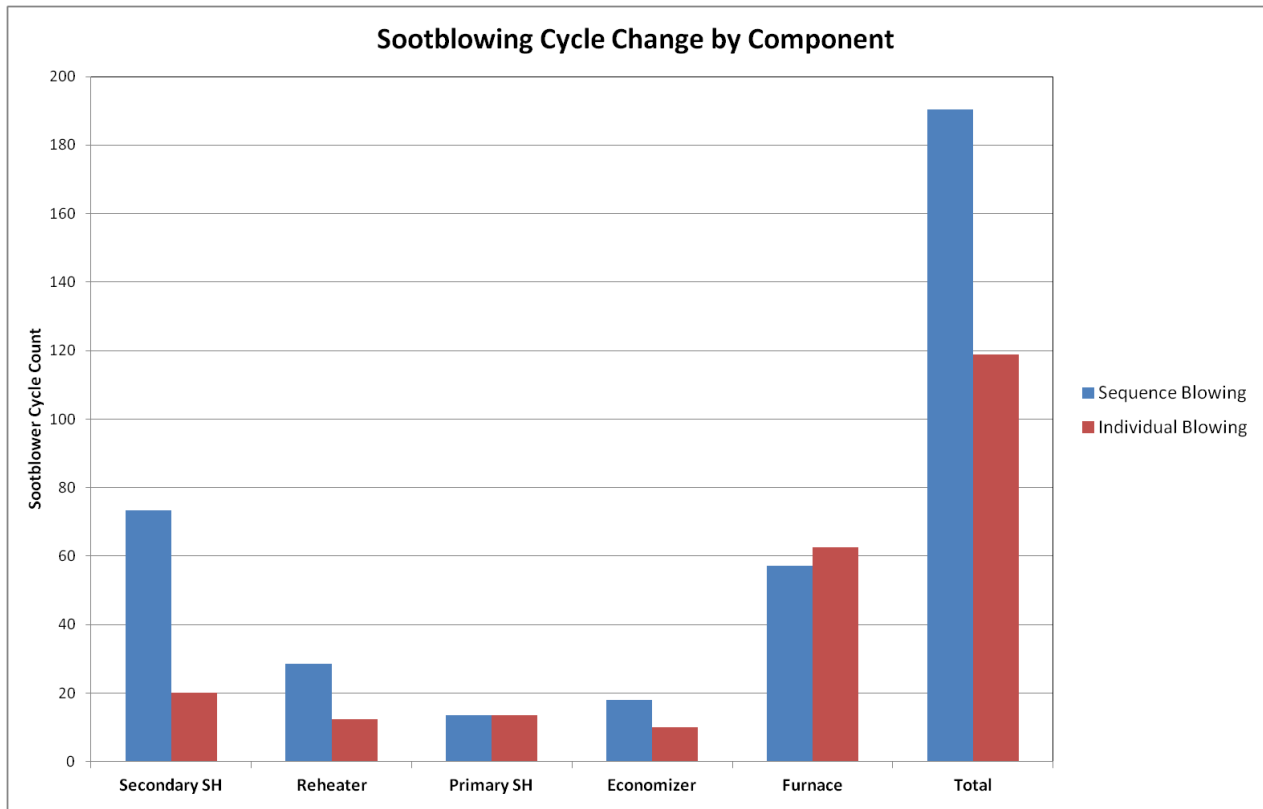


Figure 3: Sootblowing Operation Reduction

Figure 4 shows the percentage change in sootblowing cycles for each component. The largest reduction occurred in the secondary superheater, which saw a decrease in sootblowing cycles of 73% using the individual sootblowing philosophy. There was an overall 38% reduction in total boiler sootblower cycles using individual sootblowing. This equates to a significant reduction in steam usage as well as costs associated with sootblower maintenance.

Boiler efficiency is calculated by Powerclean’s Heat Transfer Manager system. During the analysis period, the efficiency did not change. This indicates that even with reduced sootblower cycles, the unit’s performance did not suffer.

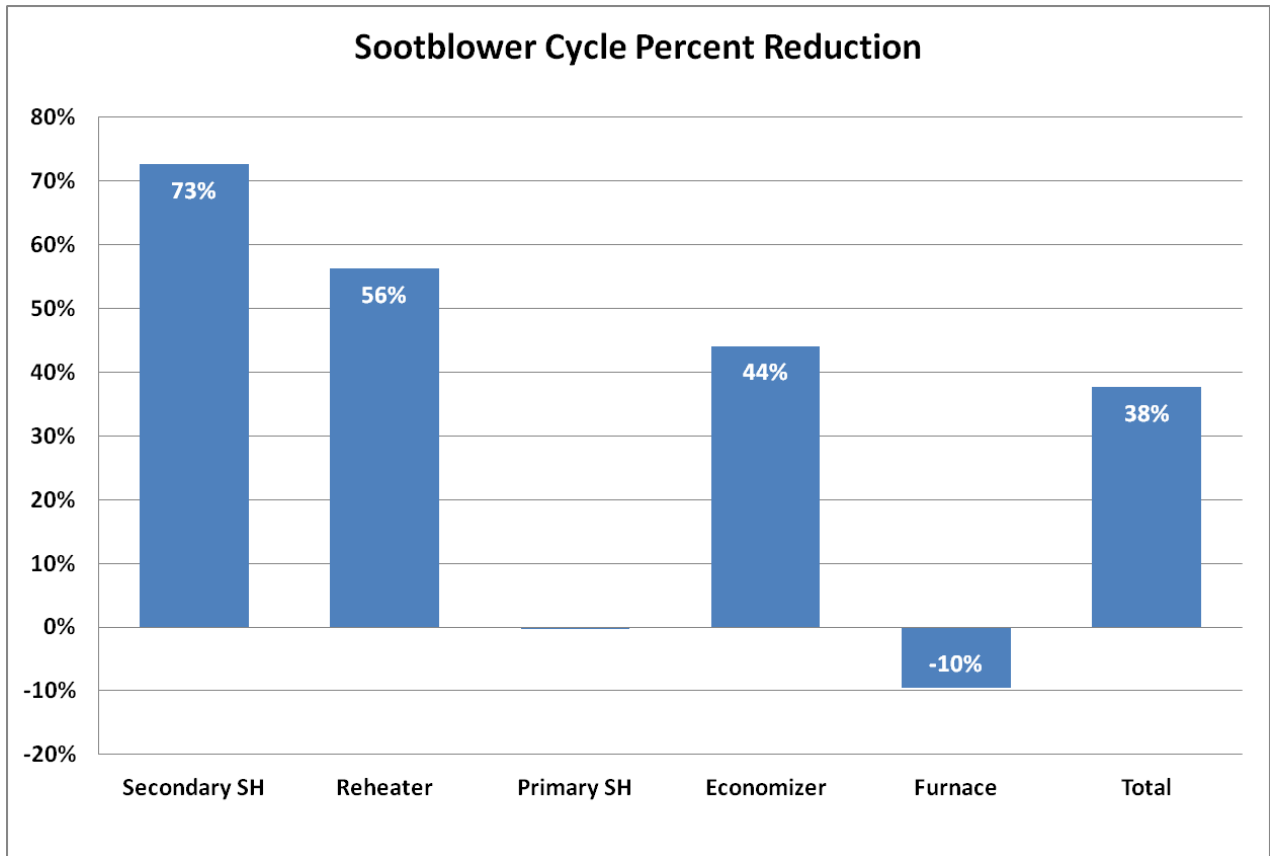


Figure 4: Sootblower Cycle Percent Reduction

Steam Reduction

While the cycle counts illustrated above show a significant reduction in sootblower cycles by using individual sootblowing rather than sequence-driven sootblowing, these numbers can sometimes be misleading. There are times when blowers fail to operate, or insert only a few feet into the boiler and fail on low flow. Although not considered a full sootblower operation, these conditions still count as a cycle. A more accurate measurement to look at the savings associated with individual blowing is the actual steam flow rates for the same period of time.

The sootblowing steam flow rates were analyzed to determine the average flow rates for the time periods of March to May 2013 and June to August 2013. Comparing the data from sequenced to individual sootblowing, there was a 14%, or 1,500 lb/hr, reduction in sootblowing steam flow (Figure 5). This roughly equates to more than \$50,000 in additional generation revenue per year. Additional benefits which cannot be as readily quantified from this reduction in steam blowing include the savings on sootblower maintenance and reduced tube erosion.

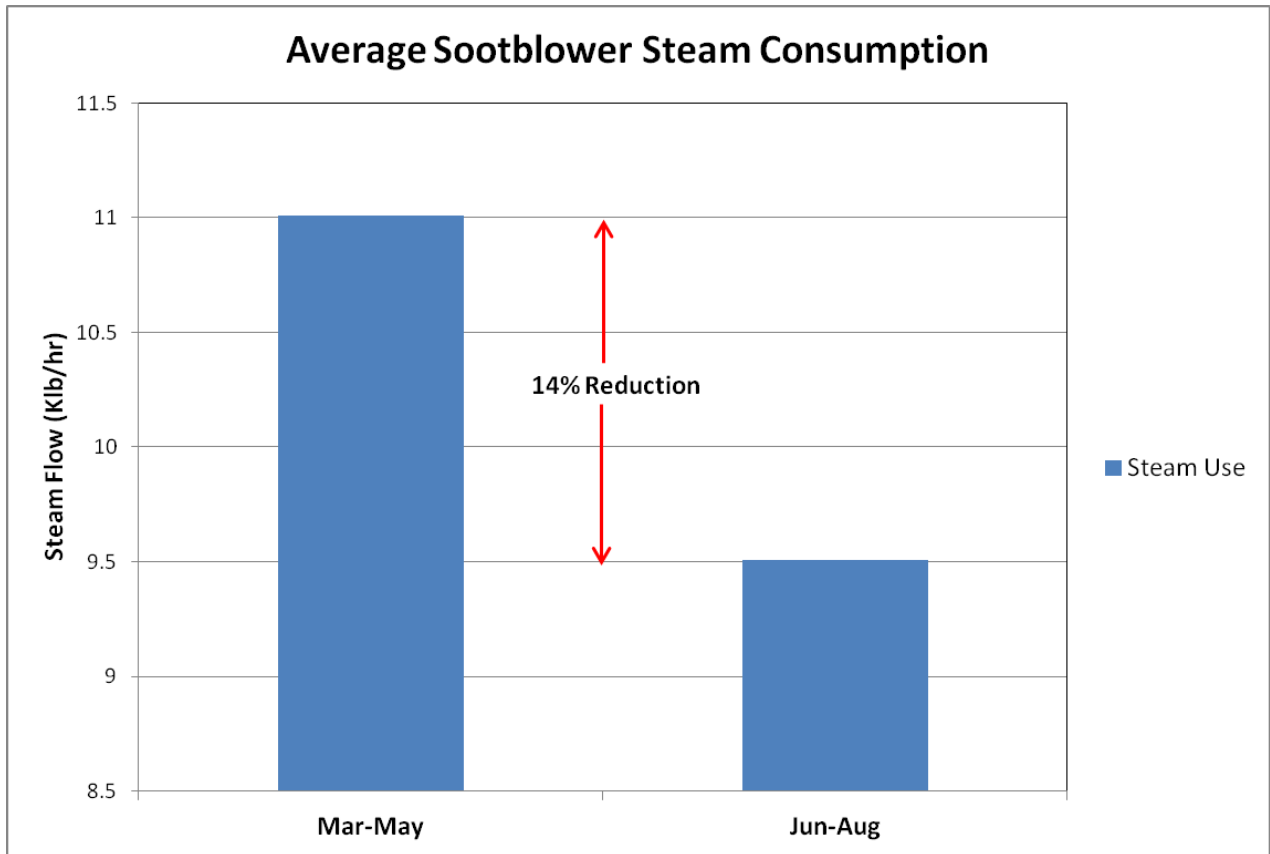


Figure 5: Average Sootblower Steam Consumption

Conclusion

The Powerclean intelligent sootblowing system has provided the customer with years of optimized sootblowing and had already significantly reduced the costs associated with the sootblowing process with the original sequenced-based version. While the original sequences were programmed to have the most sootblowing impact with the fewest cycles, this is not always possible given the constantly changing conditions of coal-fired power production. The implementation of the individual sootblowing philosophy added the ability to more finely tune and respond to changing sootblowing needs. Making use of the real-time performance information provided by the Powerclean Heat Transfer Manager system, targeted individual sootblowing when and where it is needed can effectively provide optimal heat transfer management while reducing the number of sootblowing cycles.

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