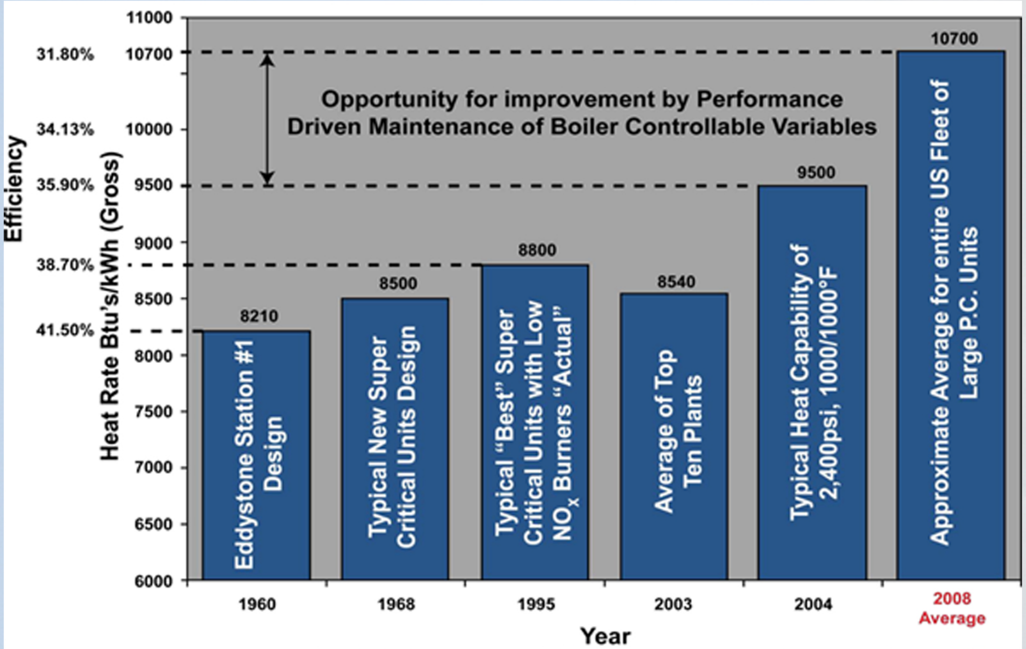
Would You Like To Better Utilize Your Outage Resources?

Performance driven maintenance has long been Storm's approach to evaluate and quantify opportunities and address issues that are causing heat rate losses which are costing you megawatts (i.e. Air In-Leakage, Pulverizer Performance, Incomplete Combustion, Airflow Management). The next several months will be spent planning and scheduling your plant's upcoming fall and spring outages. Would you not want to know what areas have the greatest opportunities for improvement prior to the outage; insuring the money spent during the outage would be used to improve oveall performance and heat rate? Storm believes that the average pulverized coal fired power plant in the USA has approximate 500 Btu per kilowatt hour of heat rate improvements laying on the table as shown in the figure below.



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Completing a thorough air in-leakage test between the furnace exit and ID fan, being sure to test around each major piece of equipment or typical areas of leakage (i.e. penthouse, economizer expansion joints, air heater, SCR, ESP/baghouse, scrubber) will help pinpoint what areas require the most attention. Air in-leakage prior to the air heater affects the efficiency and heat rate of the boiler. The effects are felt throughout the entire system:

- Increased FEGTs and Secondary Combustion
- Increased Slagging and fouling
- Increased Economizer Outlet Temperatures
- Increased L.O.I.
- Increased Spray Flows and Steam Temperature
- Less Efficient Particulate Collection/Increased Opacity
- Possible Derates

There is also increased load to the ID fans as well as false oxygen indication if leakage is present prior to the O_2 probes. This reduces the amount of combustion air entering the furnace. A common place overlooked for leakage is the penthouse; which, over time and lack of maintenance, will develop numerous leaks from the cracked refractory seals. While these are small cracks, hundreds of them can have a significant effect to the air entering the furnace. Furthermore, with the current state of the industry, where large coal fired boilers that were designed to be base loaded are now being cycled on a daily basis and even taken offline for the weekends, this can expedite the rate at which these penthouse cracks form and grow. By reducing the amount of combustion air provided to the burner belt, this obviously will negatively impact combustion in the burner belt. Which in turn will increase LOI due to lack of completed combustion in the furnace as well as increased convection pass temperatures due to the secondary combustion present. The secondary combustion also increases FEGTs which increases steam temperatures and in return increases spray flows, all of which have significant heat rate penalties.

After the unit's O_2 probes, the effects of air in-leakage to combustion are reduced, however the additional tramp air in the system means more volume that the ID fan has to move. During the hot months, the difference between 5% leakage and 10% leakage could lead to the derating of the unit due to ID fan capacity limitations.

Variable	Potential heat rate improvement (Btu/kWh)	Potential annual fuel savings
Boiler and ductwork ambient air in-leakage	300	$819,000
Dry gas loss at the air heater exit	100	$273,000
Primary airflow	75[a]	$204,750
Steam temperature	75	$204,750
De-superheater spray water flow	50	$136,500
Coal spillage	25	$68,250
Unburned carbon in flyash	25[a]	$68,250
Unburned carbon in bottom ash	25	$68,250
Slagging and fouling	25[a]	$68,250
Cycle losses	25	$68,250
All others, including sootblowing and auxiliary power factors	25	$68,250
Total	**750**	**$2,047,500**

Figure 2-Penalties of a 400MW
(http://www.powermag.com/how-stealth-combustion-losses-lower-plant-efficiency-part-1)

By completing a pre-outage air in-leakage test, plant personnel are now armed with a map of the boiler and can determine where more time and efforts should be spent inspecting the casing, expansion joints and tube penetrations. During the outage, a thorough inspection of the boiler, penthouse, dead air space, and economizer are crucial. Once completed, the air heaters, expansion joints, and duct work between the economizer to the ID fan should have a crawl through inspection. The air heater should have the circumferential and radial seals set to OEM specifications, and ensure all the baskets are in good condition and no cold end corrosion is present.

From Figure 2, the two largest contributors to heat rate penalties are air in-leakage and dry gas loss, which combine to a possible 400Btu/KWh. However, the majority of the remaining 350Btu/KWh are directly affected by poor pulverizer performance. Assuming there is no leakage throughout the entire system, if imbalances to the fuel lines equates to 20% more fuel on one side of the boiler than the other, oxygen will be depleted on the fuel rich side, resulting in increased LOI to bottom ash and flyash as well as secondary combustion. This secondary combustion has a domino effect where FEGTs are increased, which increases steam temperatures and convection pass temperatures as well as spray flows, not to mention the increased slagging and fouling. Most of this can be mitigated by ensuring the pulverizers and burners are performing optimally. This begins with ensuring all the fuel and airflows are balanced. Fineness, not only has an effect on fuel distribution but also to LOI, reduced secondary combustion, emissions, etc. Baseline testing each pulverizer is the first step to address the challenges ahead. This pre-outage evaluation can help pinpoint which pulverizers should be thoroughly inspected during the outages. If the results show relatively good balance, just slightly outside the recommended, but fineness is below 75% passing 200 mesh; maybe the critical clearances need adjusting or possibly adjusting spring tensions. What about inspecting the classifier to ensure all the blades are in good condition, reject doors are operational or inverted cone clearances are set correctly? Have the blades been installed for 5 years? If so, and they show no wear, then they probably are not providing adequate spin and recirculation. These should be adjusted to improve fineness based off of periodic testing between outages. Maintaining 75% passing 200 mesh with no more than 0.1% retained on 50 mesh will help with fuel distribution providing the clean air is balanced.

Figure 3 to the right illustrates the effects to fineness and fuel distribution with good test locations. Improving fineness can be something as simple as blowing out the sensing lines to the PA airflow measurement devices to allow the mill to accurately control the air to fuel ratio at the desired ratio. It could also mean completing a thorough inspection of the mill to ensure everything is operational and adjusted properly for optimum performance.

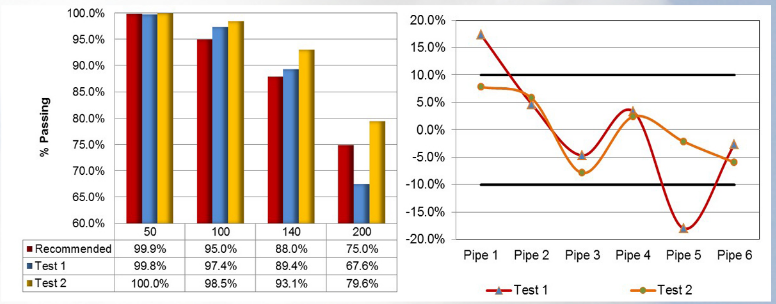


Figure 3: The effects of fuel fineness on fuel distribution once clean air flow is balanced within ±2% and primary air flow was accurately being controlled at air/fuel ratio of 1.8.

Storm and its team of engineers and technical service specialists do not believe in shortcuts when it comes to evaluating the performance of your boilers and pulverizers. However, there is one quick test that can be done which can help pinpoint if the major contributing source to your elevated LOI's is pulverizer or airflow/leakage related. Collecting an in-duct flyash sample utilizing a Storm designed insitu flyash sampling probe, where samples are collected at multiple points throughout your ductwork prior to the ESP/baghouse can be completed in an hour. This sample can then help you determine where your high LOI is pulverizer or airflow related by sieving 10g – 50g through a 200 mesh sieve to first determine the fineness of the flyash. If less than 90% of the flyash passes through the 200 mesh sieve then one contributing factor to your high LOI's is the pulverizer performance.

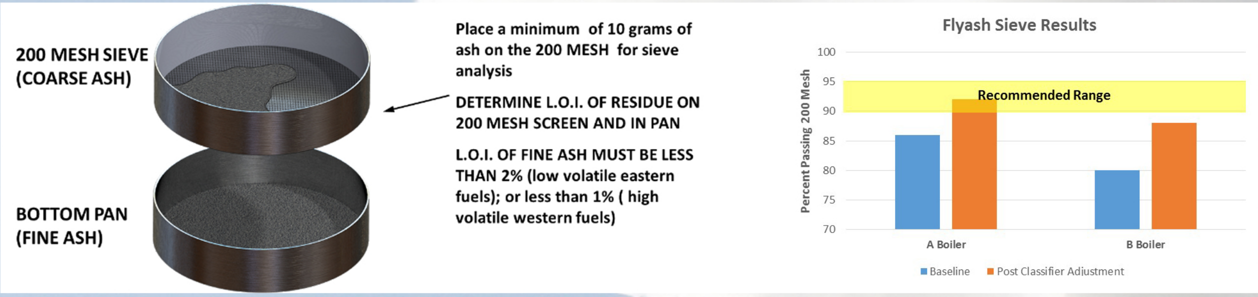
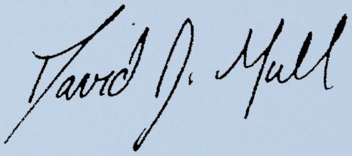


Figure 4: 3-Part Flyash Analysis

Next, we recommend determining the LOI of the composite ash, fine ash (collected in the pan) and coarse ash (remaining on the 200 mesh). If the LOI of the ash passing 200 mesh is greater than 2% then this is usually indicative of low excess oxygen at the burner front (could be attributed to air in leakage) or poor mixing of the air/fuel at the burner front (i.e. secondary air imbalances, high PA flow, burner warping, etc.).

Lastly, the best way to determine how the pulverizers and boilers are performing and how to best utilize outage manpower is to complete pre-outage performance testing. A single test is worth a thousand words and could save you money. Once you know what you have, optimizing performance, increasing reliability and production can begin. For help with pre-outage performance testing, outage inspections or determining the impact you had on performance during the outage contact Storm Technologies, Inc. We can provide you with the services, quality and results you are looking for.

Yours very truly,



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