LG&E/KU – Mill Creek, Ghent, & E.W. Brown Stations

Phase II Air Quality Control Study

Impact of PAC Injection

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1.0 PAC Injection and Fire Hazard Issues

The future air regulations for mercury (Hg), hazardous air pollutants (HAPs) and particulate matter (PM) may require addition of pulse jet fabric filter (PJFF) systems and powdered activated carbon (PAC) injection downstream of existing cold-side or hot-side dry electrostatic precipitators (ESPs) at the LG&E/KU Mill Creek, Ghent and E.W. Brown Generating Stations. Furthermore, as the power generation industry continues to learn about how other draft system components are affected by the introductions of new emission control technologies and methods, Black & Veatch is revisiting some of the future draft system layouts proposed for the LG&E/KU sites previously mentioned.

The purpose of this study is to evaluate the potential impact of fly ash pre-filtration using dry cold-side or hot-side ESPs and PAC injection upstream of a new full size PJFF. A high rate of pre-filtration would reduce the amount of nonflammable fly ash available to be mixed with the PAC injected upstream of and collected by the PJFF. The higher ratio of flammable PAC to nonflammable fly ash collected in the PJFF could present a potential fire hazard. Additionally, the higher ratio of PAC to other sorbents and fly ash will potentially blind the PJFF bags resulting in possible operational and/or maintenance issues. On the other hand, mitigating the potential fire hazard and the risk of blinding PJFF bags (fine particulate mattermay clog the fabric filter media) by reducing the amount of pre-filtering done in the ESP would also have a substantial impact on the intent to use existing ID fans upstream of the new PJFF. Based on this latest development of PAC fire hazard concern, it may be necessary to reconsider the use of existing ESPs as a fly ash pre-filter as well as the combination of an existing ID fan and new booster fan arrangement. The industry rule of thumb to acceptably minimize the PAC fire hazard concern is to target a minimum of 93% non-PAC material content in the particulate collected in the PJFF.

However, the National Fire Protection Agency (NFPA) has not yet adopted this philosophy. Currently, NFPA states that fires have been caused in bag houses due to incomplete combustion in the boiler resulting in carryover of burning particulate igniting the filter media or in this case the combustible material covering the bags or hoppers. The combustible material covering the bags has primarily been attributed to the injection of PAC. PAC, a combustible material in the presence of oxygen, may reach a high enough concentration in the particulate collected that would result in a potential fire hazard in the PJFF. Therefore, in order to mitigate the fire hazard, a well defined and designed fire protection system would be required within the PJFF itself. The fire protection systems, which consist of preaction spray systems or storage and injection of inert gas like CO_2, are expensive and can increase project costs significantly. In addition

to the fire protection system, the frequency of particulate removal in the PJFF hoppers may need to be increased (emptying the PJFF hoppers more frequently) and may require installation of low density PJFF hopper heaters (to keep the temperature lower than usual but above the acid dew point temperature). Also, the hopper design storage volume will be reduced to less than two hours to reduce the fire hazard. It is recommended that the cost for a fire suppression system be included in the cost estimate for all units with PAC injection upstream of a PJFF.

1.1 Mill Creek Generating Station

Currently, Mill Creek Units 1 and 2 each have an existing cold-side ESP (CS-ESP). The existing CS-ESP for each unit will be demolished and the fly ash from coal combustion and byproducts from PAC and sorbent injection (lime or trona) will be collected in a new PJFF, one for each unit. The existing induced draft (ID) fans for Units 1 and 2 will be abandoned and new bigger ID fans will be installed downstream of the new PJFF for Units 1 and 2. In this scenario, the addition of PAC injection upstream of the new PJFF will have minimal impact on the above described fire hazard concern because both fly ash and sorbent will be collected on the bags and stored in hoppers in a mix ratio that reduces the fire hazard substantially. This is because the existing CS-ESP and close coupled existing ID fans of each unit are scheduled to be removed to support the addition of SCR systems. Since the new PJFFs for Mill Creek Units 1 and 2 will collect more than 91% of non-PAC material, the fire hazard concern and potential of blinding PJFF bags from PAC collection have been substantially reduced. Therefore, there is no need to reconsider the PM removal equipment and ID fan arrangement as currently proposed for Units 1 and 2 at Mill Creek.

In contrast, Mill Creek Units 3 and 4 have existing CS-ESPs and a majority of the fly ash is removed by the existing CS-ESPs for possible off-site applications. The byproducts from PAC and sorbent (lime or trona) injection as well as some finer combustion particulate like fly ash which are not collected in the CS-ESP will be collected in new PJFFs for Units 3 and 4. Due to significantly lower amounts of fly ash being present in the flue gas stream entering the new PJFFs on Units 3 and 4, sorbent and PAC may blind the bags of the new PJFFs in a similar manner that fine particulate matter or ash can blind the bags from a partially de-energized ESP. In addition, a bigger issue is the fire hazard concern for Units 3 and 4 due to a higher concentration of flammable PAC collected in the PJFF.

One way to reduce the fire hazard concern and also reduce the potential of blinding PJFF bags is to de-energize some of the existing fields of Mill Creek Units 3 and 4 CS-ESPs to the point where some fly ash would be carried to the new PJFF to mix with

the injected PAC. The additional particulate leaving the ESP would, however, decrease the service life of the rotors in the ID fans currently installed downstream of the ESP.

Another option is to de-energize some or all of the existing fields of CS-ESPs and completely bypass and abandon the existing ID fans of Mill Creek Units 3 and 4 and install new ID fans downstream of the new PJFFs. Preliminary investigation indicates that Unit 3 could be supported by two centrifugal fans. These centrifugal fans would be at the manufacturing limits but would still be feasible. Alternatively, due to the new PJFF that would be located nearby, the existing Unit 3 ID fans could be reused since the existing rotors are designed for higher speeds. This would require drive and auxiliary electric system upgrades, confirmation of proper foundation design, and the rerouting of ductwork to allow them to be downstream of the PJFF. For Mill Creek Unit 4, it would be recommended that four new centrifugal ID fans be installed downstream of the new PJFF system. While the existing ID fans may be able to handle the addition of a new PJFF system (with drive system upgrades) with limited margin, their distance from the location of the new PJFF system is a significant disadvantage. Four new ID fans are recommended as opposed to just two on Unit 3 due to the manufacturing limits of centrifugal fans to allow adequate margins and the two 50 percent capacity PJFF system proposed for Unit 4. The new ID fans would eliminate the need for booster fans currently being proposed. The fly ash from coal combustion and byproducts from PAC and sorbent (lime or trona) injection would be collected in the new PJFF systems for Units 3 and 4 resulting in the reduction in fire hazard concerns and reduction in potential of blinding PJFF bags.

1.2 Ghent Generating Station

Ghent Units 1 and 2 will have similar concerns as Mill Creek Units 3 and 4. The relative locations of ESP, ID fans, and proposed PJFF on these two units would also involve concerns with the operational life of the existing ID fans with the possible elimination of the existing ESPs. This would be in lieu of using the existing ESPs as fly ash pre-filters and using the new PJFF to collect injected PAC and sorbent.

The flue gas flow path of Ghent Unit 1 is similar to Mill Creek Unit 4 and, therefore, the currently proposed addition of a new PJFF system is similar with booster fans downstream. To eliminate ID fan wear concerns with Ghent Unit 1 and PJFF fire hazards it would be recommended that four new centrifugal ID fans be installed downstream of the new PJFF system which is, again, similar to Mill Creek Unit 4. Preliminarily, it has been determined that the existing ID fans would not be suitable for continued use.

The Ghent Unit 2 draft system layout is different from Unit 1 in that there is no SCR system and particulate control is accomplished with a hot-side ESP (HS-ESP) system. To eliminate wear concerns on the existing Unit 2 ID fans and PJFF fire hazards, the HS-ESP system and ID fans would be bypassed. The new SCR system would then be designed for a high-dust application. This, along with the installation of new ID fans located downstream of the new Unit 2 PJFF system would avoid fire hazard concerns. Four new centrifugal ID fans could be used here as well.

The layout of the Ghent Units 3 and 4 draft system is similar to Unit 2 with the addition of SCR systems downstream of the HS-ESP systems. Again, fire hazards could exist in the new PJFF systems due to the HS-ESP systems pre-filtering ash. To alleviate this concern the HS-ESP systems would be bypassed or partially utilized to accommodate PAC and sorbent injection. However, if the HS-ESP systems are completely bypassed or only partially utilized, the existing SCR design would require further evaluation during detailed design to ensure proper operation under the higher dust conditions. As is currently the plan, four new centrifugal ID fans would be installed downstream of each new PJFF on Ghent Units 3 and 4 to replace the existing axial ID fans currently installed. Decreased life of the ID fans from limited use of or bypassed HS-ESP systems would not be a concern with Units 3 and 4.

1.3 E.W. Brown Generating Station

The fly ash from coal combustion and byproducts from PAC and sorbent (lime or trona) injection would all be collected in new PJFF systems for E.W. Brown Units 1-3. The CS-ESP systems on all units would be bypassed. With these draft system arrangements the addition of PAC and sorbent injection would have limited fire hazard or bag blinding impact to the new PJFF systems. Additionally, the ID fans on all units would be located downstream of the new PJFF systems and would not have the potential to be subject to high particulate loading.

2.0 Summary

Based on the above discussion regarding fire hazard issues with high PAC concentrations in PJFF systems, Black & Veatch requests that LG&E/KU review the following options for Mill Creek, Ghent and E.W. Brown Generating Station:

Mill Creek Units 1 and 2 and E.W. Brown Units 1-3:

No arrangement impact is expected for Mill Creek Units 1 and 2 and E.W. Brown Units 1-3 because the existing ESPs were already intended to be replaced by new PJFF systems with ID fans downstream. On Mill Creek Units 1 and 2 and Brown Unit 2 new ID fans are proposed. At Brown Units 1 and 3 the existing ID fans have sufficient capacity and would be reused. A preaction spray system for fire protection on each PJFF will be included in the cost estimate.

Mill Creek Units 3 and 4 and Ghent Unit 1

Option 1:

Keep existing CS-ESP and ID fans in service, install new booster fans (two each for Mill Creek Units 3 and 4 and Ghent Unit 1) downstream of the PJFF. A preaction spray system for fire protection on each PJFF will be included in the cost estimate. Additionally, an increase in the frequency of PAC/ash-byproduct removal in the PJFF hoppers will be specified during operation and installation of low density hopper heaters will be suggested to reduce the fire hazard.

Option 2:

Bypass the existing CS-ESP and ID fans and install new PJFF systems with new ID fans downstream (two for Mill Creek Unit 3 and four each for Mill Creek Unit 4 and Ghent Unit 1). Mill Creek Unit 3 may be able to reuse the existing ID fans with drive upgrades. A preaction spray system for fire protection on each PJFF will be included in the cost estimate. A negative result of this option will be the inability to sell or give away fly ash for off-site applications. Option 2 is more expensive than Option 1 up front, but Option 1 has higher O&M costs.

Option 3:

Keep the existing CS-ESP and the existing ID fans in service by de-energizing some of the existing electrical fields of the ESP and install new PJFF systems with two new booster fans downstream. A preaction spray system for fire protection on each PJFF will be included in the cost estimate. A negative result of this option will be increased maintenance and rotor replacement on the existing ID fans.

Option 4:

Keep the existing CS-ESP in service by de-energizing some of the existing electrical fields of the ESP and bypass the existing ID fans and install new PJFF systems with new ID fans downstream (two for Mill Creek Unit 3 and four each for Mill Creek Unit 4 and Ghent Unit 1). Mill Creek Unit 3 may be able to reuse the existing ID fans with drive upgrades. A preaction spray system for fire protection on each PJFF will be included in the cost estimate.

Ghent Unit 2

Option 1:

Keep existing HS-ESP and ID fans in service, and install two new booster fans downstream of the PJFF. A preaction spray system for fire protection will be included in the cost estimate. Additionally, an increase in the frequency of PAC/ash-byproduct removal in the PJFF hoppers will be specified during operation and installation of low density hopper heaters will be suggested to reduce the fire hazard. A negative result of this option will be increased maintenance and rotor replacement on the existing ID fans.

Option 2:

Bypass the existing HS-ESP and ID fans, and install a new PJFF system with four new ID fans downstream. Design the new SCR as a high-dust SCR since the existing HS-ESP would be bypassed. A preaction spray system for fire protection will be included in the cost estimate. Option 2 is more expensive than Option 1 up front, but Option 1 has higher O&M costs.

Option 3:

Keep the existing HS-ESP and the existing ID fans in service by de-energizing some of the existing electrical fields of the HS-ESP and install new PJFF systems with two new booster fans downstream. A preaction spray system for fire protection on each PJFF will be included in the cost estimate. A negative result of this option will be increased maintenance and rotor replacement on the existing ID fans.

Option 4:

Keep the existing HS-ESP in service by de-energizing some of the existing electrical fields of the HS-ESP and bypass the existing ID fans and install new PJFF systems with new four ID fans downstream. A preaction spray system for fire protection on each PJFF will be included in the cost estimate.

Ghent Units 3 and 4

Bypass or de-energize part or all of existing HS-ESP, keep existing SCR in service, bypass existing axial ID fans, and utilize the four new centrifugal ID fans downstream of the PJFF. A preaction spray system for fire protection on each PJFF will be included in the cost estimate. Additionally, an increase in the frequency of PAC/ash-byproduct removal in the PJFF hoppers will be specified during operation and installation of low density hopper heaters will be suggested to reduce the fire hazard.