LG&E/KU – Ghent Station

Phase II Air Quality Control Study

Constructability Review

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Revision B – Issued For Client Review

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LG&E KU

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Contents

1.0 Introduction

Black & Veatch (B&V) was retained by Louisville Gas & Electric/Kentucky Utilities (LG&E/KU) to provide a technical evaluation and system analysis of Units 1 through 4 at the Ghent Generating Station, which is a four unit, coal fired electrical generating station located on the south bank of the Ohio River, approximately 2 miles east-northeast of the town of Ghent, Kentucky The addition of air quality control technologies is being evaluated to ensure compliance with the emissions limitations the Ghent generating site may be required to meet in the future.

This constructability review is intended to identify site-specific construction requirements for the proposed modification to Ghent Units 1 through 4 and ensure their cost is incorporated into the overall project cost estimate. The drawings listed in Appendix A, in combination with the technical documentation gathered during the phase II study and the construction execution plan presented in this review form the basis of the cost estimate for the project.

2.0 Summary

2.1 General

This constructability review proposes methods for establishing essential construction facilities, services, and utilities necessary to support project execution; identifies modifications that should be completed at the site prior to major project mobilization; and identifies the critical work activities associated with the proposed project work scope. It is intended to help define the general construction requirements for the AQC upgrades and ensure the costs associated with them are included in the project cost estimate.

The review is based on information obtained from walk-downs conducted at the plant site, drawings and aerial plan views of the plant site, interviews with plant operations personnel, General Arrangement Drawings 168908- GCDS-1000, -1001, -1002 and -1003, listed in Appendix A, and conclusions drawn from the initial technology study.

2.2 Summary of Findings

The following is a summary of the key findings from the review:

- The existing land areas available for the EPC Contractor to develop construction facilities such as construction office trailers, construction parking and material fabrication are adequate for the AQC project scope, but not ideally located. The plant site does not have adequate material lay-down area for a project of this scope. It is likely a modified material procurement strategy and remote lay-down areas will be required to accommodate project execution.
- The schedule proposed for the project may cause it to compete with other major regional projects for craft manpower. It may be necessary to offer enhancements to the prevailing wage rate for longevity, performance, or cost of living expenses to obtain and maintain an adequate workforce.
- Existing site facilities, such as Unit 3 WFGD high voltage overhead power lines and transformers, maintenance shops and covered maintenance and utility corridor between Unit 1 & 2, elevated personnel corridor between Units 1 & 2, and a pre-engineered warehouse facility located north of Unit 4 WFGD interfere with new construction and must be relocated. It may be desirable to relocate interfering site facilities critical to plant operation via a site preparation contract prior to mobilization of the EPC Contractor.

- Crane access to new construction will be congested and require detailed planning. Access to Units 1 and 2 for construction of PJFF on both units and SCR, complete with economizer gas-side bypass on Unit 2 will be especially challenging. The project execution sequence should begin with Unit 2 to ensure adequate construction lanes are available to access the SCR and PJFF footprint.
- The project work scope is interdependent with associated projects to revise Unit 1, 2, 3, and 4 ash collection facilities. It has been assumed the revised ash facilities will be completed prior to beginning work on the new AQC system additions.
- Construction utilities, such as sewer, potable water, service water, electrical power, telephone, and data communications, are available to the EPC Contractor in sufficient quantities to perform the project and the contractual parties responsible for supplying these utilities (EPC Contractor or Owner) can be clearly defined.
- Access routes can be established to supply manpower and material to the plant site over existing roadway and railway systems.

2.3 Recommendations

B&V recommends LG&E/KU develop the plant site for project construction as shown on the drawings listed in Appendix A. The drawings locate and define approximate footprints for various AQC technologies on the Ghent plant site. The project work scope should include relocation of critical existing plant facilities via a site preparation contract performed in advance of EPC Contractor mobilization. Areas suitable for construction and approved for use by plant operations can be offered to the EPC Contractor, as shown on the referenced drawings. The EPC Contractor will be expected to determine the best use of these areas in support of its construction execution plan and to obtain additional facilities and areas that may be required.

3.0 Constructability Analysis

3.1 Project Identification

This project will be executed within the plant boundaries of Ghent generating site. The Ghent Station is located on a site containing approximately 1,670 acres of land in Carroll County, approximately 9 miles northeast of Carrolton, Kentucky. Ghent Station includes four pulverized coal fired electric generating units with a gross total generating capacity of 2,107 MW. Ghent Station began commercial operations in 1973.

The construction work scope is depicted on General Arrangement Drawings 168908- GCDS-1000, -1001, -1002, and -1003, referenced in Appendix A. Work will include installation of Selective Catalytic Reduction (SCR) technology on Unit 2 along with an economizer gas-side bypass system; installation of pulse jet fabric filter (PJFF) technology with powder activated carbon (PAC) injection on Units 1, 2, 3, and 4; sorbent injection addition on Unit 2; new booster fans on Units 1 and 2; and new ID fans on Units 3 and 4. These technologies provide the desired emissions control and will also include flue gas ductwork, air compressors, ash handling equipment, addition of new auxiliary electrical equipment, existing auxiliary electrical equipment modifications and additions to the existing Distributed Controls System (DCS), ammonia injection equipment, and all other associated equipment necessary to achieve the proposed emissions limits while burning Western Kentucky high sulfur bituminous coal.

3.2 Construction Execution

For the purpose of this evaluation, it is assumed that project construction for all four units will be performed as a single project by a selected EPC Contractor under a lump sum, firm price, contracting arrangement. A “Best Value” composite labor rate has been utilized in the cost estimate to account for the use of either union or open shop craft labor. The construction execution plan presented in this report assumes work scope associated with refurbishment of the existing Unit 1, 2 and 4 ash handling system is excluded from, but interdependent with the EPC Contract work scope. In addition, some work scope necessary to prepare the plant site for base project construction may be performed by LG&E/KU or by a separate site preparation contractor prior to EPC Contractor mobilization.

3.2.1 Construction Contracts

It is anticipated that the EPC Contractor will divide the construction work scope into the following major work packages:

- ***Piling--*** This package would cover the installation of piling to support the heavily loaded foundations.
- ***Civil Construction--*** This package would cover all work associated with preparation of the site to elevations required for placement of foundations for permanent equipment, buildings, and tanks; demolition, or partial demolition of building and equipment foundations; installation and paving of necessary roadways and preparation of material lay-down areas and fencing; installation of foundations for permanent buildings, tanks, and plant equipment; installation of underground piping, duct bank, buried conduit and grounding; and erection of miscellaneous buildings, structures, and enclosures. Some demolition/relocation activities could be accomplished separately outside the EPC contract; see Section 3.6 below.
- ***Superstructures Construction--*** This package would cover furnishing and installing process-related ductwork, metal decking, and structural steel, including erection of any permanent cranes and hoists. It would also include placement of concrete equipment bases and elevated concrete slabs; and the installation of wall panel, roofing, interior walls, HVAC (heating, ventilating, and air conditioning) systems, and all interior finishes.
- ***Field Erected Tanks--*** This package would cover the furnishing and installing of field erected tanks.
- ***Mechanical Construction--*** This package would cover furnishing and installing mechanical systems, including setting, aligning, leveling, and grouting of equipment such as skids, compressors, fans, absorber vessels, and pumps. This contract would also include installation of all above ground large and small bore piping, including the associated valves and supports and calibration and installation of all instrumentation. This package would include responsibility for startup and commissioning of all mechanical systems.
- ***Pulse Jet Fabric Filter (PJFF)--*** This package would cover furnishing and installing the selected particulate matter emissions control equipment and auxiliaries.
- ***Selective Catalytic Reduction (SCR)--*** This package would cover furnishing and installing the selected SCR reactor box, ammonia injection equipment, ductwork and catalyst modules, control equipment and auxiliaries.

- ***Fire Protection--*** This package would cover furnishing and installing the required fire protection equipment and piping by a licensed fire protection contractor.
- ***Electrical Construction--*** This package would cover all work related to the installation of medium and low voltage electrical equipment, modification to existing switchgear, lighting, heat tracing, cable, ductbank, aboveground raceway, above grade grounding, and instrumentation and controls. This subcontractor would also be responsible for making modifications and additions to the Distributed Control System (DCS). This package would include the responsibility for startup and commissioning of all electrical/control systems, including furnishing manpower and technical assistance for the startup of mechanical systems.
- ***Painting--*** This package would cover furnishing and installing field applied protective coatings on all new permanent plant facilities and equipment that require a finish coat, installing chemical-resistant coatings, labeling of piping and equipment, and installing signs.
- ***Insulation and Lagging--*** This package would cover the work associated with furnishing and installing all freeze protection system work that will be executed at the project site. This includes insulation and lagging for permanent equipment, piping, and ductwork.
- ***Site Finishing--*** This package would cover removal of construction facilities, final grading, landscaping, and final paving.
- ***Testing Services--*** This package would cover performance testing of the SCR equipment to ensure that it meets the performance criteria specified in the contract. This work scope would be contracted to a third party unaffiliated with the EPC Contractor to ensure unbiased test results.

3.3 Plant Access

The Ghent plant site is located on the south bank of the Ohio River, approximately 2 miles east-northeast of the town of Ghent, Kentucky. The town of Ghent is located to the southwest of the plant site, the Ohio River to its north and northwest, coal pile to its northeast, ash ponds on its southeast, and the plant switchyard and lay-down area to its south.

The Ohio River impedes material and manpower access to the plant from the north and west. Highway 1039 crosses the Ohio River via the Markland lock and dam complex approximately 6½ miles northeast of the plant site. In addition, North American Steel owns a barge unloading facility suitable for unloading construction material approximately 6 miles southwest of the plant site. However, transport routes between the

barge facility and the plant site must pass through the town of Ghent, Kentucky, which will present numerous low overhead obstacles to moving oversized loads. There are no other vehicle bridge crossings or suitable barge unloading sites on the river in the immediate vicinity of the plant site.

The existing interstate, federal, state, and county roadway systems provide the primary route for transporting material and personnel to the Ghent project site. Interstate 71 (I-71), a divided, multi-lane paved roadway, runs southwest to northeast between the cities of Louisville, Kentucky and Cincinnati, Ohio approximately 7 miles south of the plant site. Interstate 75 (I-75), a divided, multi-lane paved roadway, runs north to south through the City of Cincinnati, Ohio approximately 30 miles east of the plant site. The most direct route to the site from either Louisville or Cincinnati uses Interstate 71 to reach US highway 127. Turn north on this paved, two lane roadway until it intersects US highway 42 approximately 5 miles north of I-71. Taking US 42 westbound for approximately 15 miles brings you to the entrance road into the Ghent plant site.

The closest large commercial airport terminals to the Ghent plant are the Louisville International Airport (SDF) located approximately 55 miles southeast of the plant site and the Cincinnati Northern Kentucky International Airport (CVG) located approximately 50 miles northeast of the plant site.

The site is also served by the P&L railroad which has a main line running east west along the south side of US 42. A spur line located north of and parallel to the main line runs along the south side of the plant property line. The spur has several branch lines extending to various locations around the plant site. This spur is connected to the main line via a branch line which crosses US 42 at the west end of the plant site. The site railway system could be made suitable for transporting heavy construction materials such as transformers and equipment skids to the project site.

The existing plant roads, parking areas, and lay-down areas located at the west end of the plant site are suitable for use in staging and evacuating construction personnel during medical or site emergencies.

3.4 Craft Manpower

The labor force in the area is made up of both union and non-union forces with an average unemployment rate of 10 to 11% and currently a 25 – 30% unemployment rate among the building trades. The project could be executed using either union or open shop craft labor. The closest labor pools of significant size are located in Louisville, Kentucky (approx. 30 miles northeast of the jobsite); Cincinnati, Ohio (30 - 40 miles northeast of the jobsite). If the current proposed projects are approved the search for skilled labor will need to expand to the Carolina's, Georgia and Alabama.

Current research indicates there will be multiple construction projects within 150 miles of the Ghent plant site that will compete for the available craft workforce during the proposed project schedule. Continuous craft demand numbers could average 350 – 400 individuals annually from 2012 -2015 due to external projects alone. In addition, the proposed projects on LG&E/KU assets (Mill Creek Station, Ghent Station and E.W. Brown Station) could increase average continuous craft demand by another 1000 individuals over this same time period. If a majority of the construction work scope projected between 2012 and 2015 is executed, it is anticipated craft demand will quickly exceed available local union manpower. Projects will likely use a hybrid labor mix of union and non-union craft personnel to satisfy their manpower needs. This work force may contain a high number of traveling craft. Due to the large demands on labor it may become necessary to offer enhancements to the prevailing wage rate for longevity, performance, or cost of living expenses to attract and maintain the appropriate level of skilled craft.

The preliminary construction schedule for the Ghent work scope is based on a 54 month construction schedule. This should help to stabilize the project workforce by attracting and retaining local craftsmen looking for long-term job stability. It is anticipated that the project as outlined in the schedules referenced in Appendix A will utilize a peak workforce of approximately 500 field craft.

The EPC Contractor should be able to perform most work scope on a normal 40 hour workweek schedule. However, 50 hour workweeks may be necessary to attract and retain an adequate work force and to maintain the schedule for critical path activities. It is anticipated that all plant outage-related work activities that are critical to support the plant's outage schedule will be performed on an overtime basis or will use extra shifts as necessary to complete the work on time.

The cities of Louisville, Kentucky and Cincinnati, Ohio as well as the numerous small to medium size communities located within 30 - 40 miles of the jobsite should be able to offer ample temporary housing to the traveling workforce. It should not be necessary to establish RV areas or other housing options if it becomes necessary to augment the local labor pool with a large constituent of craft travelers.

Detailed manpower surveys need to be conducted during the next phase of development of the project as well as in the months just prior to start of construction. The availability of a stable, quality workforce represents a real risk to the success of the project and this uncertainty has been monetarily quantified and included in the cost estimate. The craft labor portion of the Ghent project cost estimate uses a composite labor rate that accounts for the use of union and non-union labor. Use of a composite labor mix will require site access changes to the facility as outlined in section 3.6 "Access

Requirements." In addition, the project cost estimate it has been adjusted to include increased craft incentives that may be necessary to attract and maintain skilled labor. It is based on executing the work with a 50 hour work week for the entire duration of the project to account for a high number of traveling craft in the work force.

3.5 Construction Facilities, Utilities and Services

The EPC Contractor will require a majority of the available open area around the Ghent plant site to establish the support facilities required to execute the project. These will include craft parking, office trailers, craft break areas, medical facilities, material warehousing and lay-down, fabrication areas, crane lift positions, material staging, and equipment/tool storage. The available area within the plant proper is limited, and in some cases, inadequate to accommodate the need. The EPC Contractor will likely utilize additional open land area on the southwest end of the plant site; small land parcels adjacent to and northeast of Unit 1; and the existing flue winding facility and lay down area located on the south side of Highway 42 at the south end of the plant site to obtain the necessary construction footprint. It may be necessary to obtain additional land area remote to the plant site for long term storage of construction material. The main construction facility requirements are discussed as follows.

3.5.1 Parking

Presently, plant construction craft parking consists of a dedicated parking area located on the southeast end of the plant site, south of the existing warehousing and field engineering buildings. This lot has a capacity of approximately 500 vehicles. This parking area could be optimized and expanded, possibly to the north and southeast to increase total parking capacity above 600 vehicles. This should be adequate to accommodate the maximum construction parking demand which will occur when peak construction manpower coincides with a plant outage, which is estimated to approach 700 workers.

3.5.2 Construction Trailers

Construction management, EPC Contractor, and subcontractor office trailers need to be located in proximity to the main workforce, for maximum efficiency. It is estimated the EPC Contractor will require a four wide (or equivalent) office complex and sufficient area to accommodate an additional ten single wide office trailers (or equivalent) around the project site. The area immediately north of the existing construction parking area is already developed for construction trailers and could accommodate the estimated contractor need. Additional area adjacent to Unit 1 should be

allotted for contractor trailers necessary to support the work scope at Units 1 and 2. Potential areas for locating construction trailers are shown on Construction Facilities Plot Plan drawing 168908-GCDS-1003. It is anticipated LG&E/KU will utilize the existing Field Engineering building located on the southwest corner of the plant site to house their project management team. The final location of the construction trailer complex will be determined in cooperation with the EPC Contractor after the site general arrangement is developed and approved.

The EPC Contractor will be responsible for the configuration of the construction trailer complex. It should include staff and craft supervision offices, restroom facilities, hand wash areas, craft break areas, craft change areas, and craft "on-boarding" facilities. In addition, a conference room trailer should be provided in this area for project meetings with LG&E/KU.

3.5.3 Lay-Down Area

It is estimated approximately 20 acres of lay-down/fabrication area will be required to execute the proposed work scope as a single project, using a standard material procurement and delivery template. The immediate area around the power block is nearly fully developed, and lay-down area is limited. The largest open land area is located at the southwest end of the plant site, adjacent to the forced draft cooling towers. This area contains approximately 6 acres suitable for material lay-down; however, a large portion of it will likely be used as a fabrication yard to assemble SCR reactor box, ductwork, and PJFF equipment modules. Approximately 3 additional acres of land could be developed for material lay-down on the south side of Highway 42 in the area occupied by the flue winding building and along the access road adjacent to the switchyard. The available site lay-down is not adequate to support a standard material procurement and delivery template. It is possible a material procurement plan will be implemented on the project which utilizes OEM supplier lay-down to store project material until needed. In addition, the EPC Contractor may procure remote lay-down area in close proximity to the project site for use as long term storage. The areas proposed for material lay-down and described above are shown on Site Plot Plan Drawing 168908-GCDS-1003.

The EPC Contractor is expected to supply, transport, and store all material that is required to execute the project. This includes determining the procurement strategy used to supply the project, acquiring additional offsite lay-down/fabrication area if necessary and developing storage facilities for environmentally sensitive material.

3.5.4 Fabrication Area

The areas available to fabricate and assemble large modular components or subassemblies, e.g., inlet and exhaust ductwork, fabric filter compartments, SCR reactor box segments, and structural support steel framework, is largely limited to the 6 acre land parcel and the pre-engineered metal building (flue winding shed)) and adjacent 3 acre land parcels described in Section 3.5.3. The EPC contractor will be required to cross Highway 42 with material fabricated at the remote flue winding area. Heavy haul material transport must be carefully planned and effective communication established with plant operations and the local highway department in order to efficiently use this area for field fabrication.

Limited areas exist around and within each of new major equipment footprints to establish small craft fabrication areas for "field run" items such as small bore piping, conduit, and miscellaneous structural platforms. These areas can follow and be relocated according to the adopted construction execution sequence. However, the EPC Contractor must closely coordinate use of the available areas to ensure that fabrication activities do not affect the work of other subcontractor's and plant operations. The areas proposed for field fabrication are shown on Site Plot Plan Drawing 168908-GCDS-1003. They should be sufficient for fabricating modular components. However, the plant roadways adjacent to the Ohio River are crossed by numerous utility racks which will limit the traffic routes used to transport fabricated material across the plant site.

The EPC Contractor is expected to obtain and develop additional remote fabrication sites, if required to properly execute the work scope.

3.5.5 Construction Utilities

The EPC Contractor's construction trailer complex and miscellaneous site support trailers will require various temporary utility services, including phone/data lines, potable water, electrical, and sanitary facilities. The EPC Contractor will be responsible for providing all utilities to these trailers, unless otherwise directed by LG&E/KU.

For the purposes of this report and the cost estimate, it is expected that construction utilities will be established and routed generally as discussed in the following subsections.

Potable Water and Service Water

LG&E/KU will provide potable water to the project in amounts sufficient to supply drinking water to the EPC Contractor's personnel. The EPC Contractor will be responsible for distributing potable water from the designated connection point(s) near the Ghent units to the point of need. Alternately, the EPC Contractor may choose to

establish a contract with a local bottled water supplier to provide and distribute potable water for consumption and sanitary needs.

LG&E/KU will also provide a source of service water within the jobsite for the EPC Contractor's use. The EPC Contractor will be responsible for installing freeze protection on all water services, both temporary and permanent, under its control.

Construction Power

LG&E/KU will supply electrical power for all construction activities. It will be offered to the contractor as 480 volt, three-phase power via construction panel boards located at various locations within the Ghent plant footprint and at the pre-fabricated metal building used for chimney flue winding. The EPC Contractor will be responsible for connecting to the panel boards and distributing the power to its work locations. The EPC Contractor will also be responsible for distributing and connecting the 120 volt power in the trailer area to each trailer.

Sanitary Facilities

The EPC Contractor will be responsible for providing adequate temporary toilet facilities for the site workforce employed for this project. Under this scenario, the EPC Contractor is expected to establish a contract with a local service company to supply and maintain chemical toilets for the site workforce. Construction office trailers may use bladder type holding tanks or chemical toilets, as acceptable to the agency having jurisdiction. The bladder tanks and chemical toilets will be furnished, serviced, and maintained by the EPC Contractor.

Telephone/Data Lines

LG&E/KU will supply telephone and internet connections to the EPC Contractor in sufficient capacity to perform the work scope. This connectivity will be offered at a central hub connection within the existing power block footprint or at a designated contractor trailer area. The EPC Contractor will be responsible for routing phone and data service from the existing hub to its facilities, including subcontractor's trailers and reconfiguring them to suit its needs. Any new data and LAN installations established by the EPC Contractor must be coordinated through LG&E/KU data security department to ensure they are compatible with the system host.

3.5.5 Construction Services

For the purposes of this evaluation, it is assumed the EPC Contractor will be required to provide the following construction services to support its work activities, unless stated otherwise in its contract:

- Craft break area.
- Craft drinking water stations.
- Restroom facilities.
- Water for hydrostatic tests of tanks and piping systems.
- Housekeeping.
- Security lighting (other than lighting presently installed around the plant site).
- Freeze protection.
- Snow removal (owner will maintain permanent plant roadways).
- Trash removal.
- Hazardous waste storage and disposal.
- Drug testing.
- Small tools.
- Personal protective gear.
- Construction consumables.
- Badging facilities for all construction personnel.
- Security of all facilities and areas under the control of the EPC Contractor.
- Installation of temporary construction signs, fencing, and barriers.

3.6 Site Preparation Activities

Certain work activities required to prepare a "brown field" site for a major project involve or affect operation of the existing plant; require specific knowledge of existing plant facilities; or involve businesses contractually associated with the owner. In most cases, the owner can accomplish these activities more efficiently and economically than if they were assigned to the EPC Contractor. Performing some elements of site preparation prior to mobilizing the EPC Contractor not only enhances project initiation, but can also allow LG&E/KU to maintain control over those portions of construction execution that can have the most impact on plant operations. Some activities that could be performed by LG&E/KU or by a site development contractor prior to EPC Contractor mobilization are discussed below:

- ***Ensure Existing Survey Monuments are Adequate--*** The existing plant survey monuments should be visually inspected and validated by

survey to ensure that they are in undisturbed, in good repair, accurate, and can be utilized for the proposed work scope. Preferably, monuments should encompass the basic project footprint, with at least two monuments visible while standing at any one monument. This will support the EPC Contractor in establishing horizontal and vertical control points for the project.

- ***Raise or Relocate Overhead Obstructions and Widen Pinch Points--*** Numerous utility racks cross plant access roads and create low overhead restrictions to material transport and placement of construction cranes. The plant access road running east to west and adjacent to the Ohio River has numerous low overhead obstructions, especially at its eastern end. Low overhead obstructions and plant roadway pinch points should be identified and their potential impact to construction execution assessed prior to EPC Contractor mobilization. These points should be determined in parallel with establishing site traffic patterns. Interferences that have a large impact to construction execution when compared to the cost to abate them should be modified.
- ***Relocate Existing Underground Utilities--*** Existing underground utilities and foundations may require relocation or extensive modification to accommodate new construction. Underground systems critical to the operation of the units should be modified in scheduled plant outages to the extent practical prior to EPC Contractor mobilization.
- ***Demolish and Relocate Existing Plant Structures--*** Existing plant facilities critical to plant operation that interfere with new construction should be demolished and relocated prior to EPC Contractor mobilization. These facilities include the Unit 3 WFGD high voltage overhead power lines and transformers, maintenance shops and covered maintenance/utility corridor between Units 2 & 3, and the elevated personnel corridor between Units 2 & 3. Existing site facilities requiring demolition and/or relocation are shown on attached General Arrangement Drawings 168908-GCDS-1000 through -1003. The new configuration of the relocated facilities needs to be determined and included in the EPC bid documents. A pre-engineered warehouse facility located north of Unit 4 WFGD interferes with Unit 4 PJFF and must be demolished and/or relocated. This facility is not critical to plant operations and could be demolished and relocated by either LG&E/KU or the EPC Contractor during project execution.

- ***Develop a Supplemental Parking Area--*** The existing construction parking lot may need to be enlarged to accommodate project craft personnel and outage contractors prior to the start of project construction. This activity is discussed above in Subsection 3.5.1.
- ***Address Hazardous Materials Abatement--*** Ghent plant site structures and equipment likely contain asbestos containing materials (ACM) and lead-based protective coatings that are classified as hazardous materials. Tie-in points between the new construction and existing plant should be inspected and these materials, if found, abated prior to starting the contract scope of work. The EPC Contractor is expected to locate and identify additional areas requiring abatement as they are located during project execution. LG&E/KU will then abate and dispose of hazardous materials found in the identified areas. It is essential for the EPC contract to define the roles and responsibilities of the EPC Contractor and Owner concerning hazardous material identification and abatement.
- ***Establish Site Traffic Patterns--*** LG&E/KU plant operations and project management personnel should determine the existing site roadways that will be shared with construction vehicles then modify site traffic patterns to isolate plant operations from construction to the extent possible. The affected roadways should be repaired and improved as required to support the plan. The final plant configuration may permanently modify existing plant roads. Affected plant personnel should be trained on the new traffic patterns prior to construction completion. Existing plant personnel traffic along the ground level utility corridor, maintenance skywalk, and "courtyard" area between Units 2 and 3 will be interrupted and must be rerouted. New personnel traffic patterns should be implemented at least a month prior to start of construction.
- ***Establish Construction Access--*** LG&E/KU plant operations and project management personnel should determine the location(s) that will be offered to the EPC Contractor for developing craft badging and vehicle access facilities. These points should be determined in parallel with establishing site traffic patterns. The number of access points and their configuration will vary, depending on the craft mix (union, non-union, or hybrid) and contracting strategy used to execute the project. These details are typically determined during EPC Contract negotiations therefore, the project cost estimate does not include costs to modify plant access roads,

parking areas, or craft badging facilities to accommodate labor agreements. Existing site security procedures should be reviewed and amended to account for the EPC Contractor's craft plant access points and to ensure construction manpower, material, and traffic are adequately controlled. In addition, existing entry/exit facilities should be improved as necessary to accommodate increased access traffic.

3.7 Plant Site Roadways

State Highway 42 is the primary access used by permanent plant staff, construction craft and outage contractors to enter and exit the plant site. This roadway leads directly to craft parking areas through dedicated entry roads on the west end of the plant property and to plant operations and visitor parking through entry roads on the east and central part of the property. In addition, there is an exit to the south side of Highway 42 located directly across from the main plant entry which provides access to remote lay-down and fabrication areas. This access point crosses the main line railroad and Highway 42, but could be used to transport construction material between the proposed lay-down and fabrication yards shown on Construction Facilities Plot Plan drawing 168908-GCDS-1003.

It is anticipated that construction traffic routes inside the plant perimeter fence will largely be confined to the east/west roadway running along the north side of the plant, adjacent to the Ohio River; the east/west roadway running along the south side of the power block, adjacent to the operations parking areas; and the roadways located south of the western forced draft cooling towers. The roadway running north/south from the main plant entrance and crossing Highway 42 and the railroad main line may also be used as the primary material delivery path for material traveling between remote lay-down/fabrication areas and the power block footprint. The EPC Contractor will need to carefully coordinate use of these routes with plant operations to ensure that construction traffic does not impair normal plant operation and maintenance activities. Construction crane activity during Unit 1 and Unit 2 project execution will interrupt normal plant traffic on the north/south roadway adjacent to the Ohio River and the maintenance road used to access Unit 1 and 2 forced draft cooling towers for prolonged periods of time. Alternate traffic patterns will need to be established to provide maintenance access for plant equipment in these areas.

3.8 Mobile Crane Access

Crane access around the existing plant structures and in new construction areas in general will be challenging. Numerous active underground utilities and foundations are

located within the new footprints for Units 1, 2, & 3 and must be accounted for. The partially buried circulating water piping running between Unit 2 and the Unit 2 forced draft cooling tower is located directly in the construction footprint for PJFF and ID fan erection. The EPC Contractor will be expected to supply and install temporary sub-base, crane matting and bridging as required to ensure that underground utilities are adequately protected from the ground pressure imposed by construction equipment. Numerous utility racks cross over the east/west plant access road running along the north side of the plant site and impede movement of cranes and modularized equipment components. These obstructions should be abated when it is economical to do so as discussed in section 3.6. The EPC Contractors crane plan must account for access obstructions and provide adequate area for crane swing and boom stabilization during high wind conditions. Project work scope involving SCR and economizer gas-side bypass duct construction on Unit 2 will be particularly difficult due to the congestion created by existing facilities. The eastern 50% SCR reactor and economizer bypass ductwork should be erected prior to start of work on Unit 1 PJFF in order to maintain the crane access corridor between the Unit 2 chimney and Unit 1 SCR and ESP. In addition, construction of the western 50% SCR reactor and economizer bypass ductwork should be executed prior to start of work on Unit 3 PJFF in order to provide adequate crane assess in the area west of Unit 2 boiler in the courtyard area. It is anticipated that the large cranes used to set SCR reactor box segments, ductwork, structural steel, vertical vessels, and pre-fabricated equipment modules will be lattice boom type crawler cranes with a capacity of 300 to 400 tons. Large capacity hydraulic truck cranes could be used during PJFF construction at Unit 1 and SCR construction at Unit 2 due to space restrictions imposed by existing plant facilities. Cranes used for construction of field erected tanks; pre-engineered buildings, setting of minor equipment, lay-down activities, and utility lifting will likely be small, rubber-tired, rough terrain hydraulic units. The EPC Contractor will be expected to determine actual crane needs based on its final design of the equipment, component size, weight, and the working radius available around the equipment.

3.9 Construction Execution Plan

3.9.1 Unit 1 Arrangement

The proposed Unit 1 AQC arrangement is shown on Site Arrangement Drawing 168908-GCDS-1001. It is assumed the ash handling system serving existing Unit 1 ESP has been refurbished prior to beginning construction of new AQC equipment and the PAC injection systems for Units 1 and 2 the sorbent injection system for Unit 2 are installed and operational. It is also assumes the eastern Unit 2 50% SCR reactor has been completed prior to beginning construction on Unit 1 work scope.

The AQC technology proposed for Unit 1 consists of two 50% PJFFs, two 50% VFD booster fans, PAC injection equipment, and the associated ductwork and ancillary equipment required to tie this equipment into the exhaust gas air stream. The major equipment is proposed to be located immediately south of the southwest end of Unit 2 mechanical draft cooling tower, and west of the Unit 1 WFGD. The PJFF equipment will be located above, and straddle, the existing Unit 1 WFGD inlet duct. The new booster fans will be located below (west fan) or just south of (east fan) the existing inlet duct and new PJFFs adjacent to the existing Unit 2 ID fans. This arrangement minimizes obstruction to cooling tower inlet air flow, but places the PJFFs above the outlet stacks of the cooling tower draft fans. This may create icing conditions on the PJFFs during certain weather events.

The proposed construction execution will begin with modifying existing flue gas ductwork with connecting flanges, transition ductwork and blanking flanges to allow it to accept the new equipment. This work can be accomplished during a short Unit 1 outage. This will be followed by construction of the PJFF; associated 50% booster fans; inlet and outlet ductwork; and supply/discharge piping associated with the PAC and ash handling systems. This work will be accomplished with Unit 1 in operation. After the PJFF, booster fans and ductwork are erected Unit 1 will be placed in outage to connect the new systems into existing plant ductwork, piping, and electrical facilities.

The PJFF is located above the existing WFGD inlet duct, supported by a substantial new foundation and structural steel superstructure which spans the width of the duct. The PJFF location above other new or existing equipment will require substantial work at heights and the resulting complications and inefficiencies. Installation of foundations will be problematic due to the existing congestion and the need to maintain unit operation to the extent practical. Micropiles may be required for many of the foundations.

Crane access to the construction area is limited. The main erection crane can be established on the northwest corner of the proposed footprint; however, it will have limited boom swing due to its close proximity to the Unit 2 chimney. In addition, extensive temporary structural fill and crane matting will be required to protect the half-buried cooling water piping running through this area. Additional crane and construction access can be established along the north side of the proposed footprint, in the cooling tower maintenance road. Construction activities must be closely coordinated with plant operations to ensure adequate access is maintained on the west end of the Unit 2 cooling tower to conduct routine maintenance.

The congested footprint has limited area to stage material. Major components of ductwork and the PJFF must be modularized for efficient execution of the work scope. It

is assumed that the major component modules will be fabricated in remote fabrication areas, transported to the work site via the north plant access road, raised over the Unit 2 cooling tower and set in place by the main lift crane located on the northwest end of the construction footprint.

The expected sequence of construction for installation for the Unit 1 arrangement is as follows and as noted:

- Install new flanges/blanking plates and transition duct pieces in the existing WFGD inlet duct and at the ID fan (outage).
- Construct new foundations and any supporting structural steel superstructure for the PJFF, ductwork and booster fans.
- Install new PJFF, booster fans, ancillary systems such as PAC and ash handling, plus ductwork to tie-in points.
- Complete tie-in of ductwork to existing WFGD inlet duct and ID fans (outage).
- Start-up and tune new PJFF, booster fans, PAC, and ash handling systems (combined outage and non-outage).

3.9.2 Unit 2 Arrangement

The proposed Unit 2 AQC arrangement is shown on Site Arrangement Drawing 168908-GCDS-1001. It is assumed the Unit 3 WFGD high voltage overhead power lines and transformers have been relocated; the common Unit 1 and Unit 2 ash handling building constructed; and the ash handling system serving existing Unit 1 and Unit 2 ESPs has been refurbished.;

The AQC technology proposed for Unit 2 consists of a two 50% PJFF, two 50% VFD booster fans, two 50% SCR reactors, PAC and sorbent injection and the associated ductwork and ancillary equipment required to tie this equipment into the exhaust gas air stream. Additionally, an economizer gas-side bypass system is proposed to aid SCR operation.

The two SCR modules are proposed to be located close to their respective exhaust gas trains in order to facilitate construction access and minimize new ductwork. The conceptual arrangement places the east SCR module above an existing structural steel frame supporting the Unit 1 SCR located immediately east of the Unit 2 east ESP. The arrangement tentatively includes a new structural steel tower straddling the existing steel frame, although ideally the existing framing might be incorporated into the support for the Unit 2 SCR. Additional investigation regarding the actual incorporation of the existing support tower into the support for the new SCR module must be completed at time of detail design to ensure that the existing structure and its foundation can support the loads imposed by the new construction. Installation of foundations will be

challenging due to the existing congestion and the need to maintain unit operation to the extent practical. A majority of the foundations will likely require micropiles.

The construction footprint can be accessed by construction equipment via a narrow lane running north/south from the north access road, then along the east side of Unit 2 chimney to the existing structural support frame. It is proposed that a lattice boom crawler crane or large hydraulic truck crane can be located immediately northeast of the existing support frame and used to "stick build" the new steel support frame, then lift pre-fabricated SCR and ductwork modules into place on the framing.

The proposed configuration of the west SCR module places it on a new structural support frame located on the southwest corner of Unit 2 west ESP, and below the Unit 3 and 4 coal conveyor. A support bent for the overhead coal conveyor, an existing elevated cable tray, and the Unit 2 WFGD pump building are all located in the immediate area proposed for the new west support frame and likely cannot be relocated. The frame design and final arrangement must accommodate these obstructions. It is proposed that a large lattice boom crawler crane be assembled in the "courtyard" immediately southwest of the SCR footprint and used to lift pre-fabricated support steel framing, SCR module, and ductwork modules into place. The west SCR is tentatively located directly beneath existing Coal Conveyor 3J, significantly complicating crane operation in the area. Although prefabrication of SCR support framing, modules, and ductwork sections should be used to the extent it is practical, size and weight of lifted components will be limited to that which can be maneuvered around the conveyor. Some temporary shoring or framing may be required to "land" prefabricated sections on the support frame where they can be drifted into place under the conveyor.

Construction materials can be transported to the footprint via the north/south access alley running immediately east of the existing Unit 2 WFGD or from the south through existing roll up doors installed in the enclosed ground level utility corridor. Components too large to pass through the roll up doors can be lifted over the existing personnel skywalk, utility corridor and maintenance shops using a second crane located to the south.

Gas-side economizer bypass ductwork is proposed to be installed between the upstream side of the economizer and the inlet side of each Unit 2 ESP to aid the operation of the SCR modules. The proposed location of the economizer bypass system ductwork would exit the boiler backpass above the economizer section and pass through the north exterior wall of the boiler building above the ESP inlet ductwork. This bypass ductwork would then turn downward and enter the ESP inlet ductwork at the first possible location. This configuration would be used for each ESP train. The ductwork is expected to be comprised of multiple ducts approximately 4 ft square at each ESP. The final duct

quantity and size will be determined during detailed design based on existing obstructions and flow rates required. Expansion joints and modulating dampers would be included in this ductwork. Crane access to set the new ductwork will be challenging due to its location between the north wall of the Unit 2 boiler building and coal conveyor 3J. Extensive scaffolding and access platforms will be required to position craft to prepare existing ductwork and install new bypass duct support steel and duct sections. The relatively small size of the proposed ductwork my allow it to be erected without using a ground based crane. Flat panel ductwork could be fabricated into modular sections at elevation inside the boiler building then drifted out of the building and set in its final location utilizing the new duct support steel and work scaffolding erected for craft access.

The two PJFFs and two 50% ID fans, PAC and sorbent injection systems, and associated ductwork are proposed to be located immediately north of the existing Unit 2 ESPs. The footprint for the new equipment must be reclaimed by eliminating existing ductwork in this area. This will require installation of a bypass duct connecting the common duct ending at the north end of the ESPs and the existing duct leading to the inlets of the WFGD. The bypass will allow the remaining common duct to the north to be demolished and the area prepared for foundation and support steel framing erection. The dimensions of the proposed PJFF extend across the existing north access road and encompass the existing utility rack. The PJFF, associated structural support frame, and ductwork must be elevated in order to allow the road and utility rack to pass beneath the new construction. The increased vertical height allows new electrical auxiliaries and ash handling equipment to be located beneath the elevated structure, concentrating equipment in the area it is needed and reducing the overall "sprawl" of the new construction. A new common Unit 1 and Unit 2 ash handling building (proposed under a separate project) would be located west of the old Unit 1 and 2 chimney and underneath the new PJFF. The PJFF support structure will need to be designed around this "existing" building. In addition, the elevated structure supporting the PJFFs will require careful coordination with the existing road and the elevated pipe rack immediately to the north of the road. The existing utility rack serves all four units. It cannot be taken out of service and must be accommodated in the structure's design. The foundations beneath the northernmost supports of the structure must also take into account the steeply sloping riverbank immediately to the north of the pipe rack.

The congested PJFF construction footprint contains limited area in which to stage material. Major components such as ductwork, booster fans, and PJFFs must be modularized for efficient execution of the work scope. It is assumed that the major component modules will be fabricated/dressed out in remote fabrication areas, transported to the work site via the north plant access road, and set in place by the main

lift crane, which would be located in the access road on the east or west sides of the construction footprint. It should be noted that the cranes established on the west side of the PJFF construction will likely be hydraulic, truck mount units. The PJFF support steel spanning the roadway to the east and the low overhead obstructions spanning the roadway to the west will not allow a lattice boom crawler crane to walk into place along the west side of the new construction. These obstructions will also make it difficult to lay a lattice work crane boom down along the roadway in severe weather

The expected sequence of construction (and estimated timeframe) for installation for the total Unit 2 arrangement is as follows and as noted:

- Install foundations and structural steel support frame for by-pass ductwork at PJFF.
- Install new flanges/blanking plates on existing ductwork as necessary to install by-pass damper and install by-pass ductwork at PJFF (outage).
- Demo by-passed ductwork and associated support steel at PJFF.
- Install foundations and structural steel framing supporting east side SCR
- Install new flanges/blanking plates on existing ductwork as necessary to install east SCR inlet and outlet ductwork (outage).
- Erect east side SCR and ductwork up to tie-in points.
- Tie-in east side SCR ductwork into existing duct and install blanking plates to re-direct flow through SCR (outage).
- Relocate overhead electrical lines and underground piping and ductbanks necessary to install foundations for west side SCR reactor. (outage, could be partially concurrent with outage for the east side SCR)
- Install foundations for west side SCR reactor structural steel support frame (4 months, non-outage, could be concurrent with east side SCR)
- Install new flanges/blanking plates on existing ductwork as necessary to install west SCR inlet and outlet ductwork (outage, could be concurrent with east side SCR).
- Install foundations and structural steel framing supporting for west side SCR reactor and ductwork (could be concurrent with east side SCR).
- Erect west side SCR and ductwork up to tie-in points (could be concurrent with east side SCR).
- Tie-in west side SCR ductwork into existing duct and install blanking plates to re-direct flow through SCR (outage, could be concurrent with east side SCR).
- Start-up and tune both east and west side SCRs (combined outage and non-outage).

- Install foundations and superstructure for PJFF and ductwork support frame and booster fans.
- Install PJFF, ductwork up to tie-in points, PAC/sorbent equipment, ash handling, and booster fans.
- Install ductwork to tie PJFF into existing ductwork (outage)
- Start-up and tune new PJFF, booster fans, PAC, sorbent, and ash handling systems (combined outage and non-outage).

3.9.3 Unit 3 Arrangement

The proposed Unit 3 AQC arrangement is shown on Site Arrangement Drawing 168908-GCDS-1002. For the purposed of this estimate it is assumed the maintenance shops between Units 2 and 3 have been relocated and the existing structures abandoned for EPC Contractor demolition prior to beginning construction of new AQC equipment. It is also assumed personnel traffic has been re-routed around the covered maintenance/utility corridor and the elevated personnel corridor between Units 1 and 2 and these areas have been turned over to the EPC Contractor for modification prior to beginning construction on Unit 3 new AQC equipment.

The AQC technology proposed for Unit 3 consists of a two 50% PJFFs, four 25% VFD ID fans, PAC injection system, installation of a remote sorbent unloading station, and the associated ductwork and ancillary equipment required to tie this equipment into the exhaust gas air stream.

The major equipment is proposed to be located in the courtyard area south of the Unit 3 ID fans and east of the Unit 3 power block. The PJFF equipment will be elevated to allow ground-level access to existing silos and equipment east of Unit 3. The elevated PJFF will straddle the utility corridor currently located in the walkway enclosure between Units 2 and 3. The new steel structure supporting the PJFF must be designed to maintain vehicle access to the east side of Unit 3, avoid disrupting the utility corridor in the ground level walkway, and avoid impact to the existing tanks to the south.

New ductwork will connect the exhaust ductwork upstream of the existing ID fans to the PJFF inlet. Four new 25% ID fans will be located at ground level between the PJFF outlet and existing Coal Transfer House 5 and adjacent waste sump. New ductwork downstream of the ID fans will connect to existing ductwork upstream of the Unit 3 scrubber inlet, bypassing the existing ID fans. The existing maintenance shops will require relocation to accommodate the PJFF and the skywalk will be temporarily removed during construction and then reincorporated into the new superstructures when complete.

The main crane will be located in the "courtyard" area, in close proximity to operating plant systems. Limited amounts of construction material can be staged in the courtyard, making modularization of major ductwork and PJFFs components a necessity. Major component modules will be fabricated in remote fabrication areas, transported to the work site via the south plant access road, raised over the ground level pipe corridor by a second crane, and set in place by the main lift crane located in the courtyard. Detailed rigging and lift plans must be developed for each major component installed. The proposed arrangement requires the PJFF to be installed above the existing utility corridor between Unit 2 and Unit 3, and below the Unit 3 coal conveyor. This configuration will require substantial work at heights and the resulting complications and inefficiencies. Installation of foundations will be problematic due to the existing congestion of underground utilities, existing concrete pipe vault, and the need to maintain unit operation to the extent practical. Micropiles may be required for the ID fan foundations and the ductwork support steel foundations located adjacent to existing Unit 3 building structure.

The expected sequence of construction for installation for the Unit 3 construction is as follows:

- Demo and/or relocate existing structures in the way of new construction, i.e.; utility corridor walkway enclosure, maintenance shop, personnel skywalk, etc
- Install new flanges/blanking plates and transition duct pieces in the existing inlet and outlet ductwork adjacent to the existing Unit 3 ID fans (outage, this work could also be completed at the time of the ductwork tie-in).
- Construct new foundations and any supporting structural steel superstructure for the PJFF, ductwork and booster fans.
- Install new PJFF, booster fans, ancillary systems such as PAC and ash handling, plus ductwork to tie-in points.
- Complete tie-in of ductwork to existing scrubber inlet duct and ID fans (outage).
- Start-up new PJFF, booster fans, PAC, and ash handling systems (combined outage and non-outage).
- Reinstall modified utility corridor walkway enclosure and elevated skywalk.
- Demo existing ID Fans

3.9.4 Unit 4 Arrangement

The proposed Unit 2 AQC arrangement is shown on Site Arrangement Drawing 168908-GCDS-1002. For the purposes of this study it is assumed the ash handling system serving existing Unit 4 ESP has been refurbished prior to beginning construction of new AQCS equipment. It is also assumed the pre-engineered warehouse building located north of Unit 4 absorber has been relocated and the existing structure abandoned for EPC Contractor demolition prior to beginning construction of new AQC equipment.

The AQC technology proposed for Unit 4 consists of two 50% PJFFs, four 25% VFD ID fans, PAC injection system and the associated ductwork and ancillary equipment required to tie this equipment into the exhaust gas air stream.

The major equipment is proposed to be located in the area west of the Unit 4 ESP area currently occupied by a pre-engineered metal building used as a warehouse. There are numerous underground utilities including a well/well house, electrical vault, and large bore circulating water piping on the south side of the proposed construction footprint. Ductwork supports in the pipe corridor area may be required to "bridge" the corridor to avoid excavations close to the large bore cooling lines. The PJFF equipment will be constructed on a ground-level foundation with inlet and outlet both on the east end of the PJFF. New common ductwork will connect the two exhaust ductwork trains immediately north of the Unit 4 power block and forward it to the PJFF. Four new 25% ID fans will be located at ground level at the PJFF outlet and common ductwork will forward the treated exhaust to a tie-in point upstream of the existing WFGD. The existing ID fans will be bypassed.

Crane access for construction of Unit 4 appears relatively good, although access may be limited to a great extent to the north side due to the shallow embedment of large bore circulating water piping on the south side of the construction footprint. Extensive coordination of existing ductwork modification and the installation of new ductwork on the downstream side of Unit 4 and around the existing ID fans will be required to minimize outage schedule.

The expected sequence of construction (and estimated timeframe) for installation for the Unit 4 arrangement is as follows and as noted:

- Demolish existing warehouse structure
- Install new flanges/blanking plates and transition duct pieces in the existing Unit 4 outlet duct and the inlet duct to the scrubber (outage, this work could also be completed at the time of the ductwork tie-in).
- Construct new foundations and any supporting structural steel superstructure for the PJFF, ductwork and ID fans.

- Install new PJFF, ID fans, ancillary systems such as PAC and ash handling, plus ductwork to tie-in points.
- Complete tie-in of ductwork to existing scrubber inlet duct and duct upstream of the existing ID fans (outage).
- Start-up new PJFF, booster fans, PAC, and ash handling systems (combined outage and non-outage).
- Demo existing ID Fans.

Appendix A
Reference Drawings

168908-GCDS-1000	Site Plot Plan
168908-GCDS-1001	Site Arrangement Unit 1 and Unit 2
168908-GCDS-1002	Site Arrangement Unit 3 and Unit 4
168908-GCDS-1003	Construction Facilities Plot Plan
Level 1 Project Schedule	Ghent Units 1, 2, 3, & 4 Schedule