LG&E/KU – E.W. Brown 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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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 3 at the E. W. Brown Generating Station, which is located in Mercer County, Kentucky, between the towns of Shakertown and Burgin, off of Hwy 33. The station is sited on the west side of Herrington Lake, the impoundment behind Dix Dam. The station includes three pulverized coal fired electric generating units with a total nameplate capacity of 747 MW gross. The electrical power from the E.W. Brown Station units is used to provide both load and voltage support for the 138 kV transmission systems. The addition of air quality control (AQC) technologies is being evaluated to ensure compliance with the emissions limitations the E.W. Brown generating site may be required to meet in the future.

This constructability review is intended to identify site-specific construction requirements for the proposed modifications to E.W. Brown Units 1 through 3 and ensure their cost is incorporated into the overall project cost estimate. The drawings and reports 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 ensures the costs associated with them are included in the project cost estimate.

The review is based on information obtained from walkdowns conducted at the plant site, drawings and aerial plan views of the plant site, interviews with plant operations personnel, General Arrangement Drawings 168908-BCDS-1000, -1001, -1002, and -1003, listed in Appendix A, Reports 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 lay-down/fabrication are adequate for the AQC project scope.
- The schedule proposed for the project may cause it to compete with other LG&E/KU projects and planned major capital projects in the region 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 1/2 abandoned water treatment annex building and associated chemical tanks, exhaust ductwork dust collection hopper, Warehouse No. 3, and portions of the inlet ducts on Unit 3 primary ESPs must be demolished to provide adequate footprint for new construction. 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.
- A large portion of the existing Unit 1 and Unit 2 plant parking area will be utilized for new construction footprint. The entire parking lot must be

relocated during construction. The southern portion of the parking lot remaining after construction is complete must be reconfigured and enlarged to remain functional.

- Crane access to new construction on Units 1 and 2 will be congested and require detailed planning. Exhaust ductwork and support steel between Unit 1 and 2 boilers and their new air heaters should be executed as a single project to ensure adequate construction access is maintained at the unit tie-in points.
- 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 roadways. It may be possible to transport compact, heavy components over the existing railway system.

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 E.W. Brown plant site. The project work scope should include relocation of critical existing plant facilities such as Unit 1 and 2 plant parking 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 E.W. Brown plant site. The project site consists of three coal fired electrical generating units and associated support facilities.

The construction work scope is depicted on Site Arrangement Drawings 168908-BCDS-1000, -1001, -1002, and -1003, referenced in Appendix A. Work will include installation of new single train centrifugal FD fans, air preheat systems, regenerative air heaters, and Selective Catalytic Reduction (SCR) technology on Units 1 and 2; installation of pulse jet fabric filter (PJFF) technology with sorbent and powder activated carbon (PAC) injection on Units 1 and 2; installation of pulse jet fabric filter (PJFF) technology with PAC injection on Unit 3; and installation of a new ID fan on Unit 2. Existing ID fan motors from Unit 2 will each be re-used in a new location for the new Unit 1 and Unit 2 single FD fans. This equipment will support the desired emission controls and will also include flue gas ductwork, air compressors, ash handling equipment, addition of new auxiliary electrical equipment, modifications to existing auxiliary electrical equipment 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 high sulfur Western Kentucky bituminous coal.

3.2 Construction Execution

For the purpose of this evaluation, it is assumed that project construction for all three 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. 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 plant powerblock buildings, equipment foundations, and equipment; 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.
- ***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 PJFF and 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 E.W. Brown plant site is located on the west shoreline of Herrington Lake, approximately 30 miles south-southwest of downtown Lexington, Kentucky. The area surrounding the plant site is woodland and developed farmland. The town of Burgin is located approximately 5 miles southwest of the plant site; ash ponds are located immediately to the south and west of the plant site; Herrington Lake to its east; woodland and the Dix River to its north; and a simple cycle combustion turbine facility and switchyard on its northwest side.

The existing interstate, federal, state, and county roadway systems provide the primary route for transporting material and personnel to the E.W. Brown project site. Interstate 64 (I-64), a divided, multi-lane paved roadway, runs east to west through the City of Lexington, Kentucky approximately 30 miles northeast of the plant site. Interstate 75 (I-75), a divided, multi-lane paved roadway, runs north to south through the City of Lexington, Kentucky approximately 23 miles east of the plant site. In addition, the Martha Layne Collins Blue Grass Parkway, a divided, multi-lane paved roadway, runs southwest to northeast through the City of Lexington, Kentucky approximately 20

miles northwest of the plant site. The most direct route to the site from Lexington uses US highways 68 (Harrodsburg Road) and 27 (Lexington Road). These paved roadways are four lane exiting Lexington to the south and reduce to two lane roadways as they exit the town of Nicholasville. US highway 68 merges with US 33 to cross the Kentucky River, then the two highways split. Taking US 33 south (Shakertown Road) at the split will lead to State Highway 342 (Dix Dam Road) which leads to the entrance road into the plant site.

The closest commercial airport terminal to the E.W. Brown plant is the Lexington Blue Grass Airport, which is located approximately 30 miles northwest of the plant site.

The site is also served by the Norfolk Southern railroad with additional service by the CSX railroad up to Lexington, KY. The site railway system is used primarily for delivering coal, but 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 vacant land at the north and east ends 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. The project could be executed using either union or open shop craft labor. The closest labor pools of significant size are located in Lexington, Kentucky (30 miles northeast of the jobsite); Louisville, Kentucky (80 miles northwest of the jobsite); and Cincinnati, Ohio (110 miles north of the jobsite). A detailed craft labor survey is presented in, “Craft Labor Survey, Air Quality Control Studies, E.W. Brown Generating Station”, as referenced in Appendix A.

3.5 Construction Facilities, Utilities and Services

The EPC Contractor will require a majority of the available open area around the E.W. Brown 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 northwest and west ends of the plant site to obtain the necessary construction area for proper project execution. The main construction facility requirements are discussed as follows.

3.5.1 Parking

Presently, plant construction craft parking consists of various parking areas located on the north end of the plant site, around the existing contractor trailers and training building. Additional craft parking area is located immediately west of the gas fired peaking station. The combined construction parking areas have a capacity of approximately 450 vehicles. The parking area west of the peaking station could be expanded 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.

Presently, parking for permanent plant personnel consists of a dedicated parking area located immediately east of Unit 1 which has a capacity of approximately 120 vehicles. Installation of the Phase II AQC modifications for Units 1 and 2 will take up significant area in the existing parking lot northeast of the Unit 1/Unit 2 powerhouse, specifically the majority of space north of Column Line A to the conveyors on the east and north. Additional portions of the existing parking lot will be reserved for the PAC and sorbent silos, plus truck access and unloading lanes adjacent to the silos. The existing parking lot must be refigured accordingly. A preliminary review of the parking area available after construction is complete indicates that the space can be refigured to accommodate the 60 and 70 car-sized parking spaces identified by LG&E/KU as required for normal operation and maintenance outages. This assumes several unused facilities, such as the temporary loading dock north of Unit 1 and a waste dumpster station, are removed. The lanes between the parking spaces would be available as truck access lanes to the silos as well as traffic lanes within the parking lot. The reconfigured parking lot would require new painted lane and parking space markings, as well as new signage to properly direct traffic and prevent blockage of access to the new AQC area and the silos. It is likely that additional parking spaces will be required to support outages or other periods of significant temporary traffic. Additional parking, if it is required, could be accommodated in the area north of the common WFGD or other areas northwest of the WFGD. Additional parking could also be created south of Unit 3 by demolishing the abandoned ESPs and developing the resulting footprint into parking area. The amount of additional parking areas will be determined during detailed design after a general plant arrangement is determined.

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 six single wide office trailers (or equivalent) around the project site. The Owner has established a contractor trailer complex located due north of the common WFGD. This complex is sufficient to support EPC Contractor needs for the proposed project. Additional satellite construction office trailers may be located in the Unit 1 parking area and west of the common WFGD. Potential areas for locating construction trailers are shown on Construction Facilities Plot Plan drawing 168908-BCDS-1003.

The EPC Contractor may choose to provide office and support facilities in addition to those provided by the Owner, including staff and craft supervision offices, restroom facilities, hand wash areas, craft break areas, craft change areas, and craft "on-boarding" facilities. The EPC Contractor will be responsible for utilizing the available facilities and providing additional facilities as required to support project execution. The final location of temporary construction facilities will be determined in Owner/Contractor meetings after the site general arrangement is developed and approved.

3.5.3 Lay-down Area

It is estimated approximately 15 acres of lay-down/fabrication area will be required to execute the proposed work scope as a single project, using standard procurement and delivery schedules. The power block footprint is nearly fully developed, and areas suitable for lay-down are limited. The existing lay-down area located on the southeast side of the intersection of Dix Dam Road and Curdsville Road contains approximately 15 acres and will be adequate for use on the proposed project. The area proposed for material lay-down and described above is shown on Construction Facilities Plot Plan Drawing 168908-BCDS-1003, referenced in Appendix A.

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 and developing storage facilities for environmentally sensitive material.

3.5.4 Fabrication Area

The Unit 1 and 2 FD fans, air preheat system, and air heaters; Unit 1, 2, and 3 PJFFs; and exhaust gas ductwork can be efficiently erected using modular construction. It is anticipated individual modules will be fabricated on site from flat panel sections delivered over the road from the manufacturer. Ideally, fabrication tables will be established "under the hook" of the main lift cranes in each construction footprint. The southern end of the current Unit 1 and 2 plant parking area will likely be used as a fabrication and staging yard for building PJFF, air heater, structural support framework,

and exhaust gas ductwork modules for Unit 1 and 2 modifications. A similar arrangement will likely be used for Unit 3 construction and located immediately west of the new PJFF footprint. These areas are shown on the Construction Facilities Plot Plan Drawing 168908-BCDS-1003. They should be sufficient for fabricating modular components. The area around and within each of the new major equipment footprints can be used 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 area to ensure that fabrication activities do not affect the work of other subcontractor's and plant operations. 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, 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 E.W. Brown 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 E.W. Brown plant footprint. 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. 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's data security department to ensure they are compatible with the system host.

3.5.6 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 "brownfield" 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.

- **Relocate Existing Underground Utilities--**Existing underground utilities located on the north side of Unit 1 and Unit 2 boiler buildings and the storm drainage system at the proposed footprint for Unit 3 PJFF may require relocation or 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 as described.

1. Existing Warehouse No. 3 located south of the WFGD must be demolished to make room for the Unit 3 PJFF and associated structures. Additional warehouse space is not expected to be required and Warehouse 3 will not be replaced.
2. A small oil storage building exists at the north end of the existing Unit 1 and 2 parking lot area. LG&E/KU has built a replacement oil storage building elsewhere on site. The original oil storage building can be demolished to make room for new equipment and need not be replaced.
3. The decommissioned Water Treatment Building annex and associated chemical tanks, pumps and containment structures located north and northeast of Unit 1 boiler house interfere with installation of new exhaust gas ductwork and ductwork support framework and must be demolished. These items are no longer in use and will not be replaced once demolished.

- ***Develop a Supplemental Parking Area--***Over one half of the Unit 1 and 2 parking area will be donated to develop Phase II AQC modifications for Units 1 and 2. In addition, the entire parking area will be used for lay-down and fabrication area during construction. Supplemental parking area must be developed to accommodate Unit 1 and 2 plant staff during construction and during peak parking times after construction is complete. This work will need to be completed prior to EPC Contractor mobilization.
- ***Address Hazardous Materials Abatement--***E.W. Brown 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 must be inspected and these materials, if found, must be abated prior to starting the contract scope of work. The EPC Contractor is expected to locate and identify the areas requiring abatement. LG&E/KU will then abate and dispose of hazardous materials found in the identified areas. It is necessary to establish in the EPC contract a minimum duration for notice of when LG&E/KU will need to perform the 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 and develop site traffic patterns to re-route existing traffic 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.

- ***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. 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

The existing plant entrance road along the coal delivery rail spur will remain the primary means of accessing new AQC installations. This roadway leads directly to craft parking areas and main craft entry into the project site. This road may be temporarily impacted by Unit 3 PJFF construction, but it can be re-established in its current location once construction is complete.

A secondary road between the parking lot north of Unit 1 and the east side of the Unit 1 cooling tower will be interrupted by the new Unit 1 and Unit 2 construction. However, this road will be re-established and incorporated into the Unit 2 ID fan maintenance road upon completion of construction. Access to the Unit 1 cooling tower from the south will be maintained. Supports carrying the ductwork from Unit 3 air heater to the Unit 3 PJFF will be designed to span the road west of Unit 3 and maintain access through that area.

Driveways from the main roads to access new AQC structures and buildings will be established upon completion of construction. Turnouts and truck unloading lanes will be added to the existing roads adjacent to new bulk material storage silos to minimize impact on road traffic during deliveries and unloading.

In general new roads will be asphalt paved to match existing roads, although gravel surfacing may be allowed in low or infrequent traffic areas.

It is anticipated that construction traffic routes inside the plant perimeter fence will largely be confined to the east/west roadway running along the south side of the plant, adjacent to the coal pile. Unit 1 and 2 construction execution will also use the east/west roadway running along the north side of the plant and terminating between the forced draft cooling towers. The main plant road entrance (Dix Dam Road) will likely be used as the primary material delivery path for incoming construction material, and material traveling between the main lay-down and the fabrication areas. 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 will frequently interrupt normal plant traffic on the southern east/west roadway and may require it to be re-routed when heavy loads are lifted and set in place. The final new construction footprint will likely require some existing secondary plant roadways and traffic patterns to be permanently re-routed.

3.8 Mobile Crane Access

Crane access around the existing plant structures and in the new construction footprint in general will be limited but adequate. In particular, it will be challenging to site the crane(s) used to install ductwork and ductwork supports along the north side of Unit 1 and 2 boiler building. Existing plant structures such as the abandoned water treatment facility and the exhaust gas duct ash collection hoppers interfere with new equipment construction and crane access and must be demolished. Numerous active underground utilities and foundations such as cooling water piping to the forced draft cooling towers are located within the new footprint and must be accounted for. The EPC Contractor will be expected to supply and install crane matting and bridging as required to ensure that underground utilities are adequately protected from the ground pressure imposed by construction equipment. Project work scope involving PJFF, SCR, and air heater construction on Units 1 and 2 will be predominately constructed from their south side due to the congestion created by existing facilities. It is anticipated that the large cranes used to set 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, supplemented with hydraulic truck mount cranes. 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, 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

"Brown-field" construction of major new equipment on the existing E.W. Brown plant footprint will present significant challenges in construction due to congestion, obstructions, and the need to keep existing units on line during construction. Each of the three units present access and construction execution challenges to implementing the selected AQC technologies. Accordingly, a high level constructability analysis was completed as part of this study in order to identify and evaluate potential concerns with the arrangement presented for each unit. Two conceptual site arrangement drawings (one covering both Units 1 and 2, the other covering Unit 3) are referenced in Appendix A. Each drawing depicts the current proposed arrangement, including refinements made per site walk down inspections and joint project team discussion. Because of the need to maintain generation capacity to the maximum practical, it is expected that major work requiring a unit outage will be done sequentially by unit and not simultaneously. However, Unit 1 and Unit 2 are enclosed in a common building structure, require similar modifications, and share a portion of the new ductwork support frame. For the purposes of this study, it is assumed a large majority of the non-outage work for Units 1 and 2 will be executed concurrently as a single construction project to minimize staggered remobilization and access concerns. Any work expected to be completed concurrently for Units 1 and 2 will be so noted in the description that follows. The planned construction for Unit 3 is located well away from Units 1 and 2, and will be considered independently.

Following is a generalized discussion of the sequence and concerns identified with the arrangement presented for Units 1 and 2 and for Unit 3.

3.9.1 Unit 1 and Unit 2 Arrangement

The proposed Unit 1 and 2 AQC arrangement is shown on Site Arrangement Drawing 168908-BCDS-1001.

As detailed on the conceptual arrangement plan, the AQC technology proposed for both Unit 1 and Unit 2 consists of replacing the existing air heaters, air preheat systems, and FD fans with new single train (100 percent capacity) equipment "remote" from that existing. Both Units 1 and 2 will each be provided with a new 100 percent capacity SCR and a corresponding 100 percent PJFF. A preliminary check confirmed

that the existing Unit 1 ID fan is adequately sized for the new design conditions and will be reused in its current location. The two 50 percent ID fans existing at Unit 2 will be replaced with a single new 100 percent capacity ID fan. PAC and sorbent transfer equipment, associated ductwork, and ancillary electrical and ash handling equipment required for Units 1 and 2 will be provided in facilities common for both units, to the extent practical.

The area directly north of the existing Unit 1 and Unit 2 powerblock structure is extremely congested with ductwork, the Unit 2 chimney, the (mostly inoperative) Water Treatment Building, and other equipment. Reclaiming this area for new construction would involve extensive demolition and unacceptably long unit outages.

Accordingly, the major equipment required for Units 1 and 2 is proposed to be located in the parking lot area east of the Unit 1 ID fan. A new structure supporting a new FD fan, air preheat system, new air heater, and new SCR module would be erected for each unit in the area closest to the Unit 1 ID fan. A new PJFF would be erected for each unit immediately east of the SCR/air heater structures. The new Unit 2 ID fan would be located between the Unit 2 SCR/air heater structure and the Unit 2 PJFF. The remainder of the area west and south of the existing coal conveyor would be reserved for ash handling, electrical power and control, and PAC and sorbent facilities common to both Unit 1 and Unit 2. A small oil storage building exists at the north end of the existing parking lot area to be occupied by the Unit 1/Unit 2 AQC modifications. LG&E/KU has built a replacement oil storage building elsewhere, allowing this original oil storage building to be demolished.

Exhaust ductwork downstream of the PJFFs would remain unit-dedicated. Unit 1 exhaust ductwork would be routed from the Unit 1 PJFF outlet to the inlet of the existing Unit 1 ID fan, with the new arrangement reusing the fan in its current location. This would include the reuse of the ductwork connected to the old Unit 1 stack for boiler venting. Ductwork downstream of the Unit 1 ID fan outlet would remain unchanged to the extent practical. Unit 2 exhaust ductwork would be routed from the Unit 2 PJFF outlet, through the new Unit 2 ID fan, and parallel as practical to the Unit 1 duct. It would then turn and tie into the existing Unit 2 exhaust ductwork above, and bypassing, the existing Unit 2 ID fans. Separate routing of Unit 1 and 2 exhaust ductwork will allow maximum reuse of existing duct as well as maintain Unit 2's ability to discharge to the old Unit 3 chimney, bypassing the WFGD if required.

The existing ductwork inside the Unit 1 portion of the common powerhouse will require extensive modification to connect the new Unit 1 FD fan, air preheat system, air heater, and SCR module. The U-shaped combustion air plenum that is routed across the back and sides of the boiler just inside the north wall of the building will have to be cut

into two side sections and the base of the U removed to make way for new ductwork. The new combustion air ductwork will connect to and supply the remaining portion of the existing plenum along the sides of the boiler. Similarly, the existing hot-side ductwork below the existing air heater will have to be cut and connected to new ductwork exiting the north side of the building through the area opened up by the partial removal of the combustion air plenum. Due to the very poor access it is assumed new ductwork will be transported to the appropriate boiler level in flat panel sections and welded into duct sections either in place, or in close proximity to their final location. The existing air heaters, hot air recirculation fans for air preheat, and FD fans are assumed to be abandoned in place unless re-use of the space justifies their removal. Existing ductwork inside the building will also be modified by the addition of economizer bypass ductwork. This will be a series of smaller ducts, including controlling dampers, connecting the duct upstream and downstream of the existing Unit 1 economizer. Final routing of this ductwork, and thus the required modifications to existing duct, will be determined at time of detailed design.

The existing ductwork inside the Unit 2 portion of the common powerhouse will require modification to connect the new Unit 2 FD fan, air preheat system, air heater, and SCR module. New ductwork will be installed to bypass the existing FD fans inside the building, air preheat coils, and the cold side of the existing air heater. Additional new ductwork will be installed connecting to the ductwork downstream of the economizer to bypass the hot side of the existing air heater. Existing ductwork and the existing air heaters will be demolished and removed to the extent required to complete these connections. Due to poor access, difficulty expected in removal, and the relatively poor usability of the space occupied, the existing FD fans are assumed abandoned in place. If a use is found for that space that justifies their removal, the bypassed fan can be removed. Existing ductwork inside the building will also be modified by the addition of economizer bypass ductwork. This will be a series of smaller ducts, including controlling dampers, connecting the duct upstream and downstream of the existing Unit 1 economizer. Final routing of this ductwork, and thus the required modifications to existing duct, will be determined at time of detailed design.

Portions of the north wall of the Common Unit 1/Unit 2 Powerhouse north of the Unit 1 boiler will require modification and removal to allow installation of the ductwork serving Unit 1 from the remote equipment. Girts, metal panel, brickwork, and architectural finishes will require removal to install the duct and partial

replacement/improvement to complete a weather-tight seal around the penetrating ductwork and a restored matching facade.

Exterior ductwork between Units 1 and 2 and the new air heaters and SCRs would be routed immediately adjacent to the north wall of the powerblock structure. The ductwork would be stacked to minimize its footprint and thus reduce the amount of demolition or relocation of existing equipment north of the powerblock.

The congestion north of the powerblock building, the extensive ductwork in the area, and the coal conveyor greatly complicate crane access for installation of the new ductwork next to the building. The existing chemical storage tanks and pumps in the area will have to be relocated or demolished, and the old Water Treatment Building and the dust collection ductwork and hoppers at Unit 2 will have to be demolished to gain sufficient access along the north building wall to install the ductwork support foundations and structural framing. Since these items are no longer in use, they will not be replaced once demolished. Other equipment in this area, such as Unit 1 circulating water pipe and associated pumps, must remain in service and will be worked around during installation of the ductwork supports. It is anticipated the ductwork foundations will be supported from micropiles due to the limited access available for construction equipment.

It is expected that a common steel structure carrying both Unit 1 and Unit 2 ductwork would be constructed with a crane located to the east of this area. To minimize foundations, the support structure would likely be designed as a series of trussed "bridges" sharing foundations. Each section of ductwork would be swung into the east end of the bridge, drifted horizontally to the west on a rail or roller system, and jacked into its final location within the trusswork. Due to routing limitations, Unit 1 ductwork must be erected first on the top tier of the support frame. However, by simultaneously installing the maximum amount of Unit 1 and Unit 2 ductwork in one operation, the crane will be allowed to "work bottom to top and west to east" as ductwork for both units is completed while maintaining the east end of the truss work support frame open to land and jack ductwork segments into place. It may be possible to set some sections of the ductwork directly in place on the support frame as the frame is erected if the lifting crane can be positioned to avoid vertical obstructions and maintain a suitable swing radius. This would eliminate jacking of the ductwork, but may complicate the frame design and rigging plans. Main crane access for construction of Unit 1 and Unit 2 would be from the parking lot area to the east, with a secondary crane located between Unit 1 and Unit 2 cooling towers for installation of downstream exhaust duct. Detailed rigging and lift plans must be developed for each major component installed.

Construction activities must be closely coordinated with plant operations to ensure adequate access is maintained to both Units 1 and 2 ESPs, ID fans, and associated

ductwork while construction is ongoing. The congested footprint limits available area to stage material. Major components of ductwork and PJFFs must be modularized for efficient execution of the work scope. It is assumed that major component modules will be fabricated in remote fabrication areas, transported to the parking lot area east of Unit 1 or between the two cooling towers, and set in place by the main lift cranes located as noted above.

As part of each unit outage, the respective existing air heaters and FD fans will need to be bypassed inside the powerblock building. Tie-in work will likely begin prior to the outage by modifying the north exterior boiler wall and associated structural wall girts adjacent to each tie in point at Unit 1 and Unit 2. Temporary rigging and support steel will be installed as required to remove existing ductwork and install modified tie-in duct sections. In addition, lagging and insulation will be removed from the ductwork around the tie-in points and new ductwork flat panel sections will be staged in available floor space inside the boiler building. During the outage, existing ductwork will be demolished at the tie-in point(s) and connecting flanges installed to accept the new ductwork section(s). Once the old ductwork sections have been removed, new duct section(s) will be fabricated in place from the flat panel duct pieces previously staged in the boiler building.

The two existing Unit 2 ID fan motors will be removed from their current location and the motors refurbished for reuse on the new Unit 1 and Unit 2 FD fans. Ductwork upstream and downstream of the fans will be removed as required to allow connection of new Unit 2 ductwork downstream of the new Unit 2 ID fan. Remaining ductwork downstream of the Unit 2 ESPs will be removed as required for stability or abandoned in place.

New ductwork downstream of the Unit 1 PJFF outlet will be routed to the inlet flange of the existing Unit 1 ID fan, which will be reused in place. Portions of the existing ductwork between the Unit 1 ESP and the ID fan must be removed as required to allow the connection. However, the existing duct also includes an NFPA 85 vent for Unit 1 which must be retained. The existing duct above the ID fan inlet containing the vent will remain in place, although a new damper may need to be installed to isolate it during normal operation. The existing support steel around the ductwork will also be reused in place to the extent practical. The portions of the existing ductwork that does not need to be removed to make the new connection and to retain the NFPA 85 vent, along with the ESP upstream, are intended to be abandoned in place or removed to the extent required for stability. Permanent duct blanks will be installed in the existing ductwork as required to isolate the abandoned ductwork while retaining the required duct in service.

Post outage work will likely include insulating and lagging the new ductwork, closing the north exterior wall around the duct penetrations, and removing demolished material from the building.

The proposed Unit 1 and 2 arrangement is expected to be erected in the following sequence:

- Demolish/relocate chemical tanks and equipment and portions of the Water Treatment Building necessary to install the ductwork support structure adjacent to the Unit 1/Unit 2 powerblock building. (non-outage)
- Install foundations and structural steel for the common ductwork support structure to the extent allowed with units on line. Set, slide, and jack sections of Unit 1 and Unit 2 ductwork in and on the common support structure. (non-outage).
- Construct new foundations and any supporting structural steel superstructure for the Unit 1 and 2 SCRs, air heaters, FD fans, PJFFs, and dedicated ductwork, plus foundations for common facilities (non-outage).
- Install new Unit 1 FD fan, air preheat system, air heater, SCR, and PJFF, plus remaining ductwork upstream and downstream to tie-in points (non-outage, to work concurrently with Unit 2 similar work scope).
- Install new Unit 2 FD fan, air preheat system, air heater, SCR, PJFF and ID fan, plus remaining ductwork upstream and downstream to tie-in points (non-outage, to work concurrently with Unit 1 similar work scope).
- Install common facilities such as the ash handling equipment, electrical facilities, and PAC and sorbent storage and transfer equipment (non-outage).
- Demolish required portions of Unit 1 ductwork and equipment to complete tie-in of ductwork to existing Unit 1 ductwork and ID fan (outage).
- Start-up and tune new Unit 1 SCR, air heater, air preheat system, PJFF, FD fan, PAC, sorbent, and ash handling systems (combined outage and non-outage).
- Demolish required portions of Unit 2 ductwork and equipment to complete tie-in of ductwork to existing Unit 2 ductwork (outage).
- Start-up and tune new Unit 2 SCR, air heater, air preheat system, PJFF, FD fan, ID fan, PAC, sorbent, and ash handling systems (combined outage and non-outage).

3.9.2 Unit 3 Arrangement

The equipment configuration for Unit 3 is shown on Site Arrangement Drawing 168908-BCDS-1002. It is assumed the following work scope has been completed prior

to beginning construction of new AQC equipment: The existing pre-engineered metal warehouse building has been relocated and the abandoned building demolished. The AQC technology proposed for Unit 3 consists primarily of a 100 percent PJFF, PAC silos and transfer equipment; and the associated ductwork and ancillary equipment required to tie this equipment into the exhaust gas air stream. The two existing 50 percent ID fans are expected to be re-used in place and a new SCR and sorbent injection system are expected to be in place and operational prior to installation of the PJFF.

The new PJFF is proposed to be located south of the existing WFGD module and west of the existing ID fans. A relatively significant difference in grade exists between the area to receive the PJFF and that surrounding the WFGD. Grade stabilization and possibly a retaining wall will be required between the WFGD and the PJFF to maintain stability of the PJFF without compromising the foundation at the WFGD.

New ductwork is routed from the Unit 3 air heater outlets just inside the south wall of the Unit 3 powerblock building. The ductwork exits the Unit 3 boiler building under the new SCR facility, then turns west, and crosses over the existing access road and the existing Unit 3 ductwork downstream of the ID fans to the PJFF inlet. New ductwork is also routed from the PJFF outlet to the inlets of the existing ID fans. No changes are expected to any ductwork or attached equipment downstream of the ID fans. Existing primary or secondary ESPs south of Unit 3 will be bypassed and abandoned in place to the extent practical. However, the existing ESP outlet ductwork also includes an NFPA 85 vent for Unit 3 which must be retained. A majority of the existing duct running below the existing ESPs over to the ID fan inlets containing the vent will remain in place, although a new damper may need to be installed to isolate it during normal operation. The existing support steel around the ductwork will also be reused in place to the extent practical. The portions of the existing duct not required to be removed to make the new connection and to retain the NFPA 85 vent, along with the ESP upstream, are intended to be abandoned in place or removed to the extent required for stability. Permanent duct blanks will be installed in the existing ductwork as required to isolate the abandoned ductwork while retaining the required duct in-service. New ash handling equipment will be located near the new PJFF with ash transfer pipelines to be installed on racks to the new common ash silos. New electrical power and control equipment will be located adjacent to the PJFF and a new PAC station and transfer station will be located accessible from the road west of Unit 3. The conceptual arrangement takes into account the currently planned SO_3-control sorbent handling facility northwest of the ID fans.

A major constructability concern will be installation of new ductwork beneath the SCR south of Unit 3. Routing of the new ductwork must take into account the SCR support structure, the existing ductwork in the area, and the to-be-bypassed ESP. It is

assumed the ductwork will be supported from a dedicated structure requiring foundations for new ductwork supports to be installed in extremely congested locations. This work will be executed with the unit on line to avoid extended outages. Special "bridged" duct support framework, similar to that conceived for Units 1 and 2, and independent of the SCR framework, must be installed to allow sections of ductwork to be set from the west side of the SCR area, drifted horizontally to the east on a rail or roller system, and jacked into place on the support framework. A report titled, "Review of Constructability and Coordination Issues at Unit 3 SCR," File 41.0803, compiled separately, recommends designing the new SCR superstructure to support the PJFF ductwork for this project. This document has been included for reference in Appendix A. A combined structure supporting both the SCR and the new ductwork to PJFF is expected to be overall more economical and could allow faster and easier installation than two separate support structures.

A portion of the Unit 3 original electrostatic precipitators (ESP) will be demolished in order to tie-in the ductwork for the new pulse jet fabric filter (PJFF). This work will be executed with Unit 3 in outage. Demolition of the ESPs will be limited to the inlet sections and, to the extent it can be avoided, not the ESP fields themselves. The un-demolished portions of the original ESPs and the secondary ESPs added subsequently are intended to be blanked off and abandoned in place. The abandoned units can be removed at a later date, should a use be found for the area occupied by the ESPs that justifies the cost of demolition.

The main crane for PJFF construction will be located adjacent to the roadway south of the PJFF, with a second crane for ductwork installation located in the area west of the SCR. Existing plant traffic along the south plant road and road west of Unit 3 will be interrupted and must be re-routed. Existing traffic patterns must be reestablished prior to start of construction. Limited amounts of construction material can be staged in these areas, making modularization of major ductwork and PJFF components a necessity. Major component modules will be fabricated in remote fabrication areas, transported to the work site via the plant access roads, raised over or around existing obstructions, and set in place by the cranes. At locations overhead access is blocked by existing components, as under the SCR, duct sections will be set on the end of the steel support superstructure, drifted horizontally on a rail or roller system, and jacked into final position. Detailed rigging and lift plans must be developed for each major component installed. Micropiles will likely be required for the ductwork foundations under the SCR.

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

- Demolish and/or relocate existing structures in the way of new construction, i.e.; fire hydrant station and underground utilities, demolish Warehouse 3 building and slab, etc. Complete necessary earthworks and retaining wall, if necessary, to accommodate the existing grade immediately surrounding the WFGD (non-outage).
- Construct new foundations for the PJFF, ductwork, PAC station, and associated ancillary facilities (non-outage).
- Install new PJFF and ancillary systems such as PAC, electrical gear, and ash handling, plus ductwork to tie-in points. (non-outage).
- Complete tie-in of ductwork to existing air heater outlet scrubber and ID fans. This includes selected demolition of the existing ESP units to allow installation of ductwork exiting the building from the air heater outlet. This is assumed to include removal of a section of inlet ductwork from each ESP, modifying structural framing to accommodate the removed section(s), and installation of vertical blanking plates over exposed ends. (outage).
- Start-up new PJFF, PAC, and ash handling systems (combined outage and non-outage).

Appendix A
Reference Drawings and Reports

Drawings

168908-BCDS-1000	Site Plot Plan
168908-BCDS-1001	Site Arrangement Unit 1 and Unit 2
168908-BCDS-1002	Site Arrangement Unit 3
168908-BCDS-1003	Construction Facilities Plot Plan
Level 1 Project Schedule	E.W. Brown Units 1, 2, & 3 Schedule

Reports

"Craft Labor Survey, Air Quality Control Studies, E.W. Brown Generating Station"
"Review of Constructability and Coordination Issues at Unit 3 SCR," File 41.0803