

1.0 Executive Summary

1.1 Phase II Air Quality Control Study

The purpose of this Phase II Air Quality Control (AQC) Study is to build upon the previous fleet-wide, high-level air quality technology review and cost assessment conducted for six LG&E/KU facilities (Phase I) in order to develop a facility-specific project definition consisting of a conceptual design and a budgetary cost estimate for selected AQC technologies (Phase II) for the Ghent Station.

This report summarizes the work performed by B&V. Descriptions of the documents prepared and included in this report are provided in Article 1.3 of this executive summary. The key documents included are the following:

- Air Quality Control Validation Report, which resulted in the validation of the AQC technology and selection of the preferred technology.
- Capital Cost Estimates
- O&M Cost Estimates
- Level 1 Schedules
- Cash Flows

The completed conceptual design also includes studies and technical descriptions, drawings, diagrams, and lists.

The estimated overnight capital cost for the Ghent Station is \$648 million which includes \$24 million in common facilities, \$120 million for Unit 1, \$234 million for Unit 2, \$142 million for Unit 3, and \$129 million for Unit 4. The schedule is based on beginning preliminary engineering in September 2011 and completing all work in early 2017.

Additionally, on March 28, 2011 LG&E/KU determined that installation of an SCR will not be required on Unit 2 and requested revisions to the estimated overnight capital costs to reflect this change in scope. Therefore, Black & Veatch modified the facility project costs “with SCR” on Unit 2 to reflect a new facility project cost “without SCR” on Unit 2. These estimated overnight capital costs and updated O&M costs, schedules, and cash flows are included in Addendum 1. However, the supporting information for the “with SCR” scenario was not revised for the “without SCR” scenario.

1.2 Primary Technologies Validated

The following primary technologies for control of the specified air emissions were evaluated and validated:

- Selective Catalytic Reduction (SCR) system for nitrogen oxides (NO_x) control (Unit 2).
- Pulse jet fabric filter (PJFF) with collection of powder activated carbon (PAC) for all four units for particulate (PM), mercury (Hg), and Dioxin/Furan control.
- Sorbent (trona/lime) for Unit 2 for sulfuric acid (SO₃) control.
- Neural Networks for all four units for carbon monoxide (CO) control.

1.3 Documents Prepared and Included in Report

In performing this assignment, B&V prepared design criteria, studies and technical documents, drawings, diagrams, lists, technical descriptions, cost estimates, and schedules. With this draft report, each of these is being submitted to LG&E/KU for their review and comment. The final version of each of these documents will be included in the final report.

The following is a listing of the documents included in this report and a brief statement for each document.

1.3.1 Design Criteria

1.3.1.1 Project Design Memorandum (B&V File Number 166943.22.1000) The project design memorandum defines the technical and functional requirements to which the Ghent Phase II AQC Study is to be designed.

1.3.2 Studies and Technical Documents

1.3.2.1 Air Quality Control Validation Study (168908.41.0803) The following primary technologies for control of the specified air emissions were evaluated and validated in this study:

- SCR system for NO_x control on Unit 2.
- PJFF with collection of PAC for all four units for PM, Hg, and Dioxin/Furan control.
- Sorbent (trona/lime) for Unit 2 for SO₃ control.
- Neural Networks for all four units to improve CO control.

A validation presentation was held on December 7, 2010 at the Ghent Station to discuss the results of the validation study with LG&E/KU. The following arrangements were validated for conceptual engineering and cost estimating.

Unit 1 includes the existing SCR, existing CS-ESP, existing ID fans, new PAC injection system, existing sorbent injection system, new PJFF, new booster fans, existing WFGD system, and the existing Unit 1 chimney. A neural network is also included. The new split box PJFF (2 x 50%) is located above the existing Unit 1 WFGD inlet ductwork.

Unit 2 includes the existing HS-ESP, new SCR, existing ID fans, new sorbent injection system, new PAC injection system, new PJFF, new booster fans, existing WFGD system and utilizes the existing common Unit 2/Unit 3 chimney. A neural network is also included. One of the new SCR reactors is located to the east of Unit 2 east HS-ESP above the Unit 1 SCR support steel and the other reactor is located southwest of Unit 2 west HS-ESP below the existing Unit 3 and 4 coal conveyor. The new split box PJFF is located to the north of existing Unit 2 and extends over the existing plant access road and pipe rack.

Unit 3 includes the existing HS-ESP, existing SCR, existing sorbent injection system, new PAC injection system, new PJFF, new ID fans, existing WFGD system and utilizes the existing common Unit 2/Unit 3 chimney. A neural network is also included. The new split box PJFF is located in the courtyard area between Units 2 and 3 which requires demolition and relocation of the existing maintenance shop. A new permanent frac tank is also included since the courtyard area will no longer be available for temporary frac tanks during chemical cleaning activities.

Unit 4 includes the existing HS-ESP, existing SCR, existing sorbent injection system, new PAC injection system, new PJFF, new ID fans, existing WFGD system and the existing Unit 4 chimney. A neural network shall also be included. The new split box PJFF is located north of the WFGD and requires demolition and relocation of an existing warehouse.

1.3.2.2 Auxiliary Electric System (168908.41.0809) This analysis determined the recommended modifications and additions to the existing auxiliary electric equipment.

1.3.2.3 Constructability Review (168908.41.0813) A constructability review was developed for the suite of technologies proposed for each unit. A construction facilities drawing was included in the document.

1.3.2.4 Construction Materials (168908.41.0814.1) This analysis describes details of materials of construction for each of the new AQC equipment proposed for the Ghent Units. The equipment includes PJFF, SCR, sorbent injection and PAC injection systems.

1.3.2.5 Sparing and Capacity (168908.41.0814.2) This analysis summarizes B&V Reliability, Availability, and Maintainability (RAM) analysis on the new components proposed for Units 1-4 AQC upgrades and modifications. This analysis was completed in order to evaluate system availability. The availability model reflects the expected configuration and redundancy of major equipment critical to plant operation on a per unit basis and used Monte Carlo simulation to provide the expected average availability.

1.3.2.6 Draft System (168908.41.0814.3) The flue gas draft system requires evaluation to determine if modifications or replacements of the existing fans and other draft system components will be required. This is due to the installation of additional draft system equipment to control, or enhance the control of, certain flue gas emissions.

1.3.2.7 Fly Ash and Landfill Waste Disposal (168908.41.0814.4) The purpose of this analysis is to evaluate the physical and chemical composition of the fly ash material removed by the new PJFF on Units 1-4. This study does not discuss any potential impact of disposal of fly ash byproducts on the existing landfill. The potential impact analysis on the existing landfill should be considered by LG&E/KU.

1.3.2.8 Fly Ash Handling (168908.41.0814.5) This analysis evaluated the existing or currently planned fly ash handling and storage systems. The systems need to be capable of handling additional sorbents and powder activated carbon injected and collected in the PJFF. An additional fly ash transfer system is included on Unit 3.

1.3.2.9 Impact of PAC Injection (168908.41.0814.6) This analysis was completed to inform LG&E/KU of the current industry concerns considering the injection of PAC into the flue gas. The concerns include the increased risk of injecting a combustible material into the flue gas, collection of this material in the PJFF, and the need for fire suppression systems. In addition, options for bypassing current ESPs are discussed.

1.3.2.10 Comparison of Sorbent Receiving and Distribution Systems (168908.41.0814.7) The intent of this high level comparison was to evaluate whether a centralized station-wide or a decentralized unit-specific dry bulk material receiving and distribution system is most appropriate for Ghent Station.

1.3.2.11 Unit 2 Cooling Tower Impacts (168908.41.0814.8) This document summarizes the investigation that was performed to determine the performance impact of the Unit 2 Cooling Tower. Installation of the Unit 1 PJFF may impact the performance of the existing Unit 2 cooling tower.

1.3.3 Drawings and Diagrams

1.3.3.1 Site Arrangements (168908.41.0402) Site arrangement drawings were developed for the overall site, for Units 1 and 2, and for Units 3 and 4. A construction facilities plot plan was also developed.

1.3.3.2 Plant Arrangements (168908.41.0402) Plant arrangement drawings were developed for all four units. The 3-D models developed during the validation study serve as the plant arrangements for this phase of the project. Various screen shots have been included.

1.3.3.3 Equipment and Load List (168908.41.0801) Equipment and electrical load lists were developed for each unit. The electrical load list was used to help develop the electrical one-line diagrams.

1.3.3.4 Electrical One-Lines (168908.41.0809.1) Electrical one-lines were developed for each unit and for the common reserve system.

1.3.3.5 Process Flow Diagrams (168908.41.0815) High-level process flow diagrams for major systems were developed for each unit.

1.3.4 Technical Descriptions

1.3.4.1 Modifications, Interfaces, and Tie-Ins to Existing Equipment and Systems with Terminal points (168908.41.0804.1) Descriptions were developed to state the modifications, interfaces and tie-ins that would be required to major existing equipment and systems. Each description contains a terminal point list for the associated tie-in.

1.3.4.2 Specifications and Systems Lists (168908.0804.2) Specifications and systems lists were developed for each unit. The specifications lists were used in the cost estimate and the system lists were used to develop the system descriptions.

1.3.4.3 System Descriptions (168908.41.0804.3) System descriptions were developed for each major system for each unit. The system descriptions included system identification, function, and process description.

1.3.4.4 Demolition and Relocation Requirements (168908.41.0804.5) The purpose of these descriptions is to describe the conceptual demolition and/or relocation requirements of the Ghent Station existing site structures. In general, the descriptions cover the work involving the major items to be demolished or relocated.

1.3.5 Cost Estimates

1.3.5.1 Capital Cost Estimate with Plan and Basis Memo (166943.41.0805) A capital cost estimate was developed for each unit and for common facility systems. A Plan and Basis memorandum was included with the capital cost estimate to describe assumptions and basis for the development of the cost estimate.

1.3.5.2 O&M Cost Estimate (166943.41.0805.1) An O&M (Operations and Maintenance) cost estimate was developed to show estimated differential O&M costs from current operations for each unit.

1.3.6 Schedules

1.3.6.1 Level 1 Schedule (166943.41.0807) Level 1 schedules were developed for each unit based on the proposed construction described in the Constructability Review document mentioned above in section 1.3.2.2. The schedules were based on the assumption that new regulations would require the environmental equipment to be in service prior by the end of 2017. However, to the extent that the schedules for the regulatory requirements change, the schedule for placing the environmental equipment in service will change accordingly. Per the Level 1 schedule, preliminary engineering and preparation of the EPC specification would need to begin in September 2011 with award of the EPC contract by the end of August 2012. It would also require starting preparation of the air permit application in November 2011.

1.3.6.2 Cash Flows (168908.0807.1) Cash flows were developed based on the capital cost estimates and the Level 1 schedules.