Minnkota Power
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November 1, 2018

Ms. Karlene Fine
Executive Director
ATTN: Lignite Research Development and Marketing Program
North Dakota Industrial Commission
State Capitol, 14th Floor
600 East Boulevard Avenue, Department 405
Bismarck, ND 58505-0840

Dear Ms. Fine:

Subject: Minnkota Power Cooperative Proposal Entitled "Project Tundra FEED"

Minnkota Power Cooperative is pleased to submit an original and one copy of the subject proposal in partnership with the U.S. Department of Energy, BNI Energy, Mitsubishi Heavy Industries, the Energy & Environmental Research Center (EERC), Eagle Energy Partners, I, LLC (EEPI) and Burns & McDonnell. In addition to the $100 application fee, you will find an application for your support of the research and development required to commercialize a transformational technology that will revolutionize the use of lignite. The Project Tundra team is committed and ready to complete the project as described in the proposal with the support of the Commission, which is imperative in the development of new technologies securing the continued use of lignite in our state into the future.

If you have any questions, please contact me by phone at (701) 794-7234 or by e-mail at GPfau@minnkota.com.

Sincerely,

Gerry Pfau
Senior Manager of Project Development

Enclosures

Lignite Research, Development and Marketing Program

North Dakota Industrial Commission

Application

Project Title: Project Tundra FEED

Applicant: Minnkota Power Cooperative

Principal Investigator: Gerry Pfau

Date of Application: November 1, 2018

Amount of Request: $15,000,000

Total Amount of Proposed Project: $31,164,414

Duration of Project: 32 months

Point of Contact (POC): Gerry Pfau

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ABSTRACT

Objective: The objective of the work described in this application is to complete a front-end engineering design (FEED) study for a commercial carbon capture system retrofitted onto a power plant fueled by North Dakota lignite. The FEED study will also include a pipeline to convey CO_2 for enhanced oil recovery (EOR) and CO_2 recycling facilities at the target oil field. These combined elements comprise a broader effort known as Project Tundra. The goal of Project Tundra is to implement carbon capture, utilization, and storage (CCUS) in North Dakota, preserving the use of lignite, revitalizing legacy oil fields and creating a new CO_2 EOR industry.

Expected Results: The project will result in a complete FEED study for Project Tundra and will enable the Tundra Team to finance and construct Project Tundra.

Duration: The project schedule is 32 months with an anticipated start date of January 1, 2019.

Total Project Cost: The proposed project budget is $31,164,414, with $15,000,000 anticipated from the U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) via submission of a competitive proposal to a DOE NETL funding opportunity announcement (FOA) expected in early 2019, $15,000,000 from the North Dakota Industrial Commission (NDIC), and $300,000 cash and $864,414 in-kind from Minnkota Power.

Participants: The project lead is Minnkota Power Cooperative, and the project will be conducted in partnership with NDIC through the Lignite Research Council and the Lignite Energy Council; DOE; BNI Energy; Eagle Energy Partners I, LLC (EEPI); the Energy & Environmental Research Center (EERC); Burns & McDonnell; Mitsubishi Heavy Industries (MHI); and others identified during the project. This partnership brings together a powerful group of industry leaders in lignite, oil and gas, and carbon capture technology. With the expertise and drive of the Project Tundra team, the outcome will be a commercial postcombustion CCS project in North Dakota.

PROJECT SUMMARY

Energy leadership is part of North Dakota's DNA as evidenced by the environmentally sound means used to produce our lignite and oil reserves. Project Tundra (Figure 1) is the next step in continuing our industry leadership as energy consumers look for ways to reduce carbon intensity while maintaining significant baseload power in North Dakota. North Dakota is fortunate to have proximal, large-scale carbon dioxide utilization and storage potential in the form of enhanced oil recovery (EOR) in the state's conventional oil fields and one day soon in the Bakken shale play.

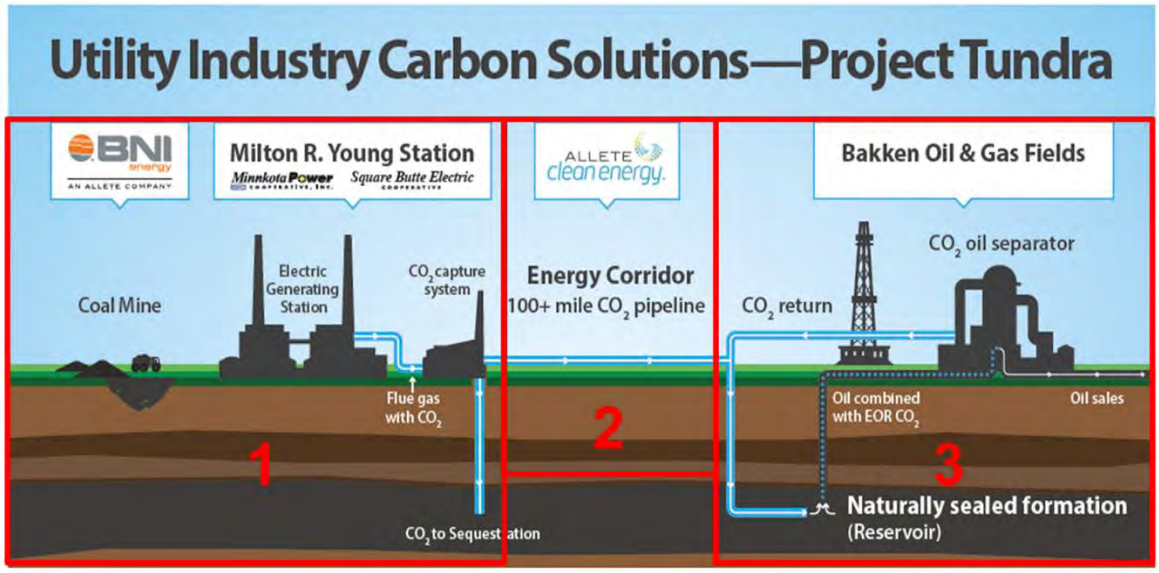

Figure 1. Project Tundra

Policy leaders in North Dakota recognize both the challenge to the lignite industry with continued pressure to reduce carbon emissions and the enormous potential that carbon dioxide can provide in driving in-state EOR. Understanding the nature of these capital-intensive projects, and despite difficult budget constraints in 2017, the Legislature specifically provided funding for advanced energy projects to develop "*large scale demonstrations that show the potential to lead to near-term application in North Dakota with a focus on technologies that will sustain or grow*

the lignite industry." Project Tundra fits entirely within the vision for those enhanced program dollars.

In this project, we will employ a technology called CCUS (carbon capture, utilization, and storage) which, when paired with North Dakota-specific opportunities, gives the state the opportunity to simultaneously reduce carbon intensity while increasing energy production. With Project Tundra, we will establish a market entirely within our state where coal-powered utilities provide CO_2 to oil producers to produce otherwise stranded crude oil and, in the process, permanently and safely store the CO_2 underground. The Project Tundra team requests that the North Dakota Industrial Commission (NDIC) help fund a FEED (front-end engineering design) study that will confirm the best design and cost to build a CCUS system at the 477-MW Milton R. Young Unit 2 Station (MRY2).

The goal of this project is to complete the FEED study for the entire scope of Project Tundra from the CO_2 capture facility at the power plant through the CO_2 pipeline across the western third of the state, and finally including surface facilities (aka, recycling facility) at the oil field. This FEED study will continue on the path set forth in current pre-FEED work, which is also cofunded by NDIC and being conducted by the same project team. The following specific objectives for the FEED study have been identified:

- Complete final design for constructing CO_2 capture system at MRY2.
- Conduct optimization studies to deliver a "best in class" CO_2 capture system.
- Finalize a permitting strategy for the overall project, not just the capture system.
- Complete initial design for CO_2 pipeline for the anticipated route.
- Develop a preliminary plan for the oilfield recycling facilities to support EOR activities in the oil field.

- Complete a FEED-level cost estimate and schedule for constructing all of the above items.

To accomplish the above objectives, the project has been structured into seven tasks: Task 1 – Project Management and Technology Transfer, Task 2 – Project Tundra Engineering and Design – CO_2 Capture System, Task 3 – Identification and Performance of Optimization Studies, Task 4 – Development of Permitting Strategies, Task 5 – Project Tundra Cost Estimating, Task 6 – Pipeline and Recycling Facility Design, and Task 7 – Geologic Storage Investigation. Project deliverables will include sufficient detail such that Project Tundra can move into financing and early procurement of long-lead-time equipment. High-level deliverables include:

- Final design basis information relating to building construction, process flows, steam cycle impacts, and equipment performance.
- FEED-level cost information for constructing Project Tundra capture, pipeline, and recycling facilities.
- Determination of permitting requirements and strategies to attain them for Project Tundra.

The project anticipated start date is January 1, 2019 (DOE proposal preparation only), with an end date of August 31, 2021, thus resulting in a 32-month period of performance for Project Tundra FEED study. Activities associated with the FEED study will begin after August 2019. The proposed budget is $31,164,414 with $15,000,000 anticipated from a U.S. Department of Energy (DOE) National Energy Technology Laboratory (NETL) funding opportunity announcement (FOA), $15,000,000 from NDIC, and $300,000 cash and $864,414 in-kind from Minnkota Power.

PROJECT DESCRIPTION – PROJECT TUNDRA CCUS, PIPELINE, AND RECYCLE FACILITY FEEDS

Objectives: The objective of the work described in this application is to complete a FEED study for a commercial carbon capture system retrofitted onto a power plant fueled by North Dakota lignite. The FEED study will also include a new ~120-mile pipeline to convey the captured CO_2 to an oil field for EOR and necessary CO_2 recycling facilities at the target oil field. The combined elements previously mentioned comprise a broader effort known as Project Tundra. The overarching goal of Project Tundra is to implement CCUS in the state of North Dakota as a means to preserve lignite-based energy production in North Dakota while revitalizing legacy oil fields and creating a new CO_2 EOR industry.

Method: The ultimate goal of this project is to complete a FEED study for a commercial carbon capture system retrofitted onto a power plant fueled by North Dakota lignite, transport the captured CO_2 via an approximately 120-mile-long new pipeline, and use (thereby storing) that CO_2 to boost oil production in a North Dakota conventional oil field. In order to meet the goals and objectives and support construction of Project Tundra, seven tasks have been identified and described below.

The capture system is anchored by an amine-based solvent that has been chosen for this project because the technology is the most mature and ready for demonstration at full commercial scale. Mitsubishi Heavy Industries (MHI) has an amine-based technology that has been successfully implemented at a smaller scale; the engineering firm of Burns & McDonnell has the most experience with Minnkota's MRY Station. These two companies have been chosen to conduct the capture system portion of the FEED study, and Burns & McDonnell will be conducting the pipeline FEED. The project team will use industry standard design and costing methodologies to determine a FEED-level estimate for Project Tundra.

Special Note: Minnkota Power reserves the right to monitor and review the work and progress during the FEED study and make changes to the project team (in consultation with the Lignite Research Council [LRC] and NDIC) as it deems necessary to ensure the timely and successful completion of the project.

SCOPE OF WORK

Through the support of the state of North Dakota, this project will pave the way for improving and quickly deploying CO_2 capture in the North Dakota lignite industry and CO_2 EOR in the state's oil and gas industries. While driven by anticipated commercial opportunity, the project will also better position the North Dakota lignite industry, should carbon management be required in the future. Task 1 will begin January 1, 2019, with DOE proposal preparation activities, the remaining tasks are scheduled to begin after August 2019.

Task 1 – Project Management and Technology Transfer

The planning and management of all project activities will be performed by Minnkota Power with support from EERC personnel over the duration of the project period of performance. This task includes communication of project activities and direction with the project team to provide updates and obtain inputs to prioritize the project focus. Specific activities will include the preparation of quarterly progress reports according to NDIC requirements, the preparation of a comprehensive final report, securing cost-share dollars from DOE, and planning and executing project status meetings. In Q1 (Quarter 1) 2019, DOE intends to issue a FOA for a FEED study for postcombustion CO_2 capture from a coal-fired facility. The key findings from the ongoing CO_2 capture pre-FEED study of Project Tundra will be compiled, analyzed, and compared to the objectives of this imminent DOE funding opportunity. A scope of work will be developed to satisfy these objectives, and the partnership between Minnkota, EERC, NDIC, and the rest of the

project participants will be leveraged to submit a proposal to secure the competitive federal funding.

Technology transfer activities will include, at a minimum, the presentation of results through these meetings and reports as well as presentations at relevant technical conferences. Substantial travel is included in the project budget to allow project review meetings in Japan (quarterly), Bismarck, Houston, and Kansas City. Additional travel is included for kickoff and project review meetings with DOE staff in Pittsburgh. In addition, this task will include facilitating the involvement of an NDIC designee, as available, in project meetings. Results of all tasks will be provided in project meetings and reports. All additional deliverables noted in the following tasks will be summarized in all quarterly and final reports.

Task 2 – Project Tundra Engineering and Design – CO_2 Capture System

This task will focus on the engineering and design of the CO_2 capture system. Similar work is outlined in Task 6 for the pipeline and recycle system. The EERC previously initiated a pre-FEED study, with financial support from NDIC and DOE, which will be utilized as the framework for this overall effort. The following major components will be accomplished within this task (additional detail is provided within Appendices A and B, specifically within the scopes of work for Burns & McDonnell and MHI):

1) A formal design manual will be created to ensure all parties are squared away on the project.
2) A 3-D model will be developed and utilized for equipment, structural, electrical, and piping depiction. Using the 3-D model, the project team will conduct a review and finalize the equipment location plan.

3) Material takeoffs (MTO) will be exported from the 3-D model. These MTOs will be mainly for large bore pipe lengths, fittings, flanges, valves, raceway, cables, and instrumentation. Some small bore (2 inch and less) MTO will be factored based on large bore quantities using ratios appropriate for the gas processing industry. Structural steel and concrete takeoffs will be developed from structural design software and sketches.
4) A general arrangement drawing will be developed and optimized. This drawing can have a large impact on constructability, design, and costs. Opportunities will be identified to reduce cost and improve constructability, operability, and maintainability prior to finalizing.
5) Laser scanning will be conducted as required for design of the major tie-ins to the existing unit. In this case, the laser scan will be primarily used to help route process piping from the existing unit to the CCS facility. The laser scan information will be built into the 3-D model, integrating the design with real-world data.
6) Tie-in locations, preliminary pipe routings and interfaces, and electrical interconnections will be identified. A key deliverable during the FEED study will be a tie-in list and location plan. Input from construction specialists during the detailed design phase of the project will help to eliminate rework. Process and instrumentation diagrams (P&IDs) and one-lines will be marked and updated as needed with tie-in information.
7) Mechanical engineering for equipment specifications will be completed, focusing on the long-lead-time items first to allow the team to obtain budgetary quotes to support

the FEED estimate. Detailed specifications will be developed for the major equipment packages.

8) A hazards and operability (HAZOP) analysis will be conducted utilizing the overall P&IDs. The HAZOP will primarily focus on the high-energy piping systems and chemical feed systems.
9) The steam turbine will be analyzed to determine the impacts from extracting the steam required for the CO_2 capture process. A preliminary extraction design and the associated performance and cost impacts will be developed.
10) A fire protection study work will be conducted per applicable National Fire Protection Agency (NFPA) Codes and Standards.
11) Plans will be developed for power and control design, including plans for electrical equipment, cable/cable tray routing and required supports design, area classification, lighting, and grounding.
12) An instrument control list including inputs and outputs and distributed control system (DCS) points will be developed. General instrument and control (I&C) conceptual junction box plans and layout will be developed to help produce quality MTOs. Budgetary specifications will be developed for all other major I&C packages.
13) An initial site plan will be developed and transitioned into the 3-D model as it is developed. Geotechnical engineering, with support from civil engineering, will develop a geotechnical investigation specification for additional borings beyond those obtained during the pre-FEED.
14) Exploratory excavation plans and specifications will be generated to verify that proposed foundation and subsurface facilities are clear of obstructions.

15) Preliminary foundation sketches will be developed to support the MTOs required for the FEED cost estimate. Foundation costs will be developed using in-house data. The 3-D model will include preliminary modeling of structural components (foundations, structural steel, ductwork, handrail, grating).
16) Preliminary architectural drawings and sketches will be developed to support a budgetary specification for preengineered buildings and HVAC. These specifications will be used to obtain budgetary quotes to support the FEED cost estimate.
17) The overall design of the KM CDR (critical design review) Process™ will be conducted, including systems engineering, 3-D modeling, and estimates of supply costs of major equipment and proprietary MHI items.
18) A consolidated FEED study report and cost estimate that includes all deliverables will be developed.

Task 3 – Identification and Performance of Optimization Studies

The purpose of Task 3 is to identify and conduct any short-term studies to address findings from the pre-FEED or the FEED study that need to be addressed before the final product. The scope of such "optimization studies" will be determined in near-real-time and will be designed to ensure the project goal is accomplished: to commercialize technologies that will foster the continued economic use of in-state lignite along with production of in-state oil in a market that demands an increasingly lower carbon footprint. To ensure that the project results in a FEED study that describes the most economic Project Tundra possible, the project plan and scope will be optimized as quickly as findings are reached. It is conceivable that optimization study topics will include choice of process equipment, redundancy philosophy, selection of materials of construction, effluent identification and disposition, means of process heat recovery, steam

supply selection between cogeneration and steam turbine extraction, additional reservoir modeling to aid in pipeline and recycle facility design, cooling system evaluation vs. water availability and, possibly, even overall EPC (engineering and procurement) contractor approach.

Task 4 – Development of Permitting Strategies

Permitting is an important consideration for Project Tundra. The project team will use work completed in the pre-FEED study as it becomes available to support the following components of this effort.

Minor Source (Non-PSD) Air Permit Application

Existing permits and permitted emission rates for the existing MRY2 boiler will be reviewed. It is assumed that maximum hourly emission rates will be unchanged, except for CO_2, which will be reduced. The CO_2 maximum emission rate will be determined within the Task 2 engineering and design activities. It is assumed there will be no increase in capacity because of installation of the absorber (CO_2 control system). As such, a prevention of significant deterioration (PSD) netting analysis will not be required.

A preapplication meeting with the North Dakota Department of Health (NDDH) will be conducted to discuss project activities and requirements for air permitting. At this meeting, the project schedule as well as any additional information pertinent to the project and air permit application will be discussed. During the discussions regarding the project, specifics regarding application requirements will be determined with input from NDDH.

A permit application will be developed with supporting emission information and calculations along with information necessary for agency review. The report will include a project description, federal and state regulations review for the new CO_2 capture system, and

emission estimates, as applicable. The NDDH construction permit application forms will also be included with the permit application, as determined from discussions with NDDH.

It is assumed that air dispersion modeling will not be required by NDDH because the project will not be subject to PSD. However, initial modeling was performed in the pre-FEED project to determine appropriate stack height, parameters, and location. A model has already been set up and run for the project. In order to confirm that the site will not exceed the National Ambient Air Quality Standards (NAAQS), an additional air dispersion model will be developed, using the final FEED study parameters, emissions, and layout. The model will include NO_2, SO_2, PM_{10}, and $PM_{2.5}$ for the MRY2 absorber stack, along with the MRY1 stack to determine compliance. Note that no fugitive or other PM (particulate matter) sources will be included in the model. This task assumes up to three iterations of the model will be run to confirm compliance with NAAQS. Necessary data will be obtained from the NDDH website for the modeling.

If NDDH requires the submittal of air dispersion modeling, a draft model protocol will be submitted to NDDH for its review and approval. The modeling protocol describes the air dispersion model to be used and other modeling parameters, such as receptor grid and meteorological data, which may impact air dispersion modeling results. The modeling protocol will also identify representative monitors for background values for each PSD pollutant. This protocol will be submitted to NDDH for its approval before modeling is submitted. Additionally, an air dispersion modeling full report will be prepared that discusses the model, modeling methodology, receptor grid, results, and conclusions to be submitted with the modeling files to NDDH for its review, as required.

NPDES Storm Water General Permit and Stormwater Pollution Prevention Plan

Because Project Tundra would disturb one or more acres of land, a National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges from Construction Activities from NDDH will be required prior to construction. In addition to the application package, and as a requirement of the General Permit, a Storm Water Pollution Prevention Plan (SWPPP) will be developed. A typical SWPPP contains the project description and location, best management practices (BMPs), type and location of erosion and sediment control structures, revegetation requirements, and good housekeeping. The SWPPP will be completed prior to submitting the notice of intent (NOI).

NPDES Individual Permit for Industrial Wastewater Discharges

Because the project may discharge and/or dispose of industrial wastewater, the MRY2 plant is required to modify its NPDES Permit for Industrial Wastewater Discharges through NDDH. If the only discharges from the site during project operation will be storm water, the project may qualify for coverage under the NPDES Multi-Sector Industrial General Permit. This permit requires the submittal of a NOI and the application fee. The submittal package must be delivered a minimum of 30 days prior to commencing operation of the project facility. A SWPPP must be developed and implemented prior to submitting the NOI.

Task 5 – Project Tundra Cost Estimating

A FEED quality estimate will be prepared that can be converted into a firm project price with minimal updates for commodity escalation and inflation. The team will use quantity takeoffs and price quotes from vendors for the majority of the equipment and commodities. Key inputs to the price estimate will be:

- P&IDs.

- One-lines.
- Detailed and budgetary specifications for major equipment issued to obtain price quotes from vendors.
- General arrangement drawings.
- Project design manual.
- MTOs by discipline.
- Indicative pricing from fabricators.
- Construction costs and indirect costs, including engineering, construction management, and home office (procurement and project controls), will be generated from bottom-up estimates based on the scope of services. To aid in this, the project team will engage local subcontractors to obtain current labor rates and productivity.
- Contingency and escalation will be assigned depending on the quality of the information, quotes, and risks associated with the various components of project.

Task 6 – Pipeline and Recycling Facility Design

Other key components of Project Tundra are the EOR operations (specifically CO_2 recycling) and necessary pipeline to transport the captured CO_2 to and within the target oil field. The proposed target oil field for delivery of CO_2 for EOR activities is the Foreman Butte Field in McKenzie County, North Dakota. The Foreman Butte oil field has been under primary production since the early 2000s. In recent years, production rates from the oil field have declined as the easily produced oil has been depleted. A pilot area of the oilfield reservoir is being evaluated for waterflood response (i.e., secondary production) and potential field rejuvenation. The components of Task 6 will be managed by Minnkota in conjunction with the EERC and EEPI.

EOR Recycle Facility FEED Study

In the EOR process, injected CO_2 moves through a reservoir and interacts with the oil. Some CO_2 and the newly mobilized oil are extracted from the reservoir at nearby production wells. At the surface, CO_2 is separated from the produced hydrocarbon, compressed, and reinjected (i.e. recycled) to mobilize more oil. The recycling process is driven by economic reasons, as the purchased CO_2 comes at a cost to the operator. A CO_2 EOR recycle facility FEED study will be conducted to determine what surface facilities will be needed for the recycling component of the CO_2 EOR operation and the cost to build and operate that system. More specifically, the study will determine how many recycle compression locations are needed, the required size of compressors and water pumps, and the extent of flow lines needed in the field to receive produced fluids and deliver new and recycled CO_2 for injection. Although field-specific studies, tests, and modeling will be necessary before a final investment decision is made, for the purposes of this FEED study, assumptions regarding field production, injection pattern size, and CO_2 flood strategy will be made.

Pipeline Pre-FEED Study

To transport the captured and separated CO_2 from MRY to the Foreman Butte Field, Project Tundra will use a 12–24 inch-diameter underground pipeline approximately 120 miles long. As much as possible, the pipeline route will be colocated along or within existing utility and pipeline rights-of-way, avoiding as much as possible construction in greenfield areas and reducing potential environmental and socioeconomic impacts (see Figure 2 for conceptual route).

The pipeline pre-FEED study will be conducted to determine the size, design, route, cost, and schedule of the CO_2 pipeline along with controls and monitoring systems. All segments of the pipeline will be installed below ground, with only pipeline location markers, cathodic

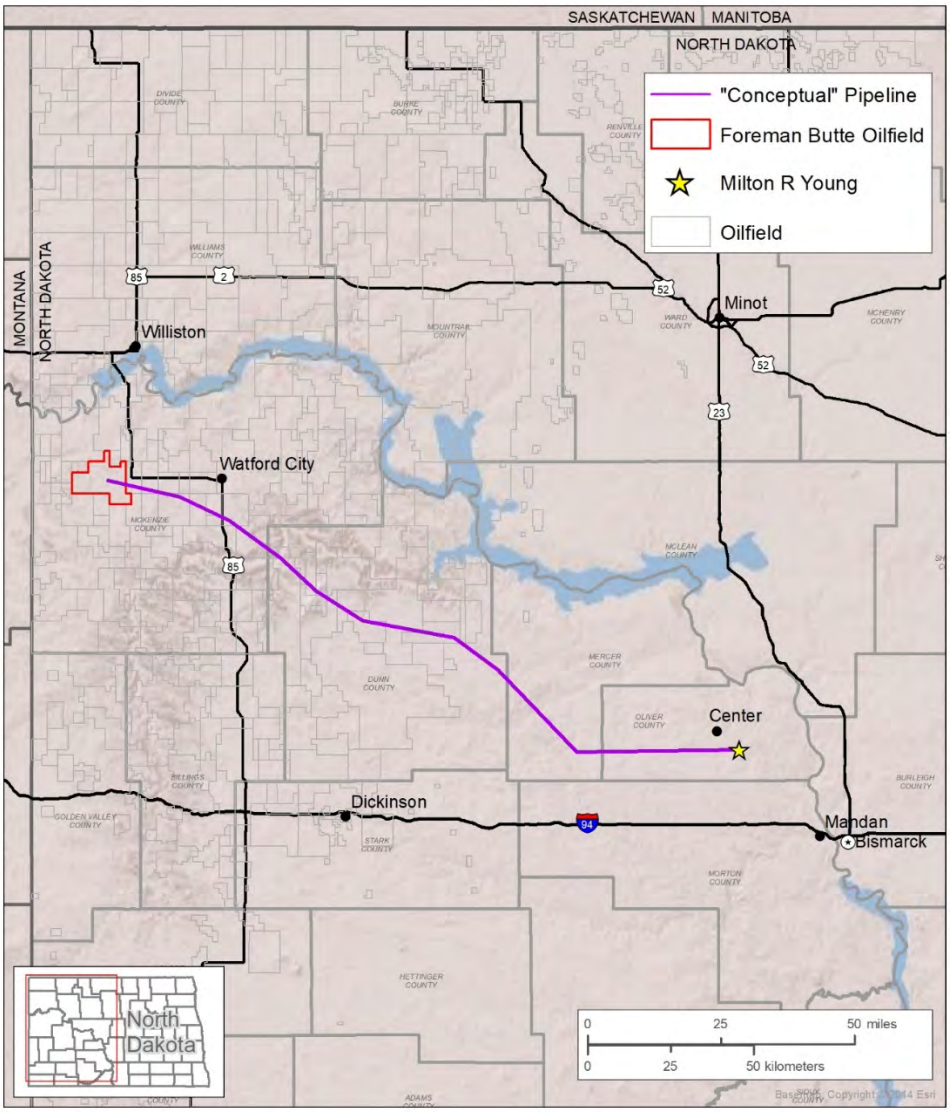

Figure 2. Conceptual pipeline route.

protection test stations, main live valves, launchers/receivers, and meter stations being visible above ground. The pipeline design will follow common industry practice for pipelines of this length and will include shutoff valves on either side of each major river crossing, plus block and check valves at regular intervals as required by U.S. Department of Transportation (DOT) regulations. The pre-FEED will also determine the need for intermediate pumping stations and, if so, the location and preliminary design of each.

The pipeline will be constructed of carbon steel and will be rated to operate at pressures up to 2050 psia, although normal operating pressure is expected to be 1900 psia or less. The CO_2 in the pipeline will be a supercritical fluid, resembling a liquid but expanding to fill space like a gas, and will have a density heavier than air and a very low viscosity (i.e., it will flow readily). To minimize pipeline corrosion, the water content of the CO_2 will be reduced during compression via dehydration systems common to the industry. Minimal water content (and thus corrosion risk) in the CO_2 stream allows the pipeline to be constructed using carbon steel rather than the more expensive stainless steel.

The CO_2 pipeline will be sited, designed, constructed, and operated in accordance with applicable state and federal regulations. Regulations include those of DOT (via PHMSA), the North Dakota Public Service Commission, and the North Dakota Department of Mineral Resources, which were enacted to ensure adequate protection of the public and to help prevent pipeline accidents and failures. In addition, applicable best practices identified by the EERC's legislatively directed pipeline leak detection and monitoring report series will be employed.

It is anticipated that the pipeline will be a "common carrier," thereby facilitating further carbon dioxide capture projects among the cluster of coal-fired power plants near the MRY Station and delivery of CO_2 to other candidate CO_2 EOR fields in western North Dakota.

Task 7 – Geologic Storage Investigation

Project Tundra includes the development and installation of permanent geologic CO_2 storage to manage excess CO_2 that is otherwise unable to be shipped and sold to EOR markets throughout Project Tundra's operational life cycle. This supplemental, or "buffer storage," would be operated on an as-needed basis to account for differences in demand for CO_2 from EOR markets and CO_2 capture from MRY Station. CO_2 demand for EOR is expected to fluctuate on both daily

and seasonal cycles, as demand will be subject to various market forces that currently affect oil production in western North Dakota. Plans to develop buffer storage for Project Tundra will be developed under Task 7.

Task 7 will focus on the acquisition, analyses, and development of site characterization data necessary to establish a geologic storage complex appropriate for buffer storage, as well as the requirements needed to meet North Dakota underground injection control (UIC) Class VI permitting regulations. To do so, this task will address both technical and nontechnical factors involved with siting a geologic CO_2 storage complex for buffer storage. Technical aspects to be evaluated include the suitability of the geology beneath the vicinity of the MRY Station to accept the expected volume of CO_2, the size of the area around the MRY Station that would need to be designated for storage, and Class VI compliant plans to conduct buffer storage. Nontechnical aspects include an evaluation of pore space ownership, rights of way, permitting requirements and procedures, and financial agreements needed to support this business model.

Task 7 will be managed by project partner EERC. The commitment of $3.75 million for Task 7 from project funds will be contingent upon EERC receiving funding for separate and complementary DOE research focused on saline storage of CO_2 from coal-fired facilities, with a FOA (for geologic storage) expected in the first quarter of 2019. If the EERC is awarded this complementary project, Task 7 will be carried out to evaluate this critical aspect of Project Tundra.

Project Contingency

Project contingency has been included in the project budget and will be appropriately allocated pending detail in the DOE FOA that may preclude certain scope components included in this

proposal. Precluded scope may include all efforts associated with pipeline pre-FEED and the CO_2 recycling facility FEED study (Task 6).

Resources

A team of industry experts will perform all project activities, with the primary project administrative services provided by the EERC. Industry sponsor and overall project manager Minnkota Power will provide additional project advisory services. Additional strength is added to the project team by Project Tundra partners (BNI Energy and EEPI) and technology owner (MHI) and owner's engineer (Burns & McDonnell) participation.

Techniques

The primary technique for data generation under this project will be to use industry standard design and costing techniques for FEED-level efforts. The individual partners and subcontractors mentioned within the proposed project represent decades of experience in CO_2 capture and coal plant/oilfield operations.

This project will also update the performance and economic modeling projections utilizing specific data for the MRY Station. The team has constructed detailed models with currently funded efforts that will be updated to provide heat and mass balance information in the final design phases. The team will utilize Aspen software as the primary modeling tool for this effort. Aspen software is a comprehensive process simulation tool and has modules to evaluate economics, kinetics, and heat and material balances for complex processes. Details are contained in the individual tasks above and in the appendices to this proposal.

ENVIRONMENTAL AND ECONOMIC IMPACT

The project's environmental impact during the period of performance will be minimal because no experimental activities are anticipated. The long-term incentive for this project comes from

providing technology solutions to North Dakota's lignite industry now. This industry is currently valued as having a $3 billion economic impact on the state: the business case for postcombustion carbon capture (PCC) and EOR. Large-scale CCUS appears to be the only feasible near-term option that lignite users have to ensure viability of a lignite industry for years to come. In addition to permanently storing CO_2, Project Tundra will produce oil that is "greener" than conventional means within the context of a CO_2 footprint and extending the life of legacy North Dakota oil fields (Azzolina et al., 2016). More of the specific economic benefits are discussed in the "Value to North Dakota" section.

PROJECT JUSTIFICATION

This project will determine a FEED-level cost for installing PCC on the MRY Station and much better inform the efficacy of PCC for the current fleet of lignite-fired power plants by providing the critical information needed to support the business case for carbon capture and storage (CCS). Investing in this project ensures that our state can make wise decisions critical to the long-term preservation of our lignite industry, revitalize legacy oil fields within the state, and create a new CO_2 EOR industry. Keeping current tax revenue, growing new tax rolls, and new job development are all positive outcomes from Project Tundra moving forward. Project Tundra will develop a cost-effective way to use lignite in a carbon-constrained world, supporting the entire premise upon which the entire lignite industry is built, namely, the sustainable combustion of lignite for power production.

STANDARDS OF SUCCESS

This project will reduce the technological and economic risks associated with investing in a PCC system for lignite coal. It is a continuing step of measured due diligence to determine if retrofitting the existing fleet of lignite-fired power plants with PCC technology is economically

viable. Successful outcomes for the project include a firm project price that will allow Project Tundra to go directly into the procurement and construction phases.

Quantifiable metrics for success come from the projected market needs as estimated by DOE NETL regarding the timescale and cost of carbon capture (U.S. Department of Energy, 2013). These targets have been established based on the needed metrics to keep coal-based power competitive in a carbon-constrained environment and extend to 2035. According to DOE NETL analysis, the following long-term performance goals for retrofitting coal-fired power generation facilities have been established:

- Develop PCC technologies that:
  - Are ready for demonstration in the 2020–2035 period (with commercial deployment beginning in 2025).
  - Cost less than \$45/tonne of CO_2 captured by 2025, dropping to \$30/tonne in 2035.

Under this project, this information will be used to revise the technology's economic projections and readiness horizon in order to make comparisons to DOE NETL criteria, while ensuring readiness for Project Tundra.

BACKGROUND

The long-term continued use of North Dakota lignite is dependent on creating a business case for CCUS, that at the same time addresses societal desires to reduce carbon emissions. CCUS with EOR appears to be the most feasible option that utilities will have to sustain and grow the lignite industry, and North Dakota is fortunate to have proximal, large-scale storage potential in the form of EOR in the state's conventional oil fields and in the Bakken shale play. However, even with these advantages, establishing a market where lignite-powered utilities provide CO_2 to oil producers is still dependent on knowing the true costs of installing and operating CO_2 capture

systems. Project Tundra will set the example for a fully integrated CO_2 capture/EOR project that aims to continue supplying electricity produced from North Dakota lignite. Regional electrical market growth, advanced amine capture technology, and EOR opportunities all point toward positive outcomes for Project Tundra.

Market Growth

The need for electric power globally and regionally is projected to grow. Based on U.S. Energy Information Administration (EIA) projections (2018), total electricity generation may increase by up to 20% from 2017 to 2050 but is highly dependent upon economic assumptions. For North Dakota, the growth in electricity demand projections ranged from a 15% increase in a low-economic-growth case to a 37% increase in a high-economic-growth case (KLJ, 2012) over the next 20 years (Figure 3). The range is between 3.2 to over 4 GW in increased demand by 2032. A dip in oil prices slowed this growth; however, with increasing oil prices and activity, meeting future growing energy needs through the use of coal is an essential metric that Project Tundra can realize.

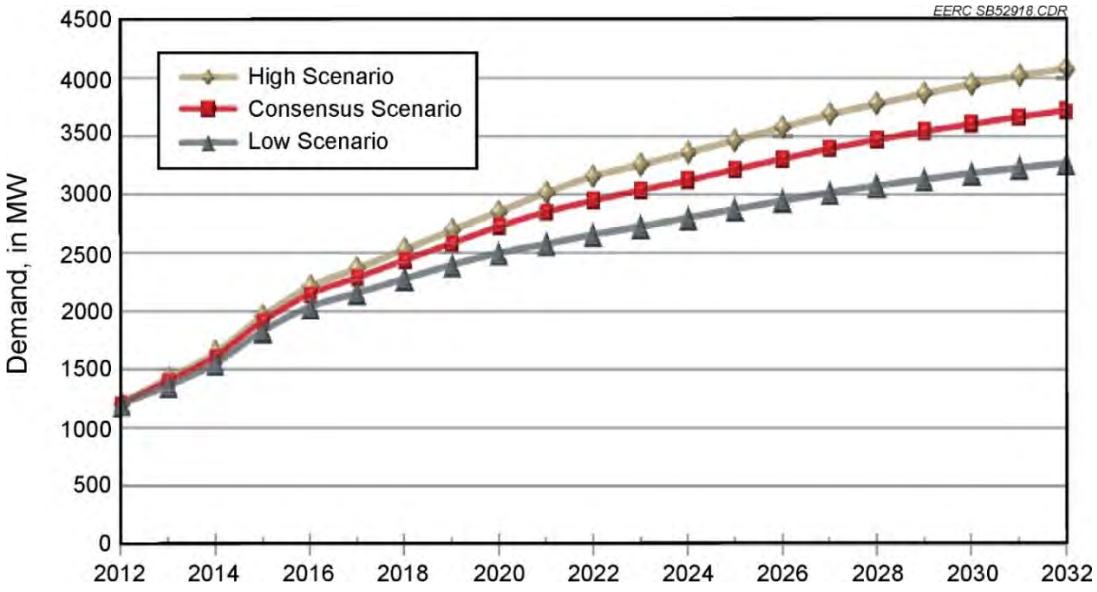

Figure 3. Williston Basin electrical demand for all regions (KLJ, 2012).

Project Tundra will also allow for development of a new EOR industry in North Dakota, while developing a new means of reducing CO_2 emissions from coal-fired power stations, the number one large stationary sources of CO_2 emissions in North Dakota. Increasing the production of domestic oil and lowering CO_2 emissions are two U.S. priorities in using CO_2 (Kuuskraa et al., 2011). Recent studies indicate 280 MMbbl to over 630 MMbbl of incremental oil recovery potential through the use of tertiary CO_2 EOR in 86 North Dakota unitized conventional oil fields (NDLM, 2014). Use of CO_2 EOR in these fields will enable revitalization of unitized conventional oil fields in North Dakota, ultimately resulting in increased daily oil production and prolonging the operational lifetime of those fields. If next-generation EOR can become a reality, even larger quantities of oil have the potential to be produced. Nationally, next-generation CO_2 EOR has the technical potential to provide an additional 137 billion barrels of recoverable domestic oil, with about 67 billion barrels being economically recoverable at an oil price of $85/barrel (Kuuskraa et al., 2011).

Postcombustion Capture

Full-capture technologies for coal-fired power plants are postcombustion options. Project Tundra intends to use this postcombustion retrofit technology. An illustration of postcombustion as a retrofit downstream of a sulfur dioxide scrubber system is shown in Figure 4.

PCC offers the greatest near-term potential for reducing power sector CO_2 emissions because it can be tuned for various levels of CO_2 capture. CO_2 capture processes include a range of technologies such as chemical solvents, solid sorbents, or membranes to separate CO_2 from the flue gas. These technologies are at various stages of development. Bhown (2014) summarized technology readiness levels (TRLs) for CO_2 postcombustion capture technologies.

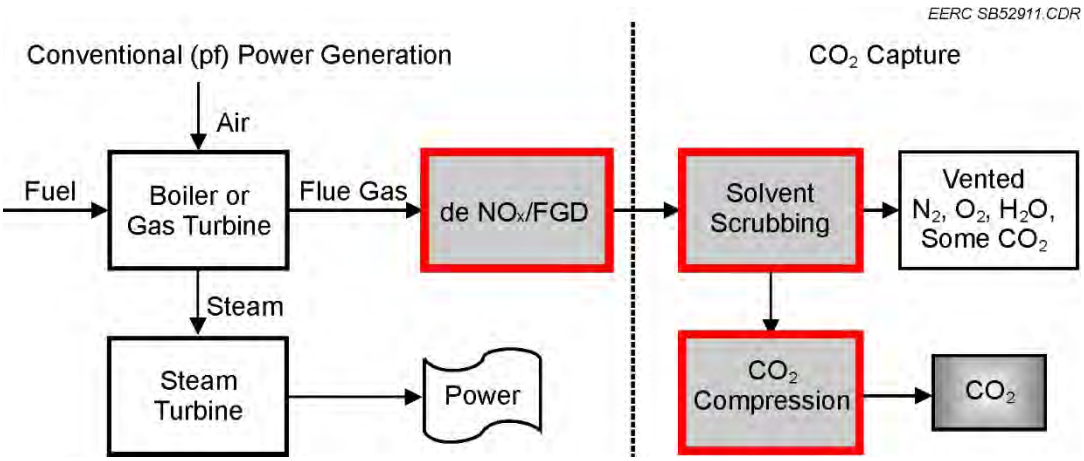

Figure 4. PCC systems (FGD is flue gas desulfurization).

The ones with the highest TRL are the most advanced regarding technical feasibility, and they are mainly the absorbent (solvent) methods, as shown in Figure 5.

Many solvent-based postcombustion commercial-scale projects are or have been in the planning stages for demonstration scale-up, including the Alstom chilled ammonia process and several amine-based processes (e.g., Fluor [Econamine], MHI, HTC Purenergy, BASF/Linde [OASE® blue], and Cansolv). While development of the Alstom chilled ammonia process has stalled, the amine-based technologies have continued demonstration.

Several companies that have developed and tested CO_2 capture technologies have offered performance guarantees or made public statements regarding the technical feasibility of their systems for CO_2 capture from fossil fuel-fired power plants:

- Linde and BASF offer performance guarantees for CCUS technology.
- Fluor has developed patented CO_2 recovery EFG+ technology.
- MHI offers a CO_2 capture system that uses a proprietary energy-efficient CO_2 absorbent called KS-1™. This technology is installed at the Petra Nova facility in Texas.

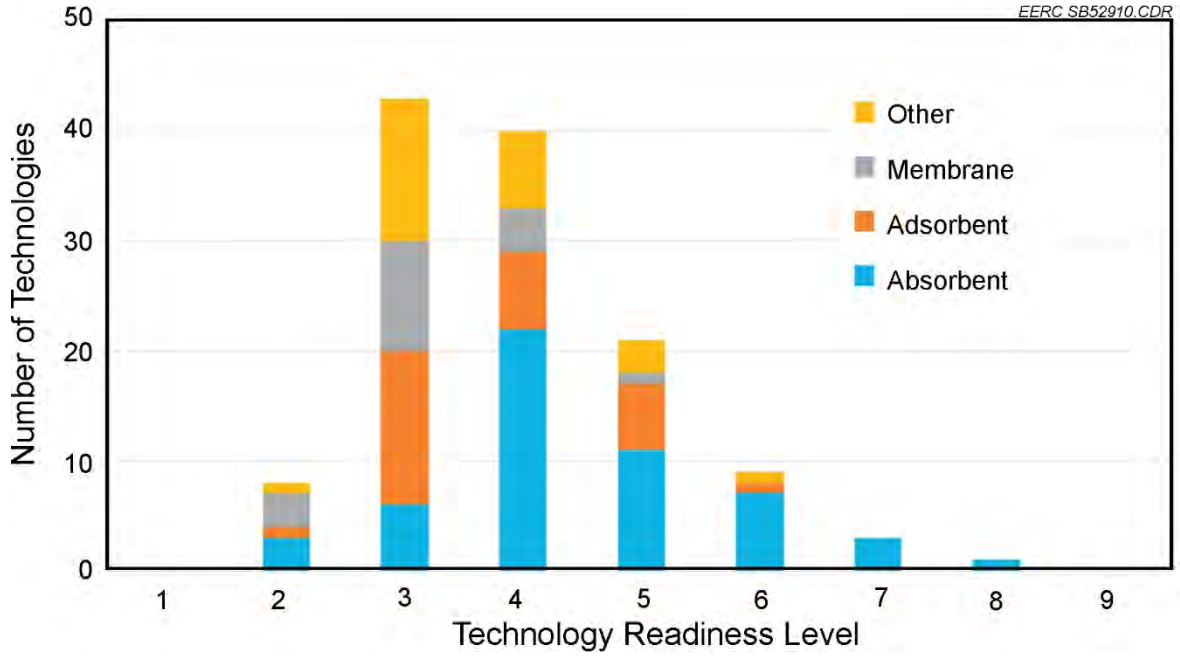

Figure 5. Histogram of the readiness of a technology (absorbent is the solvent-based technology).

- Shell has developed the Cansolv CO_2 Capture System, installed at the Boundary Dam plant in Saskatchewan, Canada.

Table 1 provides a summary of commercial postcombustion CO_2 operations and projects that are currently in operation or under construction. These are solvent-based systems. The CO_2 in these projects has been geologically sequestered (GS), used in the food industry, used for EOR, and used to carbonate soda ash. The high TRL and past implementation of the technology leads the Project Tundra team to the conclusion that amine-based PCC is the best fit for near-term projects.

CO_2 Pipeline History

The CO_2 captured at MRY2 within Project Tundra will be sent to oil fields for CO_2 EOR. Pipelines are a necessary operation to move the CO_2 safely from the point of capture to the point of utilization and storage. CO_2 EOR has been deployed at commercial scale since the early

Table 1. Summary of Postcombustion Carbon Capture and Storage Projects

Project	Facility	Unit type	Size, MW	Capture,%	CO_2 Captured, tons/year	Fate of CO_2	Location
AES Shady Point (1991)	EGU*	Coal-fired	320	10	66,000	Food-grade	OK
AES Warrior Run (2000)	EGU	Coal-fired	180	10	110,000	Food-grade	MD
Petra Nova (2017 start-up)	EGU	Coal-fired	240	90	1,600,000	EOR	TX
SaskPower (2014)	EGU	Coal-fired	110	90	1,000,000	EOR	SK
Searles Valley Minerals (1978)	Soda/ash	Coal-fired			264,898	Carbonation	CA
Fluor Corp. (1991–2005)	EGU	Nat. gas	40	90	100,000	Food-grade	MA

* Electric generating unit.

1970s, with extensive and evolving technologies and regulatory requirements; similarly, CO_2 pipelines for transport of both natural and anthropogenic CO_2 have been in existence since that time. In the United States alone, the oil and gas industry currently operates more than 8300 CO_2 injection wells (OGJ Survey, 2014) for CO_2 EOR, has more than 4500 miles of high-pressure CO_2 pipelines, injects nearly 45 million tons of CO_2 a year, and produces nearly 310,000 BOPD (barrels of oil per day) from CO_2 EOR wells (approximately 3% of total U.S. crude oil production). Figure 6 highlights some of the key CO_2 pipelines and CO_2 supply sources.

CO_2 pipelines are safer in terms of ignition potential (CO_2 is inert, rather than flammable), and there are numerous regulations regarding the safe operation of CO_2 pipelines. Current industry experience shows that when proven CO_2 EOR technologies and practices are used, EOR operators can expect wellbore integrity at levels equivalent to those seen for conventional oil and gas wells. Additionally, there are no indications from available data that geologic integrity of the receiving formations is at risk.

Figure 6. CO_2 pipelines in operation in the United States.

Current Project Results

The Project Tundra team has been gathering information from pilot-scale tests as well as an under way pre-FEED cost estimate study for the capture facility at MRY2. The results of this work point toward positive outcomes for Project Tundra. The work is being conducted under an EERC effort entitled “Project Carbon.” Key positive results for the pilot-scale tests and the capture system pre-FEED estimate follow.

Amine Tests

MHI's KS-1 solvent was tested at the EERC on lignite-derived flue gas. Tests were conducted on the EERC's 1-ton/day CO_2 capture test rig. Key observations include:

- Initial testing indicates that the KS-1 solvent is not greatly affected by North Dakota lignite-fired flue gas constituents. Foaming was not observed, and solvent viscosity was not affected.
- Ash entrained and not removed in the flue gas was filtered by the solvent handling system, and no early indications of ash dissolution were detected.
- MHI's demister design for the water wash section worked very well, with no indication of solvent leaving the water wash section.
- Aerosols were greatly reduced across the system, and measurements indicated that the aerosol content of the flue gas exiting the stack was much lower than that measured in the ambient air.

Pre-FEED

The primary outcome will be a pre-FEED-level design and cost estimate for installing CO_2 capture at an existing coal-fired electric generating unit. The project will provide valuable information on the economic benefits of this technology that many in the industry desire as other utilities consider CO_2 capture projects. Economic benefits will include advanced heat integration and advancements in capture equipment and technology. Embedded risk assessment will identify potential critical issues specific to installing CO_2 capture at an existing coal-fired unit and develop mitigation options to address these issues. All of these outcomes will be valuable to any entity considering PCC, regardless of fuel type and plant configuration. The project has been active since April of 2018. During this time, the following accomplishments have been realized:

- Initial design basis has been completed. Meetings held in Kansas City and at MRY2 were used to initiate designs on the capture system. The project is currently designed to capture 95% of the CO_2 generated by MRY2. This translates to approximately 12,150 tons/day or 4.4 million tons/year of CO_2 captured (at 100% availability). See Figure 7 for a project general arrangement drawing.
- Modeling to determine the project's impact on emissions/permits has also been initiated. The current focus is on NAAQS pollutants and stack-icing models. Adequate information has been obtained to set initial stack height, temperature, and velocity.
- A draft geotechnical report has been generated for the area near the MRY2 chimney, where the project would be constructed.
- Estimates of utility requirements are being developed based on the design basis to determine potential impacts to MRY2 for integration of the MHI technology island.
- Heat and material balances are nearing completion and are expected to be finalized near the end of 2018.
- Pre-FEED-level cost estimate will be completed as early as the second quarter of 2019.

GOALS AND OBJECTIVES

The goal of this project is to complete a FEED study for Project Tundra, from the CO_2 capture facility to the pipeline and recycling facility. In order to meet the goal of the project, the following specific objectives have been identified:

- Final design for constructing CO_2 capture at MRY2.
- Address final challenges to implementing CO_2 capture with optimization studies.
- Finalize a permitting strategy for Project Tundra.Final design for CO_2 pipeline and recycling facility to support Project Tundra EOR activities.

Figure 7. Initial general arrangement drawing for Project Tundra.

- Complete a FEED-level cost estimate for constructing Project Tundra CO_2 capture, pipeline, and recycling facilities.

QUALIFICATIONS

Minnkota Power Cooperative Team

Minnkota will be the prime contractor for this project. Minnkota is a regional generation and transmission cooperative that supplies power to 11 member–owner distribution cooperatives across 34,500 square miles of North Dakota and Minnesota. Minnkota also serves as operating agent for the Northern Municipal Power Agency (NMPA). Headquartered in Thief River Falls, Minnesota, NMPA supplies the electric needs of 12 associated municipals that serve more than 15,000 consumer accounts in the same geographic area as the Minnkota member–owners. Minnkota brings expertise and insight into the regulatory acceptance of the coal industry along with in-kind cost-share contributions. Minnkota will play a crucial role in the project by providing vital information regarding the MRY facility, actively participating in design, and providing the host site for the project. Specific information provided will consist of process flows, available utilities, plant drawings, permit information, and gas compositions. The principal investigator from Minnkota will be Mr. Gerry Pfau.

Mr. Pfau, Senior Manager of Project Development for Minnkota, will provide experienced management and leadership and be responsible for the overall success of the project. Mr. Pfau will ensure each member of the project team completes their assigned tasks, complies with all scheduling and budgetary requirements, communicates properly with all other team members, and provides necessary information to meet all reporting requirements.

EERC Team

The EERC is one of the world's major energy and environmental research organizations. Since its founding in 1951, the EERC has conducted research, testing, and evaluation of fuels, combustion and gasification technologies, emission control technologies, ash use and disposal, analytical methods, groundwater, waste-to-energy systems, and advanced environmental control systems. Today's energy and environmental research needs typically require the expertise of a total-systems team that can focus on technical details while retaining a broad perspective.

Mr. Jason Laumb, Principal Engineer, Advanced Energy Systems Group Lead, will be the project lead from the EERC. Mr. Laumb will focus on ensuring the overall success of the project by providing experienced management and leadership to the reporting and administrative activities within the project. Mr. Laumb will ensure that project reports are of high quality and completed in a timely fashion. Mr. Laumb will work very closely with Mr. Pfau on administrative activities within the project.

MHI Team

With more than 80,000 employees and close to $40 billion in annual revenue (7000 employees and $6 billion in revenue in the United States alone), MHI Group delivers innovative and integrated solutions across a wide range of industries from commercial aviation, transportation, and machinery to chemical plants, energy, and integrated defense and space systems. Since the 1970s, MHI's infrastructure engineering organizations have supplied process technology and engineering, procurement, and/or construction services for dozens of petrochemical projects globally, including 13 commercial CO_2 recovery plants since 1999 and several world-scale chemicals projects in North America since 2014. For Project Tundra, MHI will build on expertise gained during the installation of the KM CDR Process at the Petra Nova project,

successfully entered into commercial operation in January 2017, and the pilot tests conducted at the EERC in September 2018.

Mr. Tim Thomas, Vice President and Deputy General Manager with Mitsubishi Heavy Industries America, Inc. (MHIA), will be responsible for all MHI and MHIA activities on this project. Mr. Thomas will be the key interface between MHIA, MHI, Burns & McDonnell, and Minnkota for capture system design and plant integration.

Burns & McDonnell Team

Burns & McDonnell will serve as the owner-retained engineer for the project and be responsible for leading the engineering and design in Task 2, permitting work in Task 4, the cost-estimating work in Task 5, and the pipeline portion of Task 6. Burns & McDonnell is a full-service engineering, architecture, construction, environmental, and consulting solutions firm, based in Kansas City, Missouri. The staff of 5700 includes engineers, architects, construction professionals, planners, estimators, economists, technicians, and scientists representing virtually all design disciplines. Burns & McDonnell is involved in the design, permitting, construction, and management of facilities all over the world. Burns & McDonnell has been involved in numerous retrofit projects at the MRY Station over the past 10 years, including over $400 million in air pollution control retrofits, with knowledge of and familiarity with the project site that is second to none.

Mr. Ronald Bryant, Principal with Burns & McDonnell, will be responsible for all Burns & McDonnell activities on this project. Mr. Bryant will be a key contact with the Project Tundra team and will be responsible for the balance of plant and construction portions of the FEED study.

EEPI Team

Mr. Robert Mau will be representing EEPI in an advisory capacity. Mr. Mau, Chair, Principal, and Operator at EEPI, has 35+ years of experience as an operator and in all aspects of the upstream and midstream oil and gas business. He currently oversees all investments made by EEPI and is Chair of the Investment Committee. Under his leadership, hundreds of wells have been drilled, produced, and operated since 1991. The company has employed secondary recovery techniques since 2002, with an average of >5 times estimated production increases achieved and, in some cases, as high as 11 times.

Greeson Consulting LLC

Mr. David Greeson will be representing Greeson Consulting. Mr. Greeson is a consultant to the carbon capture and power generation industries. Until his retirement in 2018, Mr. Greeson was the Vice President of Development for NRG Energy and led NRG's Gulf Coast business development group and the company's carbon capture program. Mr. Greeson was the developer of the $1 billion Petra Nova project from inception through commissioning. Mr. Greeson began his career in the power industry at Houston Lighting & Power in customer relations 38 years ago. Over those years he developed five major power projects which represent over $3 billion of investment.

Industry Partners

Industry partners for this project are Minnkota Power, BNI Energy, and EEPI. BNI Energy (formerly BNI Coal) has been a partner in electric generation utilizing North Dakota lignite since the MRY Station Unit 2 was constructed in 1977. BNI Energy operates the Center Mine that supplies lignite to MRY. Minnkota Power is the owner and operator of the MRY generating station. The MRY Station is currently being considered for a PCC retrofit under Project Tundra.

EEPI will be the oilfield operator for Project Tundra. EEPI is currently in the procurement phases of acquiring the Foreman Butte oil field. Letters of support from the industry partners can be found in Appendix C.

VALUE TO NORTH DAKOTA

The continued use of lignite in North Dakota is highly dependent on creating a solution for the use of CO_2. The value of this project is that it supports retrofit technology to make low-carbon lignite utilization an economically attractive option. Without retrofit technology developments, carbon capture creates economic stresses on the continued use of coal in existing plant assets.

The North Dakota lignite industry, which has a $3 billion economic impact on the state, had been previously challenged by a proposed federal-level mandate to reduce the carbon intensity of power production. On August 3, 2015, Clean Power Plan (CPP) was finalized as the rule establishing CO_2 emission limits for existing power plants (U.S. Environmental Protection Agency, 2015), and while a stay in the CPP's implementation was issued by the U.S. Supreme Court in February 2016, the plan is representative of constraints that the lignite industry could face in the future.

This project will provide vital information to support a retrofit that can also enable a new CO_2 market to exist in the state, whereby utilities that produce CO_2 can market it to oil producers for EOR. CO_2-based EOR creates a solution for carbon utilization in North Dakota and readies the industry for a carbon-constrained future. Indeed, the key limitation to future widespread application of CO_2 EOR is in finding the supply of CO_2 (Burton-Kelly et al., 2014). North Dakota's unique combination of resources, including substantial CO_2 generation capacity and proximal storage and EOR applications, suggests that the state has the potential to lead the

development of sustainable coal utilization, which will be an increasing worldwide need in the years ahead.

The economic impact of Project Tundra will be significant for the state of North Dakota. Construction jobs will be created to build the capture facility, install the CO_2 pipeline, and prepare the oil fields for CO_2 injection. Permanent jobs will be created for operation of the facilities, and tax revenue will be generated for the state from additional income tax and from incremental oil produced through EOR. Using high-level capital cost estimates and data from an economic impacts model that has been built specifically for the coal and oil industry in North Dakota, it has been determined that Project Tundra will directly and/or indirectly support 2700 jobs during construction and support 3200 permanent jobs after a 3-year construction period. The state could see additional annual tax revenue of up to $46,000,000 from income tax, oil production tax, and other taxes and revenues.

MANAGEMENT

Minnkota Power will serve as the lead organization for this project with Mr. Gerry Pfau as the overall project manager. Mr. Pfau will ensure the overall success of this project by providing experienced management and leadership to all activities within the project. As project manager, Mr. Pfau will be responsible for the project being carried out within budget, schedule, and scope; he will also be responsible for effective communication between all project partners and Minnkota project personnel. Resumes of key personnel are included in Appendix D. The management structure for this project is shown in Figure 8.

Once the project is initiated, the project team will engage in weekly conference calls to review project status and future directions. Quarterly reports will be prepared and submitted to project sponsors for review. Regular meetings will be held to review the status and results of the

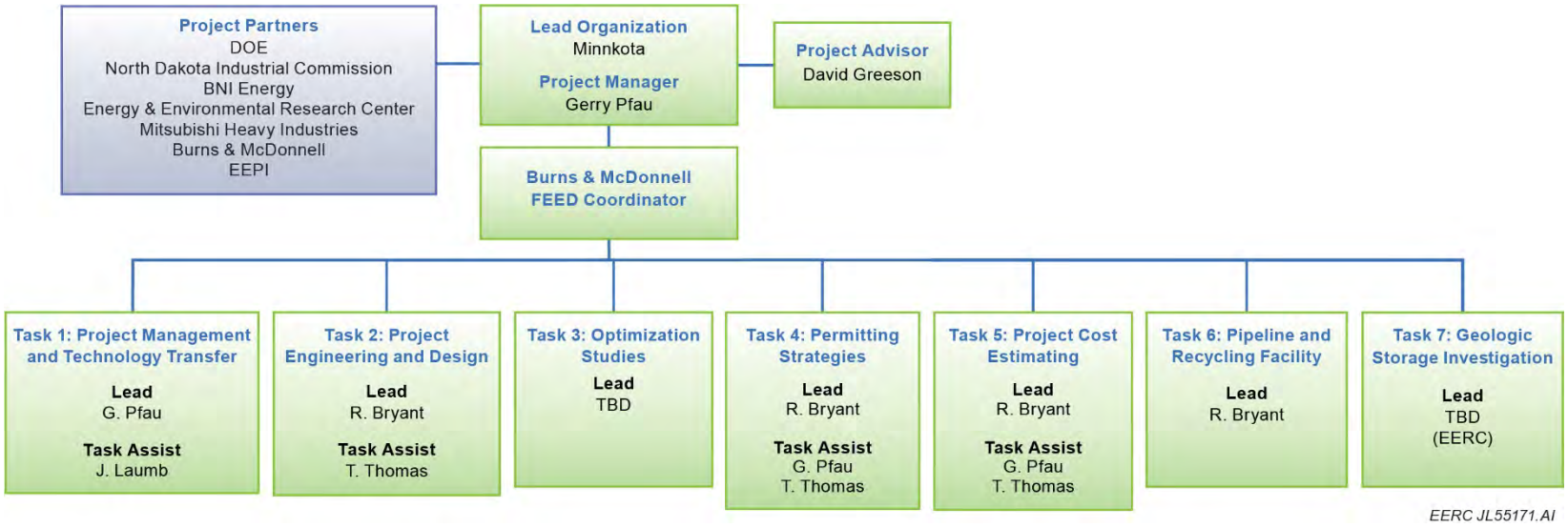

Figure 8. Simplified project management structure.

project and discuss directions for future work. A broad team approach is key to successful execution of this project.

TIMETABLE AND DELIVERABLES

A time line for the project activities is shown in Figure 9. The project anticipated start date is January 1, 2019 (Task 1 only), with an end date of August 31, 2021, thus resulting in a 32-month period of performance for Project Tundra FEED. The tasks associated with the FEED study will begin after August 2019. The actual start date of some tasks may vary owing to acquisition of DOE cost-share dollars. The primary deliverable will be an integrated final report, due upon completion of the project. The final report will summarize the tasks described in the Scope of Work section.

Specific deliverables for the project are aligned to support continued development of Project Tundra. The team will work closely with Burns & McDonnell, MHI, and the industry team to ensure all deliverables aid in the development of key steps in Project Tundra. Key deliverables to be summarized in the final report include the following:

Multidisciplinary

- Project Execution Plan
- Project Approved Vendor's List
- Project Design Manual (basic engineering design data)
- FEED Cost Estimate (including engineering, procurement, and construction)
- General Arrangement Drawing
- FEED Project Schedule
- EPC Project Schedule
- Permitting Support

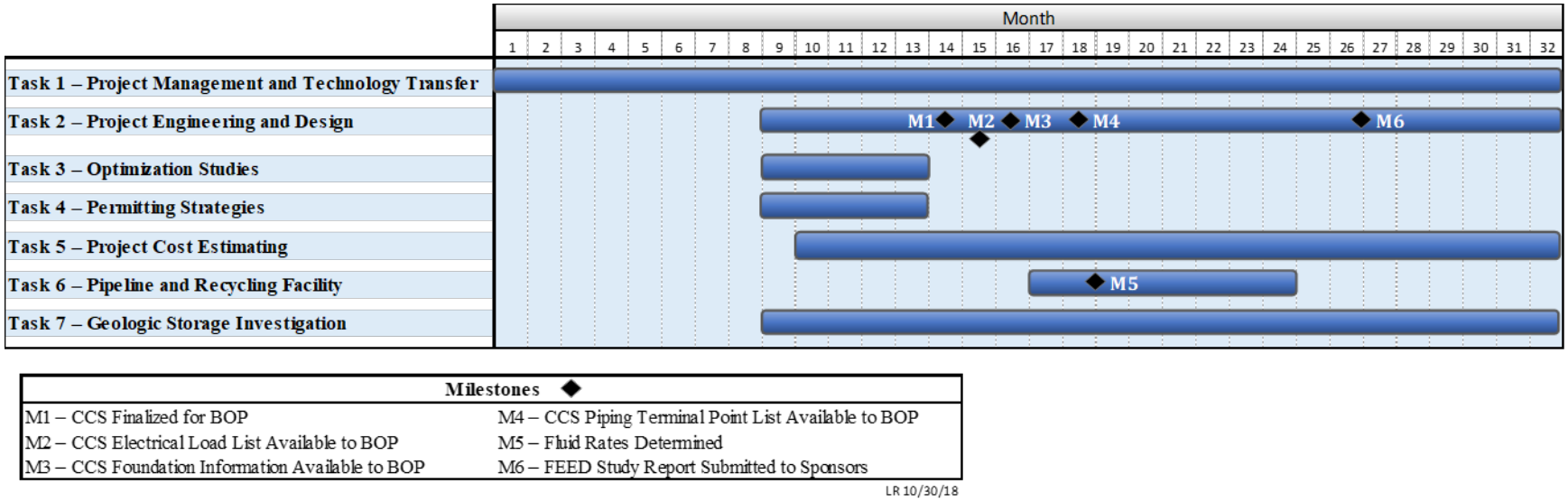

Figure 9. Simplified project schedule and milestones for Project Tundra FEED.

- FEED Report
- Document Distribution Matrix

Mechanical/Process/Piping

- Mechanical/Process/Piping Design Basis
- Overall Process Description
- Process Flow Diagrams
- Heat and Material Balance
- Water Mass Balances
- Process Equipment Data Sheets
- Instrument Valve Data Sheets (for critical valves)
- Relief Valve Summary
- Utility Summary
- Effluent Summary
- Chemicals Summary
- Piping and Instrumentation Diagrams
- HAZOP Review Participation
- Line List
- Tie-In List
- Equipment List (including capital spares)
- Equipment Criticality Review and Plan (for shop surveillance)
- Detailed Technical Specifications for the Following Major Mechanical Contracts:
  - Steam Turbine Modifications
  - Circulating Water Pumps

  - Cooling Tower
  - Fin-Fan Heat Exchangers (if required)
  - Field-Erected Tanks
  - Water Treatment
- Budgetary Specifications as Needed to Obtain Pricing for All Other Major Mechanical Equipment
- Equipment Model Review
- Site Plan/Tie-In Location Plan
- Modularization Concept
- Piping
- Piping Tie-Ins (field-located and photographed)
- Laser Scan Package
- 3-D model (Navisworks)
- Piping Materials Specifications
- Insulation Specification
- Painting Specification
- Pipe Specials List
- Preliminary Stress Analysis of High-Energy Piping
- Valve List
- Piping, Valve, and Pipe Special MTOs to Support Cost Estimate
- Fire Protection
- Review of Existing Fire Protection System and Project Scope

- Fire Protection Design Basis
- Fire Protection Drawings/Sketches/MTOs to Support Cost Estimate

Civil/Geotechnical

- Civil/Geotechnical Design Basis
- Exploratory Excavation Survey Package
- Preliminary Civil 3-D Modeling
- Preliminary Civil Drawings/Sketches (grading/drainage/roadway plans)
- SWPPP Permit Support
- Civil MTOs to Support Cost Estimate

Structural

- Structural Design Basis
- Preliminary Structural 3-D Modeling of Foundations/Structural Steel/Ductwork/ Handrail/Grating
- Preliminary Structural Drawings/Sketches
- Detailed Technical Specifications for Structural Steel, Ductwork, and Flue Gas Dampers
- Structural MTOs to Support Cost Estimate

Architectural

- Architectural Design Basis
- Preliminary Architectural 3-D modeling
- Preliminary Architectural Drawings/Sketches
- Budgetary Preengineered Building/HVAC Specification to Support Cost Estimate

Electrical

- Electrical Design Basis

- One-Line Drawings
- Electrical Load List
- Combined Cable Tray Routing/Power Plans – 3-D Model/Sketches
- Electrical Grounding Sketches
- Electrical Lighting and Panelboard Location Sketches
- ETAP Study
- Detailed Technical Specifications for Auxiliary/Station Service Transformers and Packaged Electrical Equipment
- Formal Short Circuit/Load Flow Report
- Cable Schedule

Instrument/Controls

- I&C and Control System Design Basis
- Instrument Index
- I/O List
- Work with Mechanical Engineering to Identify Instrument Air Requirements
- Junction Box Location Sketches
- Cable Schedule Input
- Instrument Selection and Pricing to Support Estimate
- DCS Design to Support Estimate
- Control System Architectural Details to Support Estimate
- Detailed Technical Specifications for CEMs and DCS
- Budgetary Specifications as Needed to Obtain Pricing for All Other Major I&C Equipment

The specific deliverables mentioned above will be presented to the project team in the form of a draft and final report. The draft report will be issued to the project team for comments prior to a project final report.

BUDGET

The proposed budget is $31,164,414 as shown in Table 2. This proposal requests $15,000,000 from NDIC (48%). Minnkota will provide $1,164,414 in the form of cash and in-kind. Minnkota will submit a request to DOE for $15,000,000 under a DOE NETL FOA. Because of the unknown cost-share requirement of the DOE funding source, it is requested that the state funding be made available at the above requested amount. The project team recognizes that the DOE funding is not guaranteed. However, the project partners feel confident that this project aligns with federal priorities and has a high probability of DOE support. The project partners have already received significant investment from DOE and expect that support will continue with the current funding allocated to the federal budget in 2019. In the case that the DOE cost share is not secured, the team will reprioritize funding needs and seek additional possibilities within the state or from among project partners. Project contingency has been included in the project budget and

Table 2. Project Budget

Project Associated Expense	NDIC Share (Cash)	DOE (Cash)	MPC (Cash/In-Kind)	Total Project
Labor	$ -	$ 833,900	$ -	$ 833,900
Travel	$ -	$ 77,160	$ -	$ 77,160
Supplies	$ -	$ 75	$ -	$ 75
Consultants	$ -	$ 11,592	$ 783,558	$ 795,150
Subcontractor - MHI	$ -	$ 10,280,000	$ -	$ 10,280,000
Subcontractor - Burns & McDonnell	$ 7,533,500	$ -	$ -	$ 7,533,500
Subcontractor - EERC	$ -	$ 3,700,000	$ 300,000	$ 4,000,000
Subcontractor - Recycle Facility FEED Study	$ 500,000	$ -	$ -	$ 500,000
Subcontractor - Optimization Studies	$ 1,000,000	$ -	$ -	$ 1,000,000
Geologic Storage Investigation	$ 3,750,000	$ -	$ -	$ 3,750,000
Contingencies	$ 2,206,500	$ -	$ -	$ 2,206,500
Facilities & Administration	$ 10,000	$ 97,273	$ 80,856	$ 188,129
Total Project Costs	$ 15,000,000	$ 15,000,000	$ 1,164,414	$ 31,164,414

will be appropriately allocated pending detail in the DOE FOA that may preclude certain scope components included in this proposal.

MATCHING FUNDS

Matching funds totaling $16,164,414 (52%) for the proposed effort will come from Minnkota and DOE as shown in Table 3.

Table 3. Funding Profile

	NDIC Share	Cost Share
NDIC – Cash	$15,000,000	
DOE – Cash		$15,000,000
Minnkota Power – Cash		$300,000
Minnkota Power – In-Kind		$864,414
Total	$15,000,000	$16,164,414
Cost Share, %	48%	52%

TAX LIABILITY

Minnkota Power is not a taxable entity; therefore, it has no tax liability.

CONFIDENTIAL INFORMATION

The MHI proposal in Appendix B contains confidential information. Please see appropriate attachment in Appendix E answering NDIC administrative questions regarding confidential information.

APPENDIX A

SUBCONTRACT PROPOSALS

BURNS & MCDONNELL SUBCONTRACT PROPOSAL

October 17, 2018

Mr. Gerry Pfau, PE
Senior Manager of Project Development
Minnkota Power Cooperative
Milton R. Young Station
3401 24th St SW
PO Box 127
Center, ND 58530-0127

RE: CO2 Pipeline Pre-FEED

Dear Mr. Pfau:

Burns & McDonnell (BMcD) is pleased to present this proposal to provide services to Minnkota Power Cooperative (Client) for the Pre-FEED study of an approximately 175-mile CO2 pipeline from Minnkota Power, near Center, ND, west to the Foreman Butte oil field.

We understand that the project partners currently do not desire to disclose the project to the public. This limits the ability to obtain options on right of way to fully define the pipeline route. Without such project definition, the efforts to estimate total installation costs will be limited in accuracy to a "Pre-Feed" level (AACE Class 4 Level). We propose to include associated risks that may impact the total install cost estimate to help determine budgetary costs for planning purposes.

EXECUTION PLAN

Project Description

BMcD proposes to identify and evaluate a proposed corridor for a CO2 pipeline including preliminary design, total install cost estimate and identified project definition risks. The project will include a macro corridor study that is commiserate with the North Dakota Public Service Commission (PSC) and which can be used in the future should it be decided to file for a Certificate of Corridor Compatibility.

In addition, based on the proposed corridor, a preliminary design will be developed, and total install costs will be estimated. The overall process to obtain a certificate from the ND PSC and obtaining right-of-way is anticipated to be in the project's critical path and will be included in a preliminary project schedule.

Scope of Services and Schedule

Kick-off Meeting

To review and define project scope and develop a project schedule, BMcD proposes to hold a Kick-off meeting via teleconference. During the meeting, BMcD will review the project scope, schedule, deliverables, and communication protocol. Prior to the meeting, BMcD will issue a request for information to begin review. Based on cursory review of information, BMcD will be prepared to discuss general scope basis with Minnkota.

Pipeline Corridor and Preliminary Design

BMcD will conduct a macro corridor study commiserate, preliminary design and cost estimates:

- Desktop analysis to obtain existing reports, maps, and other important literature to assist in understanding environmental and land use issues, constraints, and opportunities
- Identify up to three potential corridors for project construction, 6 miles wide (based on ND PSC requirements for consideration.
- Compare alternative corridors using factors within the categories of Land Use, Environmental, Social, and Engineering and consider the Exclusion and Avoidance criteria.
- Travel to the potential corridors and observe the general characteristics of the corridors as much as possible without accessing private property.
- Develop a letter report to document the review process containing a description of study area resources, analysis of the alternative corridors, and rationale for selection of a preferred corridor for project development.
- Hydraulic analysis based on anticipated flow requirements and operating parameters of the identified CO2 pipeline including identification of additional compression along the route.
- Preliminary design to size pipe, select material and determine equipment needs.
- Develop a total install cost estimate (AACE Class 4) of a likely pipeline route within the selected corridor which shall include construction, material and equipment.
- Develop a project definition risk registry with potential total install cost impact and likelihood of occurrence
- Develop preliminary schedule including anticipated permit process and construction.

The total install cost estimates will utilize our experience with projects of similar size and will be adjusted for geographic region. If courtesy quotes for material or construction are agreed acceptable to be utilized, BMcD will obfuscate the specifics to keep project confidentiality intact. Additional owner costs to be included, such as right-of-way costs, will be based on experience in the region but with no implied AACE estimate level.

Project Documentation
Burns & McDonnell will capture the results of this corridor macro study in a letter report. The preliminary design and total install cost estimate will be documented in a Design Basis Manual with a TIC estimate appendix for the benefit of project stakeholders.

Schedule
BMcD proposes the following schedule for the Scope of Services. Tentative milestone dates include the following based on a Notice to Proceed (NTP).

Item	Task Completed	Tentative Date
1.	Kick-off conference call	2 weeks after NTP
2.	BMcD desktop macro corridor study	10 weeks after NTP
3.	Preliminary design and TIC	16 weeks after NTP

CLARIFICATIONS

Burns & McDonnell submits the following clarifications to the proposed Scope of Services:

1. Total Install Cost estimates are based on limited project definition due to lack of secured right-of-way and will not exceed AACE Class 4.
2. The "Risk Registry" is not a comprehensive list and is intended to facilitate the determination of a budgetary cost to use.
3. BMcD will not identify or contact individual property owners.
4. BMcD will not seek permission to access pipeline route from private property owners unless granted permission and additional scope to do so by Client.
5. BMcD will not initiate any permit application process.

COMPENSATION

Burns & McDonnell proposes to perform the Scope of Services described herein on a "time and materials" basis, including reimbursement for the cost of expenses incurred, in accordance with the Schedule of Hourly Professional Service Billing Rates currently in place with Minnkota Power. The estimated target price to perform the Scope of Services is $75,000.

COMMERCIAL

Burns & McDonnell proposes to perform the Scope of Services described above in accordance with the Professional Services Contract, dated July 26, 2005, and Amendment 2, dated November 3, 2015, currently in place between Minnkota Power and Burns & McDonnell.

This proposal is valid for 30 calendar days from the date of the proposal.

Thank you for the opportunity to submit our proposal for professional services. If you have any questions regarding this proposal, please contact me at 816-823-7535 or Ron Bryant at 816-822-3023.

Sincerely,

Dana Book, P.E.
Director of Pipeline Services
Burns & McDonnell

BURNS McDONNELL

PROPOSAL FOR

PROJECT TUNDRA CO2 CAPTURE FEED STUDY

SUBMITTED TO
MINNKOTA POWER

OCTOBER 2018

BURNS McDONNELL

October 19, 2018

Mr. Gerry Pfau, P.E.
Sr. Manager of Project Development
Minnkota Power Cooperative
Milton R. Young Station
3401 24th St. SW
Center, ND 58530

Re: FEED Proposal for the Minnkota Power – Project Tundra CO2 Capture

Dear Mr. Pfau:

Minnkota Power can efficiently and predictably execute Project Tundra by leveraging Burns & McDonnell's track record of technical engineering and construction success. We understand that for you to be successful, you need a reliable FEED estimate and an efficient detailed design and construction plan. We have put together a dedicated and trustworthy project team and FEED proposal to address the design and installation requirements of this project based on the following:

- **Assignment of a Great Team:** We have assembled a quality, experienced, and dedicated team who has worked together on multiple projects, to come alongside you as true partners to execute this project. Ron Bryant is one of our most experienced Project Managers. He has led numerous successful Minnkota projects, and our proposed team was personally hand-picked by him. Our team is committed to developing relationships with your team on a project that aligns with your business objectives, because when you succeed, we succeed.
- **Commitment to Minnkota Power:** Burns & McDonnell has a long track-record of executing successful projects for Minnkota Power over the last 25+ years. We have been trusted to handle some of your most strategic and challenging projects, including the consent decree air quality projects. This CO2 capture project is a strategic project for both Minnkota Power and Burns & McDonnell as we work to lead the industry in reducing carbon emissions.
- **Organizational Accountability:** Throughout our long history of working together, Burns & McDonnell has demonstrated a commitment and focus on project success. This is one of the biggest benefits of working with an employee-owned firm, every single person working on your project has a vested interest in a successful project completion. Ron Bryant, our proposed Project Manager, and his team will be accountable for a successful outcome. Our Burns & McDonnell team will bring the resources to bear, and foster the relationships and lines of communication to achieve success.

Our execution plan, FEED deliverables list, project team, schedule, commercial offering, and project experience summaries are included in this proposal. If you have any questions regarding the enclosed information, please feel free to contact Ron Bryant at (816) 822-3023.

Sincerely,

Doug Riedel, P.E.
Senior Vice President, Energy

9400 Ward Parkway \ Kansas City, MO 64114
O 816-333-9400 \ burnsmcd.com

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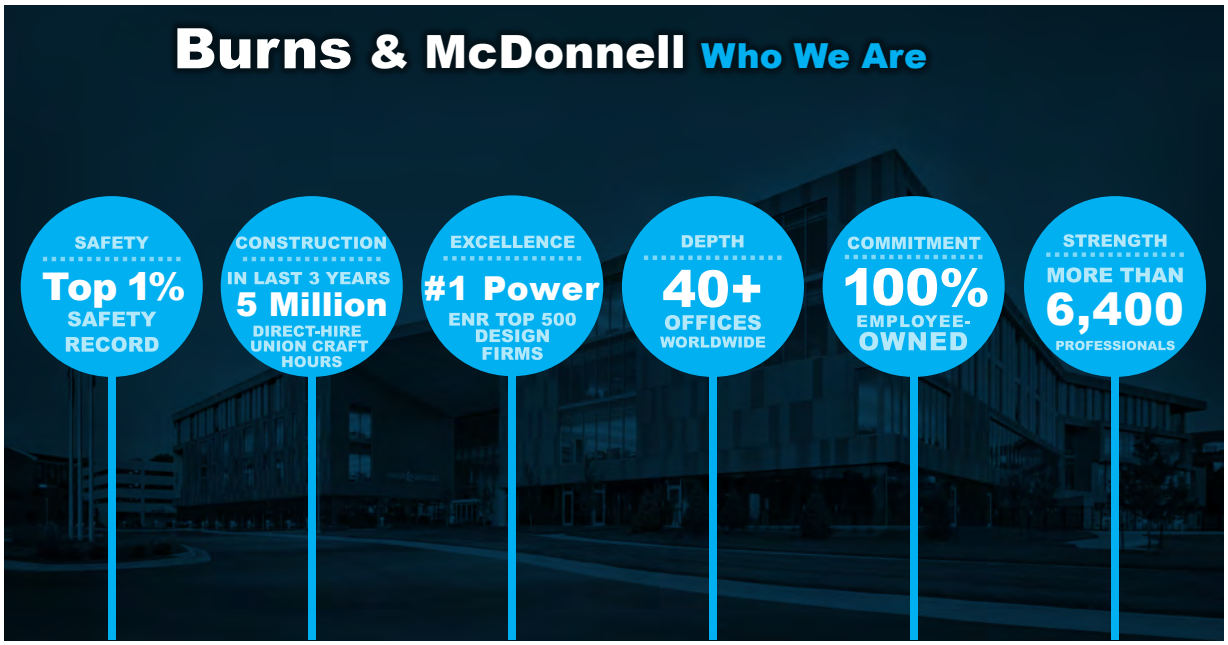
INTRODUCTION

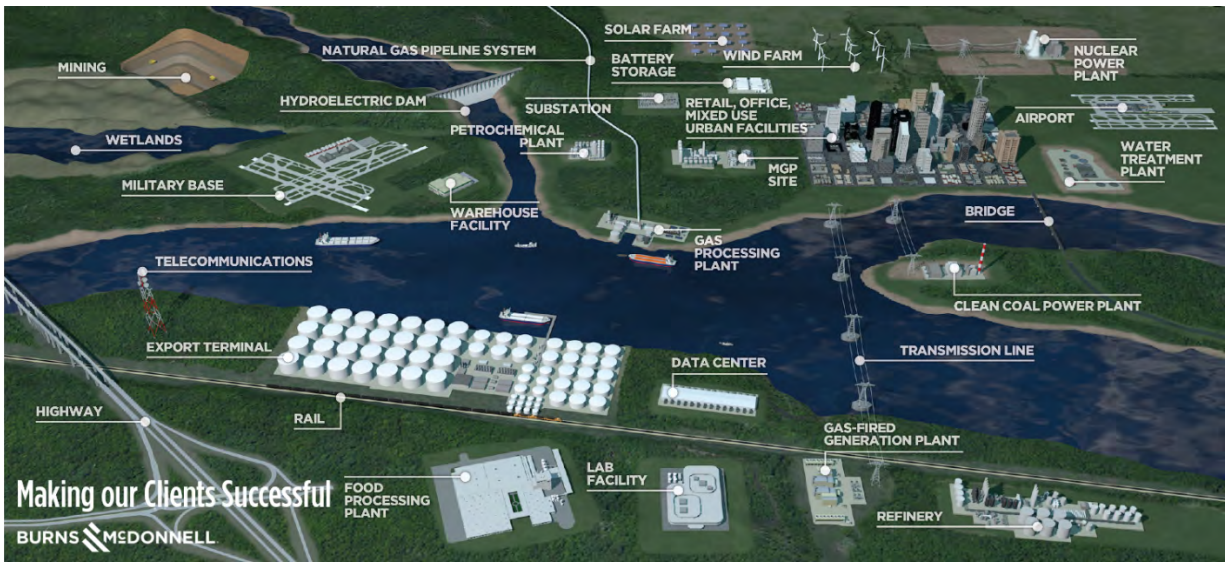
INTRODUCTION

Minnkota Power can be confident of predictable project results on Project Tundra by partnering with Burns & McDonnell. With our focus on your continued success we believe a Burns & McDonnell and Minnkota Power project team will provide the best chance of a predictably executed project.

Who We Are

Burns & McDonnell is a full-service engineering, architecture, construction, environmental and consulting solutions firm, based in Kansas City, Missouri. With our staff of over 6,400 includes engineers, architects, construction professionals, planners, estimators, we represent virtually all aspects of a project execution team. We plan, design, permit, construct and manage facilities all over the world, with one mission in mind: Make our clients successful. The following graphics demonstrate some of the unique facets that contribute to this mission as well as the key industries we serve.





Why Burns & McDonnell?

We understand Minnkota Power's goal for this phase is to define a specific scope and generate a predictable cost estimate and schedule for the construction of the CO2 capture project. We are dedicated to helping you achieve these goals while focusing our preliminary design on safety, capital efficiency, and constructability.

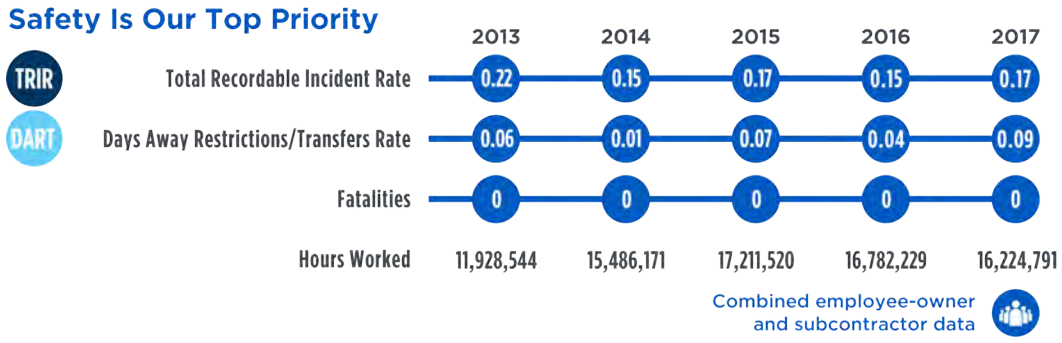
Burns & McDonnell has been involved in numerous projects at the MRY Station for more than 25 years, including a major rebuild of the Unit 1 and Unit 2 electrical system, refurbishment of the Unit 2 chimney, and new ductwork to the Unit 1 scrubber modules. One project in particular began in 2006 when Burns & McDonnell provided engineering for over $400 MM in MRY air pollution control retrofit upgrades leading to extensive knowledge and familiarity with the project facility. Not only have we provided engineering support at MRY, we have also provided scheduling, safety, QA/QC, and startup support services. This integral familiarity with the MRY facility and staff lends greatly to the successful execution of this FEED study.

In addition to participating in the ongoing Project Carbon Pre-FEED study, Burns & McDonnell also has experience in performing both FEED studies and carbon capture assessments. The Taylorville Energy Center is a perfect example of this, as Burns & McDonnell supported our client through the FEED process in evaluating an IGCC facility with CO_2 capture capabilities. We feel confident that our experience developing and executing large generation projects will make Minnkota Power successful. Appendix B contains highlights of relevant project experience.

Safety First

No incidents, everyone goes home safely

As a long-term customer of Burns & McDonnell, you know that we, like Minnkota Power, integrate safety into our everyday culture and measure ourselves against the strictest standards. It is our intrinsic expectation that everyone working on a project goes home safely to their families every night – our people as well as our subcontractors and clients. From the earliest stages in a project we seek to design with construction in mind, to provide a design that is cost effective and schedule oriented, but can also be safely installed in the field. This focus on safety from day one is why Burns & McDonnell has consistently performed in the *top quartile* of the Construction Industry Institute member companies for Total Recordable Incident Rates (TRIR). We have recently completed over 1 million man-hours on the Saskpower Chinook Power Station EPC project with zero recordable incidents.



Effective Collaboration with MHI

Blending multiple companies to make one integrated team

We are very well positioned to smoothly collaborate with MHI on this project. Our teams have experience working together on the ongoing Project Carbon Pre-FEED study. In addition we have supported front-end planning for a confidential client to retrofit a post combustion CO_2 capture system onto an existing coal-fired electric generating unit located in the Midwest.

Proven Front-End Execution Model with Smooth Transition to Future Phases

Predictable and accurate project cost and schedule

Burns & McDonnell has years of experience working on Minnkota Power projects and other FEED studies. We will use our proven front-end estimation model developed from this experience to identify the right scope and produce a trustworthy cost estimate. We bring an experienced team who will leverage Burns & McDonnell's past experience to develop a cost effective and technically sound design for Project Tundra.

EXECUTION PLAN

PROJECT EXECUTION PLAN

Burns & McDonnell has extensive experience executing projects for Minnkota Power. We have a proven execution plan that has led to numerous safe, on time, under budget, and successful projects. Minnkota Power can be confident that Burns & McDonnell has the experience to execute a safe and accurate FEED study. We will be working extensively alongside your team to define a high-quality scope and develop a trustworthy schedule and cost estimate.

SAFETY

The first priority and responsibility of the Burns & McDonnell team is to execute all phases of the project safely. This includes having safety as an integral part of our execution plans and overall design to promote safety during the FEED phase and subsequent phases. We believe that zero incidents is an achievable project goal, but reaching it takes deliberate and focused efforts from every member of the team. The key project safety initiates will include:

- **Pre-Task Safety Analysis** – Developed by each Burns & McDonnell employee for each site visit.
- **Task Safety Observations** – Behavior-based observations of both office and field activities
- **Safety in Design** – The design will be reviewed to incorporate practices that promote safety during construction and long-term operation.

In the last five years, Burns & McDonnell and our subcontractors have completed more than 65 million man-hours on all projects with a total recordable incident rate of 0.17

PROJECT OBJECTIVES

The primary objective of this project is the installation of a CO2 capture facility at the MRY Station to remove approximately 95% of the CO2 from the current emissions.

The end goal of the FEED study is to have the major governing project deliverables defined. A list of all deliverables is included later in this proposal. These deliverables will support the overall FEED cost estimate.

KEYS TO SUCCESSFUL EXECUTION

- Strong engineering team
- Schedule with “buy-in” from all project stakeholders
- Leverage past Milton R. Young Station and MHI experience
- Previous FEED study experience
- Effective collaboration with MHI

PROJECT SCOPE

The project scope consists of the Carbon Capture System (CCS) deliverables provided by MHI and the Balance of Plant (BOP) deliverables provided by Burns & McDonnell. A detailed breakdown of scope responsibility between MHI and Burns & McDonnell is provided in Appendix C.

PROJECT EXECUTION PLAN
(Continued)

A high-level breakdown summary is as follows:

a. MHI
   - MHI's proprietary CO2 capture technology will be utilized inside the CCS building
   - MHI will provide piping and electrical design for the CCS scope, including Power Distribution Center (PDC)
   - MHI will provide structural steel design and building steel design for CCS scope

b. Burns & McDonnell
   - Civil/earthwork design for CCS and BOP
   - Foundation design for CCS and BOP
   - Ductwork from existing chimney to CCS scope
   - Steam turbine extraction modifications in existing turbine building to CCS scope
   - Cooling system to support CCS and BOP cooling loads
   - BOP piping to and from the CCS scope
   - Auxiliary building to house maintenance/warehouse, administration, control room, and BOP equipment
   - PDC and associated electrical distribution design for BOP

FEED PROJECT EXECUTION

Upon award of the project, Burns & McDonnell will conduct kickoff meeting with the project stakeholders. The meeting will be an opportunity to introduce the teams, align expectations, identify key stakeholders, review major project milestones, and discuss key activities for the FEED study. We would expect this kickoff meeting to occur at Burns & McDonnell headquarters in Kansas City or the MRY Station.

Project Coordination and Communication Plan

Communication is integral to the successful execution of this project. We have identified several key activities to facilitate alignment between Minnkota Power and Burns & McDonnell and establish good communication practices:

- The key project team members for Burns & McDonnell are shown in Appendix A. Burns & McDonnell will generate a key project stakeholders contact list immediately after kickoff meeting and will be a living document during the FEED study and beyond.
- Burns & McDonnell plans to have the following meetings with Minnkota Power:
  - Weekly engineering meeting between the project stakeholders and Burns & McDonnell engineering team. Burns & McDonnell will issue an Action Item List ahead of the meeting to track key activities.
  - Project leadership team will meet periodically as required for a progress update, schedule review, cost review, and look-ahead. Burns & McDonnell will issue a summary ahead of this meeting.

PROJECT EXECUTION PLAN
(Continued)

Document Control

On a project this size and with this scope, having an efficient document control system is imperative. We propose to use Burns & McDonnell's document control system, referred to as "Document Locator (DL)" to store and share official record documents, manage applicable vendor submittals, document workflow review cycles, and version control. Burns & McDonnell can provide training to key stakeholders. Burns & McDonnell will maintain access to this system through a web interface throughout the life of the project. Burns & McDonnell's document control lead assigned to the project will be available to help throughout the lifecycle of the project. There will be a document distribution matrix for the project identifying the deliverables for the FEED. This will identify the review and approval requirements from all the Minnkota Power key stakeholders.

Engineering

Multi Discipline

Design Manual

Early in the FEED study, each discipline will review the Design Manual developed during Pre-FEED to establish a clear overall design basis for the project. Each discipline will work closely with their Minnkota Power counterpart to understand expectations and obtain alignment on design requirements that will be utilized throughout the life of the project. Each lead will document the agreements made with their counterparts and issue a formal Design Manual to the project stakeholders so that all parties are aligned on the basis for the project.

Model Reviews

Our designers will work with the team to develop the 3D model that will be used for equipment, structural, electrical and piping depiction. We plan to conduct the 30% model review during the FEED Phase for the equipment location plan. The 60% and 90% model reviews will be part of the Detailed Design Phase.

Material Take Offs

Material Take Offs (MTO) will be exported from 3D model. This MTO will be mainly for large bore pipe lengths, fittings, flanges, valves, raceway, cables, and instrumentation. Some small bore (2" and less) MTO will be factored based on large bore quantities. Structural steel and concrete take-offs will be developed from structural design software and sketches. Cut and fill quantities will be developed from the grading/drainage plans.

All MTO's will be used to support the FEED cost estimate.

General Arrangement

The general arrangement drawing can have a significant impact on constructability, design, and costs. Our team will optimize and confirm the general arrangement with input from Minnkota Power, MHI and other Burns & McDonnell disciplines including construction. We will identify opportunities to reduce cost and improve constructability, operability and maintainability prior to implementation. Emphasis will be given to maximize modularization where possible.

Laser Scanning

Laser scans have proven valuable in creating a design that can be safely constructed and minimizing rework on the project. Laser scanning provides a three-dimensional point cloud that allows for precise design interfaces and efficient routing in and around existing facilities.

Our team will perform laser scanning as required for design of the major tie-ins to the existing unit. In this case, the laser scan will be primarily used to help route process piping from the existing unit to the CCS facility. The team will develop the scope of work for the laser scan and perform the laser scan utilizing in house staff. The laser scan information will be built into our 3D model, integrating our design in real world data.

Tie-Ins

The engineering team will work with Minnkota Power personnel to identify tie-in locations, preliminary pipe routings and interfaces, and electrical interconnections. With input from Minnkota Power operations, we will identify any hot taps required. Tie-in locations will be identified in a timely manner to provide adequate definition and minimize rework.

During the FEED, we will complete a tie-in list and location plan. Input from construction during the detailed design phase of the project will help to eliminate rework. P&IDs and One-Lines will be marked and updated as needed with tie-in information.

FEED Report

All disciplines will provide input to a FEED report that includes the deliverables discussed herein for the Burns & McDonell Scope. Additionally, MHI will be providing a FEED report for the MHI scope of this project.

Burns & McDonnell will consolidate the two reports into an overall FEED report and overall FEED cost estimate for Minnkota Power to submit to the Department of Energy (DOE).

Mechanical Engineering

Mechanical engineering will develop equipment specifications, focusing on the long-lead items first to allow the team to obtain budgetary quotes to support the FEED estimate. Detailed specifications will be developed for the major equipment packages listed in the Deliverables section. Short form budgetary specifications will be

developed for all other major packages. Budgetary or e-mail quotes will be obtained with these specifications for all major equipment. Minor equipment will be priced using in house data.

Mechanical engineering will support the engineering team for layout, piping and instrumentation to help quantify the MTO in support of the FEED estimate.

During the FEED phase, our mechanical engineers will hold P&ID reviews. The P&ID's will be issued for a HAZOP review to be hosted by EERC. We have included 3 days of participation in a HAZOP review for the mechanical engineering team. It is assumed the HAZOP will focus on the high energy piping systems and chemical feed systems.

Burns & McDonnell's mechanical engineers will generate a sized equipment list. We will also work with Minnkota Power to identify alternative design considerations that may affect cost and schedule. As part of this analysis, impacts to existing systems will be considered.

As part of this project, the steam turbine will be further analyzed to determine the impacts from extracting the steam required for the CO2 capture process. Burns & McDonnell will work with Siemens to establish a preliminary extraction design and the associated performance and cost impacts.

A specialized group within the mechanical engineering department will handle the fire protection study work. This study will be per applicable NFPA Codes and Standards. This group will provide a preliminary fire protection design appropriate for the hazards present with consideration of the MRY protection philosophy including suppression and fire alarm related system extensions or new provisions as well as those necessary for hydrants, monitors, and aboveground suppression systems. Method(s) of activation, alarm and detection, as well as plant personnel involvement of the necessary appurtenances will be finalized as well. A firewater layout sketch will be prepared and reviewed with Minnkota Power.

Electrical Engineering

Burns & McDonnell's electrical engineers will develop plans and details for power and control design. This includes plans for electrical equipment, cable/cable tray routing and required supports design, area classification, lighting and grounding. Electrical engineers will generate one-line diagrams, cable schedule, and an equipment list for the project. Our electrical engineers will also update the existing power system model and perform power system studies on the new equipment.

Electrical engineering will model cable tray and electrical equipment in the overall plant 3D model.

Detailed specifications will be developed for Auxiliary/Station Service Transformers and Packaged Electrical Equipment (UPS, Switchgear, and MCC's). Budgetary specifications will be developed for all other major packages. These specifications will be used to obtain budgetary quotes for all major equipment. Minor equipment will be priced using in house data.

PROJECT EXECUTION PLAN
(Continued)

Engineering required for the re-route of the existing 230 kV transmission system and associated tap for connection to the new auxiliary transformer is not included. We have included costs for the preliminary design of the connection from the new auxiliary transformer to the new tap location provided by Minnkota Power.

Instrumentation & Controls (I&C) Engineering

I&C engineering will work closely with Minnkota Power's engineers to establish control philosophy for the unit along with a Control System Architectural diagram. Our I&C engineers will conduct field investigations to review existing infrastructure to establish I&C tie-in requirements. Our I&C engineers will participate in the P&ID review sessions and HAZOP review.

We will develop an instrument list and generate an I/O list for this project, including DCS points. General I&C conceptual junction box plans and layout will be developed to help produce quality MTOs.

Detailed specifications will be developed for the CEMS and DCS. Budgetary specifications will be developed for all other major I&C packages. These specifications will be used to obtain budgetary quotes for all major equipment. Minor equipment will be priced using in house data.

Civil/Geotechnical Engineering

Civil engineers will take the lead on the initial site plan development activities until this transitions to the mechanical engineering group once the 3D model is developed.

Geotechnical engineering, with support from civil engineering, will develop a geotechnical investigation specification for additional borings beyond those obtained during the Pre-Feed. These new borings locations will be finalized once the General Arrangement drawing is finalized. The findings of this investigation will be required to support preliminary foundation design activities and electrical grounding design by the electrical team.

Exploratory excavation plans and specifications will be generated to verify proposed foundation and subsurface facilities are clear of obstructions.

Civil engineering will develop a Site Survey specification to provide an accurate topography of the existing site. This information will be utilized to develop cut/fill quantities for the site.

Allowances for the Geotechnical Investigation, Pilot Trenching, and Surveying subcontractors are included in the commercial section of this proposal.

Civil engineering will produce grading/drainage/roadway drawings to support the MTO's required for the FEED cost estimate. Geotechnical engineers will produce piling location drawings to support the FEED cost estimate.

PROJECT EXECUTION PLAN
(Continued)

The 3D model will include preliminary modeling of civil and geotechnical components to support an early model review with Minnkota Power, as well as to prepare for the potential of a smooth transition to the next phase of execution.

Civil engineering will support of the SWPPP permit activities described in the Permitting section of this proposal

Structural Engineering

Structural engineering will support development of the Geotech Investigation specification. The findings of this investigation will be utilized to support the preliminary foundation design activities.

Structural engineering will produce preliminary foundation sketches to support the MTO's required for the FEED cost estimate. Foundation costs will be developed using in house data.

The 3D model will include preliminary modeling of structural components (foundations, structural steel, ductwork, handrail, grating).

Detailed specifications will be developed for the Structural Steel, Ductwork, and Flue Gas Dampers. These specifications will be used to obtain budgetary quotes. Minor equipment will be priced using in house data.

Architectural

Preliminary architectural drawings and sketches will be developed to support a budgetary specification for Pre-Engineered Buildings and HVAC. These specifications will be used to obtain budgetary quotes which will support the FEED cost estimate.

The architectural group will provide preliminary 3D models of the Pre-Engineered Buildings to support the overall modeling effort.

Permitting

Minor Source (Non-PSD) Air Permit Application

Burns & McDonnell will provide air permitting assistance for the addition of a CCS system. The proposed scope of services includes the following tasks:

Burns & McDonnell will review existing permits and permitted emission rates for the existing Unit 2 boiler. It is assumed that maximum hourly emission rates will be unchanged, except for CO2, which will be reduced. The CO2 maximum emission rate will be determined by MHI and reviewed/confirmed with Minnkota Power and Burns & McDonnell engineers. It is assumed that there will be no increase in capacity due to the installation of the absorber (CO2 control system) and as such, a PSD netting analysis will not be required.

PROJECT EXECUTION PLAN
(Continued)

Burns & McDonnell will attend a pre-application meeting at the NDDH's offices in Bismarck or via conference call to discuss the project and requirements for air permitting. This task assumes one Burns & McDonnell air permitting specialist will attend this meeting in person with the NDDH. At the meeting, the project schedule as well as any additional information pertinent to the project and air permit application will be discussed. During the discussions regarding the project, specifics regarding application requirements will be determined with input from the NDDH.

Burns & McDonnell will prepare the entire permit application with supporting emissions information and calculations along with information necessary for agency review. The report will include a project description, federal and state regulations review for the new absorber system, and emission estimates, as applicable. Burns & McDonnell will complete the NDDH construction permit application forms to be included with the permit application, as determined from discussions with the NDDH.

Burns & McDonnell will provide an electronic copy of the draft air permit application for Minnkota Power's review. Burns & McDonnell will incorporate one round of edits and comments from Minnkota Power. Up to three hard copies of the application will be prepared for agency submittal and/or Minnkota Power's records. Electronic copies of the air permit application will be provided as well.

Burns & McDonnell will provide support to agency follow-up and respond to agency comments and questions regarding the air permit application after submittal. This also includes a review of the draft permit and response to public comments, but does not include expert testimony or involvement in a contested case. This also does not include participation in a public hearing for the project.

It is assumed that air dispersion modeling will not be required by the NDDH since the project will not be subject to PSD. However, since initial modeling was performed for the project to determine appropriate stack height, parameters, and location, a model has already been set up and run for the project. In order to confirm that the site will not exceed the National Ambient Air Quality Standards (NAAQS), Burns & McDonnell will perform another set air dispersion modeling, using the final FEED parameters, emissions and layout. Burns & McDonnell will model NO2, SO2, PM10, and PM2.5 for the Unit 2 absorber stack, along with the Unit 1 stack to determine compliance. Note that no fugitive or other PM sources will be included in the model. This task assumes up to 3 iterations of the model will be run to confirm compliance with the NAAQS. The met data will be obtained from the NDDH website for the modeling. A short memo that discusses the final modeling results, along with input parameters and modeling methodologies will be prepared (updated from pre-FEED modeling memo) and submitted to Minnkota Power for their records.

If the NDDH requires the submittal of air dispersion modeling, Burns & McDonnell will draft a modeling protocol to submit to the NDDH for their review and approval. The modeling protocol describes the air dispersion model to be used and other modeling parameters, such as receptor grid and meteorological data, which may impact the air dispersion modeling results. The modeling protocol will also identify representative monitors for background values for each PSD pollutant. This protocol will be submitted to the NDDH for their approval before modeling is submitted. Additionally, an air dispersion modeling full report will be prepared that discusses the

model, modeling methodology, receptor grid, results and conclusions to be submitted with the modeling files to the NDDH for their review, as required.

NDPES Storm Water General Permit and Stormwater Pollution Prevention Plan

Because the Project would disturb one or more acres of land, a National Pollutant Discharge Elimination System (NPDES) General Permit for Storm Water Discharges from Construction Activities from the NDDH will be required prior to construction. To obtain this permit, Burns & McDonnell will prepare the Notice of Intent (NOI) and pertinent Project information and provide it to Minnkota Power for review and one round of comments. Upon receiving Minnkota Power's comments, Burns & McDonnell will finalize the submittal package and provide it to Minnkota Power for signature and submittal to the NDDH. The submittal package will include the signed NOI and the application fee. The application fee will be paid by Minnkota Power.

In addition to the application package, and as a requirement of the General Permit, Burns & McDonnell will prepare a Storm Water Pollution Prevention Plan (SWPPP). A typical SWPPP contains the Project description and location, Best Management Practices (BMPs), type and location of erosion and sediment control structures, re-vegetation requirements, and good housekeeping. It is assumed that Minnkota Power will provide any necessary information for completing the SWPPP. The SWPPP will be completed prior to submitting the NOI; however, it is not necessary to submit the SWPPP to the NDDH for review unless requested. Burns & McDonnell will provide a draft SWPPP to Minnkota Power for review and one round of comments. Upon receiving Minnkota Power's comments, Burns & McDonnell will finalize the SWPPP and provide copies of the SWPPP to Minnkota Power.

NDPES Individual Permit for Industrial Wastewater Discharges

Since the Project may discharge and/or dispose of industrial wastewater, Minnkota Power is required to modify their NPDES Permit for Industrial Wastewater Discharges through the NDDH. To modify Minnkota Power's current NPDES wastewater permit, Burns & McDonnell will prepare the modification permit application. It is assumed that the FEED study, MHI, and Minnkota Power will provide any pertinent project information needed to complete the application. Upon receiving comments on the draft application, Burns & McDonnell will finalize the submittal package and provide it to Minnkota Power for signature and submittal to the NDDH. The submittal package will include the signed application forms, topographic map, water balance, and the application fee. The application fee will be paid by Minnkota Power.

If the only discharges from the site during project operation will be storm water, the project may qualify for coverage under the NPDES Multi-Sector Industrial General Permit. This permit requires the submittal of a NOI and the application fee. The submittal package must be submitted a minimum of 30 days prior to commencing operation of the Project facility. A SWPPP must be developed and implemented prior to submitting the NOI.

PROJECT EXECUTION PLAN
(Continued)

Cost Estimating

Burns & McDonnell will prepare a FEED quality estimate using quantity take offs and budgetary pricing for the majority of the equipment and commodities. Key inputs to the estimate will be:

- P&IDs
- One-Lines
- Detailed and budgetary specifications for major equipment issued to obtain budgetary pricing.
- General Arrangement drawings
- Project Design Manual
- MTOs by discipline
- Indicative pricing from fabricators.
- Construction costs and indirect costs including engineering, construction management, home office (procurement, and project controls) will be generated from bottoms up estimates based on the scope of services. To aid in this, we will engage local subcontractors to obtain current labor rates and productivity.
- Contingency and escalation will be assigned by Burns & McDonnell depending on the quality of the takeoff information, quality of obtained quotes, and the risks associated with the project. Burns & McDonnell will consult with Minnkota Power to determine any site-specific issues and productivities.

DELIVERABLES

DELIVERABLES LIST

FEED Deliverables

Below is a comprehensive list of deliverables anticipated and planned to be prepared for the FEED phase of Project Tundra. The deliverables are for the Burns & McDonnell scope of supply as defined by the Division of Responsibility matrix between Burns & McDonnell and MHI in Appendix C.

Multi-Discipline

- Project Execution Plan
- Project Approved Vendor's List
- Project Design Manual (Basic Engineering Design Data)
- FEED Cost Estimate (including engineering, procurement, and construction)
- General Arrangement Drawing
- FEED Project Schedule
- EPC Project Schedule
- Permitting Support
- FEED Report
- Document Distribution Matrix

Mechanical/Process/Piping

- Mechanical/Process/Piping Design Basis
- Overall Process Description
- Process Flow Diagrams
- Heat and Material Balance
- Water Mass Balances
- Process Equipment Datasheets
- Instrument Valve Data Sheets (for critical valves)
- Relief Valve Summary
- Utility Summary
- Effluent Summary
- Chemicals Summary
- Piping and Instrumentation Diagrams
- HAZOP Review Participation
- Line List
- Tie-in List
- Equipment List (including capital spares)
- Equipment Criticality Review and Plan (for shop surveillance)
- Detailed Technical Specifications for the following Major Mechanical Contracts:
  - Steam Turbine Modifications
  - Circulating Water Pumps
  - Cooling Tower
  - Fin-Fan Heat Exchangers (if required)
  - Field Erected Tanks
  - Water Treatment
- Budgetary specifications as needed to obtain pricing for all other major mechanical equipment
- Equipment Model Review
- Site Plan / Tie-In Location Plan
- Modularization Concept
- Piping
  - Piping Tie-Ins (field located and photographed)
  - Laser Scan Package
  - 3D model (Navisworks)
  - Piping Materials Specifications
  - Insulation Specification
  - Painting Specification
  - Pipe Specials List
  - Preliminary stress analysis of high energy piping
  - Valve list
  - Piping, Valve, and Pipe Special MTO's to support cost estimate
- Fire Protection
  - Review existing Fire Protection System and project scope
  - Fire Protection Design Basis
  - Fire protection drawings / sketches / MTO's to support cost estimate

Civil/Geotechnical

- Civil/Geotechnical Design Basis
- Exploratory Excavation Survey Package
- Preliminary Civil 3D modeling
- Preliminary Civil drawings/sketches (grading/drainage/roadway plans)
- SWPPP Permit Support
- Civil MTO's to support cost estimate

DELIVERABLES LIST

(continued)

Structural

- Structural Design Basis
- Preliminary Structural 3D modeling of foundations/structural steel/ductwork/handrail/ grating
- Preliminary Structural drawings/ sketches
- Detailed Technical Specifications for Structural Steel, Ductwork, and Flue Gas Dampers
- Structural MTO's to support cost estimate

Architectural

- Architectural Design Basis
- Preliminary Architectural 3D modeling
- Preliminary Architectural drawings/sketches
- Budgetary Pre-Engineered Building/HVAC specification to support cost estimate

Electrical

- Electrical Design Basis
- One-line Drawings
- Electrical Load List
- Combined cable tray routing / power plans – 3D model / sketches
- Electrical Grounding Sketches
- Electrical Lighting & Panelboard Location Sketches
- ETAP Study
- Detailed Technical Specifications for Auxiliary/Station Service Transformers and Packaged Electrical Equipment
- Formal Short Circuit / Load Flow Report
- Cable Schedule

Instrument/Controls

- I&C and Control system Design Basis
- Instrument Index
- I/O List
- Work with mechanical engineering to identify instrument air requirements
- JB location sketches
- Cable Schedule input
- Instrument selection and pricing to support estimate
- DCS design to support estimate
- Control system architectural details to support estimate
- Detailed Technical Specifications for CEMS and DCS
- Budgetary specifications as needed to obtain pricing for all other major I&C equipment

SCHEDULE

SCHEDULE

A focus on an accurate schedule brings predictability and accountability to a project's estimation and execution.

Our goal is to provide Minnkota Power with an efficient FEED study focused on the project's final success. At Burns & McDonnell, we believe that solid planning on the front end provides predictable results and financial gains on the back end. Upon contract award, Burns & McDonnell will develop a schedule in Primavera format that covers the FEED effort. In order to develop this schedule, we will hold an interactive project planning meeting (IPPM) with our project team, Minnkota Power, and MHI. The purpose of the IPPM is to obtain buy-in from the team on dates and requirements to meet client and project needs.

The primary schedule drivers for the FEED schedule are finalization of the design basis (including MHI's BEDD), receipt of MHI's P&ID's and equipment data sheets, receipt of MHI piping terminal point list, receipt of MHI GA and 3D model. This information allows Burns & McDonnell to finalize the overall site GA, which allows us to proceed with the Geotechnical Investigation required to support structural design. Other key drivers include receipt of MHI MTO's, MHI auxiliary load list, MHI equipment loads, and receipt of the Siemens turbine modification study.

Subsequent to the development of the FEED schedule, Burns & McDonnell will hold an additional IPPM with the project stakeholders to develop an EPC project schedule which covers engineering, procurement, construction, and startup efforts during the Execution Phase.

A preliminary key milestone schedule for the FEED is attached for reference in Appendix D.

Figure 1: Typical IPPM Coordination

KEY PERSONNEL

PROJECT TEAM

Dedicated and experienced leadership focused on Minnkota Power success.

Burns & McDonnell is dedicated to making Project Tundra a success. Burns & McDonnell has a long track-record of executing successful projects for Minnkota Power over the last 25+ years.

We have assembled an experienced project team to support Project Tundra. Our team combines past experience on Minnkota Power projects, CO2 capture, working with MHI and familiarity with executing work in cold weather climates. Ron Bryant, Senior Project Manager, has over 33 years of experience and has worked with Minnkota Power and the Milton R. Young Station for close to 13 years.

In order to provide a predictable and efficient project execution, we have selected team members familiar with Project Carbon and Minnkota Power.

Project team member resumes are included in Appendix A.

COMMERCIAL

COMMERCIAL

COST PROPOSAL

The services will be performed on a “time and materials” basis, including reimbursement for the cost of expenses incurred. The estimated total cost for Burns & McDonnell engineering and associated expenses is $6,122,000.

Additionally, the subcontracts shown below will be included in Burns & McDonnell scope. We have provided allowances as shown below.

Cost Summary	
Burns & McDonnell	
Engineering	$6,052,000
Expenses	$70,000
Total Burns & McDonnell Engineering and Associated Expenses	$6,122,000
Subcontract Allowances	
Geotechnical Investigation	$100,000
Pilot Trenching	$200,000
Survey	$100,000
Siemens Steam Turbine Study	$750,000
Potable Water Test Wells	$65,000
Subcontract Markup (10%)	$121,500
Total Subcontract Allowances	$1,336,500
Estimated Total Cost	$7,458,500

TERMS & CONDITIONS

Burns & McDonnell proposes to perform the services described in accordance with the Professional Services Contract, dated July 26, 2005, Amendment 2, dated November 3, 2015, and the associated Schedule of Hourly Professional Service Billing Rates.

APPENDIX A – PROJECT TEAM RESUMES

RON BRYANT, PE

Project Manager

Mr. Bryant currently serves as a senior project manager with Burns & McDonnell in the Energy Division. His primary responsibilities include coordination of multiple discipline design projects for fossil fuel power plant retrofit projects. His experience includes evaluation, design, and implementation of capital projects for the electric utility industry.

EDUCATION

- BS, Mechanical Engineering

REGISTRATIONS

- Professional Engineer (MO)

27 YEARS WITH BURNS & MCDONNELL

33 YEARS OF EXPERIENCE

Hawthorn, Iatan, LaCygne, Montrose and Sibley Generating Stations | Kansas City Power & Light

Kansas City, Missouri

Project director for a multi-site CCR and ELG compliance project. Burns & McDonnell performed studies to develop options for complying with CCR regulations and potential ELG regulations. Process modifications were designed to reduce CCR contact water. Detailed design for pond closures, bottom ash stack out slabs, and scrubber waste slurry basins were designed. Engineering was performed to install under boiler drag chain conveyors to convert units from wet bottom ash removal systems to dry bottom ash removal systems. The project included developing equipment procurement specifications, installation specifications, reviewing vendor and contractor submittals, and maintaining a document control and management system. As Project Director, Mr. Bryant is responsible for the execution of the engineering activities at all five sites.

Brown 3, Trimble 1 and Gent 1-4 Generating Stations | Louisville Gas & Electric - Kentucky Utilities

Louisville, Kentucky

Project director for a multi-site pulse-jet fabric filter and coal combustion residuals transport project. Burns & McDonnell was the Owners' Engineer for the installation of six PJFFs at three sites and the installation of two CCRT systems at two sites. The project included developing equipment procurement specifications, installation specifications, reviewing vendor and contractor submittals, and maintaining a document control and management system. As Project Director, Mr. Bryant was responsible for the execution of the engineering activities at all three sites.

Muskogee Units 4 & 5 Natural Gas Retrofit | Oklahoma Gas & Electric

Muskogee, Oklahoma

Project manager and is responsible for the schedule and design necessary to convert Muskogee Units 4 and 5 from coal to natural gas. The project consists of developing technical procurement documents and detailed mechanical, electrical, controls, structural, and civil documents for converting the units to natural gas. Each unit is rated at 550 MW nominal. The boilers are Alstom tangential-fired, each capable of 3,364,546 lb/hr steam flow at 2620 psig and 1005 Fwas responsible for developing preliminary design documents necessary to determine feasibility and cost to convert Muskogee Units 4 and 5 from coal to natural gas. The project consisted of developing process flow diagrams, general arrangement drawings, electrical one line diagrams, project schedule, and detailed cost estimates for converting Units 4 and 5 from coal to natural gas. Each unit is rated at 550 MW nominal. The boilers are Alstom tangential-fired, each capable of 3,364,546 lb/hr steam flow at 2620 psig and 1005 F.

RON BRYANT, PE
(continued)

Wisdom Generating Station Unit 1 Natural Gas Retrofit | Corn Belt Power Coop
Spencer, Iowa

Project manager and was responsible for the evaluation and design to convert an existing pulverized coal fired unit to natural gas and fuel oil. The project included performing preliminary engineering, preparing general arrangement drawings, and developing costs estimates for converting the unit to natural gas and complying with NFPA 85 recommendations.

Combustion Turbine Relocation | NRG Energy
Houston, Texas

Project manager for providing Owner's Engineering services to assist NRG with relocating six combustion turbines to a new site in Galveston County, TX. Site development scope of services included detailed design of access road, laydown areas, water supply, and gas supply. A storm water pollution prevention plan and ambient noise study was also performed. Foundation structural reviews were performed to determine suitability of foundations for the new site. Burns & McDonnell also reviewed contractor submittals and performed document control.

Air Emission Compliance Evaluation | Luminant
Dallas, Texas

Project manager and was responsible for the evaluation of air emission compliance strategies for multiple coal fired plant sites in Texas. The project included selecting various air pollution control technologies, performing preliminary engineering, preparing general arrangement drawings, and developing costs estimates for each type of technology at each plant site.

Ottumwa Generating Station | Alliant Energy
Ottumwa, Iowa

Project manager for the evaluation of plant improvement projects for the 673 MW coal fired unit. The project included developing multiple options for plant heat rate, MW, and reliability improvements. Each option was evaluated on technical and economical merit. A detailed report was prepared with recommended options to implement.

Milton R Young Generating Station | Minnkota Power Cooperative
Grand Forks, North Dakota

Project manager and had overall responsibility for the engineering, design, and startup of air pollution control systems on two lignite fired cyclone units. The systems include a new wet lime FGD scrubber system on a 250 MW unit, upgrades to an existing FGD scrubber system on a 475 MW unit, a new 550' reinforced concrete chimney with FRP liner, a dry flue gas to wet flue gas chimney conversion on an existing 550' chimney, and a new redundant lime preparation system serving both units. The project is being executed using a multi-contract approach.

Milton R Young Generating Station | Minnkota Power Cooperative,
Grand Forks, North Dakota

Project manager and was responsible for the engineering, design, and startup of two over-fire air systems on a 250 MW lignite fired unit and a 475 MW lignite fired unit.

Gibbons Creek Station | Texas Municipal Power Agency
Carlos, Texas

Project manager and was responsible for the investigation of LP turbine upgrade options at the 482 MW Gibbons Creek Station Unit 1. Predicted performance and cost estimates were developed for each option. Impacts on other plant equipment

RON BRYANT, PE

(continued)

were examined. An economic analysis of each option was performed. A detailed report with recommended upgrades was prepared. Performance standards and scope of work for the design and installation of the LP turbine upgrade were developed. Bids were received and evaluated on technical and commercial merit. Technical review included evaluating design and performance expectations. The impact on other plant equipment was checked. An economic evaluation was performed to determine a net present value and payback period for each bid.

JEFF SCHWARZ, PE

Project Manager

Mr. Schwarz has served as Project Manager, Assistant Project Manager, and Engineering Manager for the technical development and execution of simple-cycle, combined-cycle, cogeneration, reciprocating engine, IGCC, and coal fired projects for Burns & McDonnell's Energy Division. His duties include project management, engineering management, and project development. Mr. Schwarz has extensive international experience having performed projects in South America, Central America, Europe, Southeast Asia, and Canada.

EDUCATION

- BS, Mechanical Engineering

REGISTRATIONS

- Professional Engineer (MO)

17 YEARS WITH BURNS & MCDONNELL

21 YEARS OF EXPERIENCE

Schofield Generating Station | Hawaiian Electric Company

Indiana

Project manager for a reciprocating engine project located in Oahu, Hawaii. Burns & McDonnell, in a Joint Venture with American Piping and Boiler is serving as the EPC Contractor for this for this reciprocating engine facility consisting of a 6 Wärtsilä 20V34DF Engines to provide electricity to the grid and Schofield Army Barracks. As Project Manager, Mr. Schwarz is responsible for oversight of engineering, procurement, project controls, and startup, as well as coordinating with our JV partner on construction issues. Mr. Schwarz is responsible for ensuring the deliverables to the Owner and JV partner are provided on-schedule and on-budget, while still meeting all of the quality and safety objectives of the project. Mr. Schwarz is the primary interface with the Owner for Burns & McDonnell.

MTV Repower Project | SABIC Innovative Plastics Mt. Vernon, LLC

Indiana

Project manager for a cogeneration project located in Indiana. Burns & McDonnell, in a Joint Venture with Industrial Contractors Skanska Inc. is serving as the EPC Contractor for this for this cogeneration facility consisting of a single GE 7EA Gas Turbine and HRSG, and two Auxiliary Boilers designed to provide process steam and power for an existing industrial facility. As Project Manager, Mr. Schwarz is responsible for oversight of engineering, procurement, project controls, and startup, as well as coordinating with our JV partner on construction issues. Mr. Schwarz is responsible for ensuring the deliverables to the Owner and JV partner are provided on-schedule and on-budget, while still meeting all of the quality and safety objectives of the project. Mr. Schwarz is the primary interface with the Owner for Burns & McDonnell.

Warren County Power Station | Dominion Virginia Power

Front Royal, Virginia

Engineering manager / project manager for the Warren County Power Station located in Front Royal, Virginia. This project received Power Engineering Magazine's award in 2015 for Gas Fired Project of the Year and Overall Project of the Year.

Burns & McDonnell, in a joint venture with Zachry Industrial Inc., is serving as the EPC Contractor for this for this 1,350 MW (nominal) 3x1 combined cycle utilizing Mitsubishi 501G gas turbines, Mitsubishi steam turbine, Alstom HRSGs, and SPX Air Cooled Condenser.

JEFF SCHWARZ, PE
(continued)

As Engineering Manager, Mr. Schwarz is responsible for ensuring all engineering disciplines are meeting the project requirements in terms of quality, schedule, and budget. Mr. Schwarz is also responsible for working with the Owner and JV construction partner to ensure satisfaction with the overall engineering design.

Mr. Schwarz later transitioned to Project Manager. As Project Manager, Mr. Schwarz is responsible for overseeing engineering, procurement, project controls, construction, and startup, as well as coordinating with our JV partner on construction issues. Mr. Schwarz is also responsible for interfacing with the Owner.

Shepard Energy Centre | ENMAX
Calgary, Alberta, Canada

Project manager for the Shepard Energy Centre located in Calgary, Alberta, Canada. Burns & McDonnell is serving as the Owner's Engineer for this 800 MW (nominal) 2x1 combined cycle utilizing Mitsubishi 501G gas turbines, Mitsubishi steam turbine and Vogt HRSGs. As Project Manager, Mr. Schwarz was responsible for development of the EPC RFP, evaluation of the EPC Contractors' bids, and development/negotiation of the EPC contract with the selected EPC Contractor. During execution of the EPC contract, Mr. Schwarz was been responsible for ensuring the EPC Contractor is complying with the EPC contract. Additionally, Mr. Schwarz remained in constant contact with the Owner's team, the OE team, and EPC Contractor to ensure the goals of the project are being met.

Halton Hills Generating Station | TransCanada
Toronto, Canada

Assistant project manager for the Halton Hills Generating Station located near Toronto Canada. Burns & McDonnell, in a joint venture with Aker Kvaerner Songer, was the EPC Contractor for this 700 MW (nominal) 2x1 combined cycle utilizing Siemens gas turbines, Alstom STG, Alstom HRSGs, and a SPX air cooled condenser. As Assistant Project Manager, Mr. Schwarz was responsible for establishing project strategy, contract negotiations, and oversight of engineering, procurement, schedule/cost control, and construction. Mr. Schwarz was also responsible for oversight of Hatch Energy, who performed the electrical and structural engineering on a subcontract basis.

Termocerromatoso Autogeneration Project | BHP Billiton
Puerto Libertador, Colombia

Project manager for Burns & McDonnell in the development of a 200 MW coal fired unit located near Puerto Libertador, Colombia. As Project Manager for Burns & McDonnell, Mr. Schwarz was responsible for management of the development process, including capital cost, operating costs, and performance estimates. Mr. Schwarz was also responsible for establishing alternative contracting strategies that could be employed by the Owner during the project execution stage.

IGCC Evaluation | Electric Power Research Institute (EPRI)
Texas

EPRI, in conjunction with CPS Energy, hired Burns & McDonnell to evaluate the feasibility of installing an IGCC project in Texas, firing PRB fuel. Mr. Schwarz served as Project Manager for this effort and was responsible for evaluating capital cost, performance, O&M for IGCC technology in addition to PC technology. The results of this study were published by EPRI (EPRI Document # 1014510 entitled "Feasibility Study for an Integrated Gasification Combined Cycle at a Texas Site").

JEFF SCHWARZ, PE
(continued)

Wisconsin Public Service
Mr. Schwarz was responsible for providing a technology assessment evaluating 32 technologies including coal, natural gas, nuclear, and renewable energy. The technology assessment included a general discussion of each technology, capital cost, performance, emissions, O&M. Following this study, the selected technologies were evaluated further for multiple sites.

Cleco Corporation
Cleco Corporation was interested in evaluating the repower of two existing gas-fired boilers with coal-fired CFB boilers. Cleco hired Burns & McDonnell to develop capital costs, O&M costs, and performance estimates for two existing units. The new equipment for each site consisted of two CFB boilers, polishing scrubbers, baghouses, material handling, and other BOP equipment.

Additionally, a new 2x1 IGCC facility was evaluated for the Rodemacher site.

Confidential Client
Development engineer for evaluation of four repowering alternatives for 3x175kpph coal fired boilers and two steam turbines. These alternatives included upgrading existing boilers with additional air pollution control equipment, replacement of existing boilers with natural gas package boilers, replacement of boilers and steam turbine with gas turbine/HRSG, and conversion of existing coal fired boilers to hybrid gas/coal burners. Analyses included O&M cost, capital cost, fuel cost, electrical cost; all of which were used as inputs to pro forma evaluations of each alternative to determine the most viable option for the Owner.

El Paso Electric
Development engineer for evaluation of simple cycle and combined cycle power projects utilizing 7FA gas turbines. Mr. Schwarz performed several economic evaluations to help further define the optimal equipment selection for this project. These evaluations included duct firing vs. non-duct firing, wet vs. dry cooling and an inlet air cooling study that evaluated evaporative cooling, fogging, and chilling utilizing thermal storage (off-peak chilling). In addition, Mr. Schwarz provided capital cost estimates for many construction approaches, including simple cycle, combined cycle, and phased construction of simple cycle to combined cycle.

Colorado Springs Utilities
Development engineer for evaluation of 21 different electrical generation options for an Electric Resource Supply Cost Study. These generation options ranged from 500 kW fuel cells to 500 MW coal fired generating station. Each generation option was evaluated on performance, capital cost, O&M, emissions, and availability estimates. Mr. Schwarz also provided very comprehensive site-specific estimates for a 250 MW and 500 MW PC Unit to be located at the Nixon site. Additionally, Mr. Schwarz was involved in development of a 150 MW CFB Project utilizing an advanced CFB boiler design from Foster Wheeler. Mr. Schwarz supplied CSU with a site-specific capital cost estimate, O&M estimate, heat balance, site layout, and project schedule to aid CSU in obtaining a grant from the Department of Energy for the Clean Coal Power Initiative.

Bonnet Carre Project | Sempra Energy Resources
New Orleans, Louisiana

Development engineer for two blocks of 2x1 7FA Combined Cycle to be located in New Orleans, Louisiana. This effort included providing performance estimates for the project, as well as performing a heat rejection optimization that determined the optimum condenser and cooling tower sizing to maximize performance and minimize capital cost.

JEFF SCHWARZ, PE
(continued)

Power Iowa Initiative | Alliant Energy
Mason City, Iowa

Development engineer for 2x1 7FA duct fired combined cycle in Iowa including conceptual design, performance estimates, emissions estimates and capital cost estimate

Batesville Project | LS Power
Lead performance test engineer for three (3) 1x1 501 F Combined Cycle Units. Included development of performance test procedure, direction of Unit Performance Tests, and generation of performance test report. Performance testing was in general accordance with PTC 46.

Gateway Project | Tenaska
Lead performance test engineer for 3x1 GE 7FA Combined Cycle Unit. Included development of performance test procedure, direction of Unit Performance Tests, and generation of performance test report in general accordance with PTC 46.

City Public Service
San Antonio, Texas

Performance test engineer for 2x1 GE 7FA Combined Cycle Unit located in San Antonio, Texas. Included development of performance test procedure, performance testing, and generation of performance test report. Performance test was in general accordance with PTC 46.

Ft. Myers Project | Florida Power & Light
Ft. Myers, Florida

Lead performance engineer for repowering of two existing steam turbines with six (6) GE 7FA gas turbines and (6) Foster Wheeler HRSGs. Mr. Schwarz was responsible for development of detailed heat balances and sizing of major equipment.

Map Ta Phut | Cogeneration Company (COCO)
Rayong, Thailand

Performance test engineer for 2 x 225 MW CFB Hybrid Unit in Rayong, Thailand. This Plant consisted of two blocks, each comprised of two (2) GE 6B gas turbines, two (2) Foster Wheeler Heat Recovery Units (HRU), and one (1) 950,000 lb/hr Foster Wheeler CFB boiler. The gas turbines/HRUs were used as economizers and reheat section for the CFB boiler. Mr. Schwarz was involved with performance test procedure development, performance testing, and report generation.

Performance Testing (General)
In addition to the other projects shown, Mr. Schwarz has also been involved in performance testing on a 2x1 7FA combined cycle, 2x1 501F combined cycle, 3x1 7FA combined cycle, 8xLM6000 simple cycle, 2x6FA simple cycle, 1 x 1 V94.2 combined cycle, and 120 MW PC Unit.

STEVE ROTTINGHAUS, PE

Project Manager

Mr. Rottinghaus directs the mechanical and process design execution of energy projects in Burns & McDonnell's Energy Division. Prior to this position, Mr. Rottinghaus served as the Development Manager, where he specialized in the preliminary design, feasibility, economic analysis and optimization of conventional and First-of-a-Kind power projects. Steve is a specialist in thermal design and performance optimization, serving as performance manager on several power projects.

EDUCATION

- BS, Mechanical Engineering

REGISTRATIONS

- Professional Engineer (MO)

26 YEARS WITH BURNS & MCDONNELL

26 YEARS OF EXPERIENCE

Coal to Hydrogen Conversion, First-Of-A-Kind Technology Development, Nebraska Public Power District

Lincoln, Nebraska | 2015-2017

Project consultant to evaluate multiple options for producing electricity from a byproduct gas with high hydrogen content (> 95%) from an adjacent manufacturing facility. As part of the evaluation, Burns & McDonnell compared technical features and limitations, capital costs, performances, and emissions for each option. The evaluated options included hydrogen gas fired boiler(s), simple cycle gas turbines combusting the hydrogen, and combined cycle configurations combusting the hydrogen in both the gas turbines and duct burners. Study progressed into FEL-2 concept design and cost estimating. Provided technical direction on the conceptual design as well as performance and cost optimization.

Innovative Coal / Biomass Based Coproduction Combined Heat and Power Facility | University of North Dakota

Grand Forks, North Dakota | 2010

Project manager on a feasibility study evaluating installation of a cogeneration facility involving a lignite fired pulverized coal boiler, a biomass fired circulating fluidized bed boiler, a multiple hearth furnace producing activated carbon, and a backpressure steam turbine for power generation. Study involved screening various technologies for the optimal configuration to achieve the project goals and a feasibility evaluation of the selected configuration.

Blast Furnace Gas Cogen First-of-a-Kind FEED study | Confidential

2010

Project manager on a Front End Engineering Design project for a cogeneration plant that utilized blast furnace gas as a fuel to a combined cycle facility. Facility included blast furnace gas clean-up and compression equipment, GE 7EA gas turbine, and a condensing extraction steam turbine. Managed process concept development, optimization, scope development, and definitive estimate development (FEL-3 activities).

2x2x1 “F” Class Integrated Gasification Combined Cycle | Tenaska Taylorville

Illinois | 2009

Supervised the development of conceptual design of the heat balances and performance estimates for the facility. Role included solicitation of budgetary equipment bids that were ultimately converted to firm equipment bids and supported the technical evaluation of those bids.

STEVE ROTTINGHAUS, PE
(continued)

Various Post Combustion CO_2 Capture Facility Studies | Multiple clients
2009-2010

Supervised the technical development of feasibility grade economic information for integration of a full commercial scale post combustion CO2 capture facilities onto a new proposed coal plant facilities for multiple clients developing coal plant projects. Scope included technology evaluation, conceptual design, design optimization, development of water balances, evaluation of steam sources, evaluation of net generation impact to the facility, and development of capital costs estimates. On one project, involvement evolved into an Owner's Engineering role through the bid, evaluation, and selection of a technology supplier for the CO2 capture system and integration of the system into the facility.

500 MW Lignite Fired Coal Plant Post Combustion CO_2 Capture Retrofit | PowerSpan
North Dakota | 2009

Supervised the development of feasibility grade economic information for integration of a full commercial scale post combustion CO2 capture facility onto an existing lignite fired plant at the Antelope Valley Station near Beulah, ND. Scope included conceptual design, development of water balances, evaluation of steam sources, evaluation of net generation impact to the facility, and development of capital costs estimates.

700 MW Pulverized Coal Unit | Basin Electric Cooperative
South Dakota | 2007

Supervised technical and economic development of a Greenfield coal plant in South Dakota. Project included evaluation of various coal conversion technologies and pollution control options for a new unit burning PRB coal with consideration for future CO_2 controls. Additional studies included evaluation of steam conditions, feedwater heaters, boiler feed pump drives, coal handling and other plant configuration options. Project included development of a Project Definition Report including control scope, budget, O&M, and schedule.

500 MW Lignite Unit
North Dakota | 2006

Project engineer for economic and technical evaluation of coal conversion technologies and pollution control options for burning North Dakota Lignite. Studies included evaluation of emerging technologies and timelines for implementation of such technologies. Evaluations included a sensitivity of impacts and evaluation of various CO_2 capture technologies.

Power Iowa Energy Center | Alliant Energy

Performance engineer for the 560 MW Power Iowa Energy Center. Responsibilities included development and optimization of plant performance and coordination with key performance equipment vendors. Facility includes General Electric (GE) Frame 7FA gas turbines, a GE D11 Steam, and Alstom heat recovery steam generators (HRSGs). Facility includes a moderate amount of duct firing up to the limits the GE standard structured steam turbine (roughly 240 MW).

Various Clients

Project manager, project engineer, or ***performance engineer*** for conceptual design and feasibility for multiple simple and combined-cycle projects utilizing Pratt & Whitney FT8 and FT8 Twin Pac machines; GE LM2500, LM6000, 6B, 6FA, 7B, 7EA, and 7FA machines; Siemens Westinghouse B11, V64.3, V84.2, 501D5A, and 501F machines; Alstom GTX100, 11N2, and GT24 machines and several other manufacturer's equipment. Equipment arrangements included single to multiple unit simple cycle plants and 1x1, 2x1, and 3x1 combined-cycle configurations.

STEPHANIE VILLARREAL, PE

Sr. Mechanical Engineer

Mrs. Villarreal is a Sr. Mechanical Engineer and Project Manager in the project development department. Her career with Burns & McDonnell began as a mechanical engineer executing detail design of mechanical system, performing contract engineer activities including writing technical specifications and reviewing submittals, and development of construction contracts. She has over two years of field experience as an onsite lead engineer, with her experience including the installation and construction turn-over of the first 3x1 CCGT 'G" class facility in the US, with a project value of over $1 billion. Since returning to the office, Mrs. Villarreal has worked within the project development department to provide clients with the following services:

EDUCATION

- BS, Mechanical Engineering

REGISTRATIONS

- Professional Engineer (KS)

9 YEARS OF EXPERIENCE

9 YEARS WITH BURNS & MCDONNELL

- Project Management
- Project Development Consulting, including but not limited to;
    - Contracting strategy development, generation technology assessment, development of major OEM equipment specifications and construction contracts, development of EPC specifications and EPC bid evaluations, and permitting support.
- Project execution and technology assessment
- Cost estimate development for project budget approval
- Risk Assessment
- Proposal Management

Her experience has included performing these services on wide array of facilities, including combined cycle generation facilities, simple cycle generation facilities, CCR/ELG water treatment plant at an existing coal generation facility, and a ZLD water treatment plant at an existing CCGT facility.

Sundance 7 | TransAlta Corporation

Edmonton, Alberta, Canada

Project engineer and assistant project manager for developing Power Island and EPC specifications for a 2x1 Combined Cycle Plant with a gross generation capacity of 856 (MW). The role included providing full Owner's Engineer services to develop technical specifications, support permitting application, technical and commercial proposal evaluations, and providing cost evaluation studies for equipment selection.

Beech Hollow | Burns & McDonnell/Robinson Power Developers

Robinson Township, Pennsylvania

Project engineer for the development of a new 1,000 MW combined cycle generation facility in Robinson Township, Pennsylvania. BMcD, in a partnership with Robinson Power, is developing the CCGT project for future sale of the generating asset to a power investor. Mrs. Villarreal has support the overall project development including permitting review and support, major equipment specification development, EPC contract development for execution by BMcD, and support of cost estimating activities.

STEPHANIE VILLARREAL, PE
(continued)

Warren County Energy Center | Dominion Virginia Power
Front Royal, Virginia

Lead mechanical field engineer and system design engineer for the 3x1, 1,329 MW Combined Cycle Plant in Front Royal, VA. Field engineering role included managing procurement scope, supervising installation mechanical equipment, construction planning, engineering modifications, preventative maintenance during installation, and start-up of mechanical systems. Design engineering role included utility system design, major equipment procurement contract engineer, management of fire protection design and hazard analysis report.

Lake Charles Power Station and Montgomery County Power Station | Entergy
Lake Charles, Louisiana and Willis, Texas

Independent engineer and project manager providing third party review of Entergy's self-build proposal for new 2x1 combined cycle generation facilities located in Louisiana and Texas. With her experience, she led the self-build reviews including an analysis of the proposed equipment scope, quantity of bulk materials, hours for engineering, schedule, permitting, construction management, and start-up. As a part of the self-build review, her involvement included a detailed review of the projects risk assessment, including evaluating the bidders identified risks and level of owner's contingency carried on the project.

Ghent, Trimble County, and Mill Creek Generation Facilities | LG&E / KU
Multiple Locations, Kentucky

Proposal manager for an EPC lump sum, turn-key contract for designing, procuring, and construction of water treatment facilities at LG&E/KU's existing coal combustion facilities, to comply with expected CCR/ELG regulations. Mrs. Villarreal led a team to perform preliminary design, negotiate major equipment contracts and performance guarantees, develop a project execution strategy, negotiate EPC contract technical and commercial terms, and develop/submit final contract pricing for the execution of these facilities at three separate facilities. All projects were to be executed at three separate facilities with simultaneous project schedules, while allowing for continued operation of the generation systems.

Rock Springs Generation Facility | Old Dominion Electric Company (ODEC)
Rock Springs, Maryland

Development engineer and project manager for performing a fuel oil feasibility study and has carried to the project to perform a project definition report to define a project budget for ODEC, to convert two (2) GE F-class turbines from gas fired, to duel fuel fired combustion turbines. The scope of work has included scope development, cost estimating, technology assessment, preliminary design and general arrangement development and permitting assessment, as well as evaluating hot SCR retrofit design and cost on a simple cycle frame machine.

High Desert Power Project | Tenaska
Victorville, California

Served as ***project engineer and assistant project manager*** providing technical support and cost evaluations to amend the plant's existing permit to utilize state allocated water resources to secure a consistent water supply. Also, evaluated the facilities cooling tower blowdown Zero-Liquid Discharge (ZLD) water treatment process to improve treatment capabilities and increase capacity needed for plant to accept reclaim water (treated sanitary water effluent) from nearby resources.

STEPHANIE VILLARREAL, PE
(continued)

Chinook Generating Station | SaskPower
Swift Current, Saskatchewan, Canada
Project engineer developing owner self-build estimate for a 1 x 1 combined cycle generating plant near Swift Current, Saskatchewan. Roles included developing major equipment bid packages, bid evaluations, and economic evaluations for technology selection.

Amite South | Entergy
St. Charles Parish, Louisiana
Mrs. Villarreal served as an ***independent engineer*** providing third party review of Entergy's self-build proposal for a new 2x1 combined cycle generation facility. She was involved in the scope of the review, including an analysis of the proposed equipment scope, quantity of bulk materials, hours for engineering, construction management, and start-up.

Naughton Generating Station | PacifiCorp Energy
Kemmerer, Wyoming
Mechanical engineer for proposal development of the Naughton Generating Station Air Pollution Control and Wet Flue Gas Desulfurization System upgrade. Responsible for developing technical specifications for miscellaneous slurry pumps, shop fabricated tanks, fire protection system design and compressed air system design for all upgrades. System design responsibilities included piping and instrumentation design for the facility's utility systems.

IGCC Grey Water Treatment Center | Duke Energy
Edwardsport, Indiana
Mechanical engineer assisting in designing a first-of-a-kind water treatment system for grey water slurry from a wet-coal gasification center. Administered various mechanical contracts, designed a slurry feed and circulation system, including control valve and pump design. Also, performed piping stress analysis of a steam jacketed molten sulfur transport system. At the conclusion of detailed design, transferred to the site and performed as a field mechanical engineer during the completion of the project, supervising construction turn-over to Owner start-up personnel.

Moselle Repower | Southern Mississippi Electric Power Association (SMEPA)
Moselle, Mississippi
Lead mechanical engineer managing system design, procurement submittals, and final contract close-out of a project to add 150 MW of new generation capacity to the existing plant with two GE Frame 7EA combustion turbines connected to heat recovery units.

Oak Grove Power Plant | Luminant Energy
Franklin, Texas
Mechanical design engineer, evaluating steam turbine lube oil supply system. The evaluation included a full system hydraulic analysis of the oil supply to ensure adequate flow to all turbine bearings, and confirmed flow velocities for the system flushing during a plant outage.

KATIE BLAND, PE

Project Manager

Katie Bland works primarily on environmental engineering projects within the industrial and power industries. Her experience in the power generation sector includes air quality projects entailing design and construction phases of flue gas desulfurization (FGD) retrofit work, completing feasibility assessments and cost estimates for air pollution control technologies for the control of SO_2, NO_x, particulate, and mercury emissions. She has been involved in multi-pollutant control studies to evaluate potential future regulatory scenarios, and the costs and feasibility of compliance with these scenarios. Katie has worked on all aspects of these projects, from initial proposal phase and cost estimates, through design and construction phases. Recently, Katie's power sector engineering expertise has enabled her to serve and transition into a leadership role in a wide variety of environmental engineering projects, from water treatment to solid waste projects. Most recently she has led the Environmental group's efforts in coal combustion residual (CCR) research and marketing. She actively follows utility regulatory actions and has provided comments to the United States Environmental Protection Agency on a client's behalf to address major new environmental regulations in the power generation sector. Katie is a registered Professional Engineer in the states of Missouri, Iowa, and South Carolina.

SPECIALTIES

- Industrial Water Treatment
- Constructed Wetland Treatment Systems
- Coal Combustion Residual Impoundments/Landfills
- Environmental Regulations
- Solid Waste
- Air Pollution Control Technology

EDUCATION

- BS, Civil Engineering
- MS, Environmental Engineering

REGISTRATIONS

- Professional Engineer (MO, IA, SC)

12 YEARS WITH BURNS & MCDONNELL

12 YEARS OF EXPERIENCE

PROJECT MANAGEMENT EXPERIENCE

Water Balance Study Plans | Alliant Energy

Wisconsin | 2018

Katie is currently managing a water balance revision for Alliant's Edgewater Station near Sheboygan, Wisconsin. The scope of this project includes flow monitoring, sampling, and revision of the plant water balance. It also includes an update to the utility's Request for Variance with the state regulatory agency on the arsenic concentration in the plant's discharge stream.

CCR Groundwater Monitoring Field Investigation and Sampling Plan | Western Farmers Electric Cooperative

Oklahoma | 2015-Present

Katie is currently managing groundwater monitoring work for Western Farmers Electric Cooperative's Hugo plant in the state of Oklahoma. The scope of this project included review of the site's existing groundwater monitoring networks, the placement of additional wells for CCR compliance, and extensive field work to install the wells and determine the location of the site's uppermost aquifer. Katie has acted as Project Manager for this work and for the development of the site's Sampling and Analysis Plan (SAP) for CCR groundwater monitoring.

CCR Groundwater Monitoring Program Management | MidAmerican Energy Company

Iowa | 2015-2016

Katie is currently managing the groundwater monitoring program as required by the CCR rule for four MidAmerican plants in the state of Iowa. The scope of this project includes review of the company's current groundwater monitoring networks,

KATIE BLAND, PE

(continued)

gap analysis of current networks and CCR rule requirements, and identifying locations of additional wells as needed. Katie managed bid package development for drillers and is currently managing the development of work plans and sampling and analysis plans for each of the four sites. The sites include work with both CCR landfills and impoundments.

PROJECT EXPERIENCE

Project Carbon at Milton R. Young Station | North Dakota EERC

North Dakota | 2018

Katie is working on Project Carbon for the North Dakota EERC as a Project Engineer. This project is a collaborative study of carbon capture feasibility at the Milton R. Young Station near Center, North Dakota. The study is a collaboration amongst the EERC, Burns & McDonnell, Allete, Minnkota Power, and Mitsubishi Heavy Industries. Burns & McDonnell's scope includes evaluation of plant impacts, and balance of plant design and cost estimates.

CCR Closure and Post-Closure Plans | East Kentucky Power Cooperative

Kentucky | 2016

Katie developed CCR Closure Plans and CCR Post-Closure Plans for three East Kentucky Power Cooperative sites. These plans were developed in accordance with the requirements of the final CCR Rule for closure and post-closure design and maintenance of CCR landfills and impoundments.

CCR Fugitive Dust Control Plans | MidAmerican Energy Company

Iowa | 2015

Katie has completed CCR Fugitive Dust Control Plans for four MidAmerican plants in the state of Iowa. Katie evaluated conditions for CCR disposal at each site, participating in detailed site walkdowns of all CCR handling activities. She then prepared dust control plans describing CCR handling and disposal at each site, and describing the way in which the client shall mitigate fugitive dust for these processes. The plans include all information required by the CCR rule.

CCR Fugitive Dust Control Plans | Kansas City Power & Light

Missouri & Kansas | 2015

Katie worked on CCR Fugitive Dust Control Plans for four Kansas City Power & Light plants in the states of Kansas and Missouri. Katie evaluated conditions for CCR disposal at each site, participating in detailed site walkdowns of all CCR handling activities. She prepared dust control plans describing CCR handling and disposal at each site and described the way in which the client shall mitigate fugitive dust for these processes. The client is currently evaluating some additional dust control technologies that are not yet common in the utility industry.

CCR Groundwater Monitoring Consulting | CLECO

Louisiana | 2015

Katie managed groundwater monitoring tasks as required by the CCR rule for two CLECO plants in the state of Louisiana. The scope of this project included review of the company's current groundwater monitoring networks, gap analysis of current networks and CCR rule requirements, and identifying locations of additional wells as needed. The sites included work with both CCR landfills and impoundments.

KATIE BLAND, PE

(continued)

CCR Fugitive Dust Control Plans | CLECO

Louisiana | 2015

Katie completed CCR Fugitive Dust Control Plans for two CLECO plants in the state of Louisiana. Katie evaluated conditions for CCR disposal at each site, participating in detailed site walkdowns of all CCR handling activities. She prepared dust control plans describing CCR handling and disposal at each site and described the way in which the client shall mitigate fugitive dust for these processes.

CCR Fugitive Dust Control Plans | Western Farmers Electric Cooperative

Oklahoma | 2015

Katie completed a CCR Fugitive Dust Control Plan for one Western Farmers Electric Cooperative plant in the state of Oklahoma. Katie evaluated conditions for CCR disposal at the site, participating in a detailed site walkdown of all CCR handling activities. She prepared a dust control plan describing CCR handling and disposal at the site and describing the way in which the client shall mitigate fugitive dust for these processes.

ENVIRONMENTAL ENGINEERING EXPERIENCE

Constructed Wetland Treatment System, Jeffrey Energy Center | Westar Energy, Inc.

St. Marys, Kansas | 2012-2014

Katie acted as ***assistant project manager*** on the full-scale design and construction phases of a constructed wetland treatment system (CWTS) at the Jeffrey Energy Center. The system was designed following conclusion of a wetland pilot project. Katie has worked on several phases of the project including the design estimate and proposal, the project design, the construction estimate and proposal, contract administration, and technical review and approval of contractor submittals. During the design phase of the project, Katie researched water use at the plant and updated the plant water balance. In addition to these updates, Katie performed water quality modeling to determine the plant's level of compliance with surface water quality standards.

Effluent Guidelines Regulatory Review and Preparation of Client Comments, Jeffrey Energy Center | Westar Energy, Inc.

St. Marys, Kansas | 2013

Katie served as ***project manager*** for the preparation of comments, on behalf of the client, to the Environmental Protection Agency's Proposed Effluent Guidelines for the Steam Electric Generating Category. Katie prepared the project proposal and cost estimate. Katie also led the project research by coordinating a visit to the regional EPA office and conducting meetings with industry experts. Katie then collaborated with the client to provide a thorough compilation of constructed wetland treatment system pilot project data and analysis of the data. This data and accompanying analysis were sent to the EPA for the purpose of influencing the agency's decision on the final regulation.

Landfill Gas to Energy Plant, Carbon Credit Registry | Kansas City Power & Light

St. Joseph, Missouri | 2012-2013

Katie served as ***project manager*** for evaluation of the plant's potential to register with a carbon credit market. Burns & McDonnell prepared initial documentation for registry of the project and continued in a consulting role during the legal registration process.

KATIE BLAND, PE

(continued)

Constructed Wetland Treatment System Pilot Project, Jeffrey Energy Center | Westar Energy, Inc.

St. Marys, Kansas | 2011-2012

Katie was a ***project engineer*** on the Jeffrey Energy Center constructed wetland treatment system (CWTS) pilot project. The pilot was designed to treat a portion of the effluent from the existing FGD scrubber blowdown treatment building. Constituents of concern included selenium, mercury, fluoride, and boron. The pilot was constructed to evaluate multiple wetland technologies. Burns & McDonnell and Westar collaborated with a local university for assistance with research and laboratory testing during the 2-year operational period. Katie also managed the compilation of a detailed Antidegradation report for the Kansas Department of Health and the Environment and for public stakeholders.

Landfill Monitoring, Jeffrey Energy Center | Westar Energy, Inc.

St. Marys, Kansas | 2011-2012

Katie served as the ***construction quality assurance monitor*** for landfill construction activities at the Jeffrey Energy Center. Landfills monitored at this site included a gypsum landfill, bottom ash landfill, and fly ash landfill. Katie conducted quarterly on-site investigations and prepared reports for the client's submittal to the Kansas Department of Health and the Environment.

Merom Station Upgrades | Hoosier Energy

Merom, Indiana | 2011

Katie was the lead process engineer on an air pollution control retrofit project at the Merom Station. Burns & McDonnell acted as the owner's engineering on this project. The scope of the contract included review of the contractor's proposal and design for the upgrade of the Merom Station's flue gas desulfurization (FGD) systems.

Milton R. Young Station Upgrades | Minnkota Power Cooperative, Inc.

Center, North Dakota | 2007-2011

Katie was the lead process engineer for an air pollution control retrofit project at the Milton R. Young Station. The scope of the contract included the retrofit of a wet lime FGD system for Unit 1 and the addition of a new lime preparation system that will service both Unit 1 and Unit 2. Katie acted as the contract engineer, working with Marsulex Environmental Technologies, who will design, furnish, and erect both the FGD and lime preparation systems. Responsibilities included preparation of a design manual for the project, preparation of technical specifications and bid documents for the FGD system and lime preparation system, technical evaluation of bids, administration of the system contract, and technical review and approval of Contractor submittals.

Iatan Unit 2 | Kansas City Power & Light

Westin, Missouri | 2007-2008

Katie acted as the contract engineer for the demineralization system installed with Unit 2 at the Iatan Generating Station. The scope of the contract included the installation of a multimedia filer, reverse osmosis, and ion exchange systems. Responsibilities included the technical evaluation of bids, administration of the system contract, and technical review and approval of Contractor submittals.

Rollin M. Schahfer Generating Station | Northern Indiana Public Service Company

Wheatfield, Indiana | 2007

Katie assisted in the preparation of a study evaluating possible sources for FGD solids carryover, and potential solutions minimizing solids carryover from the FGD system to the settling pond. Study involved an assessment of the current FGD

KATIE BLAND, PE

(continued)

system operating conditions, collection of FGD process samples for analysis, evaluation of potential solutions to minimize solids carryover from the FGD system into the settling pond, and development of a plan to minimize solids carryover from the FGD system into the settling pond.

IGCC Feasibility Study | Confidential Client

2007

This project involved the evaluation of wet vs. dry cooling for a proposed IGCC facility. Katie obtained vendor quotes from various suppliers of water-cooled condensers, air-cooled condensers, and cooling towers to perform a cost evaluation for wet vs. dry cooling. Katie evaluated water balance and reported the differences in equipment required for water treatment for both cases. She also evaluated effects of dry cooling on net power output.

Jeffrey Energy Center | Westar Energy, Inc.

St. Mary's, Kansas | 2006-2007

The project involved the rebuild of existing scrubbers onsite for compliance with SO2 emissions requirements. Katie developed plant process flow diagrams as part of a scrubber upgrade project. She assisted in evaluating effects on plant water balance after scrubbers were operational again and estimated chemical makeup of future scrubber blowdown for water treatment evaluation. Katie researched other plants burning PRB coal with similar operating conditions as a way of predicting FGD operating parameters at the Jeffrey Energy Center (JEC). Katie went to a site with similar conditions and took process samples for analysis.

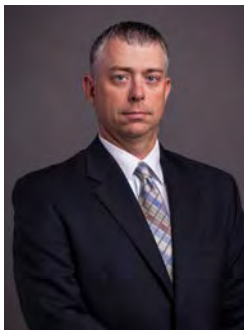
APC Feasibility Studies | Minnesota Power

2006

Katie assisted in developing feasibility studies and reports on implementing control technologies for SO2, NOx, and mercury emissions control at Minnesota Power's Laskin, Taconite Harbor, and Boswell Stations. Additionally, she researched EPA requirements for opacity monitoring, and developed a report for the client detailing requirements of implementing opacity monitoring at the plant. Katie also assisted in developing cost estimates for various types of emissions control equipment including wet and dry scrubbers for SO_2 control, and SCR and SNCR for NOx control.

SHANE GARDEN, PE

Associate Structural Engineer



As an Associate Structural Engineer in Burns & McDonnell's Energy Division, Mr. Garden is responsible for leading the effort of all structural and architectural scope of the project. This includes basic design and estimates, C/S/A design criteria, structural and miscellaneous steel design, concrete and foundation design, specifications, quality control, project staffing and coordination with the other discipline engineers, detailers and Project Manager assigned to the project.

EDUCATION

- BS, Civil Engineering

REGISTRATIONS

- Professional Engineer (AL, IA, MO, NY, ND, UT)
- Envision Sustainability Professional

19 YEARS WITH BURNS & MCDONNELL

19 YEARS OF EXPERIENCE

Valley Energy Center | CPV Valley, LLC

Orange County, New York | 2015-Present

Project lead structural engineer for an Engineer-Procure-Construct project consisting of 2x1 combined cycle facility for CPV Valley, LLC. As Project Lead Structural Engineer, duties included the supervision of design engineers and CADD technicians for the design and detailing of all foundations and structural steel design for the utility rack and various superstructures. Mr. Garden's duties also included reviewing geotechnical subgrade reports, writing specifications, evaluating bids, working with detailers/designers putting construction documents together, coordinating multi-discipline project meetings, reviewing submittals and shop drawings for equipment, foundation reinforcing, structural steel, concrete and grout results, and miscellaneous products. In addition, Shane worked directly with construction site to answer questions and look into construction challenges as they occur.

Madison Unit 3 ACI Project | Brame Energy Center, CLECO

Lena, Louisiana | 2013-2015

Engineering manager and lead structural engineer for an Activated Carbon Injection (ACI) System project for CLECO. His duties include coordinating with the client, writing specifications, evaluating bids, assisting the client with contract negotiations, performing foundation design for the new ACI silo and additional electrical equipment, coordinating with other discipline engineers, detailers and Project Managers, reviewing submittals, and coordinating project staffing.

EPC Project Development

2010-2015

Lead structural engineer assisting with developing EPC projects for major AQCS upgrades and combined/simple cycle combustion turbine projects. His duties include reviewing the clients RFP, writing specifications, writing project definition reports and project design manuals, evaluating budgetary pricing bids, overseeing a team of engineers performing preliminary design, performing preliminary design, and coordinating with other discipline engineers, estimators, and joint venture partners.

Monticello Power Plant | Luminant Energy

Monticello, Texas | 2012

Project lead structural engineer for a ductwork repair/replacement and flue gas reheat project. His duties included field assessments of existing ductwork and structural steel, managing a design team of structural engineers for the design of ductwork and structural steel modifications, and creating construction drawings and specifications. The project also included

the addition of a Dibasic Acid (DBA) Injection System, in which, Mr. Garden was responsible for overseeing the design of a new foundation and unloading/containment area.

Calaveras Power Station | CPS Energy
San Antonio, Texas | 2010-2012

Project lead structural engineer for a steel corrosion study of the coal yard coal handling systems for CPS Energy. His duties included field assessments of existing coal handling structures, taking photos as they related to areas needing repair, writing a report of findings, designing repairs, performing repair cost estimates, creating construction drawings and specifications, and assisting the owner evaluate construction bid packages.

Milton R. Young AQCS Upgrades | Minnkota Power Cooperative
Center, North Dakota | 2008-2010

Project lead structural engineer for the addition of a new Flue Gas Desulfurization System project for Minnkota Power Cooperative, Inc. His duties included writing specifications, evaluating bids, overseeing a team for foundation design and steel design of the new FGD equipment building and Selective Non-Catalytic Reduction (SNCR) building, coordinating with other discipline engineers, detailers and Project Managers, reviewing submittals, and coordinating project staffing.

Iatan Unit 2 | Kansas City Power & Light
Weston, Missouri | 2006-2008

Project co-lead structural engineer for the addition of a new 850 MW (nominal) coal-fired power plant project for Kansas City Power & Light. As Co-Project Lead Structural Engineer, duties included the supervision of design engineers and CADD technicians for the design and detailing of the new turbine building and miscellaneous above grade structures, developing specifications and evaluating bids for various contracts, coordinating with the Client on project needs and some detailed design work. Additional duties include: coordinating with other discipline engineers, detailers, and Project Manager, reviewing submittals, and coordinating project staffing.

La Cygne Station Unit 1 | Kansas City Power & Light
La Cygne, Kansas | 2005-2006

Project lead structural engineer in an Owner's Engineer role on a SCR addition project for Kansas City Power & Light. As Lead Structural Engineer, his duties included, writing specifications, developing conceptual arrangement drawings for the complete SCR System, designing economizer wall modifications at the SCR tie-in locations, and evaluating proposals. During the SCR design and construction phases, Mr. Garden reviewed submittals, provided technical assistance to the Owner, and provided on-site assistance overseeing construction activities.

New Madrid Units 1 & 2 Overfire Air | Associated Electric Cooperative, Inc.
New Madrid, Missouri | 2005-2006

Project lead structural engineer for an overfire air project for Associated Electric Cooperative, Inc. As Project Lead Structural Engineer, his duties included the review of existing windbox ductwork and structural framing and the design of a new overfire air system. Mr. Garden also assisted in writing specifications, evaluating proposals and reviewing shop drawings.

Gerald Gentleman Station – Unit 1 BES Mechanical Installation | Nebraska Public Power District
Sutherland, Nebraska | 2004-2005

SHANE GARDEN, PE
(continued)

Project lead structural engineer for a burner equipment replacement and overfire air project for Nebraska Public Power District. As Project Lead Structural Engineer, his duties included the review of existing windbox ductwork and structural framing and the design of a new overfire air system. Mr. Garden also assisted in writing a detailed report of the newly designed burner equipment system and overfire air system, which discussed the design and installation of each system.

Generation Sheboygan Falls Energy Facility | Alliant Energy
Sheboygan Falls, Wisconsin | 2004-2005

Project lead structural engineer for an Engineer-Procure-Construct project consisting of two simple cycle combustion turbine units for Alliant Energy Generation. As Project Lead Structural Engineer, he worked closely with other disciplines to establish project design manuals to be used throughout the project and to be used as reference in the future. Mr. Garden's duties also included reviewing geotechnical subgrade reports, writing specifications, designing foundations (including dynamic and static analyses of deep foundations), evaluating bids, working with detailers/designers putting construction documents together, coordinating multi-discipline project meetings, reviewing submittals and shop drawings for equipment, foundation reinforcing, structural steel, concrete and grout results, and miscellaneous products. In addition, Shane worked directly with construction site to answer questions and look into construction challenges as they occur.

Emery Generating Station | Alliant Energy Generation
Mason City, Iowa | 2002-2004

Lead structural steel design engineer on a two-on-one combined cycle project for Alliant Energy. Mr. Garden's duties included writing specifications, structural steel design, and evaluating bids. He also provided on-site field support during construction where he administered contracts and worked directly with contractors, solving construction issues.

Merchant Service Clarksdale Public Utilities – Crossroads Energy Center | Aquila
Clarksdale, Mississippi | 2001

Project lead structural engineer for an Engineer-Procure-Construct project consisting of four simple cycle combustion turbine units for Aquila Merchant Service. As Project Lead Structural Engineer, he worked closely with other disciplines to establish project design manuals to be used throughout the project and to be used as reference in the future. Mr. Garden's duties also included determining governing building codes, reviewing geotechnical subgrade reports, writing specifications, designing foundations (including dynamic and static analyses of deep foundations), evaluating bids, working with detailers/designers putting construction documents together, coordinating multi-discipline project meetings, reviewing submittals and shop drawings for equipment, foundation reinforcing, structural steel, concrete and grout results, and miscellaneous products. In addition, Shane worked directly with construction site to answer questions and look into construction challenges as they occur.

Hawthorn Unit 5 Rebuild | Kansas City Power & Light
Kansas City, Missouri | 2000-2001

Mr. Garden provided ***on-site field support*** acting as Owner's Engineer and Contract Administrator, overseeing foundation installation and steel erection on a nominal 550 MW coal fired boiler rebuild project.

Asbury Power Plant Overfire Air | The Empire District Electric Company
Asbury, Missouri | 1998-2000

Lead structural engineer on an Overfire Air project for The Empire District Electric Company. His duties included determining overfire air duct routing, duct design and analysis, analysis of existing ductwork and structural steel, writing specifications, evaluating bids and reviewing shop drawings.

SHANE GARDEN, PE
(continued)

Plant Number 2 Repower | West Texas Municipal Power Agency
Lubbock, Texas | 1998-2000

Assistant structural engineer on a repower project for West Texas Municipal Power Agency. His duties included the design and finite element analysis of a foundation for a new HRSG unit. He was also responsible for the design of two building foundations and numerous tank foundations.

Isoprene Expansion Project | The Goodyear Tire & Rubber Company
Beaumont, Texas | 1998-2000

Assistant structural engineer on an expansion project for The Goodyear Tire & Rubber Company in Beaumont, Texas. This work involved the analysis and retrofitting of existing pipe rack structures. Design of new pipe rack, equipment platforms and foundations was also performed.

Trimble County Unit 1 | Louisville Gas & Electric
Louisville, Kentucky | 1998-2000

Mr. Garden was involved with a structural brace modification for the coal crusher house at Louisville Gas & Electric's (LG&E) Trimble County Unit 1. His duties involved relocating a brace to allow for additional hoist clearances.

Trimble County | Louisville Gas & Electric
Louisville, Kentucky | 1998-2000

Mr. Garden performed a field inspection of two fiberglass absorber reaction tank covers at LG&E's Trimble County Unit. The purpose of the inspection was to determine the structural integrity of the existing covers. A detailed report was prepared that documented the results and recommendations.

Critical Piping Analysis | Sikeston Power Company
Sikeston, Missouri | 1998-2000

For Sikeston Power Company of Sikeston, Missouri, Mr. Garden was responsible for the pipe stress analysis of three piping systems. This analysis involved a field inspection of the systems and a detailed computer analysis. Mr. Garden made recommendations for areas to have non-destructive testing performed. Due to these recommendations, two large cracks were discovered. The cracks were field repaired to prevent future failures

ROBERT OWENS, PE

Associate Civil Engineer

Mr. Owens is an associate civil engineer responsible for layout and design of power-related projects involving grading, drainage, roads, and underground utilities. His additional responsibilities include preparation of specifications, permit preparation support, cost estimates, and schedule development.

EDUCATION

- BS, Civil Engineering
- MS, Civil Engineering

REGISTRATIONS

- Professional Engineer (MO, DE, IA, IN, KY, MD, OK, PA)

20 YEARS WITH BURNS & MCDONNELL

20 YEARS OF EXPERIENCE

Duke Energy CCR/ELG Compliance | Duke Energy

Cayuga, Gibson and East Bend Generation Facilities | 2016-Present

Lead civil engineer for design to bring Duke Energy's Cayuga, Gibson and East Bend generation facilities in to compliance with the new Effluent Limitation Guidelines (ELG) and Coal Combustion Residuals (CCC) EPA environmental regulations. Duties included design oversight and specification preparation for construction documents for Duke Energy to receive bids from contractors for construction of the project. Schedule development, preliminary engineering and construction cost estimates were also completed as a part of this work. Scope of work at each facility is summarized below:

- **Cayuga Generating Station**
  - Design work consisted of sizing and sighting of new holding, primary and secondary basins. All waste streams that did not contain CCR related materials being discharged into existing ash ponds were diverted to the new basins via existing pumping system or new sumps included in the new design concepts. Burns & McDonnell conducted field sample testing of the waste streams to help with determination of proper setting times to enable the sizing of these basins. Basins were designed with a geo-composite clay lining system as well as an HPDE liner and cover material. A concrete slab was added to the primary and secondary basins to aid in cleanout of solids settling in these basins.
- **Gibson Generating Station/East Bend**
  - Design work consisted of development of scope, design, schedule and cost estimates to bring Gibson and East Bend Generating Stations into compliance with EPA rules for Coal Combustion Residuals (CCR) and Effluent Limitation Guidelines (ELG). The scope included the design and permitting support for repurposing an existing ash basin to a new retention basin. Also, wastewater streams and storm water originally discharged into their existing ash ponds were re-directed to these new basins. Burns & McDonnell conducted field sample testing of the waste streams to help with determination of proper setting times to size these basins. Basins were designed with a geo-composite clay lining system as well as and HPDE liner and cover material. New large sumps were construction to re-direct existing plant storm and process water flows that were discharging into existing ash ponds to the new basins.

Wildcat Point Generation Facility Raw Water Supply | Old Dominion Electric Cooperative

Peach Bottom, Pennsylvania | 2012-2017

Engineering manager for the Engineer, Procure and Construction project to supply raw water the Wildcat Point Generation Facility (WPGF) being constructed near Rising Sun, Maryland. Mr. Owens responsibilities include management of the engineering team to design, procure equipment, and provide construction documents for all aspects of the water supply project. The project consisted of an approximate five-mile pipeline corridor from the Susquehanna River near Peach Bottom, PA to the WPGF located near Rising Sun, MD. The pipeline corridor involved performing a route study, intake location studies, obtaining right of way agreements and wetland permitting the project with the local municipalities and state agencies.

ROBERT OWENS, PE
(continued)

The pump house site was situated on a steep existing slope that involved heavy excavation and rock blasting. A new 50-foot deep wet well was excavated to serve for the water supply from the intake screens located approximately 800-feet from the shore line of the river. Once the wet well excavation was completed a 60-inch diameter steel casing was installed to connect the wet well to the intake screens utilizing microtunneling construction methods. The microtunnel crossed an active railroad track. The casing housed several pipelines including two intake lines from six wedge wire cylindrical screens installed on foundations placed in the river. Major equipment procured for this project included two 6,300 GPM pumps, 69kV dry transformer, emergency diesel generator, switchgear and UPS controls that were tied back to the WPGF control room via local DSC system fiber optic cable laid adjacent to the water pipeline. Other equipment included the intake screens, surge suppression vessel and air burst system for periodical cleaning of the intake screens. Burns & McDonnel also provided construction and start-up services throughout the duration of the project.

Wildcat Point Generation Facility | Old Dominion Electric Cooperative
Rock Springs, Maryland | 2012-2017

Lead civil engineer for project definition development of a new brownfield 900 MW combined cycle generation addition to an existing combustion turbine site. Responsibilities include development of site and yard arrangement for integration of the new facility within the confines of the existing site boundary and equipment layout.

JK Smith Power Station | East Kentucky Electric Cooperative
Clark County, Kentucky | 2012

Project definition study to develop a brownfield combined cycle and simple cycle generation addition to an existing combustion turbine site. Responsibilities include development of site and yard arrangement for integration of the new facility. Other duties include cost estimate development.

Sutherland Station | Alliant Energy
Marshalltown, Iowa | 2011-2012

Project definition study to develop a green field combined cycle and simple cycle generation. Responsibilities include development of site and yard arrangement for integration of the new facility. Other duties include cost estimate development.

Ottumwa Tier One Project | Alliant Energy
Ottumwa, Iowa | 2011-Present

Lead civil engineer for the air quality upgrade work at Ottumwa Generating Station. The civil engineering scope for the dry scrubber upgrade includes construction and design coordination and permitting support. Preparation and administration of specifications and construction contracts for Site Preparation and Finish Paving construction contracts. Recent design activities include storm water, grading, and underground utility relocation. Future work involves final road and paving design.

Cypress Creek Power Station | Old Dominion Electric Cooperative
Dendron, Virginia | 2007-2010

Lead civil engineer responsible to complete engineering and permitting support for a project definition study to develop of a new greenfield 1500 MW pulverized coal fired generation station. Responsibilities include equipment and yard arrangement for all aspects of coal fired generation facility. These include optimizing locations for fuel storage and coal combustion waste disposal facilities. Mr. Owens involvement also includes preliminary design including earthwork, grading, stormwater, horizontal and vertical geometric design for access roads and railroads inside the station limits and coal combustion waste facility design. Mr. Owens also lead a railroad corridor study to access the location of the generation station with rail infrastructure from the Norfolk Southern (NS) mainline locate approximately six miles from the preferred site. Mr. Owens is

also involved with a water supply routing study to select a preferred route to the station for water supply and discharge to and from the James River located approximately 16 miles from the proposed generation station. Mr. Owens has also written several white papers to outline design requirements and summarize local regulations and to show how this station will adhere to these requirements for stormwater and coal combustion waste disposal. Future work includes preliminary horizontal and vertical design and final route selection for the railroad access the station from the NS mainline and other permitting support as needed.

Indian River Unit 4 AQCS Project | NRG Energy
Dagsboro, Delaware | 2009-2012

Lead civil engineer for the air quality upgrade work at Indian River Power, LLC Unit 4. The civil scope for the FGD upgrade includes construction and design coordination and permitting support effort. Preparation and administration of specifications and construction contracts for Site Preparation and Final Paving along with various other services contracts. Recent design activities include storm water, bioswales, grading, underground utility relocation, and final road and paving design.

Cooper Unit 2 AQCS Retrofit | East Kentucky Power Cooperative
Burnside, Kentucky | 2008-2013

Project civil engineer for the air quality upgrade work at East Kentucky Power Cooperative's Cooper Station. This project involves the addition of a new flue gas desulphurization equipment for Unit 2. Duties include conceptual layouts for initial studies and preparation of design drawings and specification for grading and storm water design. Other duties involved road and pavement design and design of expansion of the existing coal pile runoff pond.

Fayette Station Scrubber Project | Lower Colorado River Authority
LaGrange, Texas | 2005-2011

Project civil engineer for the Lower Colorado River Authority's Fayette Station scrubber project. Project involves the addition of two new flue gas desulphurization modules for the 600MW Units 1 & 2 located at their Fayette Station near LaGrange, Texas. Duties included conceptual layouts for initial studies and preparation of design drawings and specification for underground utility location, grading, stormwater, and final paving design.

Louisa Dry Scrubber Project | MidAmerican Energy
Muscatine, Iowa | 2005-2008

Project civil engineer for Mid-American Energy's Louisa Dry Scrubber project located outside of Muscatine, Iowa. This joint venture, Engineer Procure and Construction, project with Kiewit Construction company involved the installation of a new dry scrubber facility on Mid-Americans 750 MW Louisa station. Mr. Owens' duties included general site arrangements, relocation of underground utilities, site drainage, lime and waste ash rail unloading facilities, and road design.

Cholla Station Unit 3&4 AQCS Project | Arizona Public Service
Joseph City, Arizona | 2006-2009

Project civil engineer for a Joint Venture, with Zachary Construction, Design Build project for Arizona Public Service's Cholla Station in Joseph City, Arizona. This project installed of new air pollution control equipment on the facilities Units 3 and 4. Mr. Owens responsibilities included road development for lime unloading truck traffic in and around the existing facility. Other duties include drainage design and underground utilizes relocation design.

ROBERT OWENS, PE
(continued)

Single V84.3A Simple Cycle Project | Great River Energy
Cambridge, Minnesota | 2004-2006
Lead civil engineer on this project. Mr. Owens was responsible for underground utility installation along with general site drainage, site clearing, and site preparation.

Simple Cycle Project | Alliant Energy
Sheboygan, Wisconsin | 2004-2006
Project civil engineer for Alliant Energy's simple cycle project located near Sheboygan, Wisconsin. Project involved the installation of two General Electric frame 7 combustion turbines enclosed in a building. Mr. Owens was responsible for administration of the civil design and construction. Mr. Owens also assisted with permitting support for the project.

Emery Generation Station | Alliant Energy
Mason City, Iowa | 2002-2005
Project civil engineer for design of Alliant Energy's (Interstate Power and Light) Emery Generation Station near Mason City, Iowa. Project involves design and construction management services for a 2x1 combined cycle facility fully enclosed inside an engineered building. Completed work included permitting support, drainage and grading design, road layout, specification preparation and contract administration for the civil design.

Gas Turbine Project | Cornbelt Power Cooperative
Spencer, Iowa | 2001-2003
Project civil engineer for a gas turbine project for Cornbelt Power Cooperative, in Spencer, Iowa responsible for the preliminary site layout, assisting the Owner in plan permitting and preparation of turnkey specifications. Working as Owner's project civil engineer, he was responsible for review of the turnkey's consortium's design.

Sam Rayburn Generating Station | South Texas Electric Cooperative
Nursery, Texas | 2000-2003
Project civil engineer for a 3x1 combined cycle facility for South Texas Electric Cooperative's existing Sam Rayburn Generating Station near Nursery, Texas. Completed work included site layout of the new units on the compact site, detailed drainage design, final paving and grading design, and permitting support. Duties also included preparation of plans and specifications, and contract administration for the Site Preparation and Final Paving and Grading Contracts.

Goose Creek Energy Center | Aquila
Monticello, Illinois | 2000-2003
Project civil engineer of design for a new 6-unit simple cycle gas turbine facility for the Goose Creek Energy Center owned by Aquila. Tasks completed for this project include drainage and paving design, preparation of specifications, and contract administration.

Coughlin Power Station Repower Project | CLECO
St. Landry, Louisiana | 1999
Resident civil/structural project representative for the Coughlin Repower Project located near Alexandria, Louisiana. The project involved the construction of three new combined cycle combustion turbine units to repower two existing 330-Megawatt steam turbines. His duties included verifying that materials, construction, and contractor quality control and assurance were in compliance with the plans and specifications. He also assisted in reviewing proposals for field modifications and tracking job progress for payment. Construction work monitored by Mr. Owens includes earthwork, foundation installations, along with underground piping and duct bank installations.

NICHOLAS HOCH, PE

Senior Electrical Engineer

Mr. Hoch is experienced in project management, relaying, switchgear and field support. His responsibilities include managing electrical design, writing technical specifications, performing load flow analysis, fault analysis, arc-flash analysis, relay coordination studies and upgrades, specifying medium and low voltage electrical equipment, preparing electrical schematics and wiring diagrams for control and protection, and coordinating the electrical interface between major equipment suppliers.

EDUCATION

- BS, Electrical Engineering

REGISTRATIONS

- Professional Engineer (AL, IA, GA, MN, Saskatchewan)

11 YEARS WITH BURNS & MCDONNELL

11 YEARS OF EXPERIENCE

Chinook Power Station | SaskPower

Swift Current, Saskatchewan, Canada | 2016 - Present

Co-Lead electrical engineer. Electrical design team co-lead for a green-field 1 on 1 combined cycle facility. Project role includes co-managing the electrical design team, managing electrical equipment contracts containing: large power transformers and generator circuit breakers. Additional responsibilities include design of 1-lines, 3-lines, schematics, wiring diagrams, and relay settings for new electrical equipment. Interfacing with existing plant equipment and protection schemes.

Main and Tie Breaker Relay Upgrades | PowerSouth

Leroy, Alabama | 2016

Project manager. Protective relay replacement at the Lowman Generating Plant. Project responsibilities included updating of plant one-line, three-line, schematic, and wiring diagrams as well as setting the protective relays for Units 2 and 3 for the main and tie medium voltage breakers. Also spent approximately 2 weeks for each unit on site during project completion for demolition of existing panels, installation of new panels, and commissioning of the new equipment.

NERC PRC-019, 024, 025 Protection Review | Hoosier Energy

Three Sites, Indiana | 2016

Project manager. Managed the protection review project for three Hoosier facilities located in Indiana. The review compared the existing generator and transformer protective relays and excitation system limiters versus the requirements listed in NERC PRC documents PRC-019, PRC-024, and PRC-025.

NERC PRC-025 Protection Review | NRG

Two Sites, Delaware | 2016

Project manager. Managed the protection review project for two NRG facilities located in Delaware. The review compared the existing generator and transformer protective relays versus the requirements listed in NERC PRC-025.

NERC PRC-025 Protection Review | Western Farmers

Two Sites, Oklahoma | 2016

Project manager. Managed the protection review project for two WFEC facilities located in Oklahoma. The review compared the existing generator and transformer protective relays for eleven units versus the requirements listed in NERC PRC-025. Following the study, a new project for replacement of relays that were found to be non-compliant was started.

NICHOLAS HOCH, PE
(continued)

Infrastructure and Retrofit Upgrades | Minnesota Power Cooperative
Cohasset, Minnesota | 2013 – 2015

Lead electrical engineer. Electrical Infrastructure and contract engineer for AQCS Retrofit upgrades at Boswell Unit 4. Project role includes managing electrical equipment contracts containing: medium and low voltage switchgear lineups, station service transformers, isolated phase bus, non-segregated phase bus, and generator circuit breaker. Additional responsibilities include design of 1-lines, 3-lines, schematics, wiring diagrams, and relay settings for new electrical equipment. Interfacing with existing plant equipment and protection schemes.

Essential AC, DC and Diesel Generator Upgrades | PowerSouth Energy Cooperative
Leroy, Alabama | 2012 – 2013

Project manager, ***contract engineer***, and ***applications engineer***. 120V Essential AC, 125V DC, and Diesel Generator upgrades at Lowman Units 2 and 3. Project role includes managing diesel generator, electrical commodities, and construction contracts. Additional responsibilities include design of 1-lines, 3-lines, schematics, and relay settings for new electrical equipment. Interfacing with existing plant equipment and protection schemes is also included.

Generator Breaker and Relaying Upgrades | PowerSouth Energy Cooperative
McIntosh, Alabama | 2011 – 2012

Project manager, ***contract engineer***, and ***applications engineer***. Generator Breaker and Generator relaying upgrades at PowerSouth Energy Cooperative CAES Unit 1 - unit 1 is rated at 131MVA. Project role included managing generator breaker, isolated phase bus duct, relay panels, and construction contracts. Additional responsibilities included design of 1-lines, 3-lines, schematics, and relay settings for new electrical equipment. Interfacing with existing plant equipment and protection schemes was also completed. Spent 1 month onsite during construction and startup of Unit 1 for construction and relaying field support.

Electrical and FGD Upgrades | Minnkota Power Cooperative
Center, North Dakota | 2007 – 2011

Contract and ***applications engineer***. Electrical and FGD upgrades at Minnkota Power Cooperative Units 1 and 2 - unit 1 rated at 235MW and unit 2 rated at 530MW. Project role included managing isolated phase bus duct and electrical equipment contracts containing: medium and low voltage switchgear lineups, station service transformers, generator and transformer relay panels, isolated phase bus, and generator circuit breaker. Additional responsibilities included design of 1-lines, 3-lines, schematics, wiring diagrams, and relay settings for new electrical equipment. Interfacing with existing plant equipment and protection schemes was also completed. Spent 6 months onsite during construction and startup of Unit 1 for construction and relaying field support. Spent 8 months onsite during construction and startup of Unit 2 for construction and relaying field support.

Generator and Transformer Relay Upgrades | PacifiCorp
Rock Springs, Wyoming | 2006 – 2009

Project manager and ***lead electrical engineer***. Transformer protective relay upgrade on a 600 MW coal-fired unit at Jim Bridger #2 in Point of Rocks, Wyoming. Project responsibilities include completing demolition design, relay panel layouts, and installation design package. Coordinated with Exciter upgrade and metering upgrades occurring simultaneously.

Project engineer. Generator protective relay upgrade on a 600 MW coal-fired unit at Jim Bridger #3 in Point of Rocks, Wyoming. Project responsibilities include completing demolition design, relay panel layouts, and installation design package.

NICHOLAS HOCH, PE
(continued)

Project engineer. Generator protective relay upgrade on a 600 MW coal-fired unit at Jim Bridger #4 in Point of Rocks, Wyoming. Project responsibilities include completing demolition design, relay panel layouts, and installation design package. Also interfaced with General Electric to supply plant updated drawing set after replacing rotating exciter with a new EX-2100 static exciter.

Arc Flash Study | Ghirardelli Chocolate Company
Oakland, California | 2006 – 2007

Project engineer. Arc-flash study at Ghirardelli's Chocolate plant located in Oakland, California. Oakland's facility is composed of multiple lines of operation for mixing, packaging, and distribution of chocolates. Project responsibilities included an in-depth review of the arc-flash study results to determine the classification of PPE required to perform repairs on 480V switchgear and distribution MCC's within the plant. A report detailing the results and recommendations was submitted along with a proposed plan of action to resolve all "Dangerous" arc-flash hazard issues. Labels displaying the arc-flash PPE classification requirements were also supplied with the report for field application.

Load Flow and Short-Circuit Studies | Basin Electric Power Cooperative
Stanton, North Dakota | 2006

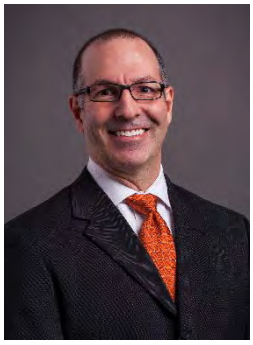
Project engineer. Load flow and short-circuit studies at Leland Olds Station Unit 2. Project responsibilities include modeling 420MW coal unit from the Generator and GSU down to the 480V MCC level. A report detailing the results and recommendations was submitted along with a proposed plan of action to resolve all short-circuit issues, including replacement of under-rated breakers. The studies were performed using SKM's Power Tools for Windows software.

Generator and Motor Relay Upgrades | PowerSouth Energy Cooperative
Leroy, Alabama | 2006 – 2008

Project engineer. Protective relay replacement at the Lowman Generating Plant near Leroy, Alabama. Project responsibilities include setting the protective relays for Units 2 and 3 for the generators, transformers, and medium voltage motors. Also spent approximately one month for each unit on site during project completion for demolition of existing panels, installation of new panels, and commissioning of the new equipment.

CLINTON MOYER, PE

Senior Mechanical Engineer



Mr. Moyer is a Senior Mechanical Engineer within Burns & McDonnell's Energy Division. He has been involved in power plant maintenance capital projects involving different plant equipment and systems and has over 27 years of design, maintenance and reliability experience in the petrochemical industry. Mr. Moyer's relevant experience includes the following:

EDUCATION

- BS, Mechanical Engineering

REGISTRATIONS

- Professional Engineer (TX)

4 YEARS WITH BURNS & MCDONNELL

32 YEARS OF EXPERIENCE

Oklahoma Gas & Electric, Various Locations

Oklahoma City, Oklahoma | October 2017 - June 2018

Mechanical engineer performed engineering services developing proposed capital project scope, costs and schedule providing client with work authorization packages for their capital budget process. Projects involved different plant systems and equipment for coal-fired and gas-fired power plants.

Oklahoma Gas & Electric, Tinker AFB Units 5A & 5B

Oklahoma City, Oklahoma | January 2018 - March 2018

Mechanical engineer performed engineering services for Operating & Maintenance (O&M) Costs Assessment for existing simple cycle combustion units. Site walkthrough, review of operating, inspection and maintenance records. Client provided report with recommendations and expected future cash flows.

Duke Energy, Roxboro Station

Person County, North Carolina | June 2017 - September 2017

Mechanical engineer performed engineering services developing mechanical piping construction packages for their water redirection and bottom ash submerged flight conveyor projects for the plant's four coal-fired units.

Oklahoma Gas & Electric, Various Locations

Oklahoma City, Oklahoma | October 2016 - June 2017

Mechanical engineer performed engineering services developing proposed capital project scope, costs and schedule providing client with work authorization packages for their capital budget process. Projects involved different plant systems and equipment for coal-fired and gas-fired power plants.

Oklahoma Gas & Electric, Sooner Station

Red Rock, Oklahoma | September 2016 - May 2017

Mechanical engineer developed and issued construction work package of mechanical specifications and utility piping drawings. Provided technical assistance during construction. Project involved replacement of coal handling conveyors supporting two coal-fired boilers.

CLINTON MOYER, PE
(continued)

Oklahoma Gas & Electric, Various Locations
Oklahoma City, Oklahoma | March 2016 - June 2016
Mechanical engineer performed engineering services developing proposed capital project scope, costs and schedule providing client with work authorization packages for their capital budget process. Projects involved different plant systems and equipment for coal-fired and gas-fired power plants.

Confidential Client
Southwest US | October 2015 – June 2016
Mechanical engineer developed and issued construction work package of specifications and drawings. Provided technical assistance during construction and commissioning. Project involved replacement of retractable sootblowers on a coal-fired boiler.

Confidential Client
Southwest US | August 2015 – March 2016
Mechanical engineer developed and issued procurement and construction work packages of specifications and drawings. Project involved replacement of a 288,000 gallon process liquor tank for the FGR section of a coal-fired power plant.

Confidential Client
Southwest US | February 2015 – March 2016
Mechanical engineer developed and issued procurement and construction work packages of specifications and drawings. Provided technical assistance during construction and commissioning. Project involved replacement of coal mill isolation valves, associated coal piping and instrumentation.

SaskPower, Queen Elizabeth Station
Saskatoon, Saskatchewan, Canada | June 2014 – November 2015
Contract engineer for Temporary Water Treatment, Steam Blows and O&M Manuals / Training contracts in support of the project startup and commissioning phase.

Confidential Client
Southwest US | October 2014 – February 2015
Mechanical engineer developed and issued construction work package of specifications and drawings. Project involved replacement of lube oil conditioning skids for main turbine lube oil systems for two units.

Confidential Client
Southwest US | July 2014 – November 2014
Mechanical engineer developed and issued construction work package of specifications and drawings. Provided technical assistance during construction and commissioning. Project involved replacement of low NOx coal burners, windbox steel repairs, burner quarl tile replacement, and boiler refractory repairs.

Confidential Client
Southwest US | January 2014 - June 2014
Mechanical engineer performed engineering services developing proposed capital project scope, costs, schedule and economics providing client with work authorization packages for their capital budget process. Projects involve replacement of generator H2 coolers and HP steam turbine main stop and control valves.

CLINTON MOYER, PE
(continued)

Confidential Client
Southwest US | January 2014 - June 2014
Mechanical engineer performed engineering services developing proposed capital project scope, costs, schedule and economics providing client with work authorization packages for their capital budget process. Projects involved replacement of generator H2 coolers, rebuilding of closed cooling water heat exchanger, replacement and improvement of coal mill isolation valves, replacement and improvement of an Administrative Building HVAC system and restoration of a turbine bridge gantry crane.

We Energies, Oak Creek
Oak Creek, Wisconsin | November 2013 - February 2014
Mechanical engineer performed on-site review, hydraulic system tubing layout and support design for new EHC system in support of GE Measurement and Controls turbine governor replacement project.

Alliant Energy, Ottumwa Station
Ottumwa, Iowa | October 2013 - March 2014
Mechanical engineer performed design review of heater drain valves and piping sizing for turbine rerate conditions. Performed design review of loop seal piping modifications and specification of new control valve. Participated in redesign of turbine exhaust hood spray supply piping revisions and specification of new control valve for turbine rerate project.

Phillips 66, Borger Refinery
Borger, Texas | September 2007 – September 2013
PM/PdM engineer trained in Taproot® RCA methodology and performed RCFA investigations for equipment and process unit related incidents. Performed process and utility unit equipment criticality reviews. Developed and maintained equipment maintenance strategies and documentation in a plant CMMS. Involved in the maintenance and troubleshooting of centrifugal pumps, centrifugal and reciprocating compressors, and steam turbines. Responsible for overseeing OST testing of large steam turbines following turnaround maintenance work. Prepared equipment procurement technical specifications, administered service contracts including bidder qualification, bid evaluation, addressing commercial and technical terms with suppliers and contractors. Provided capital project construction support including QA/QC of rotating & reciprocating equipment installation to API 686 Recommend Practice.

ConocoPhillips, Borger Refinery
Borger, Texas | December 1998 – August 2007
Reliability engineer trained in PROACT® RCA methodology and performed RCFA investigations for equipment and process unit related incidents. Performed process and utility unit RBI (Risk Based Inspection) evaluation and management of PSVs. Provided oversight of the refinery's oil analysis, vibration analysis and reciprocating compressor monitoring programs and supervised plant reliability technicians. Developed and maintained equipment maintenance strategies and documentation in a plant CMMS. Completed Six Sigma's Academy's four-week Six Sigma black belt course. Involved in the maintenance and troubleshooting of centrifugal pumps, centrifugal and reciprocating compressors, and steam turbines. Prepared equipment procurement technical specifications, administered service contracts including bidder qualification, bid evaluation, addressing commercial and technical terms with suppliers and contractors.

CLINTON MOYER, PE
(continued)

Phillips Petroleum Company, Borger Refinery
Borger, Texas | May 1997 – November 1998
TPM specialist trained in Planned Maintenance pillar of Total Productive Maintenance by Japan Institute of Plant Maintenance. Planned Maintenance facilitator for plant's Total Productive Maintenance (TPM) implementation initiative. Trained in Reliability –Centered Maintenance (RCM). Facilitated implementation of Five Ss workplace organization and improvement process in plant maintenance shops. Provided training in TPM, Five Ss, basic failure analysis, equipment lubrication and rotating equipment training for plant operators.

Phillips Petroleum Company, Borger Refinery
Borger, Texas | May 1996 – April 1997
Area maintenance team leader supervised team of area maintenance craftsmen to provide daily support to plant residuum HDS, H2 Reformer, SWS and SRUs. Supervised maintenance craftsmen during plant unit shutdowns and turnarounds throughout the refinery.

Phillips Petroleum Company, Borger Refinery
Borger, Texas | January 1990 – April 1996
Mechanical design engineer performed detailed piping, pressure vessel and heat exchanger design to support refinery crude fractionation, distillate HDS, reformer, HF alkylation, FCC, H2 reformer, SWS and SRU units. Performed refractory design for FCCUs, SRUs and fired process heaters. Prepared equipment procurement technical specifications, bid evaluation, addressing commercial and technical terms with suppliers and contractors.

Phillips Petroleum Company, Research & Development Center
Bartlesville, Oklahoma | February 1986 – December 1989
Design engineer performed detailed HVAC, machine, piping, pressure vessel and heat exchanger design in support of corporate R&D pilot plants, material manufacturing and research laboratories.

JOSEPH BERLEKAMP, RA

Lead Architect

Mr. Berlekamp is a senior architect for Burns & McDonnell. His primary responsibilities include the design of new commercial, institutional, industrial, governmental, and educational projects. He specializes in architectural services ranging from programming, conceptual planning, design, and project management to contract document preparation, specifications writing, and construction administration. His experience also includes projects involving the renovation of facilities, record documentation of existing conditions, master planning, feasibility analyses, and interior space planning. Joe provides company-wide consultation and coordination of life safety analyses, and specifications development with emphasis in roofing and corrosion control services. He has extensive experience with the requirements of all major national building, fire, and accessibility codes, including the ADAAG (Americans with Disabilities Act Accessibility Guidelines).

EDUCATION

- BS Architecture and Design

REGISTRATIONS

- Registered Architect: (KS, MO, IA, VA, IL, PA, NY, ND, IN, PA, NC, OH, AL, OK, KY, MA)
- NCARB

20 YEARS WITH BURNS & MCDONNELL

40 YEARS OF EXPERIENCE

Energy Global Practice

Kansas City, Missouri

Lead architect for numerous Burns & McDonnell Energy Division power plant projects. Joe was responsible for the general arrangement layout and design of buildings and equipment enclosures, with emphasis on control rooms, administrative and conference areas, laboratories, locker rooms, and lunchroom facilities. He was also responsible for the consultation with the design team on life safety and code analysis at the federal, state, and local levels, protective coatings, energy conservation, and accessibility for the disabled.

- Kansas City Power & Light – Hawthorn, Kansas City, Missouri
- Kansas City Power & Light – Iatan, Weston, Missouri
- Westar Energy – Jeffrey Center – St. Mary's, Kansas
- Progress Energy – Crystal River, Florida
- Lincoln Electric – Salt Valley, Lincoln, Nebraska
- Associated Electric – Thomas Hill, Missouri
- Great River Energy – Cambridge, Minnesota
- First Energy – Fremont, Ohio
- Ameren Energy – Grand Tower, Illinois
- Ameren Energy – Pinkneyville, Illinois
- Ameren Energy – Columbia, Missouri
- Alliant Energy OGS – Ottumwa,Iowa
- Alliant Energy LGS – Lansing, Iowa
- MidAmerica Energy Neal Station – Sioux City, Iowa
- Dominion – Warren County, Virginia
- SaskPower Queen Elizabeth 2 – Saskatoon, Saskatchewan, Canada
- Basin Electric – Laramie River, Wyoming
- Indiana Power – Wastewater Treatment Facility
- Valley Energy Center, Wawayanda, New York
- Oklahoma Gas & Electric, Mustang Combined Cycle, Oklahoma City, OK

JOSEPH BERLEKAMP, RA
(continued)

- Oklahoma Gas & Electric, Shawnee, Re-roof, Shawnee, OK
- Duke Energy, Wastewater Treatment and Water Redirect Program at 10 plant sites
- SaskPower - Chinook – Swift Current, Saskatchewan, Canada
- Kentucky Utilities – Ghent, Kentucky
- East Kentucky – Spurlock, Maysville, Kentucky
- Arizona Public Service – Elevator replacement, Four Corners, New Mexico

Department of Energy | Honeywell
Kansas City, Missouri

Project architect for numerous master planning, reconstruction, and relocation projects for the Facilities and Utilities operations of the Honeywell Corporation and the US Department of Energy at the Kansas City Plant. Joe was responsible for layout and design of new and existing areas, life safety analysis, inventory control, and relocation plans for manufacturing plant equipment and processing, for the administrative, laboratories, and manufacturing areas.

Tyson Foods
Forest, Mississippi

Project architect for a major re-roofing project on several buildings at the plant complex, which included inventory of all roof mounted equipment and piping systems, roof tear off and repairs to existing roof structures, and a comprehensive roof system and detailed design.

Prior to joining Burns & McDonnell: Joe worked for HOK Sports Facilities Group in Kansas City, Missouri, designing major sports venues throughout the United States.

- Pepsi Center – Basketball and Hockey Arena, Denver, Colorado
- Baltimore Football Stadium – NFL Ravens, Baltimore, Maryland
- Jacobs Field – Major League Baseball, Cleveland, Ohio

APPENDIX B – PROJECT EXPERIENCE

MILTON R. YOUNG GENERATING STATION UNITS 1&2

Grand Forks, North Dakota

Burns & McDonnell has been involved in numerous projects at the MRY Station over the past 26 years. Starting in 2006, Burns & McDonnell provided engineering for over $400 MM in air pollution control retrofits leading to extensive knowledge and familiarity with the project site.

PROJECT FEATURES

Some of the major project Burns & McDonnell provided detailed engineering services include the following:

- New Overfire Air (OFA) systems for Units 1&2
- Selective Non-Catalytic Reduction (SNCR) systems for Units 1&2
- Upgrade existing Unit 2 FGD scrubber.
- New Unit 1 FGD scrubber.
- Unit 1 major electrical system rebuild including replacing auxiliary transformers, generator breaker, isolated phase bus, non-segregated bus, medium switchgear, low voltage switchgear, DCS, MCCs, and electrical equipment buildings.
- Unit 2 major electrical system upgrades including generator step up transformer, auxiliary transformers, generator breaker, isolated phase bus, non-segregated bus, medium switchgear, low voltage switchgear, DCS, MCCs, and electrical equipment buildings.
- Unit 1 and Unit 2 station battery system, UPS, and emergency generators.
- New Unit 2 chimney and ductwork from the existing scrubber modules to the new chimney.
- New common lime unloading and preparation system.
- Refurbish the existing Unit 2 chimney for use with Unit 1.
- New ductwork from the new Unit 1 scrubber module to the refurbished chimney.

Burns & McDonnell also provided on-site engineering services for construction management, system startup, checkout, testing, and commissioning. Field staff included overall Resident Project Representative, Safety Coordinator, Discipline Engineers (civil/structural/electrical/mechanical/controls/process), Schedule Coordinator, QA/QC Coordinator, Start up and Testing Coordinator.

CLIENT

- Minnkota Power Cooperative
  1822 Mill Road
  PO Box 13200
  Grand Forks, ND 58208-3200
  (701) 795-4000

KEY PROJECT DETAILS

- Milton R. Young 1 – 250MW
- Milton R. Young 2 – 450MW
- Lignite Coal
- FGD Retrofit
- SNCR
- OFA

COMPLETION DATE

- 2010, 2011

COST

- Confidential

PROJECT MANAGER

- Ron Bryant

SERVICES PROVIDED

- Preliminary Engineering
- Technology Assessment
- Detailed Engineering
- Field Engineering Support
- Startup Assistance

BURNS McDONNELL

ANTELOPE VALLEY STATION CARBON CAPTURE STUDY

Beulah, North Dakota

LOCATION

Antelope Valley Station

COMPLETION DATES

- Feasibility Study – 2008

SERVICES

- Technical development studies
- Technical Assessment
- Performance Optimization
- Fatal flaw
- Balance of Plant Conceptual Engineering
- Cost Estimating

PROJECT DESCRIPTION

Burns & McDonnell provided professional services for a study to evaluate the feasibility of installing a 120 MW ECO2 ammonia carbon capture system demonstration plant at the Basin Electric Power Cooperative Antelope Valley Station.

PROJECT FEATURES

- 120 MW slip stream ECO2 pilot plant on existing lignite-fired coal plant
- CO2 transportation for Enhanced Oil Recovery use

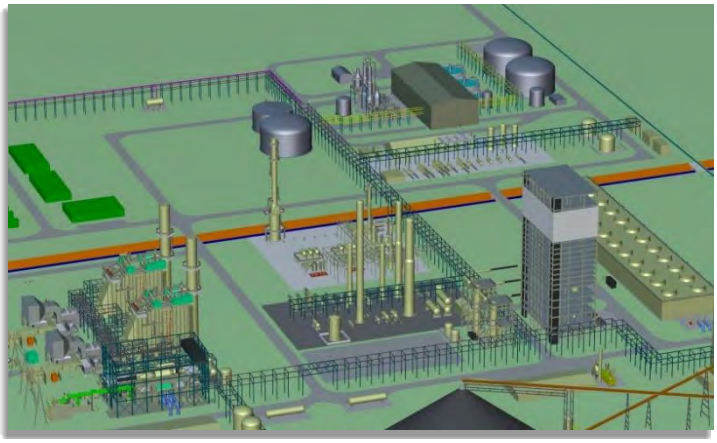
PROJECT SUMMARY

Burns & McDonnell provided technical evaluations including selecting the appropriate steam supply and condensate return for the Powerspan Technology Island. Burns & McDonnell also evaluated steam supply alternatives, cooling water requirements, and power supply alternatives all based on process requirements. The impact on the existing plant steam cycle was analyzed by modeling the existing plant cycle and determining the effects of steam and cooling alternatives and water balance impacts were developed for supply, treatment, and disposal systems. An electrical system assessment was also prepared to determine adequacy of the existing system. Burns & McDonnell collaborated with Powerspan to develop a conceptual cost estimate of the BOP facilities based on conceptual engineering design.

BURNS McDONNELL

TAYLORVILLE ENERGY CENTER, INTEGRATED GASIFICATION COMBINED CYCLE FEED

Taylorville, Illinois



CLIENT

- Christian County Generation, LLC
- Taylorville Energy Center (TEC) Commercial Scale Coal to SNG with NGCC FEED

PROJECT TEAM

- PM: Jim Jurczak

SERVICES

- FEED engineering
- Development support services
- Permitting support services
- Bridge period Engineering/procurement

Burns & McDonnell (BMcD) supported Christian County Generation, LLC (Joint Venture between Tenaska as managing developer and The ERORA Group) in the development of TEC including performing the Front-End-Engineering Design (FEED). BMcD initially worked with The ERORA Group, and closely with then technology provider General Electric, on the original FEED package and later supported the project as the technology shifted to a Hybrid IGCC concept (permitting support, project development, optionality design, project conceptual design and cost estimate, DOE support) and likewise as the project passed from The ERORA Group to Tenaska as managing developer. The project received favorable regulatory legislation in the State of Illinois and has likewise received a $2.6B federal loan guarantee from the United States DOE.

PROJECT FEATURES

- Coal to substitute natural gas facility
- 720 MW natural gas combined cycle
- Balance of plant including CO_2 capture and compression equipment
- Feedstock: Illinois Basin Coal
- State-of-the-art clean coal technologies

PROJECT BACKGROUND AND DESCRIPTION

This project consists of the design and construction of a 720 megawatt (MW) (600 MW net) Hybrid IGCC electric generating facility called the Taylorville Energy Center. This project is located in Christian County, Illinois. A local coal mine will serve as a source of fuel for the project.

In 2005/2006, Burns & McDonnell served as the Project Engineer on The ERORA Group's nominal 600 MW IGCC/chemicals co-production facility located in Southern Illinois. Burns & McDonnell was responsible for the overall engineering effort to support the project development and FEED design and coordinate with our technology partners. The facility was based on the GE gasification technology. Burns & McDonnell responsibilities included technical assistance, cost estimating, and systems design, including the preparation of Piping & Instrument Diagrams, one-line diagrams, overall plant layout drawings, process flow diagrams, and technical and commercial specifications. The FEED package was completed in late 2006.

TAYLORVILLE ENERGY CENTER, INTEGRATED GASIFICATION COMBINED CYCLE FEED

(continued)

After completion of the FEED package, Tenaska assumed the lead developer role on the Project. The Project shifted from a pure power play IGCC project to a “Hybrid IGCC” design; a Coal to SNG facility with a 2 x 1 Natural Gas-Fired Combined Cycle with process steam integration from the gasification process. In late 2009/early 2010, Burns & McDonnell worked on and submitted the FEED package to Tenaska as it related to this newly developed concept. With the modification of the project objectives, Tenaska selected Siemens gasification for the Hybrid IGCC concept. Burns & McDonnell and Kiewit were Joint Venture EPC partners on the project upon Project Implementation. The Project received significant funding from the State of Illinois for the initial study efforts, and was one of three projects to receive a Federal Loan Guarantee in the amount of approximately $2.6 Billion as the project moved into the Implementation Phase. Tenaska announced that it was cancelling Taylorville of its CCS projects in 2013 in favor of renewable and gas-fired power generation.

APPENDIX C – BURNS & MCDONNELL/MHI DIVISION OF RESPONSIBILITY

SCOPE OF WORK AND DIVISION OF WORK ("DOW")

Project Tundra FEED	
Project:	Project Tundra @ Milton R Young Power Station
Date:	October 17, 2018
Rev #:	DRAFT

LEGEND	
Customer	EERC/Minnkota Power/Allete Clean Energy
MHI	Mitsubishi Heavy Industries
B&Mc	Burns & McDonnell
NA	Not Applicable for this Project or Task

		FEED Study Phase				
Line	**Description**	**Conceptual Design**	**Bill of Quantity**	**Material Cost Estimating**	**Construction Estimate**	**Remarks**
1	**Studies and Investigations**					
2	Initial Baseline Data / Field Test	B&Mc	NA	NA	NA	Geotech by B&Mc, Field Test by EERC, Baseline Data by B&Mc
3	Physical Gas Flow Model	NA	NA	NA	NA	
4	CFD Flow Modeling Ductwork	NA	NA	NA	NA	
5	Transient Analysis / Boiler Implosion	NA	NA	NA	NA	
6	Plant Utilities Supply Data (Temp, Pres., Flow, Volts, Amps, etc.)	B&Mc	NA	NA	NA	
7	Plant Interface / Tie Point Definition	B&Mc	NA	NA	NA	
8	Hazard and Operability Study	NA	NA	NA	NA	Performed during Pre-FEED
9	ETAP Study - CCS	MHI	NA	NA	NA	
10	ETAP Study - CCS/BOP Integrated	B&Mc	NA	NA	NA	
11	Utility Supply Study (Power, Steam, Cooling Water)	B&Mc	NA	NA	NA	
12	Modularization Concept - MHI scope	MHI	NA	NA	NA	If modularized
13	Modularization Concept - B&Mc scope	B&Mc	NA	NA	NA	If modularized
14	**Permits**					
15	Environmental Permits	B&Mc	NA	NA	NA	
16	Construction Permits	B&Mc	NA	NA	NA	
17	**Process Design**					
18	**CCS Design**					
19	Design Basis / Specification	MHI	NA	NA	NA	
20	Process Flow Diagrams	MHI	NA	NA	NA	
21	Mass Balances	MHI	NA	NA	NA	
22	P&IDs	MHI	NA	NA	NA	
23	Process Control Description	MHI	NA	NA	NA	
24	Equipment Data Sheets	MHI	NA	NA	NA	
25	Pressure Drop Calculations	MHI	NA	NA	NA	
26	Operating Philosophy	MHI	NA	NA	NA	
27	O&M Cost Estimate	NA	NA	NA	NA	
28	Utility Consumption	MHI	NA	NA	NA	
29	Effluent List	MHI	NA	NA	NA	
30	**FGD Design**	NA	NA	NA	NA	
31	Design Basis / Specification	NA	NA	NA	NA	
32	Process Flow Diagrams	NA	NA	NA	NA	
33	Mass Balances	NA	NA	NA	NA	
34	P&IDs	NA	NA	NA	NA	
35	Process Control Description	NA	NA	NA	NA	
36	Equipment Data Sheets	NA	NA	NA	NA	
37	Pressure Drop Calculations	NA	NA	NA	NA	
38	Operating Philosophy	NA	NA	NA	NA	
39	O&M Cost Estimate	NA	NA	NA	NA	Limited to utilities, chemicals and manpower requirements.

SCOPE OF WORK AND DIVISION OF WORK ("DOW")

Project Tundra FEED	
Project:	Project Tundra @ Milton R Young Power Station
Date:	October 17, 2018
Rev #:	DRAFT

LEGEND	
Customer	EERC/Minnkota Power/Allete Clean Energy
MHI	Mitsubishi Heavy Industries
B&Mc	Burns & McDonnell
NA	Not Applicable for this Project or Task

		FEED Study Phase				
Line	**Description**	**Conceptual Design**	**Bill of Quantity**	**Material Cost Estimating**	**Construction Estimate**	**Remarks**
40	Utility Consumption	NA	NA	NA	NA	
41	Effluent List	NA	NA	NA	NA	
42	**BOP Design**	B&Mc	NA	NA	NA	
43	**Plant Layout**					
44	Plot Plan (CCS) - Plan & Elevation	MHI	NA	NA	NA	
45	Plot Plan (FGD)	NA	NA	NA	NA	
46	Overall Site Plot Plan	B&Mc	NA	NA	NA	
47	SWPPP (Stormwater Pollution Prevention Plan)	B&Mc	NA	NA	NA	
48	Grading Plan	B&Mc	NA	NA	NA	
49	Roadway Drawings	B&Mc	NA	NA	NA	
50	3D Model (CCS)	MHI	NA	NA	NA	Include piping (2-1/2" and larger) & piping connections, cable tray (12" and wider), motor locations, instrument locations. Underground by B&Mc.
51	3D Model (FGD)	NA	NA	NA	NA	
52	3D Model (BOP)	B&Mc	NA	NA	NA	
53	**Project Management and Administration**					
54	Project Execution Plan	B&Mc/MHI	NA	NA	NA	
55	Overall Project Schedule Development	B&Mc/MHI	NA	NA	NA	B&Mc to develop construction and BOP schedule
56	Overall Project Schedule Control	NA	NA	NA	NA	B&Mc to control integrated schedule
57	Site Construction Schedule Control	NA	NA	NA	NA	B&Mc to control integrated schedule
58	Commissioning Schedule Control	NA	NA	NA	NA	B&Mc to control integrated schedule
59	Safety Plan	NA	NA	NA	NA	
60	Engineering Quality Plan	NA	NA	NA	NA	
61	Construction Quality Plan	NA	NA	NA	NA	
62	Overall Project Progress Reports	NA	NA	NA	NA	
63	Construction Progress Reports	NA	NA	NA	NA	
64	Insurance	NA	NA	NA	NA	Each according to the needs/B&Mc needs a Builder's Insurance
65	Builder's All Risk Insurance	NA	NA	NA	NA	
66	Professional Engineering Registration - CCS	NA	NA	NA	NA	As required by law or custom
67	Professional Engineering Registration - FGD	NA	NA	NA	NA	As required by law or custom
68	Professional Engineering Registration - BOP	NA	NA	NA	NA	As required by law or custom
69	**Structural Steel**					
70	**CCS**					BOQ Divided by Categories (Extra Heavy, Heavy, Medium….)
71	Quencher Structure	MHI	MHI	MHI	B&Mc	
72	CO_2 Absorber Structure	MHI	MHI	MHI	B&Mc	
73	Vendor-Supplied Steel					
74	CO_2 Compressor Unit Steel	MHI	MHI	MHI	B&Mc	For vendor supplied steel
75	Dehydration Unit Steel	MHI	MHI	MHI	B&Mc	For vendor supplied steel

SCOPE OF WORK AND DIVISION OF WORK ("DOW")

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LEGEND	
Customer	EERC/Minnkota Power/Allete Clean Energy
MHI	Mitsubishi Heavy Industries
B&Mc	Burns & McDonnell
NA	Not Applicable for this Project or Task

		FEED Study Phase				
Line	**Description**	**Conceptual Design**	**Bill of Quantity**	**Material Cost Estimating**	**Construction Estimate**	**Remarks**
76	Precoat Filter Unit Steel	MHI	MHI	MHI	B&Mc	For vendor supplied steel
77	Other Structural Steel					
78	CCS Process Equipment Support Structure	MHI	MHI	B&Mc	B&Mc	
79	ISBL Pipe Rack	MHI	MHI	B&Mc	B&Mc	
80	Flue Gas Duct Support from Quencher Outlet to Absorber	MHI	MHI	B&Mc	B&Mc	
81	Cable Tray Support Steel	MHI	MHI	B&Mc	B&Mc	
82	Miscellaneous Support Steel	MHI	MHI	B&Mc	B&Mc	Add allowances
83	Bolts and Nuts for Structural Steel	MHI	B&Mc	B&Mc	B&Mc	Connection details by B&Mc and/or its steel fabricator.
84	Anchor Bolts	MHI	MHI	B&Mc	B&Mc	Templates and anchor plates for Regenerator and vessels
85	Building Structures	MHI	MHI	B&Mc	B&Mc	
86	**FGD**	NA	NA	NA	NA	
87	FGD Scrubber Structure	NA	NA	NA	NA	Collaboration with Quencher Design
88	Vendor-Supplied Steel	NA	NA	NA	NA	
89	Other Structural Steel	NA	NA	NA	NA	
90	FGD Process Equipment Support Structure	NA	NA	NA	NA	
91	Flue Gas Duct Support from Battery Limit to FGD Scrubber	NA	NA	NA	NA	
92	Cable Tray Support Steel	NA	NA	NA	NA	
93	Miscellaneous Support Steel	NA	NA	NA	NA	
94	Bolts and Nuts for Structural Steel	NA	NA	NA	NA	Connection details by B&Mc and/or its steel fabricator.
95	Anchor Bolts	NA	NA	NA	NA	
96	Building Structures	NA	NA	NA	NA	
97	**BOP**					
98	Flue Gas Duct Support from Chimney to Project Battery Limit	B&Mc	B&Mc	B&Mc	B&Mc	
99	BOP Pipe Rack	B&Mc	B&Mc	B&Mc	B&Mc	
100	Cable Tray Support Steel	B&Mc	B&Mc	B&Mc	B&Mc	
101	Design Evaluation of Existing Structures for Added Loads (if required)	B&Mc	B&Mc	B&Mc	B&Mc	
102	Miscellaneous Support Steel	B&Mc	B&Mc	B&Mc	B&Mc	
103	Bolts and Nuts for Structural Steel	B&Mc	B&Mc	B&Mc	B&Mc	
104	Anchor Bolts	B&Mc	B&Mc	B&Mc	B&Mc	
105	Building Structures	B&Mc	B&Mc	B&Mc	B&Mc	
106	**Modularization (if modularized)**					
107	CCS Process Rack Modules	MHI	MHI	MHI	B&Mc	
108	CCS Pipe Rack Modules	MHI	MHI	MHI	B&Mc	
109	BOP Modules	B&Mc	B&Mc	B&Mc	B&Mc	
110	**Pipe Supports**					
111	Pipe Supports Inside Battery Limit					See Piping Section
112	Pipe Supports Outside Battery Limit					See Piping Section
113	Stress Analysis (CCS)	MHI	NA	NA	NA	
114	Stress Analysis (FGD)	NA	NA	NA	NA	

SCOPE OF WORK AND DIVISION OF WORK ("DOW")

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MHI	Mitsubishi Heavy Industries
B&Mc	Burns & McDonnell
NA	Not Applicable for this Project or Task

		FEED Study Phase				
Line	**Description**	**Conceptual Design**	**Bill of Quantity**	**Material Cost Estimating**	**Construction Estimate**	**Remarks**
115	Stress Analysis (BOP)	B&Mc	NA	NA	NA	
116	**Draft System**					
117	Flue Gas Duct from Chimney to ISBL Project Battery Limit	B&Mc	B&Mc	B&Mc	B&Mc	
118	Flue Gas Duct from ISBL Battery Limit to Quencher	B&Mc	B&Mc	B&Mc	B&Mc	
119	Ductwork from FGD Scrubber to Quencher (if any)	NA	NA	NA	NA	
120	Ductwork from Quencher to Blower, from Blower to Absorber	MHI	MHI	MHI	B&Mc	
121	Duct Expansion Joints and Associated Hardware	MHI	MHI	MHI	B&Mc	for ISBL
122	Flue Gas Blower	MHI	MHI	MHI	B&Mc	
123	Flue Gas Blower Lube Oil Skid	MHI	MHI	MHI	B&Mc	Lube oil system except insulation, which is to be field installed by B&Mc.
124	Dampers and Expansion Joints (BOP)	B&Mc	B&Mc	B&Mc	B&Mc	
125	Flue Gas Drains - ISBL	B&Mc	B&Mc	B&Mc	B&Mc	
126	Flue Gas Drains - OSBL	B&Mc	B&Mc	B&Mc	B&Mc	
127	Flue Gas Drain Tank (if necessary)	B&Mc	B&Mc	B&Mc	B&Mc	Assumed in B&Mc-Supplied Auxiliary Building
128	Flue Gas Drains Tank Forwarding Pumps (if necessary)	B&Mc	B&Mc	B&Mc	B&Mc	Assumed in B&Mc-Supplied Auxiliary Building
129	**Platforms / Stairs / Ladders / Safety Gates**					
130	ISBL Platforms, Ladders, Stairs, Landings, Cages, Handrails, Safety Gates	MHI	MHI	B&Mc	B&Mc	Including Ductwork, and Quencher/Absorber Stair Tower
131	OSBL Platforms, Ladders, Stairs, Landings, Cages, Handrails, Safety Gates	B&Mc	B&Mc	B&Mc	B&Mc	
132	FGD Process Equipment & Components	NA	NA	NA	NA	
133	ISBL Process Equipment & Components	MHI	MHI	MHI	B&Mc	
134	Vendor-Supplied Access Platform					
135	CO_2 Compressor Unit Access Platform	MHI	MHI	MHI	B&Mc	
136	Dehydration Unit Access Platform	MHI	MHI	MHI	B&Mc	
137	Precoat Filter Access Platform	MHI	MHI	MHI	B&Mc	
138	Regenerator, Pressure Vessels and Tanks	MHI	MHI	MHI	B&Mc	
~~139~~	~~Quencher, CO_2 Absorber, Ductwork, and Quencher/Absorber Stair Tower~~	~~MHI~~	~~MHI~~	~~B&Mc~~	~~B&Mc~~	
140	FGD Scrubber	NA	NA	NA	NA	
141	**FGD System**	NA	NA	NA	NA	
142	FGD Scrubber Shell (including Internal Supports)	NA	NA	NA	NA	Collaboration with Quencher Design
143	FGD Mechanical Equipment	NA	NA	NA	NA	
144	FGD Recycle Pumps	NA	NA	NA	NA	
145	Other Process Pumps	NA	NA	NA	NA	
146	Manual Valves	NA	NA	NA	NA	
147	Inline Specialty Items	NA	NA	NA	NA	
148	Tower Internals	NA	NA	NA	NA	
149	Agitators	NA	NA	NA	NA	
150	Limestone Feed System	NA	NA	NA	NA	
151	Gypsum Dewatering System	NA	NA	NA	NA	

SCOPE OF WORK AND DIVISION OF WORK ("DOW")

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MHI	Mitsubishi Heavy Industries
B&Mc	Burns & McDonnell
NA	Not Applicable for this Project or Task

		FEED Study Phase				
Line	**Description**	**Conceptual Design**	**Bill of Quantity**	**Material Cost Estimating**	**Construction Estimate**	**Remarks**
152	Process Piping (Recycle Piping)	NA	NA	NA	NA	
153	Process Piping (Except for Recycle Piping)	NA	NA	NA	NA	
154	FGD Scrubber Leak Test	NA	NA	NA	NA	
155	Gypsum and Reagent Initial Fill	NA	NA	NA	NA	
156	**Transportation**					
157	Delivery/Transportation	B&Mc/MHI	B&Mc/MHI	B&Mc/MHI	NA	Each for respective scope. Heavy haul by respective supplier.
158	Routing Studies	B&Mc/MHI	B&Mc/MHI	B&Mc/MHI	NA	Each for respective scope.
159	Quantifying Construction Details	NA	B&Mc/MHI	NA	B&Mc	Each for respective scope.
160	**Piping**					
161	Large Bore ISBL Piping, Manual Valves, On/Off Valves	MHI	MHI	B&Mc	B&Mc	LB = 2-1/2" and larger, Iso's provided by MHI during EPC
162	Small Bore ISBL Piping, Manual Valves, On/Off Valves	MHI	MHI	B&Mc	B&Mc	SB = 2" and smaller, Iso's provided by MHI during EPC
163	Below Grade Piping	B&Mc	B&Mc	B&Mc	B&Mc	Process info for ISBL by MHI
163	OSBL/BOP Piping and Valves	B&Mc	B&Mc	B&Mc	B&Mc	
163	Inline Specialty Items	B&Mc/MHI	B&Mc/MHI	B&Mc/MHI	B&Mc	Each for respective piping scope.
164	Control Valves - ISBL	MHI	MHI	MHI	B&Mc	For both large and small bore
165	Control Valves - OSBL	B&Mc	B&Mc	B&Mc	B&Mc	
166	Piping Supports	B&Mc/MHI	B&Mc/MHI	B&Mc	B&Mc	Each for respective piping scope. Including clamps, hangers, rods, shoes and supplemental steel as shown on support details, required to interface pipe supports to structural steel.
167	Hose Station / Connectors	B&Mc/MHI	B&Mc/MHI	B&Mc	B&Mc	Each for respective piping scope.
170	**Trim FGD System / Quencher**					
171	Flue Gas Quencher Shell (including Internal Supports)	MHI	MHI	MHI	B&Mc	
172	Trim FGD System / Quencher Mechanical Equipment					
173	Caustic Soda Storage Tank	MHI	MHI	MHI	B&Mc	
174	Trim FGD System Recycle Pump	MHI	MHI	MHI	B&Mc	
175	Flue Gas Cooling Water Pump	MHI	MHI	MHI	B&Mc	
176	Manual Valves	MHI	MHI	MHI	B&Mc	
177	Inline Specialty Items	MHI	MHI	MHI	B&Mc	
178	Flue Gas Cooling Water Heat Exchanger	MHI	MHI	MHI	B&Mc	
179	Other CCS Process Pumps	MHI	MHI	MHI	B&Mc	
180	Caustic Waste Water Receiving Tank	MHI	MHI	MHI	B&Mc	
181	Caustic Waste Water Transfer Pump	MHI	MHI	MHI	B&Mc	
182	Tower Internals	MHI	MHI	MHI	B&Mc	
183	Tank Electric Heaters (if required)	MHI	MHI	MHI	B&Mc	
184	Process Piping					See Piping Section
185	Flue Gas Quencher Leak Test	MHI	B&Mc	B&Mc	B&Mc	Field tested by B&Mc
186	Caustic Soda Initial Fill	MHI	MHI	MHI	B&Mc	
187	**Solvent System**					

SCOPE OF WORK AND DIVISION OF WORK ("DOW")

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MHI	Mitsubishi Heavy Industries
B&Mc	Burns & McDonnell
NA	Not Applicable for this Project or Task

		FEED Study Phase				
Line	**Description**	**Conceptual Design**	**Bill of Quantity**	**Material Cost Estimating**	**Construction Estimate**	**Remarks**
188	Absorber Shell (including Internal Supports)	MHI	MHI	MHI	B&Mc	
189	CCS Mechanical Equipment					
190	Regenerator	MHI	MHI	MHI	B&Mc	
191	Regenerator Internals including Internal Support Beams	MHI	MHI	MHI	B&Mc	
192	Reboilers	MHI	MHI	MHI	B&Mc	
193	Other CCS Process Heat Exchangers (Shell & Tube / Plate & Frame)	MHI	MHI	MHI	B&Mc	
194	Manual Valves	MHI	MHI	MHI	B&Mc	
195	Inline Specialty Items	MHI	MHI	MHI	B&Mc	
196	Pressure Vessels	MHI	MHI	MHI	B&Mc	
197	Other CCS Process Pumps	MHI	MHI	MHI	B&Mc	
198	Solvent Unloading System	MHI	MHI	MHI	B&Mc	
199	Solution Storage Tank	MHI	MHI	MHI	B&Mc	
200	Solution Sump Tank	MHI	MHI	MHI	B&Mc	
201	Solution Sump Pump	MHI	MHI	MHI	B&Mc	
202	Reclaimed Waste Tank (if required)	MHI	MHI	MHI	B&Mc	
203	Cartridge Filter	MHI	MHI	MHI	B&Mc	
204	Carbon Filter (if required)	MHI	MHI	MHI	B&Mc	
205	Precoat Filter	MHI	MHI	MHI	B&Mc	
206	Tower Internals	MHI	MHI	MHI	B&Mc	
207	Tank Electric Heaters (if required)	MHI	MHI	MHI	B&Mc	
208	Process Piping					See Piping Section
209	Absorber Tower Leak Test	MHI	B&Mc	B&Mc	B&Mc	Field tested by B&Mc
210	Solvent Initial Fill	MHI	MHI	MHI	B&Mc	
211	**CO_2 Compression System and Piping**					
212	Compressor, Motor, Steels, Piping and Accessories	MHI	MHI	MHI	B&Mc	Within Compressor Module
213	CO_2 Pump (if any)	MHI	MHI	MHI	B&Mc	
214	Compressor Lube Oil System	MHI	MHI	MHI	B&Mc	Lube oil system except insulation, which is to be field installed by B&Mc.
215	Interstage Coolers	MHI	MHI	MHI	B&Mc	
216	Dehydration Unit	MHI	MHI	MHI	B&Mc	
217	Compression System Instrumentation	MHI	MHI	MHI	B&Mc	Within compressor skid
218	Manual Valves	MHI	MHI	MHI	B&Mc	
219	Inline Specialty Items	MHI	MHI	MHI	B&Mc	
220	Compressor Noise Enclosure (if required)	MHI	MHI	MHI	B&Mc	
221	Compressor Lube Oil Accumulator Nitrogen Fill	MHI	MHI	MHI	B&Mc	
222	CO_2 Piping and Valves (Outside Compressor Module to Project Battery Limit)					See Piping Section
223	CO_2 Piping and Valves (BOP)					See Piping Section
224	**Cooling System**					

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MHI	Mitsubishi Heavy Industries
B&Mc	Burns & McDonnell
NA	Not Applicable for this Project or Task

		FEED Study Phase				
Line	**Description**	**Conceptual Design**	**Bill of Quantity**	**Material Cost Estimating**	**Construction Estimate**	**Remarks**
225	Cooling Water Supply to ISBL Battery Limits	B&Mc	B&Mc	B&Mc	B&Mc	
~~226~~	~~Air Cooler (if any)~~	~~B&Mc~~	~~B&Mc~~	~~B&Mc~~	~~B&Mc~~	
227	Above Ground Cooling Water Distribution Piping					See Piping Section
228	Above Ground Cooling Water Distribution Manual Valves					See Piping Section
229	Above Ground Cooling Water Distribution Inline Specialty Items					See Piping Section
230	**Above Ground Water and Wastewater Systems**					
231	Water Supply to Battery Limits	B&Mc	B&Mc	B&Mc	B&Mc	
232	Water Distribution within Battery Limits					
233	**CCS**					
234	Utility Water Distribution					See Piping Section
235	Hose Station / Connectors					See Piping Section
236	Potable Water Distribution					See Piping Section
237	Wastewater Handling System					See Piping Section
238	Catch Basins, Valve Pits					See Piping Section
239	**FGD**	NA	NA	NA	NA	
240	Utility Water Distribution	NA	NA	NA	NA	See Piping Section
241	Hose Station / Connectors	NA	NA	NA	NA	See Piping Section
242	Potable Water Distribution	NA	NA	NA	NA	See Piping Section
243	Wastewater Handling System	NA	NA	NA	NA	See Piping Section
244	Catch Basins, Valve Pits	NA	NA	NA	NA	See Piping Section
245	Eyewash & Safety Shower with Heater Station - ISBL	MHI	MHI	MHI	B&Mc	Within battery limits
246	Eyewash & Safety Shower with Heater Station - OSBL	B&Mc	B&Mc	B&Mc	B&Mc	
247	Wastewater Transfer Pumps	B&Mc/MHI	B&Mc/MHI	B&Mc/MHI	B&Mc	ISBL by MHI, OSBL by B&Mc
248	**Steam & Condensate Systems**					
249	Steam Turbine Modification	B&Mc	B&Mc	B&Mc	B&Mc	
250	Steam Supply to Battery Limits	B&Mc	B&Mc	B&Mc	B&Mc	
251	Steam Supply & Distribution Piping					See Piping Section
252	Steam Supply & Distribution Manual Valves					See Piping Section
253	Steam Supply & Distribution Inline Specialty Items					See Piping Section
254	Condensate Collection & Return Piping from Battery Limits	B&Mc	B&Mc	B&Mc	B&Mc	
255	Condensate Collection & Return Piping					See Piping Section
256	Condensate Collection & Return Manual Valves					See Piping Section
257	Condensate Collection & Return Inline Specialty Items					See Piping Section
258	**Air System**					
259	Compressed Air Supply to Battery Limits	B&Mc	B&Mc	B&Mc	B&Mc	
260	Precoat Filter Air Receivers	MHI	MHI	MHI	B&Mc	
261	Compressed Air Distribution Piping					See Piping Section
262	Compressed Air Distribution Manual Valves					See Piping Section
263	Compressed Air Distribution Inline Specialty Items					See Piping Section

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MHI	Mitsubishi Heavy Industries
B&Mc	Burns & McDonnell
NA	Not Applicable for this Project or Task

		FEED Study Phase				
Line	**Description**	**Conceptual Design**	**Bill of Quantity**	**Material Cost Estimating**	**Construction Estimate**	**Remarks**
264	Instrument Air Piping					See Piping Section
265	Instrument Air Manual Valves					See Piping Section
266	Instrument Air Inline Specialty Items					See Piping Section
267	Hose Station / Connectors					See Piping Section
268	**Demineralized Water Piping and Valves**					
269	Demineralized Water Supply to Battery Limits	B&Mc	B&Mc	B&Mc	B&Mc	
270	Demineralized Water Piping					See Piping Section
271	Demineralized Water Manual Valves					See Piping Section
272	Demineralized Water Inline Specialty Items					See Piping Section
273	**Underground Hydraulic Systems**					
274	KS-1 Drain Piping	B&Mc	B&Mc	B&Mc	B&Mc	Process info by MHI
275	Process Area Drain (Oily Water, Wastewater)	B&Mc	B&Mc	B&Mc	B&Mc	~~Within battery limits~~
276	Cooling Water Distribution	B&Mc	B&Mc	B&Mc	B&Mc	~~Within battery limits~~
277	Fire Protection & Fire Water Loop	B&Mc	B&Mc	B&MC	B&Mc	~~Above ground valve stations included~~
278	Sanitary Sewer	B&Mc	B&Mc	B&MC	B&Mc	~~Within battery limits~~
279	Stormwater Drain	B&Mc	B&Mc	B&MC	B&Mc	~~Within battery limits~~. Roof drains by MHI to B&MC Storm
280	Lab Building Drains	B&Mc	B&Mc	B&Mc	B&Mc	Lab in BMcD-Supplied Building
281	Oily Water Drains	B&Mc	B&Mc	B&Mc	B&Mc	~~Within battery limits~~
282	**Insulation and Lagging**					
283	Piping	MHI	MHI	B&MC	B&Mc	
284	Equipment	MHI	MHI	B&MC	B&Mc	
285	Ductwork	MHI	MHI	B&MC	B&Mc	
286	Noise Insulation (if required)	MHI	MHI	MHI/B&Mc	B&Mc	CO_2 Compressor Noise Insulation Jacketing Supplied by MHI, Installed by B&Mc.
287	**Lifting & Handling Equipment**					
288	Hoist/Trolleys (where required)	MHI	MHI	MHI	B&Mc	For maintenance of pumps, major equipment, large valves, vessel isolation points and other areas requiring equipment removal - ISBL
289	Lifting Beams for Hoists (where required)	MHI	MHI	B&Mc	B&Mc	
290	Jib Crane for CO_2 Absorber (where required)	MHI	MHI	MHI	B&Mc	
291	Construction Elevator (if required)	B&Mc	B&Mc	B&Mc	B&Mc	
292	**I&C Engineering**					
293	**CCS Design**					
294	Instrument List / Database	MHI	NA	NA	NA	
295	DCS I/O List / Database	MHI	NA	NA	NA	
296	DCS I/O Signal Module Assignment	MHI	NA	NA	NA	
297	Instrument Location Plan	MHI	NA	NA	NA	
298	Operation & Control Narrative	MHI	NA	NA	NA	

SCOPE OF WORK AND DIVISION OF WORK ("DOW")

Project Tundra FEED	
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LEGEND	
Customer	EERC/Minnkota Power/Allete Clean Energy
MHI	Mitsubishi Heavy Industries
B&Mc	Burns & McDonnell
NA	Not Applicable for this Project or Task

		FEED Study Phase				
Line	**Description**	**Conceptual Design**	**Bill of Quantity**	**Material Cost Estimating**	**Construction Estimate**	**Remarks**
299	Set Point and Alarm List / Database	MHI	NA	NA	NA	
300	Control Logic Diagram	MHI	NA	NA	NA	
301	Raceway Design	MHI	NA	NA	NA	
302	Wiring & Termination Design	MHI	NA	NA	NA	
303	Instrument Hook-up (Installation Details)	MHI	NA	NA	NA	
304	**FGD Design**	NA	NA	NA	NA	
305	Instrument List / Database	NA	NA	NA	NA	
306	DCS I/O List / Database	NA	NA	NA	NA	
307	DCS I/O Signal Module Assignment	NA	NA	NA	NA	
308	Instrument Location Plan	NA	NA	NA	NA	
309	Operation & Control Narrative	NA	NA	NA	NA	
310	Set Point and Alarm List / Database	NA	NA	NA	NA	
311	Control Logic Diagram	NA	NA	NA	NA	
312	Raceway Design	NA	NA	NA	NA	
313	Wiring & Termination Design	NA	NA	NA	NA	
314	Instrument Hook-up (Installation Details)	NA	NA	NA	NA	
315	**BOP Design**	B&Mc	NA	NA	NA	
316	**I&C Procurement**					
317	**CCS**					
318	Equipment					
319	Control Room & Electronics Room Enclosure	MHI	MHI	MHI	B&Mc	
320	Control & Electronics Room Furniture	MHI	MHI	MHI	B&Mc	Chairs, Tables, Shelves, etc.
321	Telecommunications for Electrical Building	B&Mc	B&Mc	B&Mc	B&Mc	
322	Operator Station Console	MHI	MHI	MHI	B&Mc	
323	Engineering Station Console	MHI	MHI	MHI	B&Mc	
324	DCS (Hardware & Software)	MHI	MHI	MHI	B&Mc	
325	DCS Programming	MHI	MHI	MHI	NA	Includes CCS and BOP
326	Vibration Monitoring ~~System~~ Instrumentation on Equipment	MHI	MHI	MHI	NA	To be shop installed
327	Vibration Monitoring Control System	MHI	MHI	MHI	B&Mc	
328	Field Instruments	MHI	MHI	MHI	B&Mc	
329	Control & Automated On-off Valves and MOVs	MHI	MHI	MHI	B&Mc	
330	Continuous Emission Monitoring System (CEMS)	B&Mc	B&Mc	B&Mc	B&Mc	
331	CEMS - Shelter	B&Mc	B&Mc	B&Mc	B&Mc	
332	CEMS - Gas Sampling Tube Bundle	B&Mc	B&Mc	B&Mc	B&Mc	
333	Packaged Unit Vendor-Supplied Equipment					CO_2 Compressor, Precoat Filters, Dehydration Unit~~, CEMS~~
334	Control & Instrument Cables for Materials Shipped Loose (JB - Field)	MHI	MHI	MHI	B&Mc	
335	Cable Raceways for Materials Shipped Loose (JB - Field)	MHI	MHI	MHI	B&Mc	
336	Field Junction Boxes (Shipped Loose)	MHI	MHI	MHI	B&Mc	
337	Stanchion & Support Material for Instrument	MHI	MHI	MHI	B&Mc	

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Project Tundra FEED	
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MHI	Mitsubishi Heavy Industries
B&Mc	Burns & McDonnell
NA	Not Applicable for this Project or Task

		FEED Study Phase				
Line	**Description**	**Conceptual Design**	**Bill of Quantity**	**Material Cost Estimating**	**Construction Estimate**	**Remarks**
338	Instrument Tubing & Fittings w/Associated Support Hardware where Material Shipped Loose for Instrument	MHI	MHI	MHI	B&Mc	
339	Construction Materials					
340	Fiber Optic Cables	B&Mc	MHI	B&Mc	B&Mc	Material Spec by B&Mc, Quantity by MHI
341	Control & Instrument Cables	B&Mc	MHI	B&Mc	B&Mc	Material Spec by B&Mc, Quantity by MHI
342	Cable Raceways w/Support Materials	B&Mc	MHI	B&Mc	B&Mc	Material Spec by B&Mc, Quantity by MHI
343	Field Junction Boxes	B&Mc	MHI	B&Mc	B&Mc	Material Spec by B&Mc, Quantity by MHI
344	Stanchion & Support Material for Instrument	B&Mc	MHI	B&Mc	B&Mc	Material Spec by B&Mc, Quantity by MHI
345	Instrument Tubing & Fittings w/Associated Support Hardware	B&Mc	MHI	B&Mc	B&Mc	Material Spec by B&Mc, Quantity by MHI
346	Ladder Trays for Gas Sampling Tube Bundles for CEMS	B&Mc	MHI	B&Mc	B&Mc	Material Spec by B&Mc, Quantity by MHI
347	Copper Ethernet Cables for DCS	B&Mc	MHI	B&Mc	B&Mc	Between equipment located in electrical building Material Spec by B&Mc, Quantity by MHI
348	**FGD**	NA	NA	NA	NA	
349	Equipment	NA	NA	NA	NA	
350	Vibration Monitoring System (within Control Room)	NA	NA	NA	NA	To be shop installed
351	Field Instruments	NA	NA	NA	NA	
352	Control & Automated On-off Valves and MOVs	NA	NA	NA	NA	
353	SO_2 Analyzer	NA	NA	NA	NA	
354	Packaged Unit Vendor-Supplied Equipment	NA	NA	NA	NA	Dewatering System
355	Control & Instrument Cables for Materials Shipped Loose (JB - Field)	NA	NA	NA	NA	
356	Cable Raceways for Materials Shipped Loose (JB - Field)	NA	NA	NA	NA	
357	Field Junction Boxes (Shipped Loose)	NA	NA	NA	NA	
358	Stanchion & Support Material for Instrument	NA	NA	NA	NA	
359	Instrument Tubing & Fittings w/Associated Support Hardware where Material Shipped Loose for Instrument	NA	NA	NA	NA	
360	Construction Materials	NA	NA	NA	NA	
361	Fiber Optic Cables	NA	NA	NA	NA	
362	Control & Instrument Cables	NA	NA	NA	NA	
363	Cable Raceways w/Support Materials	NA	NA	NA	NA	
364	Field Junction Boxes	NA	NA	NA	NA	
365	Stanchion & Support Material for Instrument	NA	NA	NA	NA	
366	Instrument Tubing & Fittings w/Associated Support Hardware	NA	NA	NA	NA	
367	Ladder Trays for Gas Sampling Tube Bundles	NA	NA	NA	NA	
368	Copper Ethernet Cables for DCS	NA	NA	NA	NA	Between equipment located in electrical building
369	Remote IO Panel	NA	NA	NA	NA	FGD will be controlled by DCS provided by MHI.
370	**BOP**	B&Mc	B&Mc	B&Mc	B&Mc	
371	**Power Distribution System**					

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Customer	EERC/Minnkota Power/Allete Clean Energy
MHI	Mitsubishi Heavy Industries
B&Mc	Burns & McDonnell
NA	Not Applicable for this Project or Task

		FEED Study Phase				
Line	**Description**	**Conceptual Design**	**Bill of Quantity**	**Material Cost Estimating**	**Construction Estimate**	**Remarks**
372	Medium Voltage Cable Bus	MHI	MHI	MHI	See Remarks	B&Mc for field/module install, MHI for inside of PDC Building.
373	Electrical Equipment Room Prefabricated PDC Building	MHI	MHI	MHI	B&Mc	~~*Platform and stairs by B&Mc.~~
374	Transformers	MHI	MHI	MHI	B&Mc	
375	Switchgear	MHI	MHI	MHI	See Remarks	B&Mc for field/module install, MHI for inside of PDC Building.
376	Motor Control Centers (MCC)	MHI	MHI	MHI	See Remarks	B&Mc for field/module install, MHI for inside of PDC Building.
377	Bus Ducts, Bus Duct Supports	MHI	MHI	MHI	B&Mc	B&Mc for field/module install, MHI for inside of PDC Building.
378	Power Distribution Panels	MHI	MHI	MHI	See Remarks	B&Mc for field/module install, MHI for inside of PDC Building.
379	Process Equipment Variable Frequency Drives	MHI	MHI	MHI	See Remarks	B&Mc for field/module install, MHI for inside of PDC Building.
380	UPS, Battery Charger System	MHI	MHI	MHI	See Remarks	B&Mc for field/module install, MHI for inside of PDC Building.
381	UPS Batteries	MHI	MHI	MHI	B&Mc	
382	**Electric Motors**	B&Mc/MHI	B&Mc/MHI	B&Mc/MHI	B&Mc	B&Mc for BOP. MHI for ISBL
383	**Electrical**					
384	Communication / Telephone / Paging System	B&Mc	B&Mc	B&Mc	B&Mc	
385	Lighting Indoor and Outdoor	B&Mc	B&Mc	B&Mc	B&Mc	~~Lighting inside the PDC Building is MHI scope.~~ ~~*Wiring by B&Mc.~~ BMcD to provide all lighting design and materials since PDC doesn't exist.
386	Fire Protection/Detection System	B&Mc	B&Mc	B&Mc	B&Mc	~~Fire protection for MHI scope buildings to be MHI scope.~~ B&Mc will provide fire protection concept report. B&Mc will subcontract detailed design and installation to F&E Contractor
387	Power Supply for Heat Tracing	B&Mc	B&Mc	B&Mc	B&Mc	
388	Heat Tracing					
389	Heat Tracing Non-Packaged Systems - BOP (if required)	B&Mc	B&Mc	B&Mc	B&Mc	B&McD will subcontract detailed freeze protection design and supply to freeze protection vendor
390	Heat Tracing Precoat Filter Unit	NA	NA	NA	NA	
391	Heat Tracing CO_2 Compressor Unit	NA	NA	NA	NA	
392	Heat Tracing Dehydration System	NA	NA	NA	NA	
393	Heat Tracing Dewatering System	NA	NA	NA	NA	
394	Power Cables	MHI	MHI	B&Mc	B&Mc	
395	Cable Raceways w/Support Materials	MHI	MHI	B&Mc	B&Mc	
396	Underground Electrical Cables (if any)	MHI	MHI	B&Mc	B&Mc	
397	Duct bank (if any)	B&Mc/MHI*	B&Mc	B&Mc	B&Mc	*Route provided by MHI, Detailed design by B&Mc
398	Grounding	B&Mc	B&Mc	B&Mc	B&Mc	~~Above ground grounding included.~~
399	Lightning Protection	B&Mc	B&Mc	B&Mc	B&Mc	Will be design F&E subcontract for entire facility
400	Cathodic Protection (if required)	NA	NA	NA	NA	
401	Welding/Maintenance Receptacles	B&Mc	B&Mc	B&Mc	B&Mc	
402	Aviation Lighting	B&Mc	B&Mc	B&Mc	B&Mc	As required by local regulation

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B&Mc	Burns & McDonnell
NA	Not Applicable for this Project or Task

		FEED Study Phase				
Line	**Description**	**Conceptual Design**	**Bill of Quantity**	**Material Cost Estimating**	**Construction Estimate**	**Remarks**
403	**Civil**					
404	Geotechnical/Topographic Survey	See Line 2	NA	NA	NA	
405	Underground Site Survey - Verification of UG Utilities and TPs	B&Mc	B&Mc	B&Mc	B&Mc	
406	Cut and Fill	B&Mc	B&Mc	B&Mc	B&Mc	
407	Excavation	B&Mc	B&Mc	B&Mc	B&Mc	
408	Foundations & Grout	B&Mc	B&Mc	B&Mc	B&Mc	
409	Rebar	B&Mc	B&Mc	B&Mc	B&Mc	
410	Piles	B&Mc	B&Mc	B&Mc	B&Mc	
411	Electrical Underground	B&Mc	B&Mc	B&Mc	B&Mc	
412	Drain Funnels	B&Mc	B&Mc	B&Mc	B&Mc	
413	Sumps and Trenches	B&Mc	B&Mc	B&Mc	B&Mc	
414	Grading & Drainage	B&Mc	B&Mc	B&Mc	B&Mc	
415	Paving	B&Mc	B&Mc	B&Mc	B&Mc	
416	Fencing (if required)	B&Mc	B&Mc	B&Mc	B&Mc	
417	Storm Water Management (SWPPP)	B&Mc	B&Mc	B&Mc	B&Mc	
418	Modifications to Existing Underground Utilities (if necessary)	B&Mc	B&Mc	B&Mc	B&Mc	
419	Erosion Control / Site Maintenance	B&Mc	B&Mc	B&Mc	B&Mc	
420	Surface Finish, Gravel Replacement	B&Mc	B&Mc	B&Mc	B&Mc	
421	Sanitary Sewer	B&Mc	B&Mc	B&Mc	B&Mc	
422	**Site Construction Services**					
423	Demolish Existing Facilities	B&Mc	B&Mc	B&Mc	B&Mc	
424	Outage Coordination and Management	B&Mc	B&Mc	B&Mc	B&Mc	
425	Security	NA	NA	B&Mc	NA	
426	Site Supervision	NA	NA	B&Mc	NA	
427	Site Technical Supervision	NA	NA	B&Mc/MHI	NA	MHI to provide discipline Technical Field Assistants for MHI Scope.
428	Construction Advisor (Site)	NA	NA	B&Mc	NA	
429	Safety Supervision (Site)	NA	NA	B&Mc	NA	
430	Construction Coordination (Home Office)	NA	NA	B&Mc	NA	
431	Engineering Support (Home Office)	NA	NA	B&Mc/MHI	NA	
432	Site QA/QC	NA	NA	B&Mc	NA	
433	Site Support Services	NA	NA	B&Mc	NA	
434	Construction Procedures, Lifting Plan	NA	NA	B&Mc	NA	
435	Temporary Utilities & Services	NA	B&Mc	B&Mc	NA	
436	Temporary Construction Power	B&Mc	B&Mc	B&Mc	B&Mc	
437	Laydown Areas	B&Mc	B&Mc	B&Mc	B&Mc	
438	Site Unloading for All Equipment and Materials	NA	NA	B&Mc	NA	
439	Site Storage for All Equipment and Materials	NA	NA	B&Mc	NA	With security system if required.
440	Site Material Control	NA	NA	B&Mc	NA	

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Project Tundra FEED	
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MHI	Mitsubishi Heavy Industries
B&Mc	Burns & McDonnell
NA	Not Applicable for this Project or Task

		FEED Study Phase				
Line	**Description**	**Conceptual Design**	**Bill of Quantity**	**Material Cost Estimating**	**Construction Estimate**	**Remarks**
441	Spreader Bars for Lifting	NA	NA	B&Mc	NA	
442	Custom Tools for Equipment Lifting, Erection, and Maintenance (if required)	NA	MHI	MHI	B&Mc	
443	Craneage / Lifting Equipment	NA	NA	B&Mc	NA	
444	Office Trailers	NA	NA	B&Mc	NA	MHI to provide desired office space
445	Office Equipment and Supplies	NA	NA	B&Mc	NA	Including furniture, A/C, restroom, break room, lighting, internet, phones (domestic call, international call), printers, scanners, copiers, appliances, utilities, sanitary, radio, site office maintenance, etc.
446	Vehicles	NA	NA	B&Mc/MHI	NA	Each party for his own use
447	Safety Equipment	NA	NA	B&Mc	NA	
448	Site Temporary LAN Cabling	NA	NA	B&Mc	B&Mc	
449	Mobilization / Demobilization Costs	NA	NA	B&Mc	NA	
450	Site Construction Services Sub Contractor	NA	NA	B&Mc	NA	
451	Construction Consumables	NA	NA	B&Mc	NA	
452	Shims for Equipment Alignment and Leveling	NA	NA	B&Mc/MHI	NA	Any specialized shims/fixators for large equipment by MHI
453	Bolts, Nuts, Washers and Gaskets for Piping	NA	B&Mc/MHI	B&Mc	B&Mc	To be supplied by responsible party for piping supply.
454	Equipment Touch-Up Painting	NA	NA	NA	B&Mc	
455	Vendor Technical Support	NA	MHI	MHI	NA	
456	Housekeeping	NA	NA	NA	B&Mc	
457	Redline Drawing Mark-ups	NA	NA	NA	NA	
458	For Record Drawings	NA	NA	NA	NA	
459	Emergency Medical Personnel and First Aid	NA	NA	B&Mc	NA	
460	Erection & Commissioning Spare Parts~~ - CCS~~	NA	B&Mc/MHI	B&Mc/MHI	B&Mc	Each for respective scope.
461	Erection & Commissioning Spare Parts - FGD	NA	NA	NA	NA	
462	**Architectural / Buildings / Enclosures**					
463	Buildings, Enclosures, Furniture and HVAC					
464	CEMS Shelter					See Line 331
465	Prefabricated PDC Building (if required)					See Line 373
466	Process Equipment Building	MHI	MHI	B&Mc	B&Mc	Siding and roofing
467	Laboratory Building	B&Mc	B&Mc	B&Mc	B&Mc	HVAC, laboratory equipment and supplies included. Lab in B&Mc-Provided Auxiliary Building
468	Dewatering System Building	NA	NA	NA	NA	
469	Break Room & Restroom	B&Mc	B&Mc	B&Mc	B&Mc	
470	Offices / Admin. Building	B&Mc	B&Mc	B&Mc	B&Mc	
471	Maintenance Shop	B&Mc	B&Mc	B&Mc	B&Mc	
472	Storage	B&Mc	B&Mc	B&Mc	B&Mc	
473	HVAC	B&Mc/MHI	B&Mc/MHI	B&Mc/MHI	B&Mc	Each for respective building design scope.
474	**Commissioning/Startup**					

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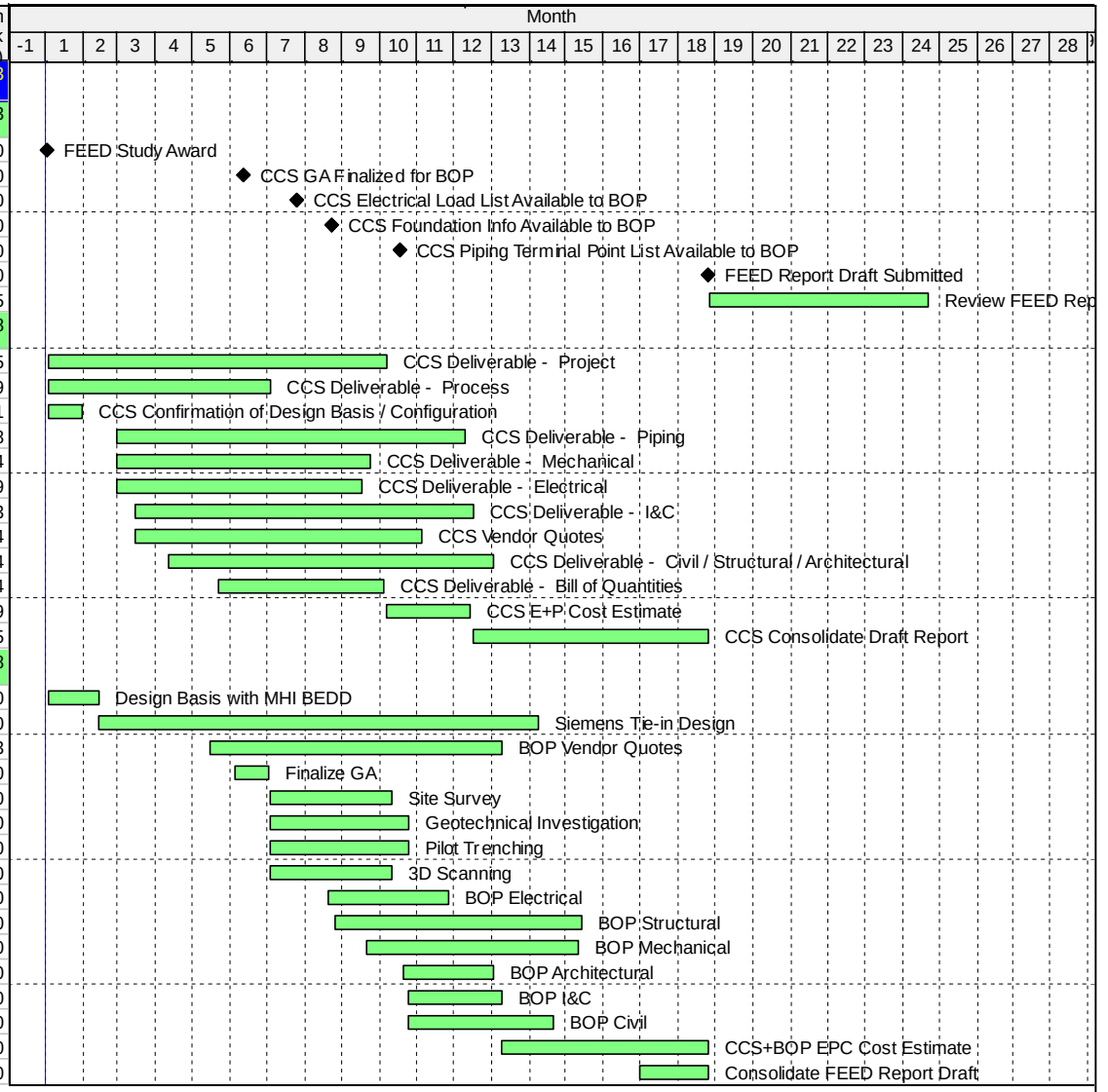
MHI	Mitsubishi Heavy Industries
B&Mc	Burns & McDonnell
NA	Not Applicable for this Project or Task

		FEED Study Phase				
Line	**Description**	**Conceptual Design**	**Bill of Quantity**	**Material Cost Estimating**	**Construction Estimate**	**Remarks**
475	Start-up Management	B&Mc	B&Mc	B&Mc	B&Mc	
476	Commissioning Technical Support	B&Mc/MHI	B&Mc/MHI	B&Mc/MHI	B&Mc/MHI	Each for respective scope.
477	Commissioning & Start-up Craft Support	B&Mc	B&Mc	B&Mc	B&Mc	
478	Start-up Strainers	B&Mc/MHI	B&Mc/MHI	B&Mc/MHI	B&Mc	Each for respective scope.
479	Commissioning Coordination	NA	NA	NA	NA	
480	Temporary Piping, Pancakes and Stars for Flushing	NA	B&Mc	B&Mc	B&Mc	
481	Temporary Steam Blow Piping	MHI	MHI	B&Mc	B&Mc	Assumed blow would be from existing STG crossover to CCS equipment inside building. Therefore design by MHI.
482	Temporary Silencer for Steam Blowing	NA	B&Mc	B&Mc	B&Mc	
483	Chemicals, Lubricants First Fill	NA	B&Mc/MHI	B&Mc/MHI	B&Mc	Each his own
484	Vendor Technical Support	NA	MHI	MHI	NA	
485	Performance Test Procedures	B&Mc/MHI		NA	NA	Each his own as required
486	Performance Testing	B&Mc/MHI		NA	NA	Each his own as required
487	Performance Test Measurement and Reporting	B&Mc/MHI	NA	NA	NA	Each his own as required
488	Performance Test Measurement Instruments	NA	MHI	MHI	NA	

APPENDIX D – PRELIMINARY FEED SCHEDULE

Activity ID	Activity Name	Duration (Work Days)
Project Tundra FEED Study Schedule		503
Major Milestones		503
MS-1	FEED Study Award	0
MS-CCS-10	CCS GA Finalized for BOP	0
MS-CCS-30	CCS Electrical Load List Available to BOP	0
MS-CCS-20	CCS Foundation Info Available to BOP	0
MS-CCS-40	CCS Piping Terminal Point List Available to BOP	0
MS-2	FEED Report Draft Submitted	0
MS-3	Review FEED Report Draft and Consolidate DOE Report	125
CCS		378
CCS-110	CCS Deliverable - Project	195
CCS-120	CCS Deliverable - Process	129
CCS-125	CCS Confirmation of Design Basis / Configuration	21
CCS-130	CCS Deliverable - Piping	198
CCS-140	CCS Deliverable - Mechanical	144
CCS-150	CCS Deliverable - Electrical	139
CCS-160	CCS Deliverable - I&C	193
CCS-200	CCS Vendor Quotes	164
CCS-170	CCS Deliverable - Civil / Structural / Architectural	184
CCS-190	CCS Deliverable - Bill of Quantities	94
CCS-210	CCS E+P Cost Estimate	49
CCS-220	CCS Consolidate Draft Report	135
BOP		378
BOP-110	Design Basis with MHI BEDD	30
BOP-120	Siemens Tie-in Design	250
BOP-270	BOP Vendor Quotes	163
BOP-130	Finalize GA	20
BOP-140	Site Survey	70
BOP-150	Geotechnical Investigation	80
BOP-160	Pilot Trenching	80
BOP-170	3D Scanning	70
BOP-220	BOP Electrical	70
BOP-250	BOP Structural	140
BOP-210	BOP Mechanical	120
BOP-260	BOP Architectural	50
BOP-230	BOP I&C	50
BOP-240	BOP Civil	80
BOP-310	CCS+BOP EPC Cost Estimate	120
BOP-320	Consolidate FEED Report Draft	40



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EERC SUBCONTRACT PROPOSAL

Energy & Environmental Research Center
15 North 23rd Street, Stop 9018 • Grand Forks, ND 58202-9018 • P. 701.777.5000 • F. 701.777.5181
www.undeerc.org

October 31, 2018

Mr. Gerry Pfau
Senior Manager of Project Development
Minnkota Power Cooperative, Inc.
1822 Mill Road
PO Box 13200
Grand Forks, ND 58208-3200

Dear Mr. Pfau:

Subject: EERC Proposal No. 2019-0047 Entitled "Project Tundra FEED Technical and Administrative Support"

Introduction

The development of Project Tundra is a key component of North Dakota's energy future. Maintaining the current lignite industry (over $3 billion) while developing a new CO_2 enhanced oil recovery (EOR) industry will further strengthen the state as an energy provider. The Energy & Environmental Research Center (EERC) is pleased to be a part of the continued development of Project Tundra by providing administrative support and technical assistance for the Project Tundra FEED (front-end engineering design) project. The EERC looks forward to working with Minnkota Power Cooperative, Inc. (Minnkota), the North Dakota Industrial Commission (NDIC) through the Lignite Research Council and the Lignite Energy Council, the U.S. Department of Energy (DOE), BNI Energy, Eagle Energy Partners I, LLC (EEPI), Burns & McDonnell, Mitsubishi Heavy Industries (MHI), and others as needed and identified during the project.

Work Scope

The EERC's involvement in current research projects that support Project Tundra uniquely qualifies the organization to aid with the FEED project. The proposed scope of work will provide technical/administrative support as well as facilitate the completion of optimization studies that may be necessary at the end of the pre-FEED, moving into the FEED study. The EERC's scope of work has been divided into two tasks as follows.

Task 1 – Administrative and Technical Management

The EERC will provide project management support to Minnkota for the Project Tundra FEED project. The EERC has well-established business systems in place and extensive experience working with government agencies. EERC personnel will work closely with Minnkota to administer the financial and contractual responsibilities related to the FEED project, offering quick access to decision makers and quick resolution of issues.

The EERC project team will assist in all aspects of project budget preparation and management, including preparing the NDIC and DOE proposal budgets, forms, and narrative ensuring that all funding opportunity announcement (FOA) requirements are met. Project expenditures and deliverables, including subcontracts and subrecipients, will be reviewed and approved by EERC staff for technical progress and cost monitoring, prior to being processed by Minnkota. Assistance will also be provided in setting up interfaces with the federal government and NDIC for processing invoices and reports and in preparing financial reports.

Support will also be provided to Minnkota in negotiating and administering sponsored agreements. This may include preparing correspondence and requesting modifications, approvals, and revisions as needed. EERC contracts staff will also prepare and negotiate subcontract/subrecepient/consultant and other purchase agreements as required by the project as well as monitor the agreements and facilitate the receipt and processing of associated invoices. Other activities may include tracking and reporting of equipment. If any intellectual property is developed, EERC Contracts will assist with paperwork and processes required.

Other project management activities to be performed will include the development and production of the DOE proposal, quarterly progress reports (according to NDIC and DOE requirements), and a comprehensive final report. EERC activities will include planning and execution of project status meetings. Technology transfer activities are anticipated to include, at Minnkota's request, the presentation of results through these meetings and reports as well as presentations at relevant technical conferences and facilitating the involvement of an NDIC designee in project meetings.

Project activities will be accomplished with a team including project management personnel, senior management, budgeting and contracts personnel, and the EERC accounting department. Results of all tasks described above will be provided in project meetings and reports. All additional deliverables will be summarized in project quarterly and final report(s).

Task 2 – Technical Assistance on Optimization Studies

The purpose of Task 2 is to describe the work involved in conducting short-term studies to address findings from the pre-FEED or the FEED that need to be addressed before construction. The scope of such "optimization studies" will be determined at the time and will be designed to ensure we accomplish the goal of the Project Tundra FEED study. To ensure that the results of a FEED study reflect the most economical Project Tundra possible, it will be prudent to optimize the plan and scope for optimization studies quickly as findings are reached. Therefore, the EERC will aid Minnkota Power in defining optimization studies as necessary to address issues as they are raised. It is conceivable that optimization study topics will include choice of process equipment, redundancy philosophy, selection of materials of construction, effluent identification and disposition, means of process heat recovery, steam supply selection between cogeneration

and steam turbine extraction, additional reservoir modeling to aid in pipeline and recycle facility design, cooling system evaluation vs. water availability, and possibly even overall engineering, procurement, and construction cost (EPC) contracting approach.

Budget

The estimated cost for EERC's scope of work is $4,000,000. Expenses will be invoiced monthly on a cost-reimbursable basis. A detailed budget is shown in Table 1, and budget notes are in Attachment A. This project is anticipated to start January 1, 2019, and will end August 31, 2021. The primary deliverables will be the final project report and quarterly reports for NDIC, DOE, and others.

Table 1. Detailed Budget

Project Associated Expense	NDIC (Cash)	DOE (Cash)	Minnkota (Cash)	Total Project
Labor	$ -	$ 2,318,282	$ 183,490	$ 2,501,772
Travel	$ -	$ 108,829	$ -	$ 108,829
Supplies	$ -	$ 3,930	$ 1,500	$ 5,430
Communications	$ -	$ 3,000	$ 600	$ 3,600
Printing & Duplicating	$ -	$ 2,031	$ 626	$ 2,657
Food	$ -	$ 1,000	$ -	$ 1,000
Laboratory Fees & Services				
Graphics Services	$ -	$ 8,560	$ 1,284	$ 9,844
Technical Software Fee	$ -	$ 12,840	$ -	$ 12,840
Facilities & Administration	$ -	$ 1,241,528	$ 112,500	$ 1,354,028
Total Project Costs	$ -	$ 3,700,000	$ 300,000	$ 4,000,000

The project will be managed by Mr. Jason Laumb, who is a Principal Engineer at the EERC. Mr. Laumb has over 18 years of experience in the management and development of projects that involve advanced energy technologies, including gas cleanup and CO_2 capture. Additional staff from the EERC's accounting, work flow, and budget analyst group will be included in the project team. EERC project team resumes are attached in Attachment B.

The proposed work will be initiated upon execution of a contract between our organizations. If you have any questions regarding the proposed work scope or schedule, please contact me by phone at (701) 777-5114 or by e-mail at jlaumb@undeerc.org.

Sincerely,

Jason D. Laumb
Principal Engineer, Advanced Energy Systems

Approved by:

for

Thomas A. Erickson, CEO
Energy & Environmental Research Center

JDL/bjr

Attachment

ATTACHMENT A

BUDGET JUSTIFICATION

BUDGET JUSTIFICATION

APPLICABLE TO FEDERAL/FEDERAL FLOW-THROUGH COST-REIMBURSABLE PROPOSALS ENERGY & ENVIRONMENTAL RESEARCH CENTER (EERC)

BACKGROUND

The EERC is an independently organized multidisciplinary research center within the University of North Dakota (UND). The EERC is funded through federal and nonfederal grants, contracts, and other agreements. Although the EERC is not affiliated with any one academic department, university faculty may participate in a project, depending on the scope of work and expertise required to perform the project.

INTELLECTUAL PROPERTY

The applicable federal intellectual property (IP) regulations will govern any resulting research agreement(s). In the event that IP with the potential to generate revenue to which the EERC is entitled is developed under this project, such IP, including rights, title, interest, and obligations, may be transferred to the EERC Foundation, a separate legal entity.

BUDGET INFORMATION

The proposed work will be done on a cost-reimbursable basis. The distribution of costs between budget categories (labor, travel, supplies, equipment, etc.) and among funding sources of the same scope of work is for planning purposes only. The project manager may incur and allocate allowable project costs among the funding sources for this scope of work in accordance with Office of Management and Budget (OMB) Uniform Guidance 2 CFR 200.

Escalation of labor and EERC recharge center rates is incorporated into the budget when a project's duration extends beyond the university's current fiscal year (July 1 – June 30). Escalation is calculated by prorating an average annual increase over the anticipated life of the project.

The cost of this project is based on a specific start date indicated at the top of the EERC budget. Any delay in the start of this project may result in a budget increase. Budget category descriptions presented below are for informational purposes; some categories may not appear in the budget.

Salaries: Salary estimates are based on the scope of work and prior experience on projects of similar scope. The labor rate used for specifically identified personnel is the current hourly rate for that individual. The labor category rate is the average rate of a personnel group with similar job descriptions. Salary costs incurred are based on direct hourly effort on the project. Faculty who work on this project may be paid an amount over the normal base salary, creating an overload which is subject to limitation in accordance with university policy. As noted in the UND EERC Cost Accounting Standards Board Disclosure Statement, administrative salary and support costs which can be specifically identified to the project are direct-charged and not charged as facilities and administrative (F&A) costs. Costs for general support services such as contracts and IP, accounting, human resources, procurement, and clerical support of these functions are charged as F&A costs.

Fringe Benefits: Fringe benefits consist of two components which are budgeted as a percentage of direct labor. The first component is a fixed percentage approved annually by the UND cognizant audit agency, the Department of Health and Human Services. This portion of the rate covers vacation, holiday, and sick leave (VSL) and is applied to direct labor for permanent staff eligible for VSL benefits. Only the actual approved rate will be charged to the project. The second component is estimated on the basis of historical data and is charged as actual expenses for items such as health, life, and unemployment insurance; social security; worker's compensation; and UND retirement contributions.

Travel: Travel may include site visits, fieldwork, meetings, and conferences. Travel costs are estimated and paid in accordance with OMB Uniform Guidance 2 CFR 200, Section 474, and UND travel policies, which can be found at http://und.edu/finance-operations (Policies & Procedures, A–Z Policy Index, Travel). Daily meal rates are based on U.S. General Services Administration (GSA) rates unless further limited by UND travel policies; other estimates such as airfare, lodging, etc., are based on historical costs. Miscellaneous travel costs may include taxis, parking fees, Internet charges, long-distance phone, copies, faxes, shipping, and postage.

Equipment: If equipment (value of $5000 or more) is budgeted, it is discussed in the text of the proposal and/or identified more specifically in the accompanying budget detail.

Supplies: Supplies include items and materials that are necessary for the research project and can be directly identified to the project. Supply and material estimates are based on prior experience with similar projects. Examples of supply items are chemicals, gases, glassware, nuts, bolts, piping, data storage, paper, memory, software, toner cartridges, maps, sample containers, minor equipment (value less than $5000), signage, safety items, subscriptions, books, and reference materials. General purpose office supplies (pencils, pens, paper clips, staples, Post-it notes, etc.) are included in the F&A cost.

Subcontracts: Not applicable.

Professional Fees: Not applicable.

Communications: Telephone, cell phone, and fax line charges are included in the F&A cost; however, direct project costs may include line charges at remote locations, long-distance telephone charges, postage, and other data or document transportation costs that can be directly identified to a project. Estimated costs are based on prior experience with similar projects.

Printing and Duplicating: Page rates are established annually by the university's duplicating center. Printing and duplicating costs are allocated to the appropriate funding source. Estimated costs are based on prior experience with similar projects.

Food: Expenditures for project partner meetings where the primary purpose is dissemination of technical information may include the cost of food. The project will not be charged for any costs exceeding the applicable GSA meal rate. EERC employees in attendance will not receive per diem reimbursement for meals that are paid by project funds. The estimated cost is based on the number and location of project partner meetings.

Professional Development: Fees are for memberships in technical areas directly related to work on this project. Technical journals and newsletters received as a result of a membership are used throughout the development and execution of the project by the research team.

Operating Fees: Operating fees generally include EERC recharge centers, outside laboratories, and freight. EERC recharge center rates are established annually.

Laboratory and analytical recharge fees are charged on a per-sample, hourly, or daily rate. Additionally, laboratory analyses may be performed outside the university when necessary. The estimated cost is based on the test protocol required for the scope of work.

Graphics recharge fees are based on an hourly rate for production of such items as report figures, posters, and/or images for presentations, maps, schematics, Web site design, brochures, and photographs. The estimated cost is based on prior experience with similar projects.

Shop and operations recharge fees cover specific expenses related to the pilot plant and the required expertise of individuals who perform related activities. Fees may be incurred in the pilot plant, at remote locations, or in EERC laboratories whenever these particular skills are required. The rate includes such items as specialized safety training, personal safety items, fall protection harnesses and respirators, CPR certification, annual physicals, protective clothing/eyewear, research by-product disposal, equipment repairs, equipment safety inspections, and labor to direct these activities. The estimated cost is based on the number of hours budgeted for this group of individuals.

Freight expenditures generally occur for outgoing items and field sample shipments.

Facilities and Administrative Cost: The F&A rate proposed herein is approved by the U.S. Department of Health and Human Services and is applied to modified total direct costs (MTDC). MTDC is defined as total direct costs less individual capital expenditures, such as equipment or software costing $5000 or more with a useful life of greater than 1 year, as well as subawards in excess of the first $25,000 for each award.

ATTACHMENT B

PROJECT TEAM RESUMES

JASON D. LAUMB
Principal Engineer, Advanced Energy Systems Group Lead
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, ND 58202-9018 USA
701.777.5114 (phone), 701.777.5181 (fax), jlaumb@undeerc.org

Principal Areas of Expertise

Mr. Laumb's principal areas of interest and expertise include biomass and fossil fuel conversion for energy production, with an emphasis on ash effects on system performance. He has experience with trace element emissions and control for fossil fuel combustion systems, with a particular emphasis on air pollution issues related to mercury and fine particulates. He also has experience in the design and fabrication of bench- and pilot-scale combustion and gasification equipment.

Qualifications

M.S., Chemical Engineering, University of North Dakota, 2000.
B.S., Chemistry, University of North Dakota, 1998.

Professional Experience

2008–Present: Principal Engineer, Advanced Energy Systems Group Lead, EERC, UND. Mr. Laumb's responsibilities include leading a multidisciplinary team of 30 scientists and engineers whose aim is to develop and conduct projects and programs on power plant performance, environmental control systems, the fate of pollutants, computer modeling, and health issues for clients worldwide. Efforts are focused on the development of multiclient jointly sponsored centers or consortia that are funded by government and industry sources. Current research activities include computer modeling of combustion/gasification and environmental control systems, performance of selective catalytic reduction technologies for NO_x control, mercury control technologies, hydrogen production from coal, CO_2 capture technologies, particulate matter analysis and source apportionment, the fate of mercury in the environment, toxicology of particulate matter, and in vivo studies of mercury–selenium interactions. Computer-based modeling efforts utilize various kinetic, systems engineering, thermodynamic, artificial neural network, statistical, computation fluid dynamics, and atmospheric dispersion models. These models are used in combination with models developed at the EERC to predict the impacts of fuel properties and system operating conditions on system efficiency, economics, and emissions.

2001–2008: Research Manager, EERC, UND. Mr. Laumb's responsibilities included supervising projects involving bench-scale combustion testing of various fuels and wastes; supervising a laboratory that performs bench-scale combustion and gasification testing; managerial and principal investigator duties for projects related to the inorganic composition of coal, coal ash formation, deposition of ash in conventional and advanced power systems, and mechanisms of trace metal transformations during coal or waste conversion; and writing proposals and reports applicable to energy and environmental research.

2000–2001: Research Engineer, EERC, UND. Mr. Laumb's responsibilities included aiding in the design of pilot-scale combustion equipment and writing computer programs that aid in the reduction of data, combustion calculations, and prediction of boiler performance. He was also involved in the analysis of current combustion control technology's ability to remove mercury and studying in the suitability of biomass as boiler fuel.

1998–2000: SEM Applications Specialist, Microbeam Technologies, Inc., Grand Forks, North Dakota. Mr. Laumb's responsibilities included gaining experience in power system performance including conventional combustion and gasification systems; a knowledge of environmental control systems and energy conversion technologies; interpreting data to predict ash behavior and fuel performance; assisting in proposal writing to clients and government agencies such as the National Science Foundation and the U.S. Department of Energy; preparing and analyzing coal, coal ash, corrosion products, and soil samples using SEM/EDS; and modifying and writing FORTRAN, C+, and Excel computer programs.

Professional Membership
American Chemical Society

Publications and Presentations
Has coauthored numerous professional publications.

JOHN A. HARJU
Vice President for Strategic Partnerships
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA
701.777.5157 (phone), 701.777.5181 (fax), jharju@undeerc.org

Principal Areas of Expertise

Mr. Harju's principal areas of interest and expertise include carbon sequestration, enhanced oil recovery, unconventional oil and gas development, waste management, geochemistry, technology development, hydrology, and analytical chemistry, especially as applied to the upstream oil and gas industry.

Qualifications

B.S., Geology, University of North Dakota, 1986. Postgraduate coursework in Management, Economics, Marketing, Education, Climatology, Weathering and Soils, Geochemistry, Geochemical Modeling, Hydrogeochemistry, Hydrogeology, Contaminant Hydrogeology, Advanced Physical Hydrogeology, and Geostatistics.

Professional Experience

2002–Present: EERC, UND.

July 2015–Present: Vice President for Strategic Partnerships. Mr. Harju leads efforts to build and grow dynamic working relationships with industry, government, and research entities globally in support of the EERC's mission to provide practical, pioneering solutions to the world's energy and environmental challenges. He represents the EERC regionally, nationally, and internationally in advancing its core research priorities: coal utilization and emissions, carbon management, oil and gas, alternative fuels and renewable energy, and energy–water.

2003–June 2015: Associate Director for Research. Mr. Harju led a team of scientists and engineers building industry–government–academic partnerships to carry out research, development, demonstration, and commercialization of energy and environmental technologies.

2002–2003: Senior Research Advisor. Mr. Harju developed, marketed, managed, and disseminated research programs focused on the environmental and health effects of power and natural resource production, contaminant cleanup, water management, and analytical techniques.

2017–Present: Adjunct Lecturer, Department of Petroleum Engineering, UND.

1999–2002: Vice President, Crystal Solutions, LLC, Laramie, WY. Mr. Harju's firm was involved in commercial E&P produced water management, regulatory permitting and compliance, and environmental impact monitoring and analysis.

1997–2002: Gas Research Institute (GRI) (now Gas Technology Institute [GTI]), Chicago, IL.
2000–2002: Principal Scientist, Produced Water Management. Mr. Harju developed and deployed produced water management technologies and methodologies for cost-effective and environmentally responsible management of oil and gas produced water.

1998–2000: Program Team Leader, Soil, Water, and Waste. Mr. Harju managed projects and programs related to the development of environmental technologies and informational products related to the North American oil and gas industry; formulated RFPs, reviewed proposals, and formulated contracts; performed technology transfer activities; and supervised staff and contractors. He served as Manager of the Environmentally Acceptable Endpoints project, a multiyear program focused on rigorous determination of appropriate cleanup levels for hydrocarbons and other energy-derived contaminants in soils. He led GRI/GTI involvement with industry environmental consortia and organizations, such as PERF, SPE, AGA, IPEC, and API.

1997–1998: Principal Technology Manager (1997–1998) and Associate Technology Manager (1997), Soil and Water Quality.

1988–1996: EERC, UND.
1994–1996: Senior Research Manager, Oil and Gas Group. Mr. Harju served as:
- Program Manager for assessment of the environmental transport and fate of oil- and gas-derived contaminants, focused on mercury and sweetening and dehydration processes.
- Project Manager for field demonstration of innovative produced water treatment technology using freeze crystallization and evaporation at oil and gas industry site.
- Program Manager for environmental transport and fate assessment of MEA and its degradation compounds at Canadian sour gas-processing site.
- Program Manager for demonstration of unique design for oil and gas surface impoundments.
- Director of the National Mine Land Reclamation Center for the Western Region.
- Co-PI on project exploring feasibility of underground coal gasification in southern Thailand.
- Consultant to an International Atomic Energy Agency program entitled “Solid Wastes and Disposal Methods Associated with Electricity Generation Fuel Chains.”

1988–1994: Research Manager (1994), Hydrogeologist (1990–1994), Research Specialist (1989–1990), and Laboratory Technician (1988–1989).

Professional Memberships
National Coal Council (2018–2019 term)
National Petroleum Council
Interstate Oil and Gas Compact Commission Energy Resources, Research, and Technology Committee (former Chair) and Carbon Capture and Geological Storage Task Force
Rocky Mountain Association of Geologists
DOE Unconventional Resources Technology Advisory Committee (2012–2014)

Publications and Presentations
Has authored and coauthored more than 100 professional publications.

DR. BRIAN P. KALK
Director of Energy Systems Development, Design, and Operations
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA
701.777.5276 (phone), 701.777.5181 (fax), bkalk@undeerc.org

Principal Areas of Expertise

Dr. Kalk's principal areas of interest and expertise include pipeline safety, species management, electric generation, and transmission planning.

Qualifications

Ph.D., Natural Resource Management, North Dakota State University, 2007. Dissertation: "Development of a Process that Ensures Regulatory Compliance and Stakeholder Satisfaction."
M.S., Environmental Engineering, North Dakota State University, 2001. Thesis: "Surface Water Flow in Golden Lake."
B.S., Social and Political Science, Campbell University, Buies Creek, North Carolina, 1991.

Professional Experience

February 2017–Present: Director of Energy Systems Development, Design, and Operations, EERC, UND. Dr. Kalk leads a multidisciplinary team of scientists and engineers focused on research, development, and commercialization of innovative energy technologies as they relate to coal utilization and emissions, carbon management, and alternative fuels and renewable energy.

2009–January 2017: Commissioner and Chair (2012–2014), North Dakota Public Service Commission (PSC), Bismarck, North Dakota. As a Commissioner, Dr. Kalk was responsible for maintaining the critical balance of ensuring reliable, affordable energy availability while preserving North Dakota's natural resources, interacting with members of industry, both political parties, the media, and numerous special interest groups. He was directly involved in determining electricity rate cases; siting for energy conversion facilities involving coal, wind, and natural gas; and determining the routes of jurisdictional pipelines and power lines. He was also responsible for policy development and implementation while managing over 40 professional staff and a $20 million budget. Dr. Kalk's portfolios included the following:

- ***Energy Generation*** – Directly involved in the siting of over $5.5 billion in facilities, including jurisdictional wind farms, natural gas facilities, and coal generation.

- ***Electric Transmission Lines*** – Directly involved in the siting of over $1.2 billion in jurisdictional power lines, which included serving on the board of the two regional transmission organizations that operate in North Dakota, direct involvement in the regional electric transmission planning and cost allocation, and testifying in front of the Federal Energy Regulatory Commission (FERC).

- ***Pipeline Safety*** – Worked with stakeholders to enhance public awareness, safety, and operation of jurisdictional pipelines, including working closely with industry and the Pipeline Hazardous Material Safety Administration (PHMSA) on new and developing technologies that enhance the operation and safety of the pipelines. Also worked with the North Dakota "One Call" board and the North Dakota Common Ground Alliance to enhance the awareness of the state's "Call Before You Dig" Program.

- ***Rate Cases*** – Determined fair rate of return and compensation for regulated utility companies under the PSC jurisdiction.

While at the PSC, he served as Chairman, member of the National Coal Council, President of the Midwest Regulatory Commissioners, and Chair of the National Association of Regulatory Commissioners (NARUC) Clean Coal and Carbon Management Committee. He was also part of the 2015 U.S. Department of Energy delegation that travelled to China to discuss Clean Energy Technologies and related policies, testified in front of the U.S. Senate Energy and Natural Resources Committee on critical energy policy, and provided perspective to the American Wind Energy Association on numerous occasions.

2006–2008: Upper Great Plains Transportation Institute, North Dakota State University, Fargo, North Dakota. As a member of the Upper Great Plains Transportation Institute, Dr. Kalk established an interdisciplinary management and logistics program to meet the needs of transportation professionals. He was directly involved in all aspects of the program, including student recruitment and advising, research and publication, coordination of instructors, budget preparation and execution, and classroom instruction.

1986–2006: United States Marine Corps.

Professional Memberships
National Coal Council

Publications and Presentations
Has authored or coauthored numerous professional publications and presentations on a variety of technical topics.

ERIN M. O'LEARY
CFFO
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA
701.777.5250 (phone), 701.777.5181 (fax), eoleary@undeerc.org

Principal Areas of Expertise

Ms. O'Leary's principal areas of interest and expertise include business analysis, development of business and operational plans and systems, project management, and team building.

Qualifications

M.B.A., University of Mary, Bismarck, North Dakota, 2007.
M.M., University of Mary, Bismarck, North Dakota, 2007.
B.A., Business Administration, University of North Dakota, 1988.

Professional Experience

2014–Present: CFFO, EERC, UND. Ms. O'Leary is responsible for leadership and management of the EERC's financial and facility operations, which include the areas of financial services, contracts, fund management, facilities management and safety, information technology and software development, and quality assurance. She conducts short- and long-range financial forecasting, evaluates and monitors business metrics, develops the annual budget and leads the budget process, implements effective internal control procedures, and effectively communicates financial information to various stakeholders. She also leads collaborative efforts to ensure that the EERC business and facility units are responsive to EERC objectives.

2006–2014: Deputy Associate Director for Business, EERC, UND. Ms. O'Leary's responsibilities included managing the business areas of the EERC, including contracts, accounting, procurement, travel, resource management, and resource information systems. Ms. O'Leary prepared financial and administrative reports, analyzed and interpreted financial data and management planning data for predicting resource needs, and developed short-term and long-range plans. She was responsible for the development and implementation of business policies and procedures to advance EERC objectives. In addition, she assisted technical staff in securing funding for research, development, and demonstration projects.

2002–2006: Senior Research Manager, Research Information Systems, EERC, UND. Ms. O'Leary's responsibilities included developing proposals; securing clients; conducting research; managing research projects with multidisciplinary technical staff; building databases and software applications for engineering and scientific projects; writing technical reports; and managing the Research Information Systems Group, a team of programmers and database administrators developing software solutions for research projects and for internal business functions of the EERC.

1996–2002: Manager, Information Systems, EERC, UND. Ms. O'Leary's responsibilities included management of the Information Systems Group and the Resource Management Group. These groups are responsible for developing and implementing database management systems, providing mainframe computer services, providing project management support for principal investigators, and providing personnel planning and financial projections.

1994–1996: Information Technology Manager, EERC, UND. Ms. O'Leary's responsibilities included evaluating, designing, implementing, and maintaining database management systems in support of research projects. In addition, duties included program development and demonstration of the database management capabilities to potential clients.

1989–1993: Research Specialist, Combustion Studies, EERC, UND. Ms. O'Leary's responsibilities included information management, network administration, project budget planning and tracking, database development and maintenance, advanced data transfer, and manipulation programming.

1989: Research Technician, Combustion Studies, EERC, UND. Ms. O'Leary's responsibilities included assisting with budget monitoring, maintaining a database for sample tracking, assisting in data reduction, and performing literature searches.

Publications and Presentations

Has authored or coauthored numerous publications and presentations.

WESLEY D. PECK
Principal Geologist, Geosciences Group Lead
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA
701.777.5195 (phone), 701.777.5181 (fax), wpeck@undeerc.org

Principal Areas of Expertise

Mr. Peck's principal areas of interest and expertise include geographic information systems (GIS), cartography, information graphics, geology, and digital asset management. Mr. Peck currently oversees GIS activities for the Plains CO_2 Reduction (PCOR) Partnership. He is also the task leader for two regional characterization efforts within the PCOR Partnership.

Qualifications

M.S., Geology, University of North Dakota, 1992. Thesis: The Stratigraphy and Sedimentology of the Sentinel Butte Formation (Paleocene) in South-Central Williams County, North Dakota.

B.S., Earth Science, North Dakota State University, 1987.

Professional Experience

2015–Present: Principal Geologist, Geosciences Group Lead, EERC, UND. Mr. Peck leads a staff of geoscientists involved in subsurface resource development with an emphasis on the Williston and Powder River Basins. He also serves as task lead and principal investigator of the regional geologic characterization component of the Plains CO_2 Reduction Partnership (PCOR) Partnership Program, which focuses on carbon dioxide storage in central North America.

2011–2015: Research Manager, EERC, UND. Mr. Peck's responsibilities include overseeing a staff of geologists and GIS specialists involved with oil and gas research activities in the Williston Basin as well as regional geologic characterization activities associated with the PCOR Partnership.

1991–2011: Research Scientist, EERC, UND. Mr. Peck's responsibilities included overseeing major GIS activities at the EERC, serving as task leader for the regional characterization component of the PCOR Partnership, as well as report and proposal writing.

1989–1991: Graduate Research Assistant, EERC, UND. Mr. Peck's responsibilities included acquisition and management of geologic data related to Cretaceous and Tertiary geology of the Williston Basin. Mr. Peck also assisted in the collection of Cretaceous and Tertiary fossils and stratigraphic information in western North Dakota and eastern Montana.

Publications and Presentations

Has authored and coauthored several professional publications.

CONFIDENTIAL

APPENDIX B

MHI PROPOSAL

APPENDIX C

LETTERS OF SUPPORT AND LETTERS OF COMMITMENT

Minnkota Power COOPERATIVE
A Touchstone Energy® Cooperative

PO Box 13200
Grand Forks, ND 58208-3200
1822 Mill Road
Grand Forks, ND 58203
Phone 701.795.4000
www.minnkota.com

October 25, 2018

Ms. Karlene Fine
Executive Director
ATTN: Lignite Research Development and Marketing Program
North Dakota Industrial Commission
State Capitol, 14th Floor
600 East Boulevard Avenue, Department 405
Bismarck, ND 58505-0840

Subject: Minnkota Power Cooperative Proposal Entitled "Project Tundra FEED"

Dear Ms. Fine:

On behalf of Minnkota Power Cooperative, Inc., this letter expresses our support for the subject proposed project for which a proposal is being submitted to the North Dakota Industrial Commission (NDIC).

Minnkota is a not-for-profit electric generation and transmission cooperative headquartered in Grand Forks, North Dakota. Formed in 1940, Minnkota provides wholesale electric energy to 11 member-owned distribution cooperatives located in eastern North Dakota and northwestern Minnesota under contractual relationships that extend through 2055. In addition, Minnkota serves as the operating agent for the Northern Municipal Power Agency (NMPA), a municipal joint action agency that serves as an energy supplier for 12 municipal utilities located within the Minnkota service area. In total, the Minnkota/NMPA "Joint System" provides electricity to more than 143,000 residential and commercial member consumers spanning over 34,500 square miles.

Considering the nature and length of our obligation to meet the needs of our member owners, Minnkota is keenly interested in continuing to assess and develop new technologies and solutions to support the lignite industry. There is a significant need for development of Project Tundra for the future of the industry in North Dakota. This project shows promise for our industry and our company. As such, Minnkota is pleased to offer support to the proposed program in the form of cash/in-kind cost share of approximately $1.1 million.

We have confidence that NDIC can support this project, as there is a significant need for development of postcombustion carbon capture with lignite for the industry in North Dakota. Again, we express our support of the proposed project and look forward to working with the NDIC, DOE, the Lignite Energy Council, Mitsubishi Heavy Industries, Eagle Energy Partners I, LLC (EEPI), Burns & McDonnell, BNI Energy, the Energy & Environmental Research Center (EERC), and other participants on this project.

Sincerely,

Mac McLennan
CEO

PHONE (701) 355-5500

BNI energy
AN ALLETE COMPANY

FAX (701) 222-1547

October 25, 2018

Mr. Gerry Pfau
Senior Manager Power Production
Minnkota Power Cooperative, Inc.
1822 Mill Road
PO Box 13200
Grand Forks, ND 58208-3200

Subject:Minnkota Power Cooperative Proposal Entitled "Project Tundra FEED"

Dear Mr. Pfau:

This letter is in response to Minnkota Power Cooperative's request for participation in the proposed project entitled Project Tundra FEED, a proposal being submitted to the North Dakota Industrial Commission (NDIC).

BNI Energy is committed to working as an industry lead to advance projects that enable environmentally and economically sustainable use of North Dakota's abundant lignite resources. Project Tundra will allow for lignite production/utilization to continue while reducing CO2 emissions and creating a new CO_2 enhanced oil recovery industry in North Dakota.

We have confidence that NDIC can support this project, as it aligns perfectly with the purpose and intent of the Advanced Energy Technology Fund and the need for development of a CO_2 EOR industry and for the future of the lignite industry in North Dakota. Again, we express our support of the proposed project and look forward to working with the NDIC through the Lignite Research Council and the Lignite Energy Council, the U.S. Department of Energy, Eagle Energy Partners I, LLC (EEPI), the Energy & Environmental Research Center (EERC), Burns & McDonnell, Mitsubishi Heavy Industries (MHI), and other participants on this project.

Sincerely,

Mr. Wade Boeshans
President and General Manager
BNI Energy

EERC
Energy & Environmental Research Center
15 North 23rd Street, Stop 9018 • Grand Forks, ND 58202-9018 • P. 701.777.5000 • F. 701.777.5181
www.undeerc.org

October 31, 2018

Mr. Gerry Pfau
Senior Manager of Project Development
Minnkota Power Cooperative
3401 24th Street SW
Center, ND 58530

Dear Mr. Pfau:

Subject: Minnkota Power Cooperative Proposal Entitled "Project Tundra FEED"

This letter expresses the Energy & Environmental Research Center's (EERC's) support for and commitment to the subject project for which a proposal is being submitted to the North Dakota Industrial Commission (NDIC).

The EERC is recognized as one of the world's leading developers of energy and environmental technologies. The EERC has a rich history of dynamic working relationships with industry, government, and research entities around the globe. We have worked with more than 1300 clients in 53 countries worldwide. Since its creation in 1951, the EERC has had great success developing technologies and demonstrating them in real-world scenarios to prove their commercial viability. This success is due to the extensive experience of its multidisciplinary team of over 200 highly skilled scientists, engineers, and support personnel as well as global industrial partnerships and state-of-the-art facilities and equipment.

We have confidence that NDIC will support this project, as there is a significant need for development of postcombustion carbon capture with lignite for the industry in North Dakota. Again, we express our support for the proposed project and look forward to working with NDIC, the U.S. Department of Energy, the Lignite Energy Council, Mitsubishi Heavy Industries, Eagle Energy Partners I, Burns & McDonnell, BNI Energy, Minnkota Power, and other participants in this project.

Sincerely,

Edward N. Steadman
Vice President for Research

ENS/kal

October 30, 2018

Mr. Gerry Pfau, PE
Senior Manager of Project Development
Minnkota Power Cooperative
3401 24th St SW
Center, ND 58530

Re: Minnkota Power Cooperative Proposal Entitled "Project Tundra FEED"

Dear Mr. Pfau:

On behalf of Burns & McDonnell, this letter expresses our support and commitment for the proposed Project Tundra FEED for which a proposal is being submitted to the Lignite Research Development and Marketing Program, North Dakota Industrial Commission.

Burns & McDonnell is a fully integrated engineering, architecture, construction, environmental and consulting firm with a multidisciplinary staff of more than 6,000 professionals worldwide. Clients appreciate the entrepreneurial ambition at Burns & McDonnell. Being 100 percent employee-owned means that everyone has an ownership stake in the success of our clients. Our internal standards and commitment to clients have also earned Burns & McDonnell a reputation based on "trust and reliability" by meeting clients' needs – no matter the size, schedule, or level-of-complexity. Additionally, Burns & McDonnell has the right experience, with a few recent projects summarized below, to make Project Tundra successful.

Project Description	Client	Role
Carbon Capture Pre-FEED Study	EERC/Minnkota Power	Balance of Plant Preliminary Engineering and Cost Estimates
Carbon Capture Retrofit and EOR Feasibility Study	Confidential Client	Economic and Technical Feasibility Studies
ECO2 Demonstration Feasibility Study	Partnership with Powerspan on Basin Electric Antelope Valley Station	Balance of Plant Engineering
CCS Engineering Design Study OE Services	Basin Electric – Antelope Valley Station	Feasibility Study and Preliminary Engineering Design
600 MW SCPC with CCS Deatailed Design	Basin Electric NextGen Project	Program Management, Detailed Design, and Construction Management
CCS Feasibility Study	Entergy and Tenaska	Feasibility Study/Balance of Plant Equipment Design

9400 Ward Parkway \ Kansas City, MO 64114
O 816-333-9400 \ F 816-333-3690 \ burnsmcd.com

In summary, Burns & McDonnell is committed to making this project a success, and these key factors distinguish our firm from others, enabling the success of this partnership:

- ***Safety Culture:*** For us, safety is not a slogan; it is a value ingrained in our corporate culture. Our Corporate Safety & Health Program is integrated with our project process and requires pre-planning work activities to support implementation of safe work measures. Every project at Burns & McDonnell operates with the safety philosophy that zero recordable incidents can be accomplished with proper planning, resources and follow-through. Our project safety records demonstrate the success of this approach.
- ***Commitment to Minnkota Power:*** For over 26 years Burns & McDonnell has successfully executed multiple retrofit projects at the Milton R. Young Station. These projects include over $400 million worth of work since 2006. Our knowledge and familiarity of this generating station is second to none. We believe that we have built a partnership with Minnkota Power over the years and are confident we can continue to be a valuable part of this team on this project and future projects moving forward.
- ***Proven Leaders:*** As summarized above and detailed in our proposal, few A/E firms can rival our experience related to development projects similar to carbon capture. Over the years we have worked on various elements of carbon capture projects, from the early stages of feasibility studies through cost estimates and balance of plant design for major mechanical and electrical systems. We have the right team, and the right approach, to tackle each step in this process.

We look forward to participating in this project on the design and costing information specific to this unit. Burns & McDonnell appreciates being considered for this project. We are available by phone or in your offices at your convenience for any questions related to this project. If you have any questions or need any additional information, please call myself at 816-822-3023 or Steve Rottinghaus at 816-822-3386. We look forward to discussing the next steps in this project.

Sincerely,

Ron Bryant

Ron Bryant, PE
Principal, Energy
Burns & McDonnell Engineering Company, Inc.

MITSUBISHI HEAVY INDUSTRIES AMERICA, INC.
Engineered Systems Division
20 Greenway Plaza Suite 600 Houston, TX 77046 Tel: (713)-351-6400 Fax: (713)-351-6450

October 30, 2018

Mr. Gerry Pfau
Senior Manager of Project Development
Minnkota Power Cooperative, Inc.
1822 Mill Road
Grand Forks, ND 58203
BY EMAIL TO: gpfau@minnkota.com

Re: Minnkota Power Cooperative Proposal Entitled "Project Tundra FEED"

Dear Mr. Pfau,

This letter is to acknowledge our support to the request by Minnkota Power Cooperative, Inc. ("Minnkota") for participation in the subject proposal to be submitted to the Lignite Research Development and Marketing Program of the North Dakota Industrial Commission ("NDIC").

Mitsubishi Heavy Industries America, Inc., a wholly-owned subsidiary of Mitsubishi Heavy Industries, Ltd. of Japan (together "MHI"), is committed to working as an industry lead to develop a lignite-based post-combustion carbon capture project in continued support of the team lead by Minnkota. The proposed effort will build off MHI's expertise on the Petra Nova project where MHI's KM CDR Process™ technology and KS-1™ solvent have been successfully deployed.

We have confidence that the NDIC and later the U.S. Department of Energy ("DOE") can support this project, as there is a significant need for continued development of post-combustion carbon capture in the United States. MHI can work to ensure project success through the ongoing pre front-end engineering and design ("FEED") process already supported by NDIC and DOE, through FEED, project execution, and beyond.

We express our support of the proposed project and look forward to working with Minnkota, NDIC, DOE, and other participants on this project.

Sincerely,

Timothy E Thomas
Vice President
Engineered Systems Division
Mitsubishi Heavy Industries America, Inc.

EAGLE ENERGY PARTNERS I LLC
2501 6th St SE Suite B
Minot ND 58701

October 26, 2018

Mr. Gerry Pfau
Senior Manager Power Production
Minnkota Power Cooperative, Inc.
1822 Mill Road
PO Box 13200
Grand Forks, ND 58208-3200

Subject: Minnkota Power Cooperative Proposal Entitled "Project Tundra FEED"

Dear Mr. Pfau:

This letter is in response to Minnkota Power Cooperative's request for participation in the proposed project entitled Project Tundra FEED, a proposal being submitted to the North Dakota Industrial Commission (NDIC).

The Eagle Energy Partners I, LLC (EEPI) team has worked together and been involved with all aspects of North Dakota's oil and gas industry for the past 35 years. The team has a proven record of successfully unitizing and applying secondary recovery techniques to multiple conventional oil fields in the Williston Basin. We see the proposed research of revitalizing legacy conventional oil fields via the prudent application of tertiary enhanced oil recovery (EOR) techniques as an opportunity to make major strides toward achieving Governor Burgum's goal of 2 million barrels per day of statewide oil production. The proposed FEED study will pave the way for CO_2 capture and CO_2 EOR and make Project Tundra a reality. EEPI is working closely with the Project Tundra team to complete the entire value chain as the CO_2 offtaker/EOR operator in ND fields that are in the process of being acquired.

We have confidence that the NDIC can support this project, as there is a significant need for development of a CO_2 EOR industry and for the future of the lignite industry in North Dakota. Again, we express our support of the proposed project and look forward to working with the NDIC through the Lignite Research Council and the Lignite Energy Council, the U.S. Department of Energy, BNI Energy, the Energy & Environmental Research Center (EERC), Burns & McDonnell, Mitsubishi Heavy Industries (MHI), and other participants on this project.

Sincerely,

Mr. Robert Mau
President, Chairman/Operator

APPENDIX D

RESUMES OF KEY PERSONNEL

Gerry Pfau

Sr. Manager of Project Development
Minnkota Power Cooperative
Milton R. Young Station
3401 24th St. SW, Center, ND 58530
701-794-8711, gpfau@minnkota.com

Education

North Dakota State University

B.S., Mechanical Engineering (Power Option), 1981

Experience

37 years of experience at the Milton R. Young Station of Minnkota Power Cooperative

Sr. Manager of Project Development 2018 – Present

Responsible for development of various projects to sustain the long term operation of the Young Station. Look for innovative, cost-effective commercial applications with the emphasis on utilizing lignite coal in North Dakota. Maintain professional representation with outside affiliations such as Lignite Research Council, Lignite Energy Council, NRECA, and other utilities. Work with power supply to evaluate future generation resources and provide valuable mentorship to plant personnel.

Sr. Manager of Power Production 2014 – 2018

Responsible for the overall leadership and supervision of all departments at the Young Station. Primary role in establishing and implementing operating and financial objectives for the station. Advocated for the plant safety objectives and ensured environmentally-compliant operations. Assisted and advised the President and CEO, and participated with other senior staff in corporate planning, policy setting, and decision making.

Plant Manager 2011 – 2014

Responsible for the overall leadership and supervision of all departments at the Young Station. Assisted with establishing and implementing operating and financial objectives for the station. Advocated for the plant safety objectives and ensured environmentally-compliant operations.

Plant Manager - Operations 2009 – 2011

Responsible for providing leadership along with daily oversight, direction, and guidance to the plant operations, environmental, and engineering departments. Assisted the plant leadership in ensuring achievement of key operating objectives in the areas of employee safety, employee relations, environmental, project management, profitability, unit availability, efficiency, equipment safety, and reliability in full compliance with all applicable laws, regulations, polices, and procedures. Provided specialized knowledge, skills, and oversight of day-to-day plant functions

• • •

Plant Engineering Superintendent 2006 – 2009

Responsible for providing leadership along with daily oversight, direction, and guidance to the plant engineering department. Assisted the plant leadership in ensuring achievement of key operating objectives in the areas of employee safety, environmental, project management, profitability, unit availability, efficiency, equipment safety, and reliability in full compliance with all applicable laws, regulations, polices, and procedures. Provided specialized knowledge, skills, and oversight of day-to-day plant functions.

Sr. Plant Engineer 2001 – 2006

Responsible for the design and implementation of various plant projects. Project engineer for plant controls upgrade to an Emerson Ovation platform including logic and graphics development along with testing. Project manager for design and installation of an over-fire air system for NOx control on Unit 2. Project manager for turbine upgrade including HP-IP turbine, LP turbines, and generator rewind. Implemented use of handheld devices for operator rounds and integration of these readings into the plant performance system.

Plant Engineer 1981 – 2001

Responsible for the design and implementation of a plant performance program including on-line performance monitoring systems. Project engineer for various plant projects, including replacement of feedwater heaters, turbine rotor & cylinder replacement, primary coal crusher change out, plant wide ventilation system, water treatment modifications, and centrifugal air compressor installation. Monitored maintenance projects during major outages, such as turbine inspections and boiler repairs.

JASON D. LAUMB
Principal Engineer, Advanced Energy Systems Group Lead
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, ND 58202-9018 USA
701.777.5114 (phone), 701.777.5181 (fax), jlaumb@undeerc.org

Principal Areas of Expertise

Mr. Laumb's principal areas of interest and expertise include biomass and fossil fuel conversion for energy production, with an emphasis on ash effects on system performance. He has experience with trace element emissions and control for fossil fuel combustion systems, with a particular emphasis on air pollution issues related to mercury and fine particulates. He also has experience in the design and fabrication of bench- and pilot-scale combustion and gasification equipment.

Qualifications

M.S., Chemical Engineering, University of North Dakota, 2000.
B.S., Chemistry, University of North Dakota, 1998.

Professional Experience

2008–Present: Principal Engineer, Advanced Energy Systems Group Lead, EERC, UND. Mr. Laumb's responsibilities include leading a multidisciplinary team of 30 scientists and engineers whose aim is to develop and conduct projects and programs on power plant performance, environmental control systems, the fate of pollutants, computer modeling, and health issues for clients worldwide. Efforts are focused on the development of multiclient jointly sponsored centers or consortia that are funded by government and industry sources. Current research activities include computer modeling of combustion/gasification and environmental control systems, performance of selective catalytic reduction technologies for NO_x control, mercury control technologies, hydrogen production from coal, CO_2 capture technologies, particulate matter analysis and source apportionment, the fate of mercury in the environment, toxicology of particulate matter, and in vivo studies of mercury–selenium interactions. Computer-based modeling efforts utilize various kinetic, systems engineering, thermodynamic, artificial neural network, statistical, computation fluid dynamics, and atmospheric dispersion models. These models are used in combination with models developed at the EERC to predict the impacts of fuel properties and system operating conditions on system efficiency, economics, and emissions.

2001–2008: Research Manager, EERC, UND. Mr. Laumb's responsibilities included supervising projects involving bench-scale combustion testing of various fuels and wastes; supervising a laboratory that performs bench-scale combustion and gasification testing; managerial and principal investigator duties for projects related to the inorganic composition of coal, coal ash formation, deposition of ash in conventional and advanced power systems, and mechanisms of trace metal transformations during coal or waste conversion; and writing proposals and reports applicable to energy and environmental research.

2000–2001: Research Engineer, EERC, UND. Mr. Laumb's responsibilities included aiding in the design of pilot-scale combustion equipment and writing computer programs that aid in the reduction of data, combustion calculations, and prediction of boiler performance. He was also involved in the analysis of current combustion control technology's ability to remove mercury and studying in the suitability of biomass as boiler fuel.

1998–2000: SEM Applications Specialist, Microbeam Technologies, Inc., Grand Forks, North Dakota. Mr. Laumb's responsibilities included gaining experience in power system performance including conventional combustion and gasification systems; a knowledge of environmental control systems and energy conversion technologies; interpreting data to predict ash behavior and fuel performance; assisting in proposal writing to clients and government agencies such as the National Science Foundation and the U.S. Department of Energy; preparing and analyzing coal, coal ash, corrosion products, and soil samples using SEM/EDS; and modifying and writing FORTRAN, C+, and Excel computer programs.

Professional Membership
American Chemical Society

Publications and Presentations
Has coauthored numerous professional publications.

RON BRYANT, PE

Project Manager

Mr. Bryant currently serves as a senior project manager with Burns & McDonnell in the Energy Division. His primary responsibilities include coordination of multiple discipline design projects for fossil fuel power plant retrofit projects. His experience includes evaluation, design, and implementation of capital projects for the electric utility industry.

EDUCATION

- BS, Mechanical Engineering

REGISTRATIONS

- Professional Engineer (MO)

26 YEARS WITH BURNS & MCDONNELL

32 YEARS OF EXPERIENCE

Hawthorn, Iatan, LaCygne, Montrose and Sibley Generating Stations | Kansas City Power & Light

Kansas City, Missouri

Project director for a multi-site CCR and ELG compliance project. Burns & McDonnell performed studies to develop options for complying with CCR regulations and potential ELG regulations. Process modifications were designed to reduce CCR contact water. Detailed design for pond closures, bottom ash stack out slabs, and scrubber waste slurry basins were designed. Engineering was performed to install under boiler drag chain conveyors to convert units from wet bottom ash removal systems to dry bottom ash removal systems. The project included developing equipment procurement specifications, installation specifications, reviewing vendor and contractor submittals, and maintaining a document control and management system. As Project Director, Mr. Bryant is responsible for the execution of the engineering activities at all five sites.

Brown 3, Trimble 1 and Gent 1-4 Generating Stations | Louisville Gas & Electric - Kentucky Utilities

Louisville, Kentucky

Project director for a multi-site pulse-jet fabric filter and coal combustion residuals transport project. Burns & McDonnell was the Owners' Engineer for the installation of six PJFFs at three sites and the installation of two CCRT systems at two sites. The project included developing equipment procurement specifications, installation specifications, reviewing vendor and contractor submittals, and maintaining a document control and management system. As Project Director, Mr. Bryant was responsible for the execution of the engineering activities at all three sites.

Muskogee Units 4 & 5 Natural Gas Retrofit | Oklahoma Gas & Electric

Muskogee, Oklahoma

Project manager and is responsible for the schedule and design necessary to convert Muskogee Units 4 and 5 from coal to natural gas. The project consists of developing technical procurement documents and detailed mechanical, electrical, controls, structural, and civil documents for converting the units to natural gas. Each unit is rated at 550 MW nominal. The boilers are Alstom tangential-fired, each capable of 3,364,546 lb/hr steam flow at 2620 psig and 1005 Fwas responsible for developing preliminary design documents necessary to determine feasibility and cost to convert Muskogee Units 4 and 5 from coal to natural gas. The project consisted of developing process flow diagrams, general arrangement drawings, electrical one line diagrams, project schedule, and detailed cost estimates for converting Units 4 and 5 from coal to natural

gas. Each unit is rated at 550 MW nominal. The boilers are Alstom tangential-fired, each capable of 3,364,546 lb/hr steam flow at 2620 psig and 1005 F.

Wisdom Generating Station Unit 1 Natural Gas Retrofit | Corn Belt Power Coop

Spencer, Iowa

Project manager and was responsible for the evaluation and design to convert an existing pulverized coal fired unit to natural gas and fuel oil. The project included performing preliminary engineering, preparing general arrangement drawings, and developing costs estimates for converting the unit to natural gas and complying with NFPA 85 recommendations.

Combustion Turbine Relocation | NRG Energy

Houston, Texas

Project manager for providing Owner's Engineering services to assist NRG with relocating six combustion turbines to a new site in Galveston County, TX. Site development scope of services included detailed design of access road, , laydown areas, water supply, and gas supply. A storm water pollution prevention plan and ambient noise study was also performed. Foundation structural reviews were performed to determine suitability of foundations for the new site. Burns & McDonnell also reviewed contractor submittals and performed document control.

Air Emission Compliance Evaluation | Luminant

Dallas, Texas

Project manager and was responsible for the evaluation of air emission compliance strategies for multiple coal fired plant sites in Texas. The project included selecting various air pollution control technologies, performing preliminary engineering, preparing general arrangement drawings, and developing costs estimates for each type of technology at each plant site.

Ottumwa Generating Station | Alliant Energy

Ottumwa, Iowa

Project manager for the evaluation of plant improvement projects for the 673 MW coal fired unit. The project included developing multiple options for plant heat rate, MW, and reliability improvements. Each option was evaluated on technical and economical merit. A detailed report was prepared with recommended options to implement.

Milton R Young Generating Station | Minnkota Power Cooperative

Grand Forks, North Dakota

Project manager and had overall responsibility for the engineering, design, and startup of air pollution control systems on two lignite fired cyclone units. The systems include a new wet lime FGD scrubber system on a 250 MW unit, upgrades to an existing FGD scrubber system on a 475 MW unit, a new 550' reinforced concrete chimney with FRP liner, a dry flue gas to wet flue gas chimney conversion on an existing 550' chimney, and a new redundant lime preparation system serving both units. The project is being executed using a multi-contract approach.

RON BRYANT, PE
(continued)

Milton R Young Generating Station | Minnkota Power Cooperative,
Grand Forks, North Dakota

Project manager and was responsible for the engineering, design, and startup of two over-fire air systems on a 250 MW lignite fired unit and a 475 MW lignite fired unit.

Gibbons Creek Station | Texas Municipal Power Agency
Carlos, Texas

Project manager and was responsible for the investigation of LP turbine upgrade options at the 482 MW Gibbons Creek Station Unit 1. Predicted performance and cost estimates were developed for each option. Impacts on other plant equipment were examined. An economic analysis of each option was performed. A detailed report with recommended upgrades was prepared. Performance standards and scope of work for the design and installation of the LP turbine upgrade were developed. Bids were received and evaluated on technical and commercial merit. Technical review included evaluating design and performance expectations. The impact on other plant equipment was checked. An economic evaluation was performed to determine a net present value and payback period for each bid.

David T. Greeson
President
David Greeson Consulting

(281) 220-7623
david@davidgreeson.com

Summary - 38 years of experience in the electric energy industry:

- Developed the world's largest post-combustion carbon capture and enhanced oil recovery project
- Led development of five major generation projects which represent $3b in project investment
- Extensive experience leading cross-functional teams and working with community, regulatory, and political stakeholders

Greeson Consulting LLC (current position)

Assisting coal-fired generation owners with development of large-scale CCUS projects. Projects currently under contract represent 18 million tons of CO_2 capture per year.

Petra Nova Project (NRG Energy, Inc. - 2016)

David wrote the initial business plan and secured funding for the world's largest post combustion carbon capture project. This project included a US Dept. of Energy grant, an oilfield interest purchase, a gray market combustion turbine from Saudi Arabia, a cogeneration plant, two equity partners, issuance of tax-exempt bonds, and a limited recourse loan backed by Japanese credit agencies.

Limestone Unit 3 (NRG Energy, Inc. - 2011)

Obtained permits and syndicated the ownership of a 900MW super-critical pulverized coal project that was ultimately not constructed due to electric market conditions.

Cedar Bayou Unit 4 (NRG Energy, Inc. - 2009)

A 550MW combined cycle power plant in Houston, TX.

Bighorn (Reliant Energy, Inc. - 2003)

This 570MW combined cycle is near Las Vegas, NV (renamed Chuck Lenzie).

Desert Basin (Reliant Energy, Inc. - 2001)

Located east of Phoenix, AZ, Desert Basin is a 600MW combined cycle project.

El Dorado (Reliant Energy, Inc. - 1999)

El Dorado is a 480MW combined cycle project in Boulder City, NV.

Education: BBA (Engineering Route), University of Texas, 1980

TIMOTHY E. THOMAS
Vice President and Deputy General Manager
Mitsubishi Heavy Industries America, Inc.
Environmental & Chemical Plant Division, 20 East Greenway Plaza, Suite 600, Houston, TX 77046
713.351.6402 (phone), tim_thomas@mhiahq.com

Education and Training
B.S., Mechanical Engineering, University of Florida, 1983.

Research and Professional Experience
Mitsubishi Heavy Industries America, Inc. – Vice President, Deputy General Manager, Project Director, 2013 to present

Mr. Thomas is currently Vice President & Deputy General Manager for the Environmental & Chemical Plant Division of Mitsubishi Heavy Industries America (MHIA) in Houston, TX. He is responsible for MHIA's CO_2 capture business in North America including research and development, business development, and project execution from initial concepts through project completion. He manages a staff of project and technical experts, and oversees multiple projects. Mr. Thomas has over 34 years of experience in project management, construction, engineering, and design associated with electric generating stations. Areas of expertise include CO_2 capture systems (CCS), flue gas desulfurization (FGD) systems, coal upgrading facilities, material handling systems, wastewater treatment systems, and particulate removal systems. Mr. Thomas has a degree in Mechanical Engineering from the University of Florida and has held PE licenses in various states.

Project Director for the preparation of multiple studies on the application of MHIA's CCS technology on power plant applications. Primary focus on the application, feasibility, and of installing CCS on coal fired power plants and natural gas combined cycle units. Heavily involved in supporting MHI's research initiatives including demonstration of MHI's High Efficiency System at Alabama Power's Plant Barry CCS demonstration facility (DOE funded project).

Project Director for the design, procurement, construction and commissioning of a multi-million dollar Coal Upgrading facility in Southern Alabama. This demonstration project was first to apply Mitsubishi's coal upgrading technology in the United States.

Project Director from 2002 to 2013 for the design, procurement, construction, and commissioning of Flue Gas Desulfurization (FGD) systems at multiple TVA fossil fuel power plants. These installations completed at over $1 billion were provided to TVA through Advatech, a joint venture of URS and Mitsubishi Heavy Industries America. For this application, Advatech provided its proprietary single module, twin tower Double Contact Flow Scrubber (DCFS) technology in order to meet TVA requirements for sulfur removal and availability.

Project Director for the FGD Conversion for Seminole Electric's Units 1 and 2. An outage driven project completed at $15 million - on schedule and within budget. Oversaw project development, execution, and implementation. Directed resources from various offices. Maintained a high level of client interaction and involvement.

Project Director for the installation of a limestone preparation system for LG&E's Mill Creek Station. Scope included barge unloading, limestone storage and handling, vertical ball mill grinding systems, and slurry transport systems. A value-driven project completed at $20 million - on schedule and within budget.

Oversaw project development, execution, and implementation. Directed resources from various offices. Maintained a high level of client interaction and involvement.

Project Manager for the conversion of LG&E's Mill Creek Station to produce a commercial grade gypsum by-product. Scope included preliminary engineering and design, economic evaluations and cost estimating for a barge loading system, forced oxidation equipment, primary and secondary dewatering modifications, limestone storage and handling, vertical ball mill grinding systems, and slurry transport systems. A value-driven project completed at $27 million - on schedule and within budget. Oversaw the efforts of a large engineering firm subcontracted by LG&E to perform detailed engineering and design. Maintained a high level of client interaction and involvement.

Project Manager and Construction Manager for the FGD Conversion for NIPSCo Schahfer Station Units 17 and 18. A fast-track outage driven project completed at $30 million - on schedule and within budget. Totally responsible for project execution, implementation, cost, schedule, and technical decisions, managing the on-site efforts of a large engineering firm subcontracted to perform detailed design, procurement, and construction management.

Project Engineering Manager during the $340 million FGD system retrofit for Pennsylvania Electric's Conemaugh Station Units 1 and 2. Managed development of system designs; design criteria; process and instrumentation diagrams; design calculations and equipment optimization; operating procedures and system descriptions. Managed review of vendor/manufacturer drawings and procedures. Inspected shop and on-site equipment prior to installation, and administered and developed performance testing protocol. Primary interface between client and vendors. Wrote all major client correspondence. Provided a high level of on-site support. Responsible for closing contract issues, analyzed contractor claims, prepared detailed evaluations, and coordinated responses with project management and client representatives.

On-site Resident Engineer for the construction of JEA/FPL's St. Johns River Power Park, two 600 MW coal-fired generating units. Oversaw the installation of the FGD systems, electrostatic precipitators, and a wastewater treatment facility. Interpreted technical requirements; reviewed drawings; ensured successful coordination with other engineering disciplines; and reviewed, managed, and negotiated contract changes ranging in value up to $1 million.

URS Corp. and Advatech LLC, Vice President, Project Director, Project Manager, 1996 – 2013

URS - Raytheon Engineers and Constructors – Ebasco Services, Project Engineering Manager, Principal Mechanical Engineer, Senior Mechanical Engineer, Mechanical Engineer, Sr. Associate Engineer, 1983 - 1996

Relevant Publications: none

Synergistic Activities: none

ROBERT MAU
Chair, Principal, and Operator
Eagle Energy Partners I, LLC (EEPI)
2501 6th Street Southeast, Suite B, Minot, North Dakota 58701
Phone: 701.837.4780, E-Mail: eagleop@yahoo.com

Professional Summary

Mr. Mau, Chair, Principal, and Operator at EEPI, has 35+ years of experience as an operator and in all aspects of the upstream and midstream oil and gas business. He currently oversees all investments made by EEPI and is Chair of the Investment Committee. Under his leadership, hundreds of wells have been drilled, produced, and operated since 1991. The company has employed secondary recovery techniques since 2002, with an average of >5 times estimated production increases achieved and, in some cases, as high as 11 times.

Mr. Mau founded Eagle Operating Inc. in 1991, where he served as President. He founded Wolverine Drilling Co. 1996, the largest North Dakota-based drilling company at time of acquisition in 2004. He founded Eagle Well Service in the early 2000s, the largest North Dakota-based well service contractor (16 rigs) at time of acquisition in 2012. He was also the founder of MW Industries, a drilling rig-manufacturing company located in Kenmare, North Dakota.

Mr. Mau is a Former Chair of the North Dakota Petroleum Council and currently serves on its Board of Directors and Executive Committee since 1999. He was appointed by North Dakota Governor John Hoeven to serve on the Interstate Oil and Gas Compact Commission and the Oil and Gas Research Council. In 2007, he received the Pioneer Award from the Energy & Environmental Research Center's Plains CO_2 Reduction Partnership. In 2013, he was inducted into the North Dakota Petroleum Council Hall of Fame.

APPENDIX E

SUPPORTING DOCUMENTATION FOR CONFIDENTIAL INFORMATION

Request for Confidential Information Pursuant to NDCC §54-63-02

Minnkota Power, with request of partial financial support from the NDIC Lignite Research Program, is proposing to perform a FEED study for retrofit of postcombustion CO_2 capture technology at the MRY facility in North Dakota. The proposed project will include detailed engineering/costing analysis of technology provided by MHI. MHI has provided Minnkota Power with confidential proposals and cost information regarding its technology that is included in Appendix B of this proposal.

Minnkota Power requests that this information remain confidential and outside of the public domain. In accordance with NDCC §54-63-02, a request must be filed with NDIC to ensure such confidentiality. Please see the below request for confidentiality set out in accordance with such informational requirements:

1. General Description of the Nature of the Information Sought to Be Protected.
   MHI has submitted confidential technical and financial information related to its technology and fees for its services as an anticipated subcontractor on this effort. The information that is considered confidential is contained in budgets and proposals submitted to Minnkota Power by MHI. Specifically, the information is contained in Appendix B of this proposal. The information is considered business-sensitive by MHI.
2. An Explanation of Why the Information Derives Independent Economic Value, Actual or Potential, from Not Being Generally Known to Other Persons.
   The information is directly associated with MHI's technology and costs associated with MHI's ability to compete in this market.
3. An Explanation of Why the Information Is Not Readily Ascertainable by Proper Means by Other Persons.
   MHI does not readily disclose this information outside of MHI.
4. A General Description of Person or Entity That May Obtain Economic Value from Disclosure or Use of the Information and How the Person or Entity May Obtain This Value.
   Economic value could be obtained by competitors of MHI that offer similar services regarding carbon capture.
5. A Description of the Efforts Used to Maintain the Secrecy of the Information.
   Minnkota Power employs strict confidential policies and procedures for handling and maintaining its, or its partners, confidentiality information. The information will not be further disclosed outside the project team. The information will only be disclosed to those people needing the information to perform the project. All deliverables (presentation and reports) derived from this proposed project will only contain nonconfidential information, which will allow public review of the project without compromising confidential information.

APPENDIX F

REFERENCES

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