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July 14, 2020

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 request for amendment to contract 220: Project Tundra FEED

Minnkota Power Cooperative (Minnkota) is very grateful for your support and the support of the Lignite Research, Development and Marketing Program, which has made it possible for us to advance the development of Project Tundra and lay out the final roadmap to the start of construction that we can now see will take us down a slightly different path that we originally proposed. With this letter and in accordance with NDAC 43-03-05-07, we are submitting the enclosed request for a contract amendment to increase the funding approval by $5 Million (from $15 to $20 Million) and add to the scope of work on our Project Tundra FEED grant.

The enclosed documentation provides full details of the reasoning for this request which is driven primarily by a switch from enhanced oil recovery as the CO_2 storage mechanism to saline formation geologic storage. This important change, which is needed because North Dakota's oilfield operators are not yet ready for the quantities of CO_2 that Project Tundra will produce, will require additional site characterization, data analysis, and simulation work to develop the CO_2 storage facility.

Despite these changes, the overall objective of the project has not changed: to complete all of the engineering, design and permitting work to prepare Project Tundra for a final investment decision and commencement of construction as early as 2022. With approval of this amendment request, together with the cost share that has been committed, the Project Tundra team is confident this objective can be met.

In addition to the enclosed request for amendment, we have also included the required $100 application fee. Please let me know if you have any questions or require any additional information to consider this request.

Sincerely,

Gerry Pfau

Gerry Pfau
Senior Manager of Project Development (Project Manager / Principal Investigator)
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REQUEST FOR CONTRACT AMENDMENT

PROJECT TUNDRA FEED

Submitted To:

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

Amendment Request Summary:

Expand scope of work and increase funding approval by $5,000,000 (Increase from $15 to $20 Million)

Submitted By:

Minnkota Power Cooperative
5301 32nd Avenue South
Grand Forks, ND 58201

Project Manager / Principal Investigator:

Mr. Gerry Pfau
Phone: 701-794-7234
Email: gpfau@minnkota.com

Mr. Gerry Pfau
Senior Manager of Project Development
Minnkota Power Cooperative

July 14, 2020

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INTRODUCTION

Project Tundra is Minnkota Power Cooperative's (Minnkota) initiative to install carbon capture and storage technology that will capture at least 90% of the carbon dioxide (CO_2) emissions from Unit 2 (455 MW) at the Milton R. Young Station (MRYS), a lignite fired power plant near Center, ND. In order to make Project Tundra a commercial reality, Minnkota needs to complete detailed engineering and design, submit and secure all permits and approvals, and then attract investors to build the approximately $1.1 Billion facility.

In November 2018, Minnkota submitted a grant proposal to the North Dakota Industrial Commission (NDIC) to secure a portion of the funding needed for the engineering and permitting work. The NDIC awarded the project $15 Million from the Lignite Research, Development and Marketing Program. With those funds in hand, Minnkota immediately commenced work on project engineering and secured the cost share contemplated in the grant.

In the 18 months since the grant was approved, there have been fundamental shifts in industry and market conditions that are requiring us to modify our approach to the project. Minnkota originally planned for captured CO_2 to be used for enhanced oil recovery (EOR) operations, and in the process geologically store the CO_2. However, the EOR markets in North Dakota have not developed as expected, except for one project in the southwest corner of the state that has already secured a CO_2 source. As a result, Minnkota has pivoted its approach to utilize saline formation storage as the primary means of storing CO_2 while retaining the enhanced oil recovery option if/when the markets are ready for CO_2.

The new focus on saline formations is supported by the Federal Government's significant continued funding opportunities through the Department of Energy's (DOE) CarbonSAFE program to research and develop saline formation storage for anthropogenic CO_2. In addition, in early 2018 Congress passed legislation dramatically increasing Section 45Q tax incentives. The passage of that legislation, combined with the publication in 2020 of guidance from the Internal Revenue Service (IRS) on how to apply for and receive those tax incentives makes saline formation storage an economically viable option for Project Tundra. This new focus on saline formations means a significant amount of additional engineering studies and permitting work will be needed for the development of Project Tundra and its CO_2 storage facility.

Consequently, in accordance with NDAC 43-03-05-07, this document details and respectfully requests an amendment to the NDIC award contract to increase the funding approval by $5 Million (from $15 to $20 Million) and expand the scope to cover the additional work. Minnkota has now successfully secured cost share in excess of $26 Million (details provided later) from our own funds and from multiple awards from the DOE to match the NDIC funds for the original scope and for the additional described herein. The requested additional NDIC funding together with the cost share we've secured will fully fund Project Tundra through the engineering and design and permitting phases of development.

AMENDMENT REQUEST STRUCTURE / APPLICATION REQUIREMENTS SUMMARY

This document is accompanied by the original 2018 proposal to NDIC (Appendix C) and is intended to be an amendment that details and justifies each of the material changes to scope and estimated cost as compared to the original proposal. The structure of this amendment includes first, a description of the changes to each of the major scope categories identified in the original proposal along with task-specific cost impacts, and second, details of the total project expenditures to date and an updated estimated cost summary based on a higher $20 Million total funding approval from NDIC.

To ensure that reviewers of this request for amendment have all information required by NDAC 43-03-04, we lay out in the following sections each of those requirements, referencing the location in the 2018 proposal where the information can be located and providing supplemental information as necessary.

Abstract

The abstract is located on Page 4 of the attached 2018 proposal to NDIC. Key changes are noted below:

- *Objective:* As detailed in this request for amendment, there have been changes to the overall scope of work as a result of a shift in near term focus from EOR to saline formation storage of CO_2. While the near term focus has shifted, Minnkota is still focused on EOR in the longer term, and thus the objective listed in the original abstract section is still accurate.

- *Total Project Cost:* The total cost of the project is now estimated at \$46,006,695, with Minnkota providing \$439,374, DOE providing \$25,567,321, and a request for NDIC to provide \$20,000,000.
- *Participants:* The major project participants are: Minnkota (overall lead), Fluor (carbon capture system FEED technical lead), Burns & McDonnell (BMcD) (owner's engineer & FEED engineering), and Energy & Environmental Research Center (EERC) (carbon capture system technical support and geologic storage lead). Many additional participants have already and will be involved in various roles in the carbon capture system and geologic storage facility development. An updated organizational chart can be found later in this request for amendment.

Project Summary

The project summary begins on Page 5 of the 2018 proposal to NDIC. Besides the overall cost estimate (detailed in previous section above) and a new focus on saline formation storage, no substantive changes are needed to this section. The project tasks and scope have been laid out to ensure that all engineering, design, costing and permitting work is completed to enable final investment decision and commencement of construction as soon as 2022.

Project Description

The project description begins on Page 8 of the 2018 proposal to NDIC. The large majority of this description is still accurate, with the key changes being noted below:

- There have been multiple changes to the overall scope of work, as detailed in this request for amendment.
- There have also been changes to the major project participants, namely we have replaced Mitsubishi Heavy Industries (MHI) with Fluor for the role of carbon capture system (CCS) technology provider and FEED technical lead. This change was approved previously by NDIC.

Standards of Success

The standards of success were described beginning on Page 23 of the original 2018 proposal to NDIC. No changes are necessary.

Background

The background section begins on Page 24 of the original 2018 proposal to NDIC. No changes are necessary. However, for purposes of technical review, it may be beneficial for reviewers to also read the previous quarterly progress reports that have been submitted to NDIC to date (included as Appendix D).

Qualifications

The qualifications section begins on Page 34 of the original 2018 proposal to NDIC. There have been changes to the overall project team that have already been reviewed and approved by NDIC. The key change was the switch from MHI to Fluor for the CCS technology vendor and FEED technical lead role. A brief summary of Fluor's qualifications is provided below.

Fluor will be both the technology vendor (Econamine FG Plus℠, EFG+) and the FEED technical lead on the project. Fluor is one of the world's largest publicly traded Engineering, Procurement and Construction (EPC) companies. For over a century, clients have trusted Fluor as an industry leader to design and build projects safely, cost effectively and on schedule. Fluor's EFG+ carbon capture technology has more than 30 licensed plants worldwide and the significant learnings accumulated through Fluor's development of the technology offer a high possibility of successful implementation at MRYS. In the FEED, Fluor will be the technical lead associated with engineering and design of the carbon capture system as well as in the cost estimating efforts. Fluor will also support the permitting strategy development through providing the Project Tundra team environmental and other technical information. Mr. Rick Graebe will be Fluor's project manager and he will be supported by Dr. Satish Reddy, Fluor's process technology director. Mr. Graebe has 23 years of experience with Fluor and has managed a wide range of commercial projects across multiple divisions of Fluor's business. He was selected for this project specifically because of his extensive EPC experience for projects of this magnitude. Dr. Reddy has more than 40 years of experience in the engineering, debottlenecking, troubleshooting, and start-up of carbon capture plants, gas processing, syngas, fertilizer, sulfuric acid, and inorganic chemical plants.

Value to North Dakota

The value to North Dakota section begins on Page 38 of the original 2018 proposal to NDIC. No changes to this section are necessary. Project Tundra has the potential to be a game changer for both the lignite and oil & gas industries in North Dakota.

Management

The management description begins on Page 39 of the original 2018 proposal to NDIC. Mr. Gerry Pfau will remain the overall project principal investigator / project manager, with a technical focus on the CCS and integrations at the Young Station. Overall project oversight and leadership will be provided by Dr. Dan Laudal, Minnkota's Environmental Manager and Project Tundra Manager. Mr. Pfau and Dr. Laudal will work closely to ensure project objectives are met on schedule and within the estimated cost.

There have been changes to the project participants. Figure 1 provides an updated project management structure, which will replace the one provided on Page 40 (Figure 8) of the original 2018 proposal. Resumes for key personnel (identified as either task lead or task assist in Figure 1) that were not identified in the original 2018 proposal (Dan Laudal, Rick Graebe, Satish Reddy, Wes Peck) are provided in Appendix A.

Timetable and Deliverables

The timetable and deliverables section was provided beginning on Page 41 of the original 2018 proposal to NIDC. There are no major changes to the deliverables. The overall project duration is not impacted by this request for amendment. However, based upon progress to date and the changes/additions to the project scope (detailed later), Figure 2 below provides an update to the overall project schedule, which will replace the one provided on Page 42 (Figure 9) of the original 2018 proposal. We note that EERC's schedule for Budget Period 2[1] of CarbonSAFE Phase 3 with DOE will extend beyond this date. However, the scope of work, schedule and expenditures planned during Budget Period 1 of CarbonSAFE are in alignment with the project objectives for the Project Tundra FEED grant.

[1] Budget Periods 1 and 2 are defined in EERC's proposal to DOE. More details can be found in Appendix B.

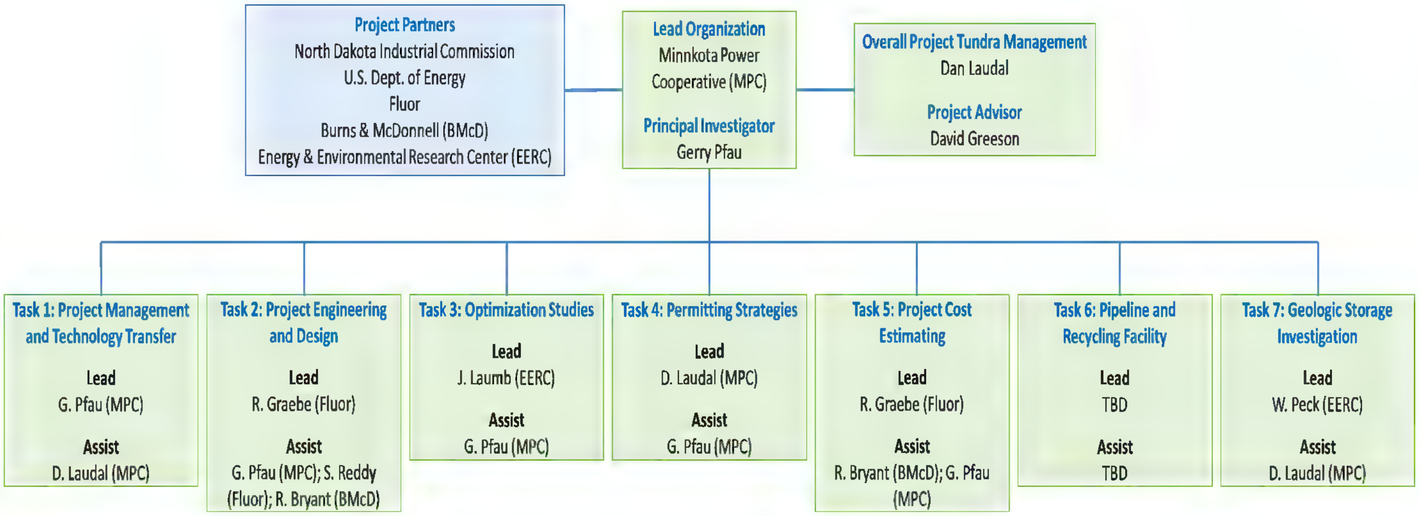
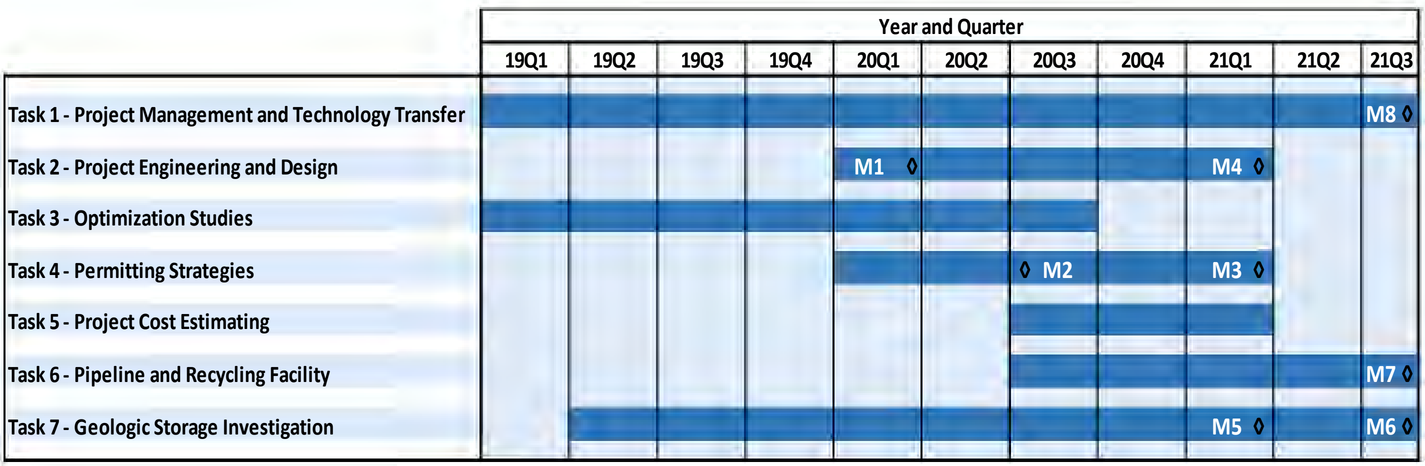


Figure 1. *Updated project management structure.*



Milestones ◊	
M1 - Complete CCS Design Manual	M5 - Storage Facility/Class VI Permits Submitted
M2 - Permitting Kickoff Meeting with NDDEQ	M6 - Site Characterization Report
M3 - All Critical Path Permits Submitted	M7 - Pipeline FEED Report
M4 - CCS FEED Report	M8 - Final Project Report

Figure 2*. Updated project schedule and major milestones. Start date was January 1, 2019 with planned completion on August 31, 2021.*

Budget

The budget section was provided beginning on Page 47 of the original 2018 proposal to NDIC. Changes to the project budget are detailed and justified in later sections of this request for amendment.

Matching Funds

The matching funds section was provided beginning on Page 48 of the original 2018 proposal to NDIC. As will be detailed in a later section of this request for amendment, 56.5% of the current total estimated cost will be provided through matching funds from a combination of Minnkota's own investment and multiple awards from DOE.

- $20 Million is being requested from NDIC
- Over $26 Million has been secured in matching funds

Tax Liability

Minnkota is a non-taxable entity; therefore, it has no tax liability.

Confidential Information

The original 2018 proposal to NDIC contained a confidential appendix that included the proposal from MHI to support the CCS FEED study. Since MHI is no longer a part of the project, that appendix has been removed. There is no new confidential information provided as a part of this request for amendment.

Appendices

Appendices to this request for amendment include the following:

- Appendix A – Resumes for key personnel added since original proposal submission, which include the following:
    - Dr. Dan Laudal, Minnkota's Environmental Manager and Project Tundra Manager
    - Mr. Rick Graebe, Fluor's Project Manager
    - Dr. Satish Reddy, Fluor's Process Technology Director
    - Mr. Wes Peck, EERC's Project Manager on CarbonSAFE Phase 3
- Appendix B – Updated subcontractor proposals from the following major project participants:
    - Select sections of EERC's proposal to DOE for CarbonSAFE Phase 3
    - EERC support of CCS FEED
    - Burns & McDonnell support of CCS FEED
    - Fluor support of CCS FEED
- Appendix C – Original 2018 Proposal to NDIC. We note that the MHI subcontractor proposal has been deleted since MHI is no longer involved in the project.
- Appendix D – Previous quarterly progress reports

DESCRIPTION OF SCOPE CHANGES/ADDITIONS

While the primary reason for this request of additional funds is the shift from enhanced oil recovery (EOR) to saline geologic storage, there are other changes to the project that have impacted the cost of the work as contemplated in the November 2018 proposal to NDIC.

- ***Individual changes explained*** *– The descriptions below detail the material changes or additions in scope, as compared to those originally proposal to NDIC, and provide explanations for why the changes are necessary.*
- ***No new tasks*** *– As described in the following sections, while there have been changes/additions to the overall project scope, the seven project tasks originally proposed still adequately describe the work required to meet project objectives. Thus, no new tasks are being proposed with this amendment.*
- ***No impact on schedule*** *– We also note, despite the changes/additions identified below, the project schedule will not be impacted and we are not requesting a change to the period of performance.*
- ***Some decreases to offset increases*** *– As indicated below, changes to certain tasks and increases in cost share funding sources have combined to result in lower NDIC funding needed on such tasks. In this amendment we have allocated those savings to offset the need for increased funding from NDIC in other tasks.*

Project Management and Technology Transfer (Task 1)

There have been no material changes or additions to this task. The cost of this task was not specifically estimated in the original proposal. However, the original proposal allocated $864,414 of Minnkota cash/in-kind cost share for consultants and facilities & administration costs. However, based upon experience to date in executing the project and the fact that the consultants' time/cost is allocated across multiple tasks, we now estimate the total cost of this task to be about $600,000.

Carbon Capture System Front End Engineering and Design (CCS FEED) (Tasks 2, 4, 5)

There have been multiple changes to this scope item since the original proposal, much of which has already been communicated to and approved by NDIC. Already approved changes include switching the carbon capture system (CCS) technology vendor from MHI to Fluor, a significant reduction in the scope of Burns

& McDonnell (a result of the CCS vendor change to Fluor), and the addition of multiple specialty vendors/consultants to support a variety of the engineering/design and permitting efforts. Overall, these changes significantly reduced the total estimated cost of the CCS FEED (reduction of ~$12.5 Million).

Subsequent to when the above changes were approved by NDIC, additional changes to the scope of the CCS FEED have been identified. Specifically, Minnkota has elected to source steam for the CCS via natural gas fired package boilers, as opposed to direct extraction from the MRYS Unit 2 steam turbine. This decision was detailed in previous quarterly progress reports (See First Quarter 2020, and Second Quarter 2020 reports). However, in summary, the change was made because the package boiler option provides significant reduction in technical and cost risk, significantly improves operational flexibility, and potentially improves overall project economics. The impact of the changes on CCS FEED estimated cost have now been quantified as described in the next paragraphs.

One of the benefits of sourcing steam from package boilers is we are now able to tie in Unit 1 to the CCS in addition to Unit 2. The proposed design does not capture CO_2 from both units at the same time, but allows for capturing CO_2 from Unit 1 when Unit 2 is offline for outages. This creates new scope associated with designing the duct work and ties-ins. Also, having both Unit 1 and Unit 2 connected to the CCS, as well as the flue gas from the package boilers, leads to additional plant controls systems and more complex emissions permitting which consequently leads to more engineering and permitting scope.

Table 1 provides a breakdown of the original estimated cost and funding sources for the CCS FEED (Nov. 2018 proposal), the estimated cost and funding approved by DOE (Project No. DE-FE0031845) (Dec. 2019), and our current estimated cost which includes the changed/added scope described above. As shown in Table 1 for the NDIC share, the current cost estimate is ~$6.5 Million less than the original Nov. 2018 proposal estimate. However, as will be discussed in a later section of this amendment, these costs savings will serve to augment cost increases in other areas of the project. Lastly, the current cost estimate in Table

1 shows an increase of $781,070 as compared to the budget approved by the DOE in Dec. 2019, which reflects the added scope discussed in the preceding paragraphs.

Table 1. *Summary of CCS FEED (Tasks 2, 4, 5) cost estimate changes since original proposal submission*

Funding Source	Original Proposal (Nov. 2018)[2]	Original DOE Award (Dec. 2019)	Current Estimate (July 2020)[3]
NDIC	9,750,000	2,455,394	3,236,464
DOE	15,000,000	9,821,578	9,821,578
TOTAL	**24,750,000**	**12,276,972**	**13,058,042**

Optimization Studies (Task 3)

This task was originally proposed quite broadly because at the time of submission it was not clear what types of studies would be needed to optimize the overall project. Since proposal submission, one major effort approved by NDIC is already underway. The study involves a series of pilot-scale tests at MRYS to prove the viability of a wet electrostatic precipitator (WESP) to remove very fine particulate in the flue gas. If not removed upstream of the CCS, these particulate would be expected to cause challenges for amine solvent emissions and degradation. Testing will be performed in conjunction with pilot-scale testing of Fluor's solvent formulation in EERC's carbon capture plant that is currently installed in the Unit 2 chimney. The findings from this pilot study will greatly expand our understanding of how CCS technologies can be successfully applied to North Dakota lignite, and will provide valuable design and performance data for the CCS FEED study and for the permitting process.

Currently, no additional optimization studies have been identified. However, budget is available for any additional optimization studies. One example of additional studies under this task would be an extension (if needed) of the pilot testing duration to gather additional long-term data or data at alternate process

[2] From page 47 (Table 2) of original 2018 proposal. NDIC share of the CCS FEED included the Burns & McDonnell subcontract ($7,533,500), Contingencies ($2,206,500), and Facilities & Administration ($10,000).

[3] Minnkota received an amendment to the DOE contract (6/10/2020) allowing the increase in non-federal cost share, shown here as the NDIC share.

conditions. Table 2 provides a summary of the original proposal cost estimate along with the current estimate. As reflected in Table 2, NDIC's share of the total cost of this task has not changed, but new cost share has been secured to cover the overall increase in cost.

Table 2. *Comparison of original and current cost estimates for Optimization Studies (Task 3)*

Funding Source	Original Proposal (Nov. 2018)[4]	Current Estimate (July 2020)[5]
NDIC	1,000,000	1,000,000
DOE	-	900,000
Minnkota	300,000	337,853
TOTAL	**1,300,000**	**2,237,853**

Pipeline FEED (Task 6)

This task was originally focused on FEED studies for an approximately 120-mile CO_2 pipeline from MRYS to conventional oil fields in western North Dakota and the infrastructure required for the CO_2 injection and recycling facilities to support EOR operations. However, as described in this request for amendment, Project Tundra has pivoted from an EOR storage philosophy to storage in saline formations deep beneath the power plant and the adjacent lignite mine. As such, this task will now also include a FEED study for a much shorter CO_2 pipeline (10 miles max) and the associated surface infrastructure required to deliver captured CO_2 to a series of injection wells located near the plant and mine.

We note that despite a shift in focus away from EOR in the short term, **EOR absolutely remains in the longer term focus. Minnkota remains committed to evaluating EOR opportunities if/when they do become available.** Therefore, as originally proposed, Minnkota still intends to complete the FEED studies

[4] From page 47 (Table 2) of original 2018 proposal. Minnkota share includes work performed by the EERC to prepare the project for the FEED study application to DOE

[5] Project partner EERC has secured funding from DOE to augment the pilot-scale testing described in this amendment request. The Minnkota share is the total expenditures to date. Since excess cost share has already been secured, no additional Minnkota cost share is anticipated.

for the longer pipeline and EOR surface infrastructure so that we can be prepared to capitalize on future EOR opportunities.

Minnkota and its team are currently in the process of preparing a request for proposal for engineering and permitting assistance to complete a CO_2 pipeline FEED as described above. Multiple potential firms have been identified and we expect to begin receiving proposals for review in August 2020. Based on previous experience, we currently estimate the cost for this shorter pipeline study to be about $300,000.

- To accommodate the added scope associated with the shorter CO_2 pipeline FEED, the estimated total cost for this task will increase to a total of $800,000, as compared to the original proposal estimate of $500,000.

Geologic Storage Investigation (Task 7)

Introduction – Switch from EOR to Saline Formation Storage:

As described previously, Project Tundra has pivoted from a storage philosophy where CO_2 would be stored as a consequence of EOR operations in the conventional oilfields of North Dakota, to solely geologic storage in the deep saline formations beneath the power plant and the adjacent lignite mine. As described in the original 2018 proposal, geologic storage was included within the scope, but on a much smaller scale, as the geologic storage was thought to be only a backup for the primarily CO_2 for EOR storage plan.

There are two major reasons for this important change to the project: 1) oilfield operators in the most productive counties of North Dakota, which were viewed as the primary likely market for CO_2 from Project Tundra, are net yet ready for commercial quantities of CO_2, and 2) a pure geologic storage project would provide project investors with greater certainty and credit quality given the low risks of geologic injection and the complete control over the injection operations. Under current and foreseeable near-future economic conditions, oilfield operators would likely not be able to provide the level of certainty over the volume and price that project investors will desire.

The original scope and estimated cost for this task were tied to securing additional DOE funds for the third phase of EERC's CarbonSAFE program. However, since the CO_2 that was originally planned to go to EOR will now go entirely into deep saline storage (as described below), the significant increase in the volume of CO_2 planned for geologic storage results in a correlating increase in required amount of site characterization, data analysis, and simulation work not contemplated in the original proposal. The justification for and description of this additional scope is provided in the following paragraphs.

Scope for Geologic Storage Facility Development:

The original concept for the geologic storage (as buffer capacity for EOR offtake) involved a much lower volume of CO_2, to be accommodated by one injection well in a single geologic horizon. However, based on a much higher volume of CO_2 storage of 4 Million tonnes CO_2/year, the development of the storage facility becomes more complex. Preliminary simulation work by the EERC, leveraging existing subsurface data, identified that at least four injection wells are needed. Further, EERC's previous work identified up to three different geologic horizons as targets for CO_2 injection, providing the opportunity for a "stacked storage" approach (Figure 3). By using stacked storage to split the volume of CO_2 injected into multiple geologic horizons, the aerial extent of the CO_2 plume can be reduced, thus reducing the number of landowners within the storage complex, minimizing costs associated with leasing pore space, and minimizing the area of review for the storage facility.

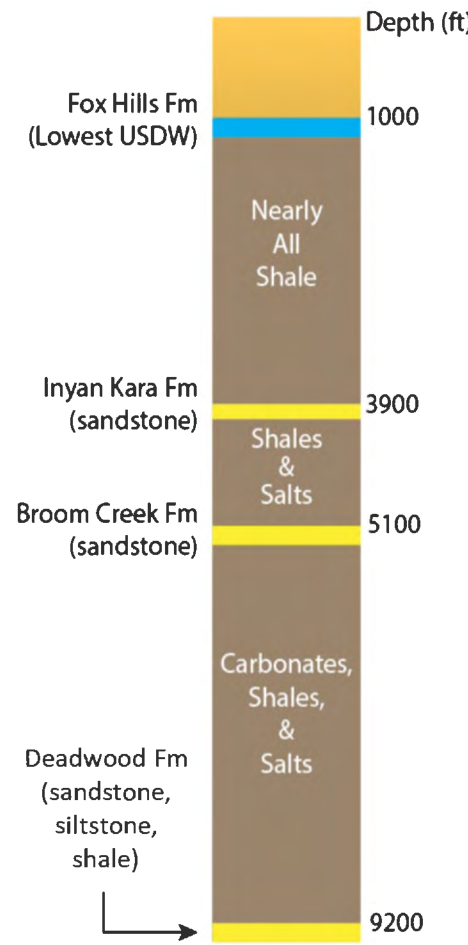


***Figure 3**. Simplified schematic of three formations that are targeted for CO_2 injection (yellow bands with porous sandstones), which allows a stacked storage approach and minimized CO_2 plume aerial extent.*

Through investigating options and understanding the importance of minimizing the aerial extent of the storage facility, two separate blocks of land (west site and east site) owned by either Minnkota or BNI Coal were identified that may be viable CO_2 storage facility locations, as shown in Figure 4. We felt it very important to identify potential CO_2 injection locations that would maximize the ownership of the surface estate (and thus the pore space as well) by either Minnkota or BNI. Although the CO_2 plume shown in Figure 4 over the west site is idealized and only illustrative, based on very preliminary EERC simulations, it appears that centering the CO_2 plumes over each of the sites will result in close to if not more than 60% of the pore space interest already being controlled by Minnkota or BNI.

Based on the stacked storage concept (Figure 3) and the two separate storage sites (Figure 4) and after initial discussions with the department of mineral resources at NDIC (state regulatory agency for CO_2 geologic storage), there are likely to be at least four and as many as six individual storage facility permits pursued for Project Tundra. Following this permitting approach, each formation receiving CO_2 injections at each separate (no overlap of CO_2 plumes within the same formation horizon) geographic location would be considered a unique storage facility. Therefore, to provide NDIC the information required to secure CO_2 storage facility permits, each formation within each of the well site locations must be characterized, and simulations must be performed to predict and understand the behavior of CO_2 in each geologic horizon.

To characterize the formations of interest in each of the two sites identified in Figure 4, two primary means of subsurface investigations are being pursued: 1) 3D seismic, and 2) drilling a stratigraphic test well and collecting rock and fluid samples (with many laboratory tests conducted on each) along with a series of subsurface wireline logs. As reflected in this request for amendment, Minnkota has elected to perform 3D seismic and drill stratigraphic test wells in each of the two storage sites.

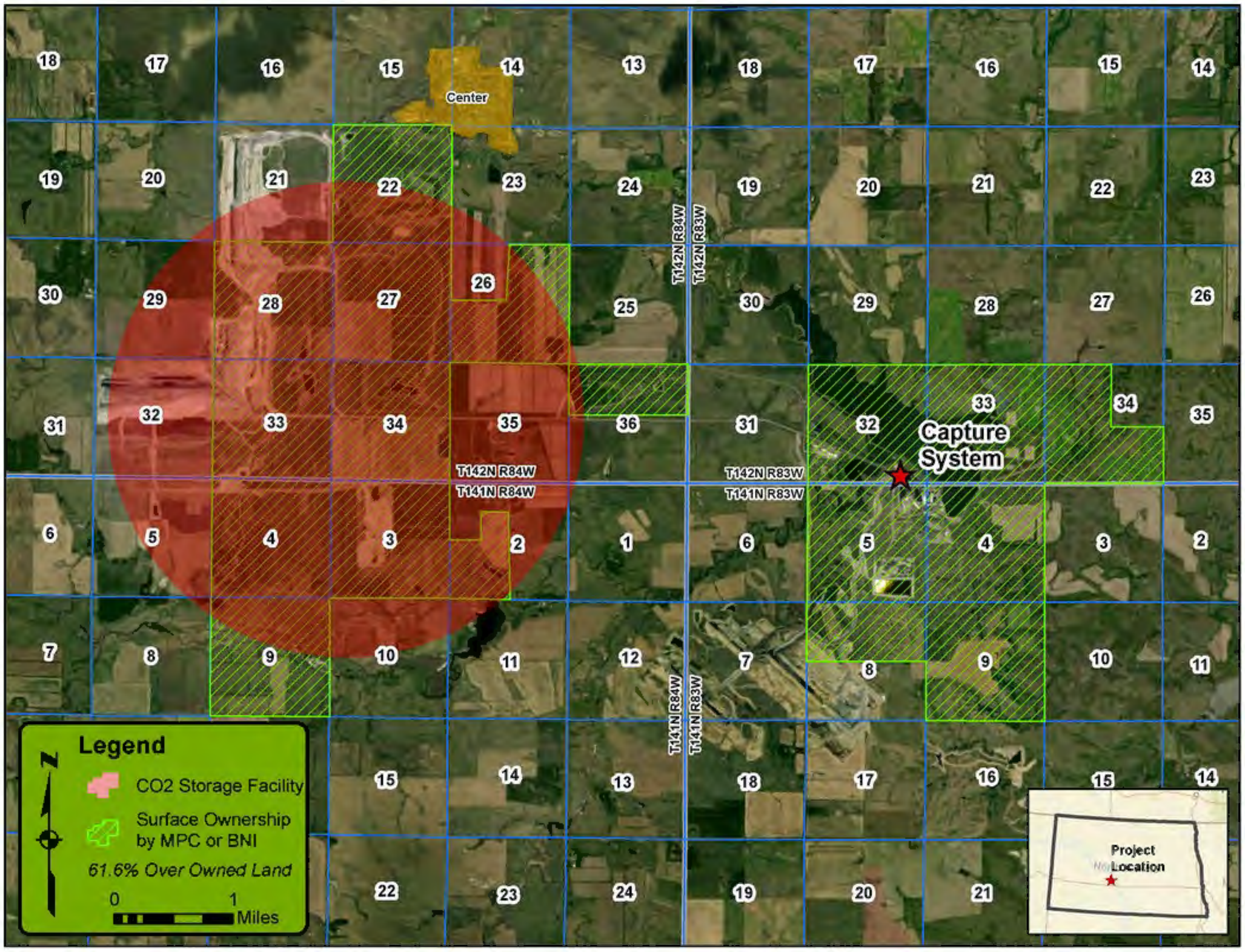


***Figure 4**. Map showing land ownership in the area surrounding the Milton R. Young Station (red star). Centering the CO_2 plumes (idealized and only illustrative for simplicity) over the two separate land ownership blocks (green hatched areas) has the potential to result in majority ownership of the pore space by Minnkota or BNI, thus limiting private land owner involvement and pore space leasing costs. Although not shown, a CO_2 plume over the east block of land would also be present and is not anticipated to overlap with the CO_2 plume centered over the west block of land.*

As stated earlier, the original proposal called for this task to be tied to the third phase of EERC's CarbonSAFE program, and would be contingent upon award of separate DOE funding. Minnkota is pleased to report that EERC's application to DOE for CarbonSAFE Phase 3 was successful, and approximately $17 Million in DOE funding is expected (currently in award negotiation phase[6]). However, delays in the timing and program schedule for the CarbonSAFE project were not conducive to Minnkota's timeline dictated by

[6] Expected award by mid July 2020. Only Budget Period 1 of EERC's proposal to DOE is in alignment with the Project Tundra FEED grant from NDIC, which includes almost $15 Million in DOE funding. See Appendix B for further details of CarbonSAFE.

the 45Q tax credit (commencement of construction before 2024) and all of the site characterization work that needs to be done to secure storage facility permits in time to meet the financing and commence construction requirement.

To maintain schedule, and with the cost savings realized on the CCS FEED study (~$6.5 Million), Minnkota initiated site characterization activities for the west site in the second quarter of 2019. Full details of the efforts completed to date and currently underway can be found in the previous quarterly reports submitted to NDIC (See Fourth Quarter 2019 Report and First Quarter 2020 Report). However, the following paragraphs provide a brief summary of the three major activities, with cumulative and expected costs incurred: **1)** seismic source test, **2)** 3D seismic survey, **3)** J-LOC1 stratigraphic test well.

Seismic Source Test: Due to uncertainty over the response of various seismic sources (i.e. vibroseis trucks and dynamite charges) on reclaimed mine land (much of the west site is reclaimed mine land), it was necessary to perform a source test prior to executing a full 3D seismic survey. The source test was conducted in July 2019. Source test results led to a decision to utilize 11-lb dynamite charges placed at a depth below the mine spoils (120-180 ft). The total cost of the source test was ~$200,000.

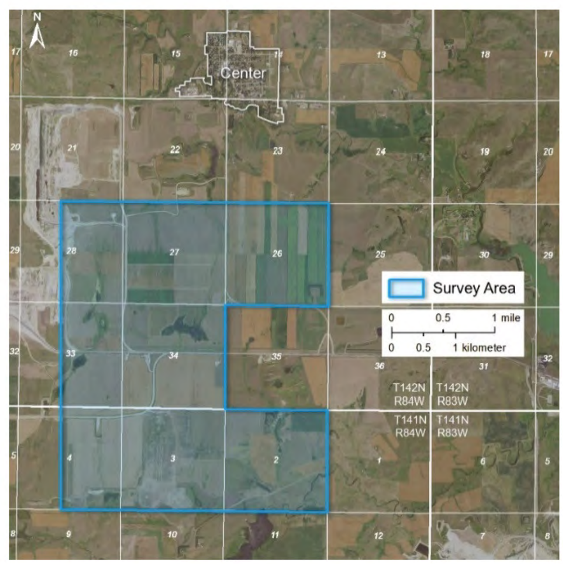


Figure 5. *Survey area for fall 2019 3D seismic*

3D Seismic Survey: Following the source test, a full 3D seismic survey was conducted during the fall of 2019 on a ~6.7 mi^2 plot of land (Figure 5). A total of 606 shot holes were drilled in a grid pattern across the survey area. The sensor array consisted of 1182 geophones laid out on the surface. The survey was successful and provided valuable subsurface data. The primary conclusion is that the target formations within the survey area do not show any indications of faults/fractures or other geologic features that would prevent them from being good CO_2 storage targets. The total cost of 3D seismic survey was ~$1,000,000.

J-LOC1 Stratigraphic Test Well*:* Minnkota received the permit to drill for the J-LOC1 well from NDIC in January 2020. The well was spudded on May 14, 2020 and successfully completed on June 17, 2020. The well is located in the northcentral portion of Section 27 (see Figure 5) within the 3D seismic survey area.

The primary goals of the J-LOC1 well were as follows: **1)** obtain rock cores for the three target formations and their respective cap and basement rocks (see Figure 3); **2)** obtain detailed wireline logging/testing data for the geologic horizons of interest (based on the requirements of the Underground Injection Control (UIC) Class VI permit process). All of the data and the rock and fluid samples collected will need a large amount of laboratory analysis and testing, which will be completed over the next few months.

Overall, we are very pleased with the execution of the J-LOC1 drilling program and believe that all of the necessary data was obtained to support the permitting of the CO_2 storage facilities (each of the three geologic horizons tested is considered a separate and unique storage facility) for the west site.

Although J-LOC1 was permitted as a stratigraphic test well, Minnkota elected to complete the well (casing and cement specs) to Class VI standards. This will enable the well to be re-permitted and used in the storage operations as a CO_2 injection zone monitoring well once commercial injection of CO_2 commences. The alternative would have been to plug and abandon the well. While this decision did add cost to the overall well program, Minnkota feels strongly that it was the most efficient use of project development funds.

- The total cost incurred on the J-LOC1 well is still being tabulated, as invoices are forthcoming from the many vendors working on the well. However, the current estimated total cost is ~$7 Million.

Next Steps – Site Characterization at the East Site, Data Analysis/Simulations, and Permit Preparation:

As mentioned previously, EERC was successful in its application to DOE for the third phase of CarbonSAFE. From this point forward on Task 7, all activities will be included within the scope of CarbonSAFE (Budget Period 1 only), which is summarized below (full details in Appendix B). The total estimated cost of CarbonSAFE is shown in Table 3.

Site Characterization: This effort will include all subsurface investigations for the east site (see Figure 4), with a new stratigraphic test well and 3D seismic survey to be completed adjacent to the MRYS. The 3D seismic and test well efforts will be similar in scope to the ones performed for the west site previously. Additional geophysical survey techniques will also be tested (gravity, magnetic and electromagnetic surveys), with a goal to identify less costly and physically intrusive alternatives to 3D seismic.

Laboratory Analysis: Analysis of core and fluid samples obtained from the test wells at each site (east and west) will be performed. We note that the J-LOC1 test well was drilled outside of the CarbonSAFE scope, but the analysis of its samples and data is included in the CarbonSAFE scope.

Modeling and Simulation: The geologic site characterization data (logs, core/fluid analysis, and seismic) will be integrated in sophisticated computer models that will predict the behavior of CO_2 in the subsurface. These are dynamic simulations that can incorporate multiple injection scenarios and overall operating conditions of the CO_2 storage facility.

Permitting: The characterization data and modeling and simulation information will be used to build all permit applications necessary to comply with North Dakota's geologic CO_2 storage regulations. These include storage facility and Class VI well-drilling permits. This task will also include development of a monitoring, reporting and verification (MRV) plan to meet the requirements of the Green House Gas Reporting Program Subpart RR as currently required under the 45Q tax credit program.

Monitoring: This task includes identifying and collecting samples from water wells within the storage facility area of review. Surface soil gas samples will be collected and analyzed from select locations. Up to two dedicated lowest-underground sources of drinking water (USDWs) monitoring wells will also be installed, likely one within each of the east and west sites.

Outreach and DOE-Specific Activities: Outreach efforts will focus on communications, via multiple mechanisms and building on EERC's materials developed under previous programs, to project stakeholders, policy makers, and the general public. EERC has also included crosscutting efforts that will focus on integrating multiple DOE-specific programs and CarbonSAFE. The crosscutting efforts are part of the DOE Budget Period 2 and are not considered to be a part of the NDIC Project Tundra FEED project.

***Table 3**. Total estimated cost for CarbonSAFE Phase 3 (Budget Period 1 only – See Appendix B)*

Funding Source[7]	**Estimated Cost**
DOE	14,845,743
Minnkota (NDIC pass through)	5,000,000
Computer Modeling Group	639,200
Schlumberger	1,333,333
TOTAL	**21,818,276**

Summary of Funding Needs to Support Geologic Storage Development:

In summary, due to the shift in the near term focus of Project Tundra from EOR to dedicated saline formation geologic storage, there has been a large amount of new scope added to this task that was not originally contemplated in the 2018 proposal to NDIC. While much of that added cost was offset by the savings realized on the CCS FEED study component of the project and EERC's CarbonSAFE award from the DOE, our current funding approval of $15 Million from NDIC is insufficient to complete all of the work described and justified in the preceding discussion of this task.

Table 4 provides a comparison of the original estimated cost for this task and the current expected cost based on the significant expansion of the scope for geologic storage development.

[7] Only the DOE funding will be counted as cost share towards the NDIC award. Both the Computer Modeling Group and Schlumberger cost share are in-kind awards associated with donation of software needed by EERC to perform the computer simulations/modeling work. The DOE share shown here is the DOE funding for Budget Period 1 only, which is in alignment with the Project Tundra FEED grant from NDIC.

Table 4. *Comparison of the original and current cost estimates for geologic storage development*

Funding Source	Original Proposal (Nov. 2018)	Current Estimate (July 2020)
NDIC	3,750,000	14,463,536 [8]
DOE	15,000,000[9]	14,845,743
Minnkota	-	6,771
TOTAL	**18,750,000**	**29,316,050**

OVERALL COST SUMMARY

Table 5 provides a comparison of the original 2018 proposal cost, the total expenditures to date, and the current estimated cost to complete all work with a higher NDIC funding approval of $20 Million. We note that over $26 Million in cost share has been secured between investment from Minnkota and multiple awards from DOE. **Table 6 provides a direct comparison of the NDIC-only share of estimated costs between the original proposal and the current estimate**. Table 7 provides our current estimated breakdown of project costs by major participants.

CONCLUSION

Minnkota is grateful for the support from NDIC and the Lignite Research, Development and Marketing Program to date over our several years of Project Tundra research and development. However, due to necessary changes in scope to our grant award described herein, we are respectfully submitting this request to increase the funding approval by $5 Million (from $15 to $20 Million). Approval of this request will

[8] Estimate includes:

West Site Seismic	1,200,000
West Site Test Well (J-LOC1)	7,000,000
CarbonSAFE Cost Share	5,000,000
Contingency	1,263,536

[9] At the time of original proposal submission, it was not known what funding level would be available in the anticipated funding opportunity from DOE. This represents DOE covering 80% of the total costs for Task 7, which is typical of DOE cooperative agreements.

enable Minnkota and our team to complete all engineering, design and permitting work to prepare for final investment decision and commencement of construction as soon as 2022.

***Table 5**. Project Tundra FEED grant cost estimate comparison: original proposal, expenditures to date, and new expected cost with a higher NDIC funding approval of $20 Million.*

Major Scope Category	Original Proposal Cost Estimate (Nov. 2018)			
	NDIC	**Minnkota**	**DOE**[10]	**Total**
Project Management (Task 1)	-	864,414	-	864,414
Capture System FEED (Tasks 2, 4, 5)	9,750,000	-	15,000,000	24,750,000
Pre-FEED & Optimization Studies (Task 3)	1,000,000	300,000	-	1,300,000
Pipeline FEED (Task 6)	500,000	-	-	500,000
Geologic Storage (Task 7)	3,750,000	-	-	3,750,000
TOTALS	**15,000,000**	**1,164,414**	**15,000,000**	**31,164,414**
% of Total Cost	48.1%	3.7%	48.1%	100.0%

Major Scope Category	Total Expenditures through May 31, 2020			
	NDIC	**Minnkota**	**DOE**	**Total**
Project Management (Task 1)	207,918	94,750	-	302,668
Capture System FEED (Tasks 2, 4, 5)	62,136	-	248,543	310,679
Pre-FEED & Optimization Studies (Task 3)	786,524	337,853	605,754	1,730,131
Pipeline FEED (Task 6)	-	-	-	-
Geologic Storage (Task 7)	2,704,159	6,771	-	2,710,930
TOTALS	**3,760,738**	**439,374**	**854,297**	**5,054,408**
% of Total Cost	74.4%	8.7%	16.9%	100.0%

Major Scope Category	Current Expected Project Cost (July 2020)			
	NDIC	**Minnkota**	**DOE**	**Total**
Project Management (Task 1)	500,000	94,750	-	594,750
Capture System FEED (Tasks 2, 4, 5)	3,236,464	-	9,821,578	13,058,042
Pre-FEED & Optimization Studies (Task 3)	1,000,000	337,853	900,000	2,237,853
Pipeline FEED (Task 6)	800,000	-	-	800,000
Geologic Storage (Task 7)	14,463,536	6,771	14,845,743	29,316,050
TOTALS	**20,000,000**	**439,374**	**25,567,321**	**46,006,695**
% of Total Cost	43.5%	1.0%	55.6%	100.0%

[10] The DOE share for Task 7 is shown as zero in the original proposal cost estimate in this table to be consistent with the original proposal documents (see page 47 Table 2 of attached 2018 proposal). However, as shown in Table 4 previously, it was expected that DOE would award funding for CarbonSAFE Phase 3, which was to be provided as cost share. Therefore, total project cost for the original estimate would have been $46,164,414.

Table 6. *Comparison of NDIC share of original proposal and current estimated project costs*

Major Scope Category	Original (Nov. 2018)	Current (July 2020)	Difference
Project Management (Task 1)	-	500,000	500,000
Capture System FEED (Tasks 2, 4, 5)	9,750,000	3,236,464	(6,513,536)
Pre-FEED & Optimization Studies (Task 3)	1,000,000	1,000,000	-
Pipeline FEED (Task 6)	500,000	800,000	300,000
Geologic Storage (Task 7)	3,750,000	14,463,536	10,713,536
TOTALS	15,000,000	20,000,000	5,000,000

Table 7. *Current estimated breakdown of project cost by major project participant.*[11]

Major Scope Category	Current Estimated Costs by Major Project Participant (July 2020)					
	Minnkota	**EERC**	**Fluor**	**BMcD**	**Others**[12]	**Total**
Project Management (Task 1)	394,750	-	-	-	200,000[13]	594,750
Capture System FEED (Tasks 2, 4, 5)	1,040,219	1,135,616	9,247,636	920,251	714,320	13,058,042
Pre-FEED & Optimization Studies (Task 3)	112,853	1,425,000	420,000[14]	-	280,000	2,237,853
Pipeline FEED (Task 6)	100,000	-	-	-	700,000[15]	800,000
Geologic Storage (Task 7)	1,800,000	9,058305	-	-	18,457,745[16]	29,316,050
TOTALS	**3,477,822**	**11,618,921**	**9,667,636**	**920,251**	**20,822,065**	**46,066,695**

[11] All funding sources are combined in this table.

[12] Includes all other vendors, contractors and consultants who have been or will be working on the project. For simplicity, only the major project participants have been identified in this table.

[13] Primarily David Greeson Consulting

[14] Includes pre-FEED work and support of the on-site pilot testing at the Young Station.

[15] The engineering firm has yet to be identified, but will likely be selected in August 2020.

[16] This large cost includes the many vendors and contractors who have and will support the seismic surveys, other geophysical surveys, and the stratigraphic test wells. Some of the higher cost vendors/contractors include:

- Schlumberger – test well general contractor and various well services
- Cyclone Drilling – drilling rig contractor
- Baranko Brothers – test well pad construction
- Reservoir Group – collection of rock cores from test well
- Breckenridge Geophysical and SAExploration – source test and 3D seismic vendors

APPENDIX A – RESUMES OF NEW KEY PERSONNEL

- Dr. Dan Laudal – Minnkota Environmental Manager & Project Tundra Manager
- Dr. Satish Reddy – Fluor Project Technology Director for CCS FEED study
- Mr. Rick Graebe – Fluor Project Manager for CCS FEED study
- Mr. Wes Peck – EERC Project Manager for CarbonSAFE Phase 3

Dr. Daniel A. Laudal
Environmental Manager / Project Tundra Manager
Minnkota Power Cooperative
Grand Forks, ND 58201
701-795-4216, dlaudal@minnkota.com

Education and Training

University of North Dakota	Chemical Engineering	B.S. 2006
University of North Dakota	Chemical Engineering	Ph.D. 2017

Research and Professional Experience

2019-Present Environmental Manager / Project Tundra Manager
As Environmental Manager, have responsibility of leading the environmental regulatory compliance efforts for Minnkota Power Cooperative, an 11-member generation & transmission cooperative serving eastern ND and northwestern MN; directing Minnkota's permitting compliance activities; monitoring environmental laws, regulations, and legislative activities; and supervising the activities of Minnkota's environmental staff.

As Project Tundra Manager, leading Minnkota's development of a commercial-scale carbon capture and storage project for the Milton R. Young Station, a lignite coal fired power plant. Responsibilities include design and costing of the capture facility; permitting of the capture facility and carbon storage facility; advising the project team on technical aspects important for project financing; and coordinating the efforts of Minnkota's Project Tundra staff and external partners, consultants and contractors.

2016-2018 Manager: Major Projects, UND Institute for Energy Studies (IES).
Primary roles included developing and writing funding proposals, managing research projects, coordinating IES research staff and students, and process design/development of innovative solutions to challenges in the energy industry. Principal Investigator or Project Manager or several DOE, State and industry funded projects. Research focused on the following major areas: carbon management for the power industry, production of co-products from coal and associated materials, value-added opportunities/technology development for North Dakota's energy industries.

2012-2015 Research Engineer, UND Institute for Energy Studies.
Lead researcher or principal investigator on several federal, state and industry funded projects. Work involved early-stage R&D of novel processes and technologies, primarily focusing on laboratory- and bench-scale demonstrations. Areas of focus included chemical looping combustion and post combustion carbon dioxide capture.

2008-2012 Research Engineer, UND Energy & Environmental Research Center.
Research involved design and operation of various lab and pilot-scale gasification, combustion and advanced power systems. Gained invaluable experience with high pressure and high temperature systems and fluidized beds.

2006-2008 Field Engineer, Schlumberger Oilfield Services.
Design, execution and evaluation of well cementing operations in the Williston Basin. Led a team of 3-5 operators in performing various types of cement and work-over operations. Lead cement lab operator – designed, tested and validated cement compositions for each job.

Selected Publications

Laudal, D., Benson, S., Addleman, S., Palo, D. “Leaching behavior of rare earth elements in Fort Union lignite coals of North America.” International Journal of Coal Geology 191 (2018) 112-124.

Laudal, D., Benson, S., Addleman, S., Palo, D. “Rare earth elements in North Dakota lignite coal and lignite-related materials.” ASME Journal of Energy Resources and Technology 140 (2018).

Mann, M; **Laudal, D.**; Benson, S. “Maintaining Coal’s Prominence in a Carbon Constrained World.” Conference Proceedings: 2017 International Conference on Coal Science and Technology and 2017 Australia-China Symposium on Energy. September 25-29, 2017. Beijing, China.

Nasah, J., Jensen, B., Dyrstad-Cincotta, N., Gerber, J., **Laudal, D**., Mann, M., Srinivasachar, S. “Method for separation of coal conversion products from oxygen carriers.” International Journal of Greenhouse Gas Control. Volume 88, September 2019, pages 361-370.

Van der Watt, J.G., **Laudal, D**., Krishnamoorthy, G., Feilen, H., Mann, M., Shallbetter, R., Nelson, T., Srinivasachar, S. “Development of a spouted bed reactor for chemical looping combustion.” Journal of Energy Resources and Technology. 140(11), 112002 (8 pages), November 2018.

Nelson, T., van der Watt, J.G., **Laudal, D**., Feilen, H., Mann, H., Srinivasachar, S. “Reactive jet and cyclonic attrition analysis of ilmenite in chemical looping combustion systems.” International Journal of Greenhouse Gas Control. Volume 91, December 2019, 102837.

Pei, P., Nasah, J., Solc, J., Korom, S. **Laudal, D**., Barse, K. “Investigation of the feasibility of underground coal gasification in North Dakota, United States.” Energy Conversion and Management. Volume 113, 1 April 2016, pages 95-103.

Pei, P., **Laudal, D**., Nasah, J., Johnson, S., Ling, K. “Utilization of Aquifer Storage in Flare Gas Reduction.” Journal of Natural Gas Science and Engineering. Volume 27, Part 2, November 2015, 1100-1108.

Benson, S., Srinivasachar, S, **Laudal, D**., Browers, B. “Evaluation of Carbon Dioxide Capture from Existing Coal Fired Plants by Hybrid Sorption using Solid Sorbents.” Final Technical Report. US Department of Energy Award Number: DE-FE0007603. May 2015

Emerson, S., Zhu, T., Davis, T. Peles, A., She, Y., Willigan, R., Vanderspurt, T., Swanson, M., **Laudal**, **D**. "Liquid Phase Reforming of Woody Biomass to Hydrogen". International Journal of Hydrogen Energy, August 2013.

Synergistic Activities

Previous to Dr. Laudal’s current position at Minnkota, he was involved in many aspects of carbon capture and storage that are relevant to the subject proposal.

Dr. Laudal is currently leading efforts to drill a stratigraphic test well west of the Milton R. Young Station to gather data needed to support permitting of Project Tundra’s carbon storage facility, and also led recently completed efforts on a 6.7 square mile 3D seismic survey in the same geographic area.

Dr. Laudal is currently an adjunct faculty member of the University of North Dakota College of Engineering & Mines and is serving on committees of graduate students involved in a range of research projects focused on North Dakota’s energy industries.

Satish Reddy | Vice President, Process Technology
Fluor Enterprises, Inc. | Energy and Chemicals
+1 281.263.1245 | satish.reddy@fluor.com

Education and Training

University of Bath, England, Chemical Engineering, Doctorate/PH.D., 1987

India, Chemical Engineering, Bachelor's Degree, 1973

Research and Professional Experience

Fluor Enterprises, Inc.

Vice President, Process Technology | 1989-Present

Dr. Reddy has more than 40 years of experience in the engineering, debottlenecking, troubleshooting, and start-up of Carbon Capture plants, Gas Processing, Syngas, (Hydrogen & Ammonia), Fertilizer, Sulfuric Acid, and Inorganic Chemical plants. He is responsible for Carbon Capture, Ammonia, and Fertilizer Technology groups at Fluor.

Imperial Chemical Industries, PLC

Process Engineer | 1984-1988

Responsible for the development of process simulator modules for simulation of nitric acid plants.

Chemicarb Industries

Process Engineer | 1977-1984

Responsible as the team leader for the process design and detailed engineering of a plant producing high purity potassium carbonate.

Chemical Industries Consulting Bureau

Process Engineer | 1975-1977

Process Engineer on the revamp of two sulphuric acid plants and an alum plant.

The Alkali and Chemical Corporation of India, Ltd. (ICI)

Process Engineer | 1973-1974

Process Engineer at a benzene hexachloride plant

Publications (Project Related)

1. Reddy, S., Bhakta, M., Balkenende, S.: Fluor Enterprises, Incorporated, CA, USA, Lindsay, I., Lowe, C.: Chevron Energy Company, USA (2008). Designing a Climate Friendly Hydrogen Plant. *Presented at: 9th International Conference on Greenhouse Gas Control Technologies, November 16-20, 2008, Washington, DC.*
2. Reddy, S., Gilmartin, J.: Fluor Enterprises, Incorporated, CA, USA (2008). Fluor's Econamine FG Plus[SM] (EFG+) echnology for Post-Combustion CO_2 Capture. *Presented at: GPA Gas Treatment Conference, February 20-22, 2008, Amsterdam, The Netherlands.*

Project Experience

Abu Dhabi Gas Development Company Ltd., CO_2 Recovery Project (Abu Dhabi, UAE)

As Vice-President of Process Technology, Satish is responsible for the EFG+ technology that is being applied to the project. Fluor provided the technology license and supplied proprietary equipment.

South Louisiana Methanol Co, Carbon Dioxide Recovery Unit (St. James Parish, Louisiana, USA)

As Vice-President of Process Technology, Satish was responsible for a FEED and the preparation of a LSTK offer for a Carbon Dioxide Recovery Unit (CDRU) designed to recover CO_2 from a portion of flue gas generated by a Methanol plant steam-methane reformer (SMR).

Fluor + E.ON, CO_2 Demonstration Plant (Wilhelmshaven, Germany)

As Vice-President of Process Technology, Satish was responsible for the design and operation of the facility.

Relevant Patents, Copyrights, & Software Systems Developed

Reddy, S., Scherffius, J., Gilmartin, J., Freguia, S. (2008). US Patent No. 7,377,967, *Split Flow Process and Appartatus,* Washington DC: US Patent and Trademark Office.

Reddy, S. (2001). US Patent No. 6,3016,927, *Autorefrigeration Separation of Carbon Dioxide,* Washington DC: US Patent and Trademark Office.

Garrick (Rick) B. Graebe

Project Director II

Education:

B.S., Civil Engineering, Tulane University, New Orleans, Louisiana
M.S., Construction Engineering and Project Management, University of Texas, Austin, Texas

Certifications/Licenses:

Professional Engineer (P.E.), State of Texas
Project Management Professional (P.M.P.), Project Management Institute

Summary: **Mr. Graebe has over twenty two years of experience in the engineering and construction industry with key project leadership positions both in the home office and at construction sites in domestic and international locations. Specific positions include Project Director, Project Manager, Business Manager, Engineering Manager, Interface Manager, Project Engineer, Project Controls Manager, and Lead Planner on revamp and grassroots upstream, downstream, petrochemical and mining projects in the United States, Canada, Argentina, Chile, Peru, and Russia.**

Specific Experience:

Project Director
Fluor
2014 - 2018

Blanchard Refining Company, LLC
Tier 3 Ultra Low Sulfur Gasoline Project
Texas City, Texas, United States

Tier 3 Ultra Low Sulfur Gasoline Project includes a new Axens Prime G+ Gasoline Desulfurization Unit (GDU), several unit revamps and associated OSBL scope with a value of $550MM.

Won proposal for the Tier 3 project and directed all aspects of the 4-year, $550 million project from feasibility through sanctioning to meet compliance deadlines and funding authorizations. Spearheaded front-end project phases to earn "Best Practical" rating from Independent Project Analysis (IPA). Delivered on-schedule and under-budget regulatory project in line with required scope, long-term operability, and compliance deadline requirements. .

Business Manager
JGC Fluor
2013 - 2014

Chevron Canada Limited
Kitimat LNG
British Columbia, Canada

The Kitimat LNG Project is an 11 MTPA capacity LNG facility executed as a joint venture between the JGC Corporation and Fluor with offices in Yokohama, Calgary and Houston.

Mr. Graebe was the Business Manager for the Kitimat LNG Project leading all Project Controls, Estimating, Risk Management, Finance and Prime Contract Management functions for the joint venture. Mr. Graebe also played a key role on the proposal to win this hybrid contract, EPC project valued at over $10B USD.

Business Services Manager
Fluor Techint
2012 - 2013

Barrick Gold Corporation
Pascua Lama Project
San Juan, Argentina

The Pascua Lama Project is the world's first bi-national mining project with scope in Chile and Argentina, located at over 13,000 feet in the Andes Mountains. Fluor performed direct hire construction with Techint for the process plant and as well as overall construction management for the $5.0B scope in Argentina.

Mr. Graebe led the Project Controls, Contracting, Human Resources, Craft Training, Labor Relations, Finance, Camp Management and Information Technology Departments for all project work in Argentina. He led the successful transition of these functions from Barrick to Fluor as part of the overall site management transition. In addition, he led the effort to set up the Fluor baseline centric work processes and systems on site. He managed a team over 200 people working on site and in the San Juan Argentina project office.

Area Project Manager
Fluor
2010 - 2012

Minera Yanacocha SRL
Conga Project
Cajamarca, Peru

The Conga Project is a new 92,000 TPD process facility and the supporting on-site infrastructure located at 13,000 feet above sea level in Northern Peru with a total project value of over $5B USD.

Mr. Graebe was responsible for managing the engineering, procurement, contracting, offsite fabrication and construction support for the infrastructure and earthworks area which had a TIC of approximately $1.4B. Mr. Graebe was directly responsible for a home office effort of approximately 600,000 work hours which were executed by Fluor Chile and multiple engineering subcontractors. This resulted in successfully supporting the aggressive construction schedule with Construction Work Packages and material deliveries.

Non-Process Area Manager
Fluor
2009 - 2010

Exxon Neftegas Limited
Odoptu First Stage Production Project
Sakhalin Island, Russian Federation

Fluor performed EPCM services for this $1.4 B modularized, fast track, First Stage Production facility to produce 35,000 BPD of oil and 80 MSCFD of gas.

Mr. Graebe managed multiple Russian contractors to successfully design and modularize 8 non-process facilities. He also managed all interfaces between the project team, Operations, Drilling, Regulatory and other third party entities. He traveled to the Odoptu Site to support system completions and turnover which resulted in achieving the planned First Oil Milestone.

Project Manager
Fluor
2007 - 2008

ConocoPhillips
Lake Charles ULSD Project
Lake Charles, Louisiana, United States

Fluor performed front-end loading and early detailed engineering for a grassroots 70,000 BPD Ultra Low Sulfur Diesel Hydrotreater.

Mr. Graebe was the Project Manager over a multi-disciplinary taskforce in the Houston office, performing front-end engineering, detailed engineering and procurement for a new $370 MM Ultra Low Sulfur Diesel Hydrotreater. He had overall responsibility to ConocoPhillips and Fluor for project performance and completed the front-end loading (FEL) phase on schedule and under budget.

Project Engineer
Fluor
2006 - 2007

ConocoPhillips
Wood River CORE Project
Roxana, Illinois, United States

The Coker and Refinery Expansion (CORE) Project was a $ 3B refinery reconfiguration and expansion project with new and revamped facilities to process 240,000 BPD of heavy Canadian crude oil.

Mr. Graebe managed the front-end loading, detailed engineering and procurement effort for approximately $500 MM of OSBL scope with over 70 miles of new interconnecting pipe including 5 miles of new and modified pipe racks as well as upgrading multiple plant wide systems.

Project Controls Manager
Fluor
2005 - 2006

ConocoPhillips
Sweeny Ultra Low Sulfur Diesel Project
Sweeny, Texas, United States

A new $170 MM 70,000 BPD ULSD hydrotreater which Fluor performed front-end loading, detailed engineering, procurement and construction management services.

Mr. Graebe was responsible for all aspects of Project Controls including implementing and managing effective cost and schedule controls on multiple lump sum construction contractors. As part of the Fluor Construction Management Team, overcame the negative impacts of two hurricanes to complete the project on schedule and under budget.

Project Controls Manager
Fluor
2003 - 2004

ConocoPhillips
Clean Fuels Program
Various Locations

A Clean-Fuels Program consisting of six detailed engineering and procurement projects to meet EPA Clean Fuels Requirements at four ConocoPhillips Refineries.

Mr. Graebe was responsible for the development, implementation and supervision of all Project Controls functions in Houston, Gliwice, and Manila for six projects. All six projects were completed on schedule and under budget which earned Fluor incentives for schedule, cost and quality.

Project Controls Manager
Fluor
2001 - 2003

Lyondell-Citgo Refining
Tier II Compliance Project
Houston, Texas, United States

The Lyondell-Citgo Tier II Compliance Project was a new 70,000 BPD sulfur removal unit in an operating refinery using Phillips' SZorb technology.

Mr. Graebe established project procedures for all forecasting, cost control, scheduling, and progress reporting in addition to supervising the setup of all project controls systems for project execution.

SAP Implementation Coordinator
Fluor
1999 - 2001

Fluor Corporation
SAP Implementation Project
Aliso Viejo, California, United States

Mr. Graebe facilitated the SAP implementation scope and schedule from concept to execution to ensure the Fluor Asia Pacific offices received appropriate training, communication and support.

Project Controls Manager
Fluor
1998 - 1999

Lyondell Chemical
TDI/TDA Expansion Project
Lake Charles, Louisiana, United States

A $110MM chemical plant expansion and revamp of toluene diisocyanate, toluene diamine, phosgene, and luxate units in an existing chemical plant.

Mr. Graebe was responsible for all project controls activities which resulted in completing the Front End Loading (FEL) phase on schedule and on budget.

Lead Planner
Fluor
1997 - 1998

Various Clients
Shared Services Group
Sugar Land, Texas, United States

Multi-Project Task Force Supporting Grassroots and Revamp Petrochemical Plant Upgrades with values up to $40 million.

Professional Associations:

Project Management Institute (PMI)

Publications:

Construction Industry Institute (CII) Planning for Startup: Analysis of the Planning Model and Other Success Drivers (RR121-11) (11/1999)

WESLEY D. PECK
Principal Geologist, Geoscience Group Lead
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
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Education and Training

M.S., Geology, UND, 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.

Research and Professional Experience

2015–Present: Principal Geologist, EERC, UND. Involved in subsurface resource development with an emphasis on the Williston and Powder River Basins. Serves as principal investigator (PI) on the multiyear U.S. Department of Energy (DOE)-sponsored North Dakota CarbonSAFE Feasibility project. Also served as task lead and PI of the regional geologic characterization component of the Plains CO_2 Reduction Partnership (PCOR) Partnership Program, which focused on CO_2 storage in central North America. Recently led a full-CO_2-chain techno-economic investigation in North Dakota linking lignite mining and electric generation to CO_2 enhanced oil recovery (EOR). Expertise includes geology, EOR, and geographic information systems (GIS).
2011–2015: Research Manager, EERC, UND. Oversaw 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. Oversaw major GIS activities, 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. Acquired and managed geologic data related to Cretaceous and Tertiary geology of the Williston Basin. Assisted in the collection of Cretaceous and Tertiary fossils and stratigraphic information in western North Dakota and eastern Montana.

Relevant Publications

Bosshart, N.W., Azzolina, N.A., Ayash, S.C., Peck, W.D., Gorecki, C.D., Ge, J., Jiang, T., and Dotzenrod, N.W., 2018, Quantifying the effects of depositional environment on deep saline formation CO_2 storage efficiency and rate: International Journal of Greenhouse Gas Control, v. 69, p. 8–19.

Azzolina, N.A., Small, M.J., Nakles, D.V., Glazewski, K.A., Peck, W.D., Gorecki, C.D., Bromhal, G.S., and Dilmore, R.M., 2015, Quantifying the benefit of wellbore leakage potential estimates for prioritizing long-term MVA well sampling at a CO_2 storage site: Environmental Science Technology, v. 49, p. 1215–1224.

Peck, W.D., Azzolina, N.A., Burton-Kelly, M.E., Kalenze, N.S., Feole, I.K., Ayash, S.C., Hurley, J.P., Jensen, M.D., Gorecki, C.D., Harju, J.A., Bangsund, D.A., and Cook, B., 2019, Techno-economic assessment of implementing lignite-based CO_2 EOR in North Dakota: Final report (October 1, 2017 – March 31, 2019) for North Dakota Department of Commerce Division of Community Services Grant Agreement No. 1867, EERC Publication 2019-EERC-04-15, April.

Glazewski, K.A., Aulich, T.R., Wildgust, N., Nakles, D.V., Azzolina, N.A., Hamling, J.A., Burnison, S.A., Livers-Douglas, A.J., Peck, W.D., Klapperich, R.J., Sorensen, J.A., Ayash, S.C., Gorecki, C.D., Steadman, E.N., Harju, J.A., Stepan, D.J., Kalenze, N.S., Musich, M.A., Leroux, K.M., and Pekot, L.J., 2018, Best practices manual – monitoring for CO_2 storage: Plains CO_2 Reduction (PCOR) Partnership Phase III Task 9 Deliverable D51 for U.S. Department of Energy National Energy Technology Laboratory Cooperative Agreement No. DE-FC26-05NT42592, EERC Publication 2018-EERC-03-15, March.

Ayash, S.C., Nakles, D.V., Wildgust, N., Peck, W.D., Sorensen, J.A., Glazewski, K.A., Aulich, T.R., Klapperich, R.J., Azzolina, N.A., and Gorecki, C.D., 2017, Best practice for the commercial deployment of carbon dioxide geologic storage—the adaptive management approach: Plains CO_2

Reduction (PCOR) Partnership Phase III Task 13 Deliverable D102/Milestone M59 for U.S. Department of Energy National Energy Technology Laboratory Cooperative Agreement No. DE-FC26-05NT42592, EERC Publication 2017-EERC-05-01, May.
Azzolina, N.A., Nakles, D.V., Ayash, S.C., Wildgust, N., Peck, W.D., and Gorecki, C.D., 2017, PCOR Partnership best practices manual for subsurface technical risk assessment of geologic CO_2 storage projects: Plains CO_2 Reduction (PCOR) Partnership Phase III Task 9 Deliverable D103 for U.S. Department of Energy National Energy Technology Laboratory Cooperative Agreement No. DE-FC26-05NT42592, EERC Publication 2017-EERC-10-21, August.
Peck, W.D., Azzolina, N.A., Bosshart, N.W., Ayash, S.C., and Gorecki, C.D., 2017, Best practices manual on optimizing and quantifying CO_2 storage resource in saline formations and hydrocarbon reservoirs: Task 1.2 – Deliverable 9 Technical Report for U.S. Department of Energy National Energy Technology Laboratory Cooperative Agreement No. DE-FE0009114, Grand Forks, North Dakota, Energy & Environmental Research Center, June.
Glazewski, K.A., Grove, M.M., Peck, W.D., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2015, Characterization of the PCOR Partnership region: Plains CO_2 Reduction (PCOR) Partnership value-added report for U.S. Department of Energy National Energy Technology Laboratory Cooperative Agreement No. DE-FC26-05NT42592, EERC Publication 2015-EERC-02-14, January.
Peck, W.D., Glazewski, K.A., Braunberger, J.R., Grove, M.M., Bailey, T.P., Bremer, J.M., Gorz, A.J., Sorensen, J.A., Gorecki, C.D., and Steadman, E.N., 2014, Broom Creek Formation outline: Plains CO_2 Reduction (PCOR) Partnership Phase III value-added report for U.S. Department of Energy National Energy Technology Laboratory Cooperative Agreement No. DE-FC26-05NT42592, EERC Publication 2014-EERC-09-09, August.
Peck, W.D., Glazewski, K.A., Klenner, R.C.L., Gorecki, C.D., Steadman, E.N., and Harju, J.A., 2014, Improvements in the application of CO_2 storage efficiency values for deep saline formations: Plains CO_2 Reduction (PCOR) Partnership Phase III Task 1 Deliverable D7 for U.S. Department of Energy National Energy Technology Laboratory Cooperative Agreement No. DE-FC26-05NT42592, EERC Publication 2014-EERC-10-09, September.

Synergistic Activities

Leads CarbonSAFE study investigating two locations in North Dakota to determine feasibility of storing 2 million tons of CO_2 per at one location and 4 million tons of CO_2 at the second location.
Led full CO_2 chain techno-economic investigation in North Dakota linking lignite mining and electric generation to CO_2 EOR.
Led regional characterization activities for the PCOR Partnership Program to determine CO_2 storage resource potential of viable saline reservoirs in the central part of North America.
Leads regional infrastructure and techno-economic activities for the PCOR Initiative to Accelerate CCUS Development
Served on the DOE committee for development of a best practice manual on site characterization for geological storage of CO_2.

APPENDIX B – UPDATED PROJECT TEAM MEMBER PROPOSALS

- Select portions of EERC's proposal to DOE for CarbonSAFE Phase 3
    - **NOTE**: Only Budget Period 1 is applicable to Minnkota's NDIC grant
- EERC Support of CCS FEED
- BMcD Support of CCS FEED
- Fluor Support of CCS FEED

PROJECT SUMMARY

Name of Applicant: University of North Dakota Energy & Environmental Research Center (EERC)

Project Title: North Dakota CarbonSAFE Phase III: Site Characterization and Permitting

Principal Investigator: Wesley D. Peck

The Energy & Environmental Research Center (EERC) proposes to perform commercial-scale site characterization and permitting of two sites for the geologic storage of anthropogenic CO_2 emissions. These sites would permanently store over 3 million metric tons (Mt) of CO_2 per year captured from the 455-megawatt Unit 2 of the Milton R. Young Station (MRYS) as part of Minnkota Power Cooperative's (Minnkota's) Project Tundra. Project partner Minnkota's ambitious initiative to build the world's largest postcombustion carbon capture and storage facility in central North Dakota demonstrates the existence of a business case for carbon capture, utilization, and storage (CCUS) in North Dakota.

Achieving the overall goal of the U.S. Department of Energy (DOE) CarbonSAFE Phase III effort will require acquisition and analysis of geologic information to fully characterize a storage complex (the target reservoir(s) and respective cap rocks) around MRYS for commercial volumes of CO_2 (i.e., 50 Mt within 30 years). To acquire the necessary near-surface and subsurface information, the EERC will oversee drilling of a stratigraphic test well from which core and geophysical logs will be collected, gather and process new 3-D seismic data, and collect baseline water quality data for underground sources of drinking water. Geologic modeling and reservoir simulation efforts will incorporate the characterization data to delineate the extent of the necessary pore space to store the CO_2 and support a risk-based area of review. The EERC and project team will leverage North Dakota's Class VI Primacy status to prepare and submit the applications for an underground injection control (UIC) Class VI permit to construct for each proposed injection well at the sites. In addition, the project will assess any National Environmental Policy Act-related issues for the chosen capture, transport, and storage sites. The EERC and project team will build upon the success, learnings, and momentum of the recently completed North Dakota CarbonSAFE Phase II feasibility study.

Demand for low-carbon energy sources is growing and will continue to grow in the foreseeable future. As CCUS grows as an accepted, viable, and necessary strategy to lower the CO_2 emissions of fossil-based energy sources, it is imperative to test, mature, and prove CCUS technologies at commercial-scale. The proposed effort leverages the significant advancements made in CCUS technologies in recent years, specifically those advancements made through the collaboration between the EERC, its partners, and DOE. Much of this experience is based on laboratory, pilot, and large-scale field projects that have validated key concepts and technologies. The proposed research and development effort will demonstrate how to efficiently and cost-effectively characterize and permit project sites within a storage complex at commercial scale.

Several public and private entities have pledged financial and in-kind support for the proposed effort. The major participants include Minnkota (operators of MRYS), the North Dakota Industrial Commission's Lignite Research Program, BNI Energy, Computer Modelling Group (CMG), and Schlumberger. These partners will provide critical support in the form of financial backing, engineering evaluations, site access, outreach collaboration, operations data, risk assessment and evaluation, and software access and support needed to achieve the proposed project objectives. In addition, substantial support exists outside of the project team (e.g., North Dakota and Minnesota congressional delegations; North Dakota governor, tax commissioner, and department of commerce; and the Oliver County Commission).

STATEMENT OF PROJECT OBJECTIVES
North Dakota CarbonSAFE Phase III: Site Characterization and Permitting

A. OBJECTIVES

The objective of the proposed Energy & Environmental Research Center (EERC) effort is to accelerate wide-scale deployment of carbon capture, utilization, and storage (CCUS) by characterizing two safe and cost-effective commercial-scale storage sites within a storage complex in central North Dakota. These sites will safely and permanently store the nominally 3.1 million metric tons (Mt) of CO_2 emissions planned for annual capture from the 455-megawatt Unit 2 of the Milton R. Young Station (MRYS) near Center, North Dakota.

B. SCOPE OF WORK

The objectives of the project will be achieved through seven tasks. Task 1, a project management, planning, and reporting activity, will span the duration of the project and ensure that all subsequent tasks and activities are completed according to specified time lines and that U.S. Department of Energy (DOE)-compliant reporting occurs. Task 2 covers National Environmental Protection Act (NEPA) compliance and submittal of required documentation within the first 6 months of the period of performance. Task 3 includes activities required to characterize the CO_2 storage complex of the proposed project, including the permitting and drilling of one new geologic characterization well, acquisition and analysis of a new 3-D seismic survey, and characterization of core and data from recent offset well(s). Task 4 activities will use data collected from Task 3 to construct/update a geologic model that will accurately represent the storage complex. The model will serve as the foundation for dynamic simulations, which will define the boundaries of a 50 Mt CO_2 plume injected at the proposed sites for developing permitting, monitoring, and outreach plans. Task 5 will develop permitting documents necessary to develop a 50 Mt CO_2 storage program at the proposed site. Permitting documents will be developed specific to North Dakota's primacy program for administering U.S. Environmental Protection Agency (EPA) underground injection control (UIC) rules. Task 6 will conduct public outreach for the proposed CO_2 storage project that will address a wide variety of stakeholders and stakeholder groups through activities designed to inform, educate, and communicate with the local and regional audiences. Task 7 will initiate baseline site-monitoring activities necessary to permit the proposed project, including the installation of dedicated groundwater-monitoring wells(s). Task 8 will direct collaborative efforts with other DOE initiatives including development of National Risk Assessment Partnership (NRAP) tool(s) and input for development of the SMART Initiative (Science-informed Machine Learning for Accelerated Real-Time Decisions in Subsurface Applications).

C. TASKS TO BE PERFORMED

Task 1 – Project Management and Planning

Subtask 1.1 – Project Management Plan

The Recipient shall manage and direct the project in accordance with a Project Management Plan to meet all technical, schedule and budget objectives and requirements. The Recipient will coordinate activities in order to effectively accomplish the work. The Recipient will ensure that project plans, results, and decisions are appropriately documented, and project reporting and briefing requirements are satisfied.

The Recipient shall update the Project Management Plan 30 days after award [Deliverable (D)1] and as necessary throughout the project to accurately reflect the current status of the project. Examples of when it may be appropriate to update the Project Management Plan include: (a) project management policy and procedural changes; (b) changes to the technical, cost, and/or schedule baseline for the project; (c) significant changes in scope, methods, or approaches; or (d) as otherwise required to ensure that the plan is the appropriate governing document for the work required to accomplish the project objectives.

Management of project risks will occur in accordance with the risk management methodology delineated in the Project Management Plan to identify, assess, monitor, and mitigate technical uncertainties as well as schedule, budgetary and environmental risks associated with all aspects of the project. The results and status of the risk management process will be presented during project reviews and in quarterly progress reports with emphasis placed on the medium- and high-risk items.

Subtask 1.2 – Data Management Plan
The Recipient shall update the Data Management Plan (DMP) as necessary and maintain throughout the project. Relevant data will be submitted to the DOE's Energy Data eXchange at the end of each project year (D5).

Subtask 1.3 – Technology Maturation Plan
The Recipient shall develop a Technology Maturation Plan (TMP) (D2) that describes the current technology readiness level (TRL) of the proposed capture technology/technologies, relates the proposed project work to maturation of the proposed capture technology, and describes known post-project work necessary to further increase the capture technology TRL level. This activity will be addressed through the FEED study (DE-FE0031751) awarded under DE-FOA-0002058.

Task 2 – National Environmental Policy Act (NEPA)
The Recipient will perform all work elements required to obtain a NEPA determination for the proposed site(s) and support the required NEPA review process.

Subtask 2.1 – Preparation and Submission of NEPA Documentation for Site Characterization and CO_2 Capture Assessment
The recipient will provide information required to obtain a NEPA determination for this project, including the provision of environmental questionnaires for all project locations and activities.

Subtask 2.2 – Preparation and Submission of an Environmental Information Volume (EIV) for potential future construction and operation
The Recipient will complete an EIV (D3) to assess any NEPA-related issues at the chosen site(s). The purpose of the EIV, http://netl.doe.gov/File%20Library/Business/forms/451_1-1-6.pdf, is to initiate analysis of the chosen capture, transportation, and storage site(s) from a NEPA perspective. The completed EIV will provide all initial environmental data and details about the future actions to take place through the post injection site care period.

Subtask 2.3 – Preparation and Submission of NEPA Documentation for potential future construction and operation
Following NEPA's review of the EIV, the recipient, in conjunction with a third party, will work on the documentation required for the probable NEPA class of action (Categorical Exclusions, Environmental Assessment or Environmental Impact Statement). The recipient, in conjunction with the third party, will provide all recommended documentation and support to NETL's NEPA department until a final NEPA document with a Record of Decision or Finding of No Significant Impact is completed (D6).

Task 3 – Site Characterization
This task encompasses the activities required to perform geologic characterization of the Inyan Kara, Broom Creek and Deadwood–Black Island Formations (planned reservoir units) and their overlying sealing formations (the Skull Creek, "Opeche", and Icebox Formations, respectively) to create UIC Class VI permits for the proposed project. Existing geologic and hydrogeologic evaluations will be updated based on new data derived from analysis of new core, subsurface fluid samples, and well logs and the acquisition and processing of new seismic surveys. Data acquired and analyzed during this task

will be used in the development of Task 4 – Geologic Modeling and Simulation. Geologic data will be summarized in a catalog of geologic material (D4).

Subtask 3.1 – Stratigraphic Test Well Drilling
This subtask will locate, permit, and drill one geologic characterization well (stratigraphic test well) near MRYS. This well will be drilled through the Deadwood Formation to the Precambrian basement rock. Four-inch core will be taken from the cap rock and reservoir intervals of the three storage formation targets of interest: the Inyan Kara, Broom Creek, and Deadwood Formations. Approximately 1000 feet of core will be collected across the three formations and their respective cap rocks, and a comprehensive logging suite will be collected including logs such as gamma ray (total and spectral), caliper, density, porosity (neutron, density, and sonic), spontaneous potential, resistivity, sonic (compressional and shear), lithoscanner, and wireline deployed geomechanical testing and fluid sampling. The well-logging suite will be analyzed to understand the distribution of petrophysical, geophysical, and lithologic properties throughout the characterization well for incorporation into Task 4. Once sampling and logging processes are completed, this well will be completed as a Class VI well that will be used for either monitoring or injection (at a later date), according to procedures and regulations established by the North Dakota Industrial Commission (NDIC).

Subtask 3.2 – 3-D Seismic Survey and Geophysical Methods
The EERC will permit and conduct a 3-D seismic survey over the portion of the anticipated CO_2 storage facility located near MRYS. Up to 11 square miles of new seismic data is planned for acquisition. Seismic data will be interpreted at the EERC to extend the point characterization data collected at the well drilled for Subtask 3.1. 2-D gravity, magnetic, and electromagnetic surveys will be acquired to complement the 3-D seismic information at specific locations. These data will be used to evaluate the structural and stratigraphic continuity of the target geologic horizons over the total area expected to be occupied by 50 Mt of CO_2 at the two planned injection sites.

The reservoir and cap rock zones of interest will be further characterized through acquisition and analysis of existing geophysical data. This additional geophysical data, which may include legacy seismic data and regional gravity and magnetic data, will be acquired from public sources or licensed as appropriate. Legacy and newly acquired geophysical data will be interpreted to identify geologic structural and stratigraphic relationships and geologic heterogeneity within the study area, as well as provide correlation points with well logs and core data collected from new and previous test wells. As part of data interpretation, rock physics models will be used to relate seismic properties of the reservoir and the surrounding formations to geologic observations. Data interpretations developed in this subtask will be provided to Task 4.0.

Subtask 3.3 – Laboratory Analysis
This subtask includes testing and analysis of core and fluid samples collected in Subtask 3.1 and core and fluid samples expected to be collected by project partner Minnkota before the anticipated start date of the proposed project. Several petrographic, petrophysical, geomechanical, and geochemical analyses will be performed on core and fluid samples to better understand factors that influence the long-term containment of CO_2, to aid in the calibration and correlation of well logs, and to improve the accuracy of geologic and simulation models. Analytical techniques will provide direct insight regarding the pore-size distribution of the target reservoir and cap rock, potential for two-phase flow in a system dominated by high-salinity brine, zones of heterogeneity within the reservoir, and major and minor mineral phases. Geomechanical studies conducted in this task will focus on mechanical strength testing and will be interpreted to determine the integrity of the cap rock. This work will be performed by the EERC's Applied Geology Laboratory.

Task 4 – Modeling and Simulation

The geologic site characterization data (logs, core analysis, and seismic) analyzed in Task 3 will be integrated into an existing geocellular model that account for the geologic properties of the study area, which comprises the injection horizons and overlying sealing formations. The geologic model provides the foundation for dynamic simulations of potential injection scenarios. Dynamic simulations are required to predict how CO_2 and its associated pressure plume would be distributed in the storage complex and the effectiveness of the sealing formation at the site during the CCUS time frame. Simulation results provide key design and operational parameters for 1) the injection wells and associated infrastructure, 2) area of review (AOR) determination, 3) MVA planning, and 4) Class VI UIC permit(s) preparation.

Subtask 4.1– Geologic Modeling
Geologic data developed in Task 3 will be used to update existing geologic models of the proposed study area using industry-standard software. The models will integrate the known and acquired geologic, structural, and fluid data of the study area (for both the reservoir and confining zones) of up to three potential geologic storage horizons. These models may be used to assess seal effectiveness in CO_2 containment, CO_2 density under reservoir conditions, CO_2 storage resource, total and effective pore volume, both lateral and vertical geologic heterogeneity (as interpreted from 2-D and 3-D geophysical data sets), and other data necessary to develop Class VI UIC permits. The geologic model will also provide the foundation for dynamic simulation of potential injection scenarios (Subtask 4.2).

Subtask 4.2 – CO_2 Injection Simulation
This subtask will conduct dynamic simulations of the geologic models to determine the potential distribution and extent of a 50 Mt CO_2 plume based on the revised geologic assessments conducted during the previous tasks. Simulation models will be developed using Computer Modelling Group Ltd.'s (CMG's) GEM dynamic simulation module. Injectivity of the storage complex will be assessed to evaluate the behavior of the injected CO_2 at the project site(s) into the minimum number of injection wells. Results will inform decisions on injection strategies. Simulations will also be used to help develop components of the Class VI UIC permit documents, including CO_2 injection plans;, CO_2 monitoring, verification, and accounting (MVA) plans; evaluations of potential risks of legacy wellbores in the study area; and emergency response strategies.

Subtask 4.3 – Area of Review (AOR) Determination
Simulation results developed in Subtask 4.2 and injection plans developed in Task 5 will be used to delineate the AOR of the proposed CO_2 storage program. A risk-based foundation for AOR will also be integrated to accommodate anomalous pressure conditions. CO_2 plume sizes will be estimated for various simulation lengths covering an anticipated 30-year injection period.

Subtask 4.4 – Geochemical Modeling
Geochemical simulations will be used to evaluate the potential for geochemical interactions between reservoir fluid, rock, and injected CO_2. Laboratory experiments will be conducted first to investigate chemical reactions that help to understand the nature and dynamics of CO_2–brine–rock interactions in the target formation. Based on the experimental results, an adaptive-implicit multiphase multicomponent flow simulation will be performed using CMG's GEM module, which implements a fully coupled approach to handle the phase and chemical equilibrium and rate-dependent mineral dissolution/precipitation in the CO_2 injection and storage processes.

Subtask 4.5 – Geomechanical Modeling (1-D mechanical earth model *[MEM])*
A 1-D MEM will be constructed for each of the two wells. Modular formation dynamics testing (MDT) data and sonic scanner geomechanical data will be acquired by a third-party company. Discrete zones and layers with facies and local deformation mechanisms will be used to construct the model's mechanical stratigraphy. Mechanical properties and stress states from lab, field measurement, and seismic data will be

used to populate the model. Failure analysis for wellbore stability will be performed, and in situ stresses from field observations and lab testing results will be verified.

Task 5 – Permitting and Regulatory Compliance

Site characterization data collected through the field activities and laboratory analyses (Task 3) and knowledge gained through the modeling and simulation (Task 4) will be used to build all permit applications necessary to comply with North Dakota's geologic CO_2 storage regulations. These include storage facility and Class VI well-drilling permits. In addition, this task will develop a monitoring, reporting, and verification (MRV) plan to meet the requirements of the federal 45Q tax incentive program as administered by the Internal Revenue Service (IRS).

Subtask 5.1 – Storage Facility Permit Application

This subtask includes all work necessary to compile, prepare, and submit one or more storage facility permit applications. The data and information necessary to assemble the storage facility permit application will be generated in Tasks 3 and 4, including geologic and hydrogeologic evaluation and site characterization (Task 3) and computational modeling to define the extent of pore space occupied by the CO_2 plume and the AOR (Task 4). The EERC will work with project partner Minnkota to identify all pore space property owners required to be notified and to generate maps showing the extent of pore space that will occupied by CO_2 in relation to the pore space ownership in the facility as required for pore space amalgamation. Tasks 3 and 4 will define the AOR for permitting purposes, and an evaluation of all potential leakage pathways will be conducted and delineated as part of the storage facility permit.

The data and information collected in Tasks 3 and 4 will be used in this subtask to develop the storage facility permit operating parameters, such as average and maximum injection rates, daily injection volume, average operating injection pressure, maximum allowable injection pressure, and total volume of CO_2 to be stored throughout the operational life of the storage facility. The results of the compatibility analysis of the CO_2 stream with the injection zone and confining zone generated in Tasks 3 and 4 will be used in the storage facility permit application to demonstrate that the site is suitable for safe, long-term storage of CO_2. This subtask also includes the development of the following documents and plans as required for the storage facility permit: 1) an emergency and remedial response plan, 2) a worker safety plan, 3) a financial responsibility demonstration, 4) a corrosion monitoring and prevention plan for all wells and surface facilities, 5) a leak detection and monitoring plan for all wells and surface facilities, 6) a leak detection and monitoring plan to monitor the CO_2 in the storage reservoir, 7) a well casing and cementing program, 8) a testing and monitoring plan, 9) an AOR and corrective action plan, 10) an injection well-plugging plan, and 11) a postinjection site care and monitoring plan.

Subtask 5.2 – Class VI Permit Application

This subtask includes all necessary permitting work to obtain approval to construct and operate at least one Class VI injection well in each approved storage facility. This subtask will either include 1) one or more applications to drill and construct Class VI injection wells or 2) one or more applications to convert stratigraphic test wells (previously drilled, constructed, and temporarily abandoned as an observation well) to Class VI injection wells. Applications to drill or convert or a combination of both will be compiled, prepared, and submitted on behalf of project partner Minnkota to ensure all regulatory approvals have been obtained to begin CO_2 injection operations. A report summarizing the storage facility and Class VI permit applications will be prepared (D7).

Subtask 5.3 – MRV Plan Development and Approval

An EPA-compliant MRV plan to meet the requirements of the IRS 45Q tax incentive program will be developed. The MRV plan will be founded on the storage facility permit application testing and monitoring plan and complement the North Dakota Class VI UIC reporting requirements.

Task 6 – Outreach

The purpose of this task is to foster an environment that helps stakeholders make informed decisions regarding their attitude toward the planned CCUS project, with the aim of neutral-to-positive opinions on the project. Areas of focus include stakeholder engagement activities and production and dissemination of informational materials. Various stakeholder groups targeted for engagement are anticipated to include local and regional officials, landowners and residents, industry employees and stakeholders (e.g., electric cooperative members), and educators.

Building on the outreach experience and materials from the Plains CO_2 Reduction (PCOR) Partnership Program and North Dakota CarbonSAFE Phase II, the project team will continue to update and add to the North Dakota CarbonSAFE outreach plan, outreach tool kit, media information, and project web pages to be hosted on the EERC website.

Task 7 – Monitoring

This task will identify and screen existing water wells and appropriate surface locations within the AOR to select sampling locations. Selected water wells will be accessed and sampled with the assistance of project partner Minnkota, when appropriate. Selected surface locations will be sampled for soil gas composition through either temporary probes or semipermanent sampling stations. Samples will be analyzed for basic geochemical data, including items such as isotopes that have demonstrated use for CO_2 site monitoring. Up to two dedicated lowest-underground sources of drinking water (USDWs) monitoring wells will also be installed in this task.

Subtask 7.1 – Baseline Data Collection

Soil gas, surface water, and groundwater sampling will be collected on a quarterly basis during baseline monitoring (1 year) and annually thereafter. Soil gas samples will be collected near any known point source (i.e., wellhead or other artificial penetration or leakage pathway) in the project area, with an emphasis on the projected CO_2 plume. A four-spot grid will be established and sampled at each of these locations (including the injection well locations). Surface water samples will be collected from perennial streams, lakes, and ponds identified during site reconnaissance. All surface waters within the projected CO_2 plume will be sampled in the spring, summer, and fall as part of the prepermitting baseline data collection efforts. Groundwater samples will be collected from a select group of existing wells as well as the two newly installed Fox Hills wells adjacent to the injection well pads.

Subtask 7.2 – Install Fox Hills Wells

A North Dakota licensed water well-drilling contractor will be contracted to install a groundwater well near each of the well pads identified in Task 4. The wells will be completed in the Fox Hills Formation. The wells will have a dedicated submersible pump and power source installed. The wells will be developed in accordance with standard drinking water well procedures to prepare them for sampling.

Task 8 – Crosscutting Collaborations with Other DOE Initiatives

This task will leverage existing synergies between the North Dakota CarbonSAFE activities, and the work being conducted through DOE's NRAP and SMART Initiative. EERC personnel directly involved with the activities across these DOE initiatives will collaborate throughout the project to communicate findings and identify opportunities for sharing data and learnings.

Subtask 8.1 – NRAP

The EERC will build on extensive experience using the NRAP suite of tools to further validate and vet the NRAP tools in a commercial-scale setting. Modeling and simulation outputs generated in Task 4 will be used as inputs to the NRAP tool testing. In addition, CO_2 injection simulations developed in Subtask 4.2 using CMG's GEM dynamic simulation module will be used as inputs to NRAP visualization tools like the REV (Reservoir Evaluation and Visualization) tool and the RROM-Gen (Reservoir Reduced-Order Model – Generator) tool, allowing comparisons between a commercial product and the NRAP tool outputs. The technical insights gained through NRAP tool testing will be documented and communicated with DOE. To the extent practical, the NRAP tools will be used for North Dakota CarbonSAFE as heuristic tools to quantify uncertainty and inform decisions about the AOR determinations from Subtask 4.3 and the potential risks to USDWs from wellbore leakage.

Subtask 8.2 – SMART Initiative
The North Dakota CarbonSAFE project team will coordinate with the SMART Initiative task leads to identify specific SMART data needs and opportunities for leveraging project-related data sets (e.g., seismic data) to both test SMART-derived tools within the North Dakota CarbonSAFE project or to support the development and refinement of SMART tools. Activities under this subtask will be defined by the specific needs and requests of the SMART Initiative.

D. DELIVERABLES

The periodic and final reports shall be submitted in accordance with the Federal Assistance Reporting Checklist and the instructions accompanying the checklist. In addition to the reports specified in the "Federal Assistance Reporting Checklist", the Recipient must provide the following to the NETL Project Manager (identified in Block 15 of the Assistance Agreement as the Program Manager).

A catalog of geologic materials/samples collected under the project must be developed and maintained throughout the project. Throughout the life of the project, the Recipient must provide DOE physical access to available materials/samples upon request ensuring this request does not impede ongoing or planned investigations. If the Recipient does not wish to retain the material/samples, then the Recipient must offer DOE the opportunity to obtain possession of available materials/samples before the material/samples are disposed.

Data generated as a result of this project shall be submitted by the Recipient to NETL's Energy Data Xchange (EDX), https://edx.netl.gov/ by the end of the project. The types of data and the rights and protections of such data will be determined during the award negotiation process at the discretion of the PI, Project Manager, and CS. The determination will be assisted by the initial submission of the DMP. The DMP should be updated to reflect the agreed upon data and timing to be submitted to EDX. Data includes but is not limited to: 1) datasets and files, 2) metadata, 3) software/tools, and 4) articles developed as part of this project.

Task/Subtask Number	Deliverable Title	Due Date
1.1	D1 – Project Management Plan	Update due 30 days after award. Revisions to the PMP shall be submitted as requested by the NETL Project Manager.
1.3	D2 – Carbon Capture Technology(ies) Maturation Plan (TMP)	3 months after award.
2.1	D3 – Environmental Information Volume	6 months after award.
1.0	D4 – Geologic Catalog of Materials	Every 12 months after award.
1.2	D5 – Data Submitted to NETL EDX	Every 12 months after award.
2.2	D6 – NEPA Documentation	12 months after award.
5.2	D7 – Application for Underground Injection Control Class VI Permit to Construct	At the end of Budget Period 1.

Note: A CO_2 Capture Feasibility Assessment will be reported as part of the Front-End Engineering & Design: Project Tundra Carbon Capture System FE0031751.

E. BRIEFINGS/TECHNICAL PRESENTATIONS

The Recipient shall prepare detailed briefings for presentation to the NETL Project Manager at their facility located in Pittsburgh, PA, Morgantown, WV, Albany, OR, or via WebEx. The Recipient shall make a presentation to the NETL Project Manager at a project kick-off meeting held within ninety (90) days of the project start date. At a minimum, annual briefings shall also be given by the Recipient to explain the plans, progress, and results of the technical effort and a final project briefing at the close of the project shall also be given. Knowledge and results generated by the project will be presented at relevant technical conferences, including the Greenhouse Gas Control Technologies (GHGT) conference series.

—End of SOPO—

Instructions and Summary

Award Number:
Award Recipient:

Date of Submission: 1/14/2020
Form submitted by: University of North Dakota EERC
(May be award recipient or sub-recipient)

Please read the instructions on each worksheet tab before starting. If you have any questions, please ask your DOE contact!

1. If using this form for award application, negotiation, or budget revision, fill out the blank white cells in workbook tabs a. through j. with total project costs. If using this form for invoice submission, fill out tabs a. through j. with total costs for just the proposed invoice and fill out tab k. per the instructions on that tab.
2. Blue colored cells contain instructions, headers, or summary calculations and should not be modified. Only blank white cells should be populated.
3. Enter detailed support for the project costs identified for each Category line item within each worksheet tab to autopopulate the summary tab.
4. The total budget presented on tabs a. through i must include both Federal (DOE) and Non-Federal (cost share) portions
5. All costs incurred by the preparer's sub-recipients, vendors, and Federal Research and Development Centers (FFRDCs), should be entered only in section f. Contractual. All other sections are for the costs of the preparer only.
6. Ensure all entered costs are allowable, allocable, and reasonable in accordance with the administrative requirements prescribed in 2 CFR 200, and the applicable cost principles for each entity type: FAR Part 31 for For-Profit entities; and 2 CFR Part 200 Subpart E - Cost Principles for all other non-federal entities.
7. Add rows as needed throughout tabs a. through j. If rows are added, formulas/calculations may need to be adjusted by the preparer. Do not add rows to the Instructions and Summary tab. If your project contains more than three budget periods, consult your DOE contact before adding additional budget period rows or columns.
8. ALL budget period cost categories are rounded to the nearest dollar.

BURDEN DISCLOSURE STATEMENT

Public reporting burden for this collection of information is estimated to average 3 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Office of Information Resources Management Policy, Plans, and Oversight, AD-241-2 - GTN, Paperwork Reduction Project (1910-5162), U.S. Department of Energy, 1000 Independence Avenue, S.W., Washington, DC 20585; and to the Office of Management and Budget, Paperwork Reduction Project (1910-5162), Washington, DC 20503.

SUMMARY OF BUDGET CATEGORY COSTS PROPOSED

The values in this summary table are from entries made in subsequent tabs, only blank white cells require data entry

Section A - Budget Summary

		Federal	Cost Share	Total Costs	Cost Share %	Proposed Budget Period Dates
	Budget Period 1	$14,840,980	$6,972,533	$21,813,513	31.96%	6/1/2020 - 5/31/2022
	Budget Period 2	$2,141,695	$986,267	$3,127,962	31.53%	6/1/2022 - 5/31/2023
	Budget Period 3	$0	$0	$0	0.00%	
	Total	$16,982,675	$7,958,800	$24,941,475	31.91%	

Section B - Budget Categories

CATEGORY	Budget Period 1	Budget Period 2	Budget Period 3	Total Costs	% of Project	Comments (as needed)
a. Personnel	$2,345,007	$775,871	$0	$3,120,878	12.51%	
b. Fringe Benefits	$1,408,097	$473,282	$0	$1,881,379	7.54%	
c. Travel	$143,723	$29,151	$0	$172,874	0.69%	
d. Equipment	$62,325	$0	$0	$62,325	0.25%	
e. Supplies	$2,360,111	$1,032,617	$0	$3,392,728	13.60%	
f. Contractual						
Sub-recipient	$11,286,832	$121,149	$0	$11,407,981	45.74%	
Vendor	$485,000	$0	$0	$485,000	1.94%	
FFRDC	$0	$0	$0	$0	0.00%	
Total Contractual	$11,771,832	$121,149	$0	$11,892,981	47.68%	
g. Construction	$0	$0	$0	$0	0.00%	
h. Other Direct Costs	$999,906	$13,456	$0	$1,013,362	4.06%	
Total Direct Costs	$19,091,001	$2,445,526	$0	$21,536,527	86.35%	
i. Indirect Charges	$2,722,512	$682,436	$0	$3,404,948	13.65%	
Total Costs	$21,813,513	$3,127,962	$0	$24,941,475	100.00%	

Additional Explanation (as needed):

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

May 8, 2019

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. 2019-0140 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), Fluor, 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. The EERC's scope of work has been divided into two tasks as follows.

Activity 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 management including tracking expenditures and deliverables, including subcontracts and subrecipients. Subcontractor 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 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/subrecipient/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.

Other project management activities to be performed will include the development and production of quarterly progress reports (according to 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 a DOE 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).

Activity 2 – Technical Assistance

The purpose of Activity 2 is to describe the work involved in project design, hazard and operability (HAZOP) review and costing efforts. To ensure that the results of a FEED study reflect the most economical Project Tundra possible, it will be prudent to ensure findings from the EERC-managed pre-FEED effort are considered. Therefore, the EERC will aid Minnkota in addressing technical issues as necessary to address issues as they arise. The EERC will aid in selection 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, cooling system evaluation vs. water availability, and possibly even overall engineering, procurement, and construction cost (EPC) contracting approach.

Budget

The estimated cost for the EERC's scope of work is $1,135,616. Expenses will be invoiced monthly on a cost-reimbursable basis. A detailed budget and rate agreement can be found in Attachment A. This project is anticipated to start September 1, 2019, and will end

August 31, 2020. The primary deliverables will be the final project report and quarterly reports for DOE and others.

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. Ms. Lucia Romuld, Principal Industrial and Management Engineer – Proposals, Resources, and Logistics, will assist with administrative management of the project. Additional staff from the EERC's accounting, workflow, and budget analyst groups will be included in the project team. EERC project team resumes and current and pending are included 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/kal

Attachment

ATTACHMENT A

BUDGET JUSTIFICATION

Applicant Name: Energy & Environmental Research Center at UND   Award Number: ____________

Budget Information - Non Construction Programs

OMB Approval No. 0348-0044

Section A - Budget Summary

Grant Program Function or Activity (a)	Catalog of Federal Domestic Assistance Number (b)	Estimated Unobligated Funds: Federal (c)	Estimated Unobligated Funds: Non-Federal (d)	New or Revised Budget: Federal (e)	New or Revised Budget: Non-Federal (f)	New or Revised Budget: Total (g)
1.				$1,135,616		$1,135,616
2.						$0
3.						$0
4.						$0
5. Totals		$0	$0	$1,135,616	$0	$1,135,616

Section B - Budget Categories

6. Object Class Categories	Grant Program, Function or Activity (1)	(2)	(3)	(4)	Total (5)
a. Personnel	$435,548				$435,548
b. Fringe Benefits	$265,684				$265,684
c. Travel	$23,117				$23,117
d. Equipment					$0
e. Supplies	$3,060				$3,060
f. Contractual					$0
g. Construction					$0
h. Other	$27,153				$27,153
i. Total Direct Charges (sum of 6a-6h)	$754,562	$0	$0	$0	$754,562
j. Indirect Charges	$381,054				$381,054
k. **Totals** (sum of 6i-6j)	$1,135,616	$0	$0	$0	$1,135,616
7. Program Income					$0

Previous Edition Usable

SF-424A (Rev. 4-92)
Prescribed by OMB Circular A-102

Instructions and Summary

Award Number: ______________________ **Date of Submission:** ______________________

Award Recipient: ______________________ **Form submitted by:** EERC

(May be award recipient or sub-recipient)

Please read the instructions on each worksheet tab before starting. If you have any questions, please ask your DOE contact!

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5. All costs incurred by the preparer's sub-recipients, vendors, and Federal Research and Development Centers (FFRDCs), should be entered only in section f. Contractual. All other sections are for the costs of the preparer only.
6. Ensure all entered costs are allowable, allocable, and reasonable in accordance with the administrative requirements prescribed in 2 CFR 200, and the applicable cost principles for each entity type: FAR Part 31 for For-Profit entities; and 2 CFR Part 200 Subpart E - Cost Principles for all other non-federal entities.
7. Add rows as needed throughout tabs a. through j. If rows are added, formulas/calculations may need to be adjusted by the preparer. Do not add rows to the Instructions and Summary tab. If your project contains more than three budget periods, consult your DOE contact before adding additional budget period rows or columns.
8. ALL budget period cost categories are rounded to the nearest dollar.

BURDEN DISCLOSURE STATEMENT

SUMMARY OF BUDGET CATEGORY COSTS PROPOSED

The values in this summary table are from entries made in subsequent tabs, only blank white cells require data entry

Section A - Budget Summary

	Federal	Cost Share	Total Costs	Cost Share %	Proposed Budget Period Dates
Budget Period 1	$1,135,616	$0	$1,135,616	0.00%	**9/1/19-8/31/20**
Budget Period 2	$0	$0	$0	0.00%	
Budget Period 3	$0	$0	$0	0.00%	
Total	$1,135,616	$0	$1,135,616	0.00%	

Section B - Budget Categories

CATEGORY	Budget Period 1	Budget Period 2	Budget Period 3	Total Costs	% of Project	Comments (as needed)
a. Personnel	$435,548	$0	$0	$435,548	38.35%	
b. Fringe Benefits	$265,684	$0	$0	$265,684	23.40%	
c. Travel	$23,117	$0	$0	$23,117	2.04%	
d. Equipment	$0	$0	$0	$0	0.00%	
e. Supplies	$3,060	$0	$0	$3,060	0.27%	
f. Contractual						
Sub-recipient	$0	$0	$0	$0	0.00%	
Vendor	$0	$0	$0	$0	0.00%	
FFRDC	$0	$0	$0	$0	0.00%	
Total Contractual	$0	$0	$0	$0	0.00%	
g. Construction	$0	$0	$0	$0	0.00%	
h. Other Direct Costs	$27,153	$0	$0	$27,153	2.39%	
Total Direct Costs	$754,562	$0	$0	$754,562	66.45%	
i. Indirect Charges	$381,054	$0	$0	$381,054	33.55%	
Total Costs	$1,135,616	$0	$0	$1,135,616	100.00%	

Additional Explanation (as needed):

a. Personnel

INSTRUCTIONS - PLEASE READ!!!

1. List project costs solely for employees of the entity completing this form. All personnel costs for subrecipients and vendors must be included under f. Contractual.

2. All personnel should be identified by position title and not employee name. Enter the amount of time (e.g., hours or % of time) and the base pay rate and the total direct personnel compensation will automatically calculate. Rate basis (e.g., actual salary, labor distribution report, state civil service rates, etc.) must also be identified.

3. If loaded labor rates are utilized, a description of the costs the loaded rate is comprised of must be included in the Additional Explanation section below. DOE must review all components of the loaded labor rate for reasonableness and unallowable costs (e.g. fee or profit).

4. If a position and hours are attributed to multiple employees (e.g. Technician working 4000 hours) the number of employees for that position title must be identified.

5. Each budget period is rounded to the nearest dollar.

SOPO Task #	Position Title	Budget Period 1			Budget Period 2			Budget Period 3			Project Total Hours	Project Total Dollars	Rate Basis
		Time (Hrs)	Pay Rate ($/Hr)	Total Budget Period 1	Time (Hrs)	Pay Rate ($/Hr)	Total Budget Period 2	Time (Hrs)	Pay Rate ($/Hr)	Total Budget Period 3			
1	Sr. Engineer **(EXAMPLE!!!)**	2000	$85.00	$170,000	200	$50.00	$10,000	200	$50.00	$10,000	2400	$190,000	Actual Salary
2	Technicians (2)	4000	$20.00	$80,000	0	$0.00	$0	0	$0.00	$0	4000	$80,000	Actual Salary
Task 1	Principal Investigator	330	$77.56	$25,595			$0			$0	330	$25,595	Escalated Rate
	Research Scientist/Engineer	445	$77.86	$34,648			$0			$0	445	$34,648	"
	Senior Management	79	$131.98	$10,426			$0			$0	79	$10,426	"
	Research Scientists/Engineers	746	$50.83	$37,919			$0			$0	746	$37,919	"
	Research Technicians	2309	$46.42	$107,184			$0			$0	2309	$107,184	"
	Technical Support Personnel	234	$36.19	$8,468			$0			$0	234	$8,468	"
Task 2	Principal Investigator	110	$77.56	$8,532			$0			$0	110	$8,532	Escalated Rate
	Research Scientist/Engineer	0	$77.86	$0			$0			$0	0	$0	"
	Senior Management	23	$131.98	$3,036			$0			$0	23	$3,036	"
	Research Scientists/Engineers	1128	$50.83	$57,336			$0			$0	1128	$57,336	"
	Research Technicians	33	$46.42	$1,532			$0			$0	33	$1,532	"
	Technical Support Personnel	0	$36.19	$0			$0			$0	0	$0	"
Task 3	Principal Investigator	110	$77.56	$8,532			$0			$0	110	$8,532	Escalated Rate
	Research Scientist/Engineer	0	$77.86	$0			$0			$0	0	$0	"
	Senior Management	23	$131.98	$3,036			$0			$0	23	$3,036	"
	Research Scientists/Engineers	1128	$50.83	$57,336			$0			$0	1128	$57,336	"
	Research Technicians	33	$46.42	$1,532			$0			$0	33	$1,532	"
	Technical Support Personnel	0	$36.19	$0			$0			$0	0	$0	"
Task 4	Principal Investigator	110	$77.56	$8,532			$0			$0	110	$8,532	Escalated Rate
	Research Scientist/Engineer	0	$77.86	$0			$0			$0	0	$0	"
	Senior Management	23	$131.98	$3,036			$0			$0	23	$3,036	"
	Research Scientists/Engineers	1128	$50.83	$57,336			$0			$0	1128	$57,336	"
	Research Technicians	33	$46.42	$1,532			$0			$0	33	$1,532	"
	Technical Support Personnel	0	$36.19	$0			$0			$0	0	$0	"
	Total Personnel Costs	**8025**		**$435,548**	**0**		**$0**	**0**		**$0**	**0**	**$435,548**	

Additional Explanation (as needed):

b. Fringe Benefits

INSTRUCTIONS - PLEASE READ!!!
1. Fill out the table below by position title. If all employees receive the same fringe benefits, you can show "Total Personnel" in the Labor Type column instead of listing out all position titles.
2. The rates and how they are applied should not be averaged to get one fringe cost percentage. Complex calculations should be described/provided in the Additional Explanation section below.
3. The fringe benefit rates should be applied to all positions, regardless of whether those funds will be supported by Federal Share or Recipient Cost Share.
4. Each budget period is rounded to the nearest dollar.

Labor Type	Budget Period 1			Budget Period 2			Budget Period 3			Total Project
	Personnel Costs	Rate	Total	Personnel Costs	Rate	Total	Personnel Costs	Rate	Total	
EXAMPLE!!! Sr. Engineer	$170,000	20%	$34,000	$10,000	20%	$2,000	$10,000	20%	$2,000	$38,000
			$0			$0			$0	$0
Fully Benefited Staff	$435,548	61.00%	$265,684			$0			$0	$265,684
			$0			$0			$0	$0
			$0			$0			$0	$0
			$0			$0			$0	$0
Total:	**$435,548**		**$265,684**	**$0**		**$0**	**$0**		**$0**	**$265,684**

A federally approved fringe benefit rate agreement, or a proposed rate supported and agreed upon by DOE for estimating purposes is required at the time of award negotiation if reimbursement for fringe benefits is requested. Please check (X) one of the options below and provide the requested information if not previously submitted.

___X__ **A fringe benefit rate has been negotiated with, or approved by, a federal government agency. A copy of the latest rate agreement is/was included with the project application.***

______ **There is not a current federally approved rate agreement negotiated and available.****

*Unless the organization has submitted an indirect rate proposal which encompasses the fringe pool of costs, please provide the organization's benefit package and/or a list of the components/elements that comprise the fringe pool and the cost or percentage of each component/element allocated to the labor costs identified in the Budget Justification.

**When this option is checked, the entity preparing this form shall submit an indirect rate proposal in the format provided in the Sample Rate Proposal at http://www1.eere.energy.gov/financing/resources.html, or a format that provides the same level of information and which will support the rates being proposed for use in the performance of the proposed project.

Additional Explanation (as necessary): Please use this box (or an attachment) to list the elements that comprise your fringe benefits and how they are applied to your base (e.g. Personnel) to arrive at your fringe benefit rate.

c. Travel

INSTRUCTIONS - PLEASE READ!!!

1. Identify Foreign and Domestic Travel as separate items. Examples of Purpose of Travel are subrecipient site visits, DOE meetings, project mgmt. meetings, etc. Examples of Basis for Estimating Costs are past trips, travel quotes, GSA rates, etc.

2. All listed travel must be necessary for performance of the Statement of Project Objectives.

3. Federal travel regulations are contained within the applicable cost principles for all entity types. Travel costs should remain consistent with travel costs incurred by an organization during normal business operations as a result of the organizations written travel policy. In absence of a written travel policy, organizations must follow the regulations prescribed by the General Services Administration.

4. Each budget period is rounded to the nearest dollar.

SOPO Task #	Purpose of Travel	Depart From	Destination	No. of Days	No. of Travelers	Lodging per Traveler	Flight per Traveler	Vehicle per Traveler	Per Diem Per Traveler	Cost per Trip	Basis for Estimating Costs
	Domestic Travel	**Budget Period 1**									
1	**EXAMPLE!!!** Visit to PV manufacturer			2	2	$250	$500	$100	$160	$2,020	Current GSA rates
Task 1	HAZOP Review	Grand Forks, ND	Unspecified Dest. (USA)	3	1	$600	$1,000	$340	$284	$2,224	GSA, Internet Pricing, UND Policies & Procedures
	Partner Review Meetings	Grand Forks, ND	Bismarck, ND	2	4	$91	$0	$319	$70	$1,920	GSA, Internet Pricing, UND Policies & Procedures
	Site Visit	Grand Forks, ND	Center, ND	2	8	$91	$0	$200	$70	$2,889	GSA, Internet Pricing, UND Policies & Procedures
	Annual DOE Review Meeting	Grand Forks, ND	Pittsburgh, PA*	2	2	$275	$900	$75	$587	$3,674	GSA, Internet Pricing, UND Policies & Procedures
	Kick-off & Final Review	Grand Forks, ND	Pittsburgh, PA	2	4	$275	$900	$75	$112	$5,448	GSA, Internet Pricing, UND Policies & Procedures
	Design & Cost Review	Grand Forks, ND	Unspecified Dest. (USA)	3	4	$400	$1,000	$128	$213	$6,962	GSA, Internet Pricing, UND Policies & Procedures
	International Travel										
										$0	
	Budget Period 1 Total									**$23,117**	
	Domestic Travel	**Budget Period 2**									
										$0	
										$0	
										$0	
										$0	
	International Travel										
										$0	
	Budget Period 2 Total									**$0**	
	Domestic Travel	**Budget Period 3**									
										$0	
										$0	
										$0	
										$0	
	International Travel										
										$0	
	Budget Period 3 Total									**$0**	
	PROJECT TOTAL									**$23,117**	

Additional Explanation (as needed): *Technology review meeting rates.

d. Equipment

INSTRUCTIONS - PLEASE READ!!!

1. Equipment means tangible personal property (including information technology systems) having a useful life of more than one year and a per-unit acquisition cost which equals or exceeds the lesser of the capitalization level established by the non-Federal entity for financial statement purposes, or $5,000. Please refer to the applicable Federal regulations in 2 CFR 200 for specific equipment definitions and treatment.

2. List all equipment below, providing a basis of cost (e.g. vendor quotes, catalog prices, prior invoices, etc.). Briefly justify items as they apply to the Statement of Project Objectives. If it is existing equipment, provide logical support for the estimated value shown.

3. During award negotiations, provide a vendor quote for all equipment items over $50,000 in price. If the vendor quote is not an exact price match, provide an explanation in the additional explanation section below. If a vendor quote is not practical, such as for a piece of equipment that is purpose-built, first of its kind, or otherwise not available off the shelf, provide a detailed engineering estimate for how the cost estimate was derived.

4. Each budget period is rounded to the nearest dollar.

SOPO Task #	Equipment Item	Qty	Unit Cost	Total Cost	Basis of Cost	Justification of need
				Budget Period 1		
3,4,5	**EXAMPLE!!!** Thermal shock chamber	2	$70,000	$140,000	Vendor Quote - Attached	Reliability testing of PV modules- Task 4.3
				$0		
				$0		
				$0		
				$0		
				$0		
				$0		
	Budget Period 1 Total			$0		
				Budget Period 2		
				$0		
				$0		
				$0		
				$0		
				$0		
				$0		
	Budget Period 2 Total			$0		
				Budget Period 3		
				$0		
				$0		
				$0		
				$0		
				$0		
				$0		
	Budget Period 3 Total			$0		
	PROJECT TOTAL			**$0**		

Additional Explanation (as needed):

e. Supplies

INSTRUCTIONS - PLEASE READ!!!

1. Supplies are generally defined as an item with an acquisition cost of $5,000 or less and a useful life expectancy of less than one year. Supplies are generally consumed during the project performance. Please refer to the applicable Federal regulations in 2 CFR 200 for specific supplies definitions and treatment. A computing device is a supply if the acquisition cost is less than the lesser of the capitalization level established by the non-Federal entity for financial statement purposes or $5,000, regardless of the length of its useful life.

2. List all proposed supplies below, providing a basis of costs (e.g. vendor quotes, catalog prices, prior invoices, etc.). Briefly justify the need for the Supplies as they apply to the Statement of Project Objectives. Note that Supply items must be direct costs to the project at this budget category, and not duplicative of supply costs included in the indirect pool that is the basis of the indirect rate applied for this project.

3. Multiple supply items valued at $5,000 or less used to assemble an equipment item with a value greater than $5,000 with a useful life of more than one year should be included on the equipment tab. If supply items and costs are ambiguous in nature, contact your DOE representative for proper categorization.

4. Add rows as needed. If rows are added, formulas/calculations may need to be adjusted by the preparer.

5. Each budget period is rounded to the nearest dollar.

SOPO Task #	General Category of Supplies	Qty	Unit Cost	Total Cost	Basis of Cost	Justification of need
				Budget Period 1		
4,6	**EXAMPLE!!!** Wireless DAS components	10	$360.00	$3,600	Catalog price	For Alpha prototype - Task 2.4
Task 1	Computer	1	$600.00	$600	Historical Cost	General Execution of the Project
	Printer Cartridges (Set)	6	$400.00	$2,400	Historical Cost	Reporting and dissemination of information
	Paper (Box)	2	$30.00	$60	Historical Cost	Reporting and dissemination of information
				$0		
				$0		
	Budget Period 1 Total			**$3,060**		
				Budget Period 2		
				$0		
				$0		
				$0		
				$0		
				$0		
				$0		
				$0		
				$0		
	Budget Period 2 Total			$0		
				Budget Period 3		
				$0		
				$0		
				$0		
				$0		
				$0		
				$0		
				$0		
				$0		
	Budget Period 3 Total			$0		
	PROJECT TOTAL			**$3,060**		

Additional Explanation (as needed):

f. Contractual

INSTRUCTIONS - PLEASE READ!!!

1. The entity completing this form must provide all costs related to subrecipients, vendors, and FFRDC partners in the applicable boxes below.

2. Subrecipients (partners, sub-awardees): Subrecipients shall submit a Budget Justification describing all project costs and calculations when their total proposed budget exceeds either (1) $100,000 or (2) 50% of total award costs. These subrecipient forms may be completed by either the subrecipients themselves or by the preparer of this form. The budget totals on the subrecipient's forms must match the subrecipient entries below. A subrecipient is a legal entity to which a subaward is made, who has performance measured against whether the objectives of the Federal program are met, is responsible for programmatic decision making, must adhere to applicable Federal program compliance requirements, and uses the Federal funds to carry out a program of the organization. All characteristics may not be present and judgment must be used to determine subrecipient vs. vendor status.

3. Vendors (including contractors): List all vendors and contractors supplying commercial supplies or services used to support the project. For each Vendor cost with total project costs of $250,000 or more, a Vendor quote must be provided. A vendor is a legal entity contracted to provide goods and services within normal business operations, provides similar goods or services to many different purchasers, operates in a competitive environment, provides goods or services that are ancillary to the operation of the Federal program, and is not subject to compliance requirements of the Federal program. All characteristics may not be present and judgment must be used to determine subrecipient vs. vendor status.

4. Federal Funded Research and Development Centers (FFRDCs): FFRDCs must submit a signed Field Work Proposal during award application. The award recipient may allow the FFRDC to provide this information directly to DOE, however project costs must also be provided below.

5. Each budget period is rounded to the nearest dollar.

SOPO Task #	Sub-Recipient Name/Organization	Purpose and Basis of Cost	Budget Period 1	Budget Period 2	Budget Period 3	Project Total
2,4	**EXAMPLE!!!** XYZ Corp.	Partner to develop optimal lens for Gen 2 product. Cost estimate based on personnel hours.	$48,000	$32,000	$16,000	**$96,000**
						$0
						$0
						$0
						$0
						$0
						$0
		Sub-total	$0	$0	$0	$0

SOPO Task #	Vendor Name/Organization	Purpose and Basis of Cost	Budget Period 1	Budget Period 2	Budget Period 3	Project Total
6	**EXAMPLE!!!** ABC Corp.	Vendor for developing robotics to perform lens inspection. Estimate provided by vendor.	$32,900	$86,500		**$119,400**
						$0
						$0
						$0
						$0
						$0
		Sub-total	$0	$0	$0	$0

SOPO Task #	FFRDC Name/Organization	Purpose and Basis of Cost	Budget Period 1	Budget Period 2	Budget Period 3	Project Total
						$0
						$0
		Sub-total	$0	$0	$0	$0

	Total Contractual		$0	$0	$0	$0

Additional Explanation (as needed):

g. Construction

PLEASE READ!!!

1. Construction, for the purpose of budgeting, is defined as all types of work done on a particular building, including erecting, altering, or remodeling. Construction conducted by the award recipient is entered on this page. Any construction work that is performed by a vendor or subrecipient should be entered under f. Contractual.

2. List all proposed construction below, providing a basis of cost such as engineering estimates, prior construction, etc., and briefly justify its need as it applies to the Statement of Project Objectives.

3. Each budget period is rounded to the nearest dollar.

Overall description of construction activities: Example Only!!! - Build wind turbine platform

SOPO Task #	General Description	Cost	Basis of Cost	Justification of need
		Budget Period 1		
3	EXAMPLE ONLY!!! Three days of excavation for platform site	$28,000	Engineering estimate	Site must be prepared for construction of platform.
	Budget Period 1 Total	**$0**		
		Budget Period 2		
	Budget Period 2 Total	$0		
		Budget Period 3		
	Budget Period 3 Total	$0		
	PROJECT TOTAL	**$0**		

Additional Explanation (as needed):

h. Other Direct Costs

INSTRUCTIONS - PLEASE READ!!!

1. Other direct costs are direct cost items required for the project which do not fit clearly into other categories. These direct costs must not be included in the indirect costs (for which the indirect rate is being applied for this project). Examples are: tuition, printing costs, etc. which can be directly charged to the project and are not duplicated in indirect costs (overhead costs).

2. Basis of cost are items such as vendor quotes, prior purchases of similar or like items, published price list, etc.

3. Each budget period is rounded to the nearest dollar.

SOPO Task #	General Description and SOPO Task #	Cost	Basis of Cost	Justification of need
		Budget Period 1		
5	**EXAMPLE!!!** Grad student tuition - tasks 1-3	$16,000	Established UCD costs	Support of graduate students working on project
1	Communications	$3,000	Historical Cost	Long distance phone & postage for technical staff.
1	Printing & Duplicating	$1,985	Historical Cost	Copies for technical staff.
1	Food	$968	Historical Cost	Hosted meetings for project partners.
1	Graphics Services	$8,480	Annually Established Recharge Center Rates	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.
2	Technical Software Fee	$4,236	Annually Established Recharge Center Rates	Use of Aspen Software
3	Technical Software Fee	$4,242	Annually Established Recharge Center Rates	Use of Aspen Software
4	Technical Software Fee	$4,242	Annually Established Recharge Center Rates	Use of Aspen Software
	Budget Period 1 Total	$27,153		
		Budget Period 2		
	Budget Period 2 Total	$0		
		Budget Period 3		
	Budget Period 3 Total	$0		
	PROJECT TOTAL	**$27,153**		

Additional Explanation (as needed):

i. Indirect Costs

INSTRUCTIONS - PLEASE READ!!!

1. Fill out the table below to indicate how your indirect costs are calculated. Use the box below to provide additional explanation regarding your indirect rate calculation.

2. The rates and how they are applied should not be averaged to get one indirect cost percentage. Complex calculations or rates that do not do not correspond to the below categories should be described/provided in the Additional Explanation section below. If questions exist, consult with your DOE contact before filling out this section.

3. The indirect rate should be applied to both the Federal Share and Recipient Cost Share. **4.**

NOTE: A Recipient who elects to employ the 10% de minimis Indirect Cost rate **cannot claim resulting costs as a Cost Share contribution, nor can the Recipient claim "unrecovered indirect costs" as a Cost Share contribution.** Neither of these costs can be reflected as actual indirect cost rates realized by the organization, and therefore are not verifiable in the Recipient records as required by Federal Regulation (§200.306(b)(1)).

5. Each budget period is rounded to the nearest dollar.

	Budget Period 1	Budget Period 2	Budget Period 3	Total	Explanation of BASE
Provide ONLY Applicable Rates:					
Overhead Rate	0.00%	0.00%	0.00%		
General & Administrative (G&A)	0.00%	0.00%	0.00%		
FCCM Rate, if applicable	0.00%	0.00%	0.00%		
OTHER Indirect Rate	50.50%	0.00%	0.00%		**MTDC**
Indirect Costs (As Applicable):					
Overhead Costs				**$0**	
G&A Costs				**$0**	
FCCM Costs, if applicable				**$0**	
OTHER Indirect Costs	$381,054			**$381,054**	
Total indirect costs requested:	**$381,054**	**$0**	**$0**	**$381,054**	

A federally approved indirect rate agreement, or rate proposed (supported and agreed upon by DOE for estimating purposes) is required if reimbursement of indirect costs is requested. Please check (X) one of the options below and provide the requested information if it has not already been provided as requested, or has changed.

__X___ An indirect rate has been approved or negotiated with a federal government agency. A copy of the latest rate agreement is included with this application, and will be provided electronically to the Contracting Officer for this project.

______ There is not a current, federally approved rate agreement negotiated and available*.

***When this option is checked, the entity preparing this form shall submit an indirect rate proposal in the format provided by your DOE contact, or a format that provides the same level of information and which will support the rates being proposed for use in performance of the proposed project. Additionally, any non-Federal entity that has never received a negotiated indirect cost rate, except for those non-Federal entities described in Appendix VII to Part 200—States and Local Government and Indian Tribe Indirect Cost Proposals, paragraph D.1.b, may elect to charge a de minimis rate of 10% of modified total direct costs (MTDC) which may be used indefinitely.As described in §200.403 Factors affecting allowability of costs, costs must be consistently charged as either indirect or direct costs, but may not be double charged or inconsistently charged as both. If chosen, this methodology once elected must be used consistently for all Federal awards until such time as a non-Federal entity chooses to negotiate for a rate, which the non-Federal entity may apply to do at any time.**

You must provide an explanation (below or in a separate attachment) and show how your indirect cost rate was applied to this budget in order to come up with the indirect costs show

Additional Explanation (as needed): *IMPORTANT: Please use this box (or an attachment) to further explain how your total indirect costs were calculated. If the total indirect costs are a cumulative amount of more than one calculation or rate application, the explanation and calculations should identify all rates used, along with the base they were applied to (and how the base was derived), and a total for each (along with grand total).

Cost Share

PLEASE READ!!!

1. A detailed presentation of the cash or cash value of all cost share proposed must be provided in the table below. All items in the chart below must be identified within the applicable cost category tabs a. through i. in addition to the detailed presentation of the cash or cash value of all cost share proposed provided in the table below. Identify the source organization & amount of each cost share item proposed in the award.

2. Cash Cost Share - encompasses all contributions to the project made by the recipient, subrecipient, or third party (an entity that does not have a role in performing the scope of work) for costs incurred and paid for during the project. This includes when an organization pays for personnel, supplies, equipment, etc. for their own company with organizational resources. If the item or service is reimbursed for, it is cash cost share. All cost share items must be necessary to the performance of the project. **Vendors may not provide cost share.** Any partial donation of goods or services is considered a discount and is not allowable.

3. In Kind Cost Share - encompasses all contributions to the project made by the recipient, subrecipient, or third party (an entity that does not have a role in performing the scope of work) where a value of the contribution can be readily determined, verified and justified but where no actual cash is transacted in securing the good or service comprising the contribution. In Kind cost share items include volunteer personnel hours, the donation of space or use of equipment, etc. The cash value and calculations thereof for all In Kind cost share items must be justified and explained in the Cost Share Item section below. All cost share items must be necessary to the performance of the project. If questions exist, consult your DOE contact before filling out In Kind cost share in this section. Vendors may not provide cost share. Any partial donation of goods or services is considered a discount and is not allowable.

4. Funds from other Federal sources MAY NOT be counted as cost share. This prohibition includes FFRDC sub-recipients. Non-Federal sources include any source not originally derived from Federal funds. Cost sharing commitment letters from subrecipients and third parties must be provided with the original application.

5. Fee or profit, including foregone fee or profit, **are not allowable** as project costs (including cost share) under any resulting award. The project may only incur those costs that are allowable and allocable to the project (including cost share) as determined in accordance with the applicable cost principles prescribed in FAR Part 31 for For-Profit entities and 2 CFR Part 200 Subpart E - Cost Principles for all other non-federal entities.

6. NOTE: A Recipient who elects to employ the 10% de minimis Indirect Cost rate **cannot claim the resulting indirect costs as a Cost Share contribution.**

7. **NOTE:** A Recipient **cannot claim "unrecovered indirect costs"** as a Cost Share contribution, **without prior approval.**

8. Each budget period is rounded to the nearest dollar.

Organization/Source	Type (Cash or In Kind)	Cost Share Item	Budget Period 1	Budget Period 2	Budget Period 3	Total Project Cost Share
ABC Company **EXAMPLE!!!**	Cash	Project partner ABC Company will provide 20 PV modules for product development at the price of $680 per module	$13,600			**$13,600**
						$0
						$0
						$0
						$0
						$0
						$0
						$0
						$0
						$0
						$0
		Totals	**$0**	**$0**	**$0**	**$0**

Total Project Cost: $1,135,616 **Cost Share Percent of Award: 0.00%**

Additional Explanation (as needed):

Applicant Name: 0 Award Number: 0

Budget Information - Non Construction Programs

OMB Approval No. 0348-0044

Section A - Budget Summary

Grant Program Function or Activity (a)	Catalog of Federal Domestic Assistance Number (b)	Estimated Unobligated Funds: Federal (c)	Estimated Unobligated Funds: Non-Federal (d)	New or Revised Budget: Federal (e)	New or Revised Budget: Non-Federal (f)	New or Revised Budget: Total (g)
1. Budget Period 1				$1,135,616.00	$0.00	$1,135,616.00
2. Budget Period 2				$0.00	$0.00	$0.00
3. Budget Period 3				$0.00	$0.00	$0.00
4.						
5. Totals				$1,135,616.00	$0.00	$1,135,616.00

Section B - Budget Categories

6. Object Class Categories	Grant Program, Function or Activity: Budget Period 1	Budget Period 2	Budget Period 3		Total (5)
a. Personnel	$435,548.00	$0.00	$0.00		$435,548.00
b. Fringe Benefits	$265,684.00	$0.00	$0.00		$265,684.00
c. Travel	$23,117.00	$0.00	$0.00		$23,117.00
d. Equipment	$0.00	$0.00	$0.00		$0.00
e. Supplies	$3,060.00	$0.00	$0.00		$3,060.00
f. Contractual	$0.00	$0.00	$0.00		$0.00
g. Construction	$0.00	$0.00	$0.00		$0.00
h. Other	$27,153.00	$0.00	$0.00		$27,153.00
i. Total Direct Charges (sum of 6a-6h)	$754,562.00	$0.00	$0.00		$754,562.00
j. Indirect Charges	$381,054.00	$0.00	$0.00		$381,054.00
k. **Totals** (sum of 6i-6j)	$1,135,616.00	$0.00	$0.00		$1,135,616.00
7. Program Income					$0

Previous Edition Usable

SF-424A (Rev. 4-92)
Prescribed by OMB Circular A-102

Applicant Name: 0 Award Number: 0

Budget Information - Non Construction Programs

OMB Approval No. 0348-0044

Section A - Budget Summary

Grant Program Function or Activity (a)	Catalog of Federal Domestic Assistance Number (b)	Estimated Unobligated Funds Federal (c)	Estimated Unobligated Funds Non-Federal (d)	New or Revised Budget Federal (e)	New or Revised Budget Non-Federal (f)	New or Revised Budget Total (g)
1. Budget Period 1				$1,135,616.00	$0.00	$1,135,616.00
2. Budget Period 2				$0.00	$0.00	$0.00
3. Budget Period 3				$0.00	$0.00	$0.00
4.						
5. Totals				$1,135,616.00	$0.00	$1,135,616.00

Section B - Budget Categories

6. Object Class Categories	Grant Program, Function or Activity: Budget Period 1	Budget Period 2	Budget Period 3		Total (5)
a. Personnel	$435,548.00	$0.00	$0.00		$435,548.00
b. Fringe Benefits	$265,684.00	$0.00	$0.00		$265,684.00
c. Travel	$23,117.00	$0.00	$0.00		$23,117.00
d. Equipment	$0.00	$0.00	$0.00		$0.00
e. Supplies	$3,060.00	$0.00	$0.00		$3,060.00
f. Contractual	$0.00	$0.00	$0.00		$0.00
g. Construction	$0.00	$0.00	$0.00		$0.00
h. Other	$27,153.00	$0.00	$0.00		$27,153.00
i. Total Direct Charges (sum of 6a-6h)	$754,562.00	$0.00	$0.00		$754,562.00
j. Indirect Charges	$381,054.00	$0.00	$0.00		$381,054.00
k. **Totals** (sum of 6i-6j)	$1,135,616.00	$0.00	$0.00		$1,135,616.00
7. Program Income					$0

COLLEGES AND UNIVERSITIES RATE AGREEMENT

EIN: 45-6002491

ORGANIZATION:

University of North Dakota
Budget
264 Centennial Drive
Stop 8233
Grand Forks, ND 58202-8233

DATE:07/27/2018

FILING REF.: The preceding agreement was dated 04/18/2017

The rates approved in this agreement are for use on grants, contracts and other agreements with the Federal Government, subject to the conditions in Section III.

SECTION I: INDIRECT COST RATES

RATE TYPES: FIXED FINAL PROV. (PROVISIONAL) PRED. (PREDETERMINED)

	EFFECTIVE PERIOD				
TYPE	**FROM**	**TO**	**RATE(%)**	**LOCATION**	**APPLICABLE TO**
PRED.	07/01/2016	06/30/2018	39.00	On-Campus	(A) Org. Res.
PRED.	07/01/2016	06/30/2018	26.00	Off-Campus	(A) Org. Res
PRED.	07/01/2016	06/30/2018	50.50	On-Campus	(A) EERC (1)
PRED.	07/01/2016	06/30/2018	26.00	Off-Campus	(A) EERC (1)
PRED.	07/01/2016	06/30/2018	35.60	On-Campus	(C) Oth Spo Pro
PRED.	07/01/2016	06/30/2018	26.00	Off-Campus	(C) Oth Spo Pro
PRED.	07/01/2016	06/30/2018	17.00	On-Campus	(C) HNRC (2)
PRED.	07/01/2016	06/30/2018	43.90	On-Campus	(C) Instruction
PRED.	07/01/2016	06/30/2018	26.00	Off-Campus	(C) Instruction
PRED.	07/01/2016	06/30/2018	39.50	On-Campus	(B) Org. Res.
PRED.	07/01/2016	06/30/2018	27.50	Off-Campus	(B) Org. Res.
PRED.	07/01/2016	06/30/2018	51.50	On-Campus	(B) EERC (1)
PRED.	07/01/2016	06/30/2018	27.50	Off-Campus	(B) EERC (1)
PROV.	07/01/2018	Until Amended		(D)	

*BASE

Modified total direct costs, consisting of all salaries and wages, fringe benefits, materials, supplies, services, travel and subgrants and subcontracts up to the first $25,000 of each subgrant or subcontract (regardless of the period covered by the subgrant or subcontract). Modified total direct costs shall exclude equipment, capital expenditures, charges for patient care, student tuition remission, rental costs of off-site facilities, scholarships, and fellowships as well as the portion of each subgrant and subcontract in excess of $25,000.

(1) Energy and Environmental Research Center
(2) Human Nutrition Research Center

(A) Facilities and Administrative Cost Rates
(B) Facilities and Administrative Cost Rates - DOD Contracts Only
(C) (A) & (B) apply

(D) Use same rates and conditions as those cited for fiscal year ending June 30, 2018.

ORGANIZATION: University of North Dakota

AGREEMENT DATE: 7/27/2018

SECTION I: FRINGE BENEFIT RATES**

TYPE	FROM	TO	RATE(%)	LOCATION	APPLICABLE TO
FIXED	7/1/2018	6/30/2019	26.80	All (1)	EERC-Permanent Employees
PROV.	7/1/2019	6/30/2022	26.80	All (1)	EERC-Permanent Employees

** DESCRIPTION OF FRINGE BENEFITS RATE BASE:

Direct salaries and wages excluding other fringe benefits.

(1) Vacation, holiday, and sick leave rate

SECTION II: SPECIAL REMARKS

TREATMENT OF FRINGE BENEFITS:

This organization charges the actual cost of each fringe benefit direct to Federal projects. However, it uses a fringe benefit rate which is applied to salaries and wages in budgeting fringe benefit costs under project proposals. The fringe benefits listed below are treated as direct costs:
SOCIAL SECURITY, HEALTH/LIFE INSURANCE, WORKERS COMPENSATION, UNEMPLOYMENT INSURANCE, RETIREMENT (STATE, TFFR, OR TIAA/CREF), DISABILITY INSURANCE, AND EMPLOYEE ASSISTANCE PROGRAM

TREATMENT OF PAID ABSENCES

Except for EERC Employees, vacation, holiday, sick leave pay and other paid absence are inlcuded in salaries and wages and are charged to federal projects as part of the normal charge for salaries and wages. Separate charges for the cost of these absences are not made.

For EERC employees, the cost of vacation, holiday, sick leave pay, and other paid absences (and associated other fringe benefits) are included in a fringe benefit rate and are not included in direct charges for salaries and wages. Charges for salaries and wages must exclude those paid to EERC employees for periods when they are on vacation, holiday, or sick leave, or are otherwise absent from work.

DEFINITION OF OFF-CAMPUS
An off-campus activity is defined as that activity performed by University employees at locations other than the main campus and not using the University's operation and maintenance facilities.

Activity such as short term (less than one month's duration) travel by employees to an off-campus site where office space is maintained on campus in their absence shall be considered on campus activity for the purposes of applying the indirect cost rates. Travel in excess of one month's duration will be reviewed and classified on or off campus on a case by case basis.

Activity performed by other than University employees through contractual arrangements is normally considered on campus with only the first $25,000 subject to the on campus indirect cost rate.

DEFINITION OF EQUIPMENT
Equipment means tangible personal property (including information technology systems) having a useful life of more than one year and a per-unit acquisition cost which equals or exceeds $5,000.

NEXT PROPOSAL DUE DATE
An indirect cost proposal based on actual costs for fiscal year ending 06/30/17, has been submitted for review.
A fringe benefit proposal based on actual costs for fiscal year ending 06/30/18, will be due no later than 12/31/18.

This rate agreement updates the fringe benefits only.

ORGANIZATION: University of North Dakota

AGREEMENT DATE: 7/27/2018

SECTION III: GENERAL

A. LIMITATIONS:

The rates in this Agreement are subject to any statutory or administrative limitations and apply to a given grant, contract or other agreement only to the extent that funds are available. Acceptance of the rates is subject to the following conditions: (1) Only costs incurred by the organization were included in its facilities and administrative cost pools as finally accepted: such costs are legal obligations of the organization and are allowable under the governing cost principles; (2) The same costs that have been treated as facilities and administrative costs are not claimed as direct costs; (3) Similar types of costs have been accorded consistent accounting treatment; and (4) The information provided by the organization which was used to establish the rates is not later found to be materially incomplete or inaccurate by the Federal Government. In such situations the rate(s) would be subject to renegotiation at the discretion of the Federal Government.

B. ACCOUNTING CHANGES:

This Agreement is based on the accounting system purported by the organization to be in effect during the Agreement period. Changes to the method of accounting for costs which affect the amount of reimbursement resulting from the use of this Agreement require prior approval of the authorized representative of the cognizant agency. Such changes include, but are not limited to, changes in the charging of a particular type of cost from facilities and administrative to direct. Failure to obtain approval may result in cost disallowances.

C. FIXED RATES:

If a fixed rate is in this Agreement, it is based on an estimate of the costs for the period covered by the rate. When the actual costs for this period are determined, an adjustment will be made to a rate of a future year(s) to compensate for the difference between the costs used to establish the fixed rate and actual costs.

D. USE BY OTHER FEDERAL AGENCIES:

The rates in this Agreement were approved in accordance with the authority in Title 2 of the Code of Federal Regulations, Part 200 (2 CFR 200), and should be applied to grants, contracts and other agreements covered by 2 CFR 200, subject to any limitations in A above. The organization may provide copies of the Agreement to other Federal Agencies to give them early notification of the Agreement.

E. OTHER:

If any Federal contract, grant or other agreement is reimbursing facilities and administrative costs by a means other thsn the approved rate(s) in this Agreement, the organization should (1) credit such costs to the affected programs, and (2) apply the approved rate(s) to the appropriate base to identify the proper amount of facilities and administrative costs allocable to these programs.

BY THE INSTITUTION:	ON BEHALF OF THE FEDERAL GOVERNMENT:
University of North Dakota	DEPARTMENT OF HEALTH AND HUMAN SERVICES
(INSTITUTION)	(AGENCY)
[signature]	Arif M. Karim -S Digitally signed by Arif M. Karim -S DN: c=US, o=U.S. Government, ou=HHS, ou=PSC, ou=People, cn=Arif M. Karim -S, 0.9.2342.19200300.100.1.1=2000212895 Date: 2018.08.01 06:32:43 -05'00'
(SIGNATURE)	(SIGNATURE)
Jed M Shivers	Arif Karim
(NAME)	(NAME)
VP Finance/COO University of North Dakota	Director, Cost Allocation Services
(TITLE)	(TITLE)
6 Aug '18	7/27/2018
(DATE)	(DATE) 7110

HHS REPRESENTATIVE: Karen Wong

Telephone: (415) 437-7820

ATTACHMENT B

PROJECT TEAM RESUMES AND CURRENT AND PENDING SUPPORT

JASON D. LAUMB

Principal Engineer, Coal Utilization Group Lead, Energy & Environmental Research Center (EERC)

Education and Training

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

Research and Professional Experience

2008–Present: Principal Engineer, Coal Utilization Group Lead, EERC, UND. Mr. Laumb's responsibilities include leading a multidisciplinary team of 15 scientists and engineers whose aim is to develop and conduct projects and programs on power plant performance, environmental control systems, the fate of pollutants, and computer modeling 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, aerosol analysis, and the fate of mercury in the environment. 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 CO_2 emissions.

2001–2008: Research Manager, EERC, UND.

2000–2001: Research Engineer, EERC, UND.

1998–2000: SEM Applications Specialist, Microbeam Technologies, Inc., Grand Forks, North Dakota.

Relevant Publications

Laumb, J.D.; Holmes, M.J.; Stanislowski, J.J.; Lu, X.; Forrest, B.; McGroddy, M. *Energy Procedia* **2017,** *114*, 573–580.

Laumb, J.D.; Glazewski, K.A.; Hamling, J.A.; Azenkeng, A.; Kalenze, N.S.; Watson, T.L. *Energy Procedia* **2017,** *114*, 5173–5181.

Laumb, J.D.; Kay, J.P.; Holmes, M.J.; Cowan, R.M.; Azenkeng, A.; Heebink, L.V.; Hanson, S.K.; Jensen, M.D.; Letvin, P.A.; Raymond, L.J. *Energy Procedia* **2013**, *37*, 6987–6998.

Trachtenberg, M.C.; Cowan, R.M.; Smith, D.A.; Horazak, D.A.; Jensen, M.D.; Laumb, J.D.; Vucelic, A.P.; Chen, H.; Wang, L.; Wu, X. *Energy Procedia* **2009**, *1* (1), 353–360.

Jensen, M.D.; Laumb, J.D.; Cowan, R.M.; Smith, D.A.; Trachtenberg, M.C. Capture of CO_2 from Combustion Flue Gas Using the Carbozyme Liquid Membrane Permeator – Results of Pilot-Scale Testing. In *Proceedings of 2008 AIChE Spring National Meeting*; New Orleans, LA, Apr 6–10, 2008.

Jones, M.L.; Pavlish, B.M.; Laumb, J.D.; Lentz, N.B.; Benson, S.A. P*repr. Pap.— Am. Chem. Soc., Div. Fuel Chem.* **2008**, *53* (2), 812.

Pavlish, B.M.; Jones, M.L.; Tolbert, S.G.; Laumb, J.D. Partnership for CO_2 Capture. Presented at the 34th International Technical Conference on Clean Coal & Fuel Systems, Clearwater, FL, May 31 – June 4, 2009.

Pavlish, B.M.; Stanislowski, J.J.; Laumb, J.D. Partnership for CO_2 Capture. Presented at the 26th International Pittsburgh Coal Conference, Pittsburgh, PA, Sept 20–23, 2009.

Pavlish, B.M.; Jones, M.L.; Laumb, J.D. Evaluation of Postcombustion CO_2 Capture Technologies with an Emphasis on Solvents. In *Proceedings of Air Quality VII: An International Conference on Carbon Management, Mercury, Trace Substances, SO_x, NO_x, and Particulate Matter*; Arlington, VA, Oct 26–29, 2009.

Synergistic Activities

Instructor, EERC Combustion and Gasification and Ash Behavior short courses; reviewer, *Fuel Process. Technol.*; Organizing Committee Member, 5th Int’l Freiberg Conference on IGCC and XtL Technologies; Member, National Advisory Board for the International Conference on Coal Science & Technology.

LUCIA ROMULD

Principal Industrial and Management Engineer, Energy & Environmental Research Center

Education and Training

B.S., Industrial and Management Engineering, Montana State University, 1984.

Pontificia Universidad Javeriana, Cali, Colombia, undergraduate courses in accounting, 1978–1979.

Colegio Colombo Britanico, Cali, Colombia, 1978.

Management and quality improvement courses/seminars sponsored by The Boeing Company. Bilingual (Spanish and English).

Research and Professional Experience

1996–Present: Principal Industrial and Management Engineer – Proposals, Resources, and Logistics, EERC, UND. Oversees technical and financial proposal development; manages EERC–U.S. Department of Energy (DOE) Joint Program on Research and Development for Fossil Energy-Related Sources and assists in the management of several additional major programs; develops and implements project budgets and schedules and provides supply chain logistics.

1989–1995: Assistant Research Manager, EERC, UND.

1985–1989: Industrial Engineer, The Boeing Company, Seattle, Washington.

Relevant Publications

Gorecki, C.D., Sorensen, J.A., Kurz, B.A., Wocken, C.A., Harju, J.A., Kalk, B.P., Dalkhaa, C., Hawthorne, S.B., Heebink, L.V., Kurz, M.C., Martin, C.L., Romuld, L., Stevens, B.G., and Torres, J.A., 2018, Bakken Production Optimization Program 2.0: Annual progress report (October 1, 2017 – September 30, 2018) for North Dakota Industrial Commission Contract No. G-040-080, Grand Forks, North Dakota, Energy & Environmental Research Center, October.

Romuld, L., Harju, J.A., Russell, C.J., Aulich, T.R., and Steadman, E.N., 2018, Energy & Environmental Research Center (EERC)–U.S. Department of Energy (DOE) joint program on research and development for fossil energy-related resources: Final report (May 1, 2008 – May 31, 2018) for U.S.

Department of Energy Cooperative Agreement No. DE-FC26-08NT43291, EERC Publication 2018-EERC-05-18, Grand Forks, North Dakota, Energy & Environmental Research Center, May.

Gorecki, C.D., Harju, J.A., Steadman, E.N., Heebink, L.V., Romuld, L., Hamling, J.A., Sorensen, J.A., Pekot, L.J., Daly, D.J., Jensen, M.D., Peck, W.D., Klapperich, R.J., Bosshart, N.W., Votava, T.F., Ayash, S.C., and Ensrud, J.R., 2017, Annual assessment report: Plains CO_2 Reduction (PCOR) Partnership Phase III Task 12 Deliverable D57 (October 1, 2016 – September 30, 2017) for U.S. Department of Energy National Energy Technology Laboratory Cooperative Agreement No. DE-FC26-05NT42592, EERC Publication 2018-EERC-01-06, Grand Forks, North Dakota, Energy & Environmental Research Center, December.

Steadman, E.N., Anagnost, K.K., Botnen, B.W., Botnen, L.S., Daly, D.J., Gorecki, C.D., Harju, J.A., Jensen, M.D., Peck, W.D., Romuld, L., Smith, S.A., Sorensen, J.A., and Votava, T.J., 2011, The Plains CO_2 Reduction (PCOR) Partnership—developing carbon management options for the central interior of North America: Energy Procedia, v. 4, p. 6061–6068.

Synergistic Activities

Program manager for a 10-year (2008–2018) cooperative agreement with DOE and 80 nonfederal partners (over $55 million in research funds) and 5-year (2015–2020) cooperative agreement with DOE and ten nonfederal partners to date (over $20 million in research funds to date).

Assisted in fund management, logistics, and report preparation for the Plains CO_2 Reduction (PCOR) Partnership Phases I–III (over $150 million of research funds from DOE and the private sector).

Provide fund management, logistics, and report preparation for the Bakken Production Optimization Program since its inception in 2013 (over $130 million of research funds from the public and private sector).

CURRENT AND PENDING SUPPORT

Jason Laumb

Project Title	Award or Proposed Amount	Sponsoring Agency	Period of Performance	Person Months per Year
Current				
Initial Engineering, Testing, and Design for a Commercial-Scale Postcombustion CO_2 Capture System	$7,500,000	U.S. Department of Energy, North Dakota Industrial Commission, Multiple Sponsors	09/01/17 – 12/31/19	2.5
Low-Pressure Electrolytic Ammonia Production	$3,164,010	U.S. Department of Energy; North Dakota Industrial Commission; Multiple Sponsors	05/01/18 – 06/14/21	0.1
Pending – None				

Lucia Romuld

Project Title	Award or Proposed Amount	Sponsoring Agency	Period of Performance	Person Months per Year
Current				
Plains CO_2 Reduction (PCOR) Partnership Phase III	$19,657,406	U.S. Department of Energy; Multiple Sponsors	04/01/16 – 09/30/19	1.3
Bakken Production Optimization Program	$24,729,231	U.S. Department of Energy; North Dakota Industrial Commission; Multiple Sponsors	11/01/16 – 10/31/19	1.5
Bakken Rich Gas Enhanced Oil Recovery	$1,000,000	U.S. Department of Energy	09/01/18 – 05/31/20	2.0
Integrated Carbon Capture and Storage for North Dakota Ethanol Production	$2,650,000	U.S. Department of Energy; North Dakota Industrial Commission	12/01/18 – 05/31/20	0.4
CO_2 Injection Monitoring with an Optimized Scalable, Automated, Semipermanent Seismic Array	$1,000,000	U.S. Department of Energy	08/15/18 – 05/30/20	0.8
Pending – None				

PROPOSAL FOR

TUNDRA BOP PROJECT

SUBMITTED TO
MINNKOTA POWER

APRIL 2020

April 15, 2020

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 Engineering Services & Owner's Engineer Proposal for the Minnkota Power Project Tundra CO2 Capture Funding Opportunity Announcement DE-FOA-0002058

Dear Mr. Pfau:

Minnkota Power can efficiently and predictably execute Project Tundra by leveraging Burns & McDonnell's history and track record of successful projects with your team. We understand that for you to be successful, you need a reliable project partner. We have put together a familiar project team to address Owner's Engineer support as well as the additional Engineering support requested on this project based on the following:

- **Assignment of a Great Team:** We have assembled a quality and experienced 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 treat this as if they are part of your team, and 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.

We greatly appreciate the opportunity to be partner with Minnkota on this project. If you have any questions regarding the enclosed information, please feel free to contact Ron Bryant at (816) 822-3023.

Sincerely,

Doug Riedel

Doug Riedel
Senior Vice President, Energy

TABLE OF CONTENTS

1.0 METHODOLOGY / TECHNICAL APPROACH

TECHNICAL EXECUTION PLAN

OVERVIEW

Minnkota Power Cooperative (Minnkota) is developing a post combustion carbon capture facility at their Milton R. Young Station located near Center, North Dakota. The new carbon capture facility will capture 90% of carbon dioxide emitted from the facilities two (2) lignite coal fired boilers and the new auxiliary boilers, which will be utilized to generate steam for the amine stripping process. Minnkota has received funding to perform a front-end engineering and design (FEED) study to establish a budget for the project. Minnkota intends to retain the services of an engineering firm to perform Owner's Engineer services as well as conceptual design of scope as detailed in the initial scope of work documents provided by Minnkota to Burns & McDonnell (BMcD).

This technical execution plan illustrates Burns & McDonnell's vision for successfully executing the services requested at the Milton R. Young Station related to the planned carbon capture facility project. In general, the scope or work included in this proposal commences with the development of the site design basis, through preliminary engineering and project definition to support development an AACE Class III estimate for the facility.

Based on our understanding of the project scope provided by Minnkota, we have identified the following primary objectives:

1. Perform Owner's Engineering services to provide technical review and project management/administration of the Carbon Capture facilities scope of work.
2. Perform a system capacity study on the power generation facility's Fire Water system to determine if the existing Fire Pumps can supply sufficient fire water pressure and flow to the new CCS facility.
3. Perform a review of the existing river water intake structure located on the Missouri River to determine the operating range required for make-up water to the site and associated water intake structure velocity for conformance with Minnkota's existing Clean Water Act Section 316(b) permit.
4. Preliminary engineering and conceptual development for the following scope to support the execution of the CCS facility:
    a. Lake Nelson intake pump structure to supply make-up water to the CCS facility
    b. Fire water supply pumps and system to the CCS facility (if required per the results of the existing Fire Water system capacity test)
    c. Unit 1 and Unit 2 flue gas duct tie-in/dampers from the existing facility to the CCS flue gas ductwork.
    d. Installation of variable frequency drive (VFD) motors and on river water intake pumps (if required per the results of the river water intake structure velocity analysis)
    e. Water pre-treatment system for make-up water to the facility
    f. Wastewater treatment system for water discharge from the facility
    g. Demineralized water treatment system
    h. Potable water supply system
    i. Chemical treatment unloading system at the CCS facility
    j. Washdown water interconnection system to the CCS facility
    k. Natural gas pipeline from gas supplier custody transfer point to Fluor's boundary limit
5. Development of Class III cost estimate

PRELIMINARY ENGINEERING, GENERAL PLANT DESIGN, PROJECT DEFINITION

Burns & McDonnell's current understanding is that the Fluor Econamine FG Plus proprietary carbon capture solution will be the selected technology to provide post combustion carbon capture at the Milton R. Young facility.

A key initial step to project development is thorough project definition to fully define the project scope. This will be the primary focus during the initial stages of the engineering activities. The following execution approach details Burns & McDonnell's vision and plan to support Minnkota with preliminary engineering activities.

Meetings

Kickoff Meeting: A web-based Project Kickoff Meeting will be convened with the Burns & McDonnell Project Team, including the Project Manager and other key team members. At the meeting, Burns & McDonnell and Minnkota will review the detailed scope of work and schedule to confirm agreement with the scope, schedule and roles on the project and to organize project communications. Prior to the Kick-off meeting, Burns & McDonnell will review the existing drawings and available information provided by Minnkota and identify any other information needed to complete the work.

Periodic Coordination Web Meetings/Conference Calls: In addition to the kickoff meeting, this proposal is based periodic web-based conference calls to review documents at key decision-making points.

On-Site Meeting: Burns & McDonnell has included a single trip to site with two (2) key team members. This trip will be upon request of Minnkota for project coordination or presenting the results of the cost estimate.

Communication through telephone conversations and e-mails will occur on a frequent basis. Verbal communications such as meetings and phone conferences will be documented with agendas and meeting notes where appropriate.

Project Development and Design Basis Memorandum

An important step in developing the project is for Minnkota and Burns & McDonnell to make decisions that result in a complete project scope. This is carried out by developing the conceptual plant design and identifying the various plant, site and balance of plant components and systems.

As part of this process, Burns & McDonnell will develop conceptual design documents for determining the balance of plant project scope.

The balance of plant design basis document will include:

- Definitions
- Industry Codes and Regulations
- Site location, design information, and design data
- Design criteria, including:
    - Geotechnical assumptions (foundation type)
    - Water supply and treatment
    - Site buildings

TECHNICAL EXECUTION PLAN
(continued)

- Site plan including modifications, additions and/or interface with existing features and systems.
- Plant control system and modifications or expansion of existing plant control room (if required)
- The plant electrical system, interface and modifications to the existing plant system (if required)
- Fire protection system and interface and modifications to the existing system (if required)
- Wastewater treatment and coordination with the existing plant facilities (if required)

Initial Scoping Meeting: Burns & McDonnell proposes to execute this activity by hosting a web-based meeting with Minnkota personnel to discuss the multitude of options available on the facility with the goal of selecting preferred options and refining project scope once the water treatment design has been determined. In this meeting, Burns & McDonnell will be prepared to discuss advantages, disadvantages, general economic impacts, and impact on plant reliability / availability for the various plant configuration options based upon Burns & McDonnell's experience on other similar projects. Burns & McDonnell expects that a decision of project scope for each item can be made during or at the conclusion of the meeting. However, should Minnkota not feel comfortable making these decisions on some items without further detailed information, then the meeting will identify additional evaluations that need to be done.

To support this meeting, Burns & McDonnell will update our standard scoping matrix to reflect the scope of the project as currently defined. This document will be used as an agenda for the meeting and each scoping item and associated sizing criteria will be discussed. Prior to the meeting Burns & McDonnell will need to obtain from Minnkota anticipated operating assumptions (indication of anticipated operating hours at each load point, anticipated number of starts, etc.) and economic assumptions (cost of capital, anticipated cost of fuel, fuel escalation rates, etc.) so that some economic evaluation criteria can be established as a basis of making decisions.

As part of the initial scoping meeting, Burns & McDonnell will develop an updated Level 1 schedule outlining the activities to be completed as part of the balance of plant preliminary engineering phase. Burns & McDonnell understands that Minnkota will have significant involvement in reviewing documents and deliverables throughout the process. The proposed schedule included herein does not specify Minnkota review periods for documents, rather time has been allocated within tasks and schedule items to allow for Minnkota's review. Burns & McDonnell will work with Minnkota during the kickoff meeting and scoping meeting to determine Minnkota's specific requirements for reviews and will incorporate this into the updated schedule.

Engineering Deliverables

Industry Codes and Regulations: The design basis manual will be developed to define and include the required codes and standards for the balance of plant scope.

Building/Equipment Arrangements: Burns & McDonnell will review the existing site plan for the project. Burns & McDonnell will develop preliminary building arrangements to support the balance of plant site development, HVAC design requirements, and estimate quantities for the scope defined herein. Fluor will provide the building design of the water treatment area, with the equipment arrangement developed by Burns & McDonnell.

Piping and Instrumentation Diagrams: Burns & McDonnell will develop preliminary P&IDs for the project. Previous, similar projects will be leveraged as a basis for development. The preliminary P&IDs developed during this stage will be used to support system definition and scope definition, to be included as part of the EPC specification and will be used to support material and quantity development for the project cost estimate development.

TECHNICAL EXECUTION PLAN
(continued)

Terminal Point List: Burns & McDonnell will provide a table of all connecting pipelines (gas, water, etc.) and any planned discharge to truck, or storage tank needed. Utility flow, pressure, location, and pipeline size as well as frequency of trucks to support operations will be identified.

Water Mass Balances: Burns & McDonnell will develop the preliminary water balance for the project. We will work closely with Minnkota to determine key water balance streams including make-up water requirements and potential sources, losses and discharges, water quality, and water treatment necessary for various uses within the CCS facility and discharge water quality requirements.

Electrical One Line Diagrams: Burns & McDonnell will identify and supply major electrical loads and locations to Fluor for incorporation into their one-line of the CCS facility. BMcD assumes that 480V MCCs will be within the BMcD scope of work to provide, but Fluor will be responsible for supplying/estimating all power cable to all medium voltage motors and low voltage MCCs.

Control System Architecture Drawing: Burns & McDonnell will red-line Fluor's control system architecture drawing that identifies the projects controls system arrangement and interfaces between this scope of work and the CCS control equipment provider.

Fire Protection: Burns & McDonnell will perform an analysis of the existing fire protection system to determine if there is adequate supply of fire protection water to the CCS facility and/or new facilities required as a part of the new project. Fluor will provide the Fire Protection Design Concept Report to indicate necessary pressure and flow requirements to the planned facility. BMcD will provide calculations, including assumptions made, to determine if the existing pumps at MRY can supply necessary water requirements to the CCS Fire Protection systems.

Section 316B: Burns & McDonnell will perform an analysis of the existing River Water Intake structure to determine maximum operating range of the existing river water intake pumps for compliance with Minnkota's 316(b) operational permit. BMcD will provide calculations, assumptions, and a sensitivity analysis to determine maximum intake velocities due to seasonal variations in Project make-up water needs and river water levels.

Process: Process design deliverables will be developed as part of the design basis document and will be used for defining the EPC Contract requirements as well.

Those deliverables include:

- Overall Block Flow Diagrams
- Process Assumptions
- Process Design Basis
- Process Description
- Process Control Philosophy
- Process Control Criteria
- Defining the extent for development of Process Documents (PFD, P&ID's)
- Winterization Philosophy

Burns & McDonnell routinely performs engineering designs and winterization philosophies on very cold climates, from the mountains of Utah, with design temperatures of -35 F (-37C), to northern Minnesota, where the project has a minimum

TECHNICAL EXECUTION PLAN
(continued)

design temperature of -51 F (-46 C). Given the project location in North Dakota, we will leverage this previously experience to assist in the development of necessary cold weather criteria and philosophy requirements for the project.

Civil / Structural / Site: Civil / structural / site design deliverables will be developed as part of the design basis document and will be used for defining the EPC Contract requirements as well. Burns & McDonnell will base the site work and structural foundation conceptual design on recommendations provided by findings in the geotechnical report. If such report is not available for conceptual design, structural design will be based on geotechnical assumptions based on other projects in the area or geotechnical information available from the existing facility. For equipment located inside of the CCS process building, BMcD will supply the size and preliminary weights of the equipment to Fluor. Fluor will be responsible for the design and estimating of equipment and water treatment building foundations inside the process building.

To support quantity take-offs and estimate development, Burns & McDonnell will utilize developed design documents (site plans, grading plans, stormwater concept, etc.). Foundation quantities will be developed using a combination of the following: (1) actual equipment, structure or building loads for the project, (2) loading data from proposed equipment or structure suppliers, (3) similar information from other projects, equipment, structure, or building loads, (4) estimated equipment, structure or building loads. To develop structural and miscellaneous steel quantity estimates for buildings, pipe racks, etc. the size/volume needed for the project will be estimated using developed sketches and conceptual designs and using steel density rates from past experience and similar projects.

Those deliverables include:

- Design Philosophy
- Design Basis and Criteria
- Project standards, specifications, codes, design, material and manufacturing documents
- Design criteria for roads, paving plant and cut and fill requirements.

Architectural: Architectural deliverables will be developed as part of the design basis document and will be used for defining the EPC Contract requirements as well.

Those deliverables include:

- Design Philosophy
- Design Basis and Criteria
- Project standards, specifications, codes, design, material and manufacturing documents

Water Treatment: Water treatment design deliverables will be developed as part of the design basis document and will be used for defining the EPC Contract requirements as well.

Those deliverables include:

- Design Philosophy
- Design Basis and Criteria
- Project standards, specifications, codes, design, material and manufacturing documents

Buildings and Loading / Unloading Facilities: Buildings and structures design deliverables will be developed as part of the design basis document and will be used for defining the EPC Contract requirements as well.

Those deliverables include:

TECHNICAL EXECUTION PLAN
(continued)

- Design Philosophy
- Design Basis and Criteria
- Enclosure Selection Criteria
- Building Functional Criteria and basis
- Building layout criteria and Basis
- Building Design criteria and Basis
- HVAC design criteria and basis
- Project standards, specifications, codes, design, material and manufacturing documents

Piping and Mechanical: Mechanical design deliverables will be developed as part of the design basis document and will be used for defining the EPC Contract requirements as well.

The mechanical engineering lead will coordinate P&ID development, preliminary line lists, manual valve lists, actuated valve lists, and piping specials lists based on similar projects and adjusted to reflect the project scope for use in developing the cost estimate. For large bore piping systems, quantities will be developed by sketching conceptual routings on overall site 2-D drawings. Quantities from past projects will be referenced and adjusted based on project scope and layout differences. Small bore piping quantities will be estimated based on a percentage of large bore piping quantities using historical information from similar projects.

Those deliverables include:

- Design Philosophy
- Design Basis and Criteria
- Material Selection Philosophy
- Material Selection Criteria and Basis
- Material Selection Diagrams
- Mechanical Equipment Design Allowance
- Equipment spacing and access criteria
- Modularization Philosophy
- Criteria for stress analysis, stress relieving, coating requirements, and insulation requirements.
- Project standards, specifications, codes, design, material and manufacturing documents

Electrical and Controls: Electrical design deliverables will be developed as part of the design basis document and will be used for defining the EPC Contract requirements as well.

The develop the electrical system quantities, overall 2-D drawings will be used to sketch the preliminary locations of cable trays, duct banks, lighting, receptacles, grounding, and equipment locations. In general, medium voltage and above cabling will be conceptually routed. Low voltage power wiring and instrument wiring take-offs will be based on estimated run lengths per item based upon Burns & McDonnell similar project experience. The quantities will be tabulated in a spreadsheet for incorporation in the estimate.

The instrumentation and controls lead engineer will develop preliminary I/O counts for the DCS as required to define the control system hardware and software. Preliminary instrument lists and control valve lists will be adjusted from previous similar projects and used for the cost estimate.

TECHNICAL EXECUTION PLAN
(continued)

Those deliverables include:

- Design Philosophy
- Design Basis and Criteria
- Controls Philosophy
- Heat Tracing design philosophy, criteria, and basis
- Project standards, specifications, codes, design, material and manufacturing documents

Level 2 Project Schedule

Based on the contract and procurement strategy developed during the conceptual design phase, Burns & McDonnell will prepare a detailed project schedule for the balance of plant through commercial operation. The schedule will identify critical path activities and inter-relationships between activities on the Project in order to provide an overall plan and define the basis for the cost estimate.

COST ESTIMATE DEVELOPMENT

To support initial planning for the facility, Burns & McDonnell will develop an AACE Class 3 estimate for the scope of the work defined herein. Burns & McDonnell will develop a control cost estimate for use in the project prior to the submission of the EPC pricing. This will be a specific detailed estimate with suitable granularity to allow the project costs to be summarized into categories that match the contracting strategy developed for the project. As an EPC contractor on other similar projects at power generation facilities, Burns & McDonnell has extensive experience in estimating costs for this scope of work. This experience has resulted in Burns & McDonnell developing a database of capital estimates for various configuration including estimates of quantities. Burns & McDonnell is proposing to use this database and pull the most representative information for use in estimating the costs for this project. This estimate will be adjusted for major project specific scope, where applicable, and will be adjusted for other variances as outlined in the following:

- Burns & McDonnell has extensive experience in estimating costs for process and power facilities. This experience has resulted in developing a database of capital estimates for various configuration including estimates of quantities. Burns & McDonnell will use this database and pull the most representative information for use in estimating the costs for equipment and make adjustments to reflect current market conditions. Where the database if felt to be insufficient or out of date, Burns & McDonnell will solicit budgetary pricing from suppliers
- Quantities will be developed as defined in each respective discipline section. For some of the smaller impact commodities, an allowance will be used based upon our experience.
- For other equipment, Burns & McDonnell will base pricing on our internal database with adjustment to project specific requirements and with general adjustments to reflect change in market conditions between the reference estimate and the current market. Where equipment pricing in the database may be out of date, Burns & McDonnell will solicit vendors for updated pricing.
- Commodity take-offs will be developed based on Preliminary Engineering and Project Definition activities. Estimates for tie-ins will be performed where necessary to reflect interface with the existing facility or connection to infrastructure off site (natural gas, water, etc.). Pricing will be based upon Burns & McDonnell's database (which is updated periodically) with adjustments to reflect current market conditions on an aggregate basis based on the labor market analysis.
- Burns & McDonnell will leverage the experience of our direct hire construction group to reflect recent labor rates and productivity for projects completed in the area.

- A detailed listing of typical Owner's costs will be extracted from the reference estimate and reviewed with Minnkota to determine which costs to include, who will be responsible for each of the costs, and to agree on an approach for obtaining the costs.
- Escalation will be included at values as agreed upon with Minnkota. Since market conditions are continuously changing, actual escalation rates are an unknown. Therefore, these costs will be maintained as a breakout. We recommend the estimate include moderate escalation rates and further include a contingency to cover more extreme escalation conditions. This allows the project to be evaluated both with and without the additional risk contingency to bracket the potential outcome of costs and to provide a good comparison against other generation options.
- A construction management plan will be developed and will include staffing costs as well as construction indirect costs such as temporary construction facilities, development of laydown yard, etc. A start-up management plan will be developed and will include costs for facilities including trailers, consumables required during start-up and testing, start-up spares, operator training, and the costs of O&M personnel prior to COD. An engineering plan will be developed indicating total estimated engineering hours and associated estimated costs. Applicable property, sales, and excise taxes will be included in accordance with North Dakota requirements as provided by Minnkota.
- A Monte Carlo simulation will be used to develop a confidence level curve that indicates the amount of contingency recommended to achieve different confidence levels that the final costs will not exceed the budgeted costs.

The estimate will be delivered to Minnkota at a summary level with breakdown of direct labor hours, direct labor cost, material costs, equipment costs, and indirect costs for each construction and equipment contract. In addition, the major assumptions and basis will be provided to Minnkota. The detailed back-up that supports this summary will be available for review by Minnkota during the cost estimate review in our office in its full entirety. However, as an EPC contractor, much of this information (specifically unit labor hours, mark-ups, and productivities) are considered company confidential and will not be provided as a deliverable during this FEED Phase.

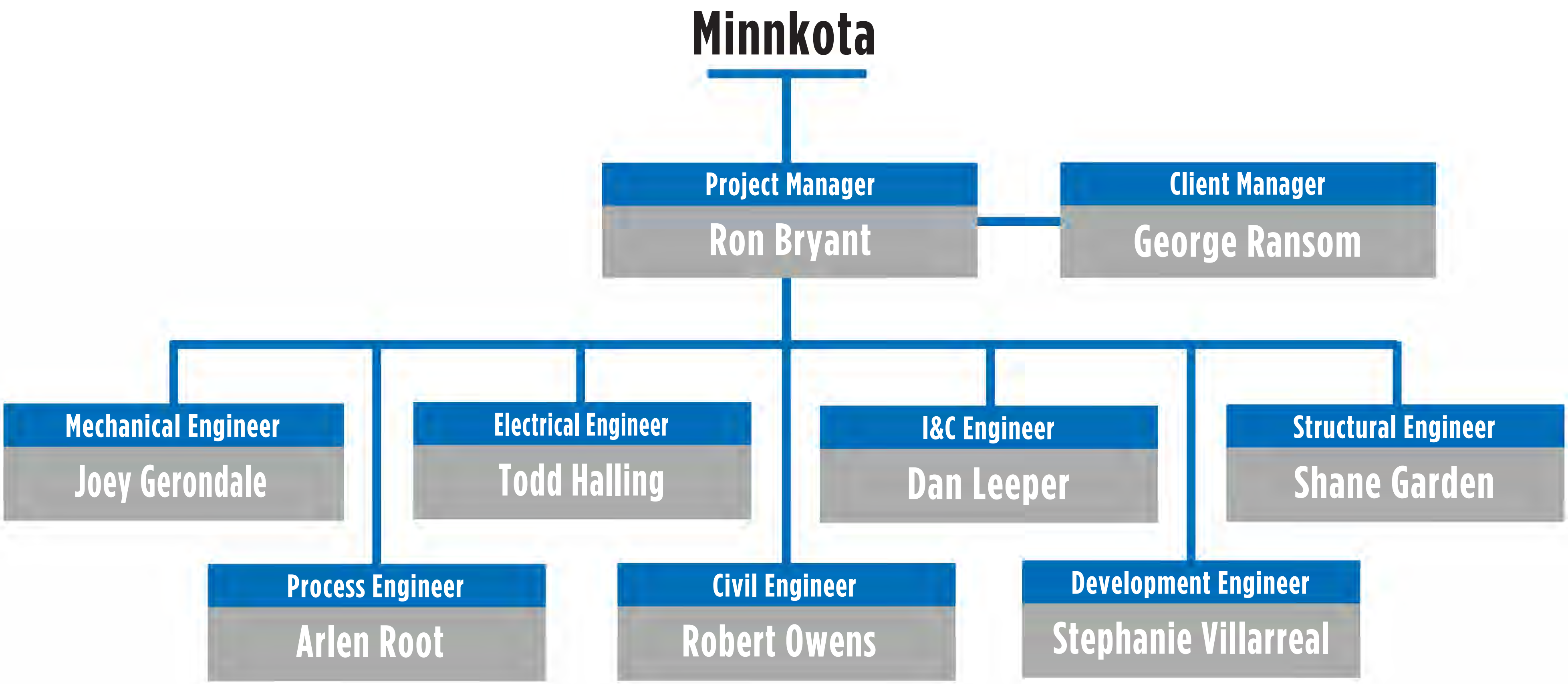
OWNER'S ENGINEERING SERVICES

As a part of the FEED study currently being developed by Fluor for the CCS facility, Minnkota is seeking assistance to provide Owner's Engineering services to provide assistance in the technical and commercial review of the scope of work Fluor is to perform. The scope of services that BMcD will provide in support of this work includes being an extension of Minnkota' s development team for the expected duration (9 months) of the proposed FEED study:

1. Provide project management and administration.
2. Schedule and lead project review meetings and teleconferences.
3. Review submittals and documents.
4. Provide document management:
    a. Receive and log documents
    b. Route and track documents for review
    c. Consolidate comments and return to vendor/contractor
    d. Maintain log and status of documents
5. Develop or track schedule.
6. Provide periodic balance of plant status reports.

2.0 PROJECT TEAM

MRY Tundra BOP
Project Team Organization Chart



BURNS McDONNELL

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

Milton R. Young Generating Station | Minnkota Power Cooperative

Center, North Dakota

Project manager for a carbon capture FEED study. Burns & McDonnell is providing balance of plant engineering for a post-combustion carbon capture facility. Cost estimates for the balance of plant equipment and balance of plant installation are being developed.

Milton R. Young Generating Station | Minnkota Power Cooperative and Energy & Environmental Research Center

Center, North Dakota

Project manager for a carbon capture Pre-FEED study. Burns & McDonnell provided balance of plant engineering for a post-combustion carbon capture facility. Cost estimates for the balance of plant equipment and balance of plant installation were developed. Burns & McDonnell is also developing technology island installation cost estimates.

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.

RON BRYANT, PE

(continued)

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.

RON BRYANT, PE
(continued)

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 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.

STEPHANIE VILLARREAL, PE

Sr. Mechanical/Development 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)

10 YEARS OF EXPERIENCE

10 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.

Minnkota Power Cooperative | CO2 Capture Facility Development

Center, North Dakota

Lead Project Development Engineer and Assistant Project Manager for the pre-FEED development of a 100% Flue Gas CO2 Capture Facility at MPC's Milton R. Young Station Unit 2. BMcD was responsible for the balance of plant design as well as integration of the CO2 process into the existing facility including but not limited to: steam and power supply and evaluation of impacts on the steam cycle and existing STG, heat recovery integration, cooling water supply strategy, and waste water disposal strategy and permitting.

J-Power | Elwood Energy Center Black Start Facility

Elwood, Illinois

Mrs. Villarreal was the Development and Proposal Manager for the J-Power Elwood Energy Center Black Start proposal, which also included supporting J-Power with their application to PJM for the Black Start Tariff, as well as permitting of the new project on their existing facility. The project will be completed in March of 2021 to provide a black start resource to support critical loads for PJM in case of a black grid emergency event.

STEPHANIE VILLARREAL, PE

(continued)

Basin Electric Cooperative

Mrs. Villarreal has assisted Basin Electric in up-front planning and development of conceptual planning and contracting strategy to assist Basin Electric to understanding schedule, risk, and financial commitments depending on the selection of technology and contracting strategy selected. Her efforts include an upfront analysis of development activities, including permitting, ISO planning requirements, cash flows, and schedule development for differing generation technologies and plant sizes.

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.

Sundance 7 | TransAlta Corporation

Edmonton, Alberta, CA

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.

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/bank 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

STEPHANIE VILLARREAL, PE
(continued)

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.

Chinook Generating Station | SaskPower
Swift Current, Saskatchewan, CA

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/bank 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.

STEPHANIE VILLARREAL, PE

(continued)

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.

JOEY GERONDALE, PE

Senior Mechanical Engineer

Mr. Gerondale is responsible for mechanical systems and equipment within power generation facilities. His duties include preparing equipment specifications, evaluating technical proposals, contract negotiation, contract administration, mechanical construction drawings, and designing various mechanical systems. Most experienced producing deliverables such as: Technical Specifications, Bid Tabulations, Piping & Instrumentation Diagrams, Hydraulic Analyses, White Papers, and Condition Assessment Reports. Mr. Gerondale's broad experience has included responsibility for technical specifications, bid evaluation / negotiation, and contract management of major power equipment such as Gas Turbines, Steam Turbines, Heat Recovery Steam Generators, Packaged Boilers, and Electrical Generators. Mr. Gerondale also has significant project experience with EPA Clean Water Act Rule 316(b) projects, EPC contract administration, and Synchronous Condensers. Mr. Gerondale excels at technical communication and coordinating the efforts of a multi-faceted team.

EDUCATION

- BS, Mechanical Engineering

REGISTRATIONS

- Professional Engineer (IN, KS, PA, WI)

12 YEARS WITH BURNS & MCDONNELL

Ethane Cracker / Polyethylene Project FEED | Confidential Client

Gulf Coast Region, Texas | June 2019 – Present

Lead Process Engineer for Utility Island OSBL systems on the project. BMcD was engaged for Front End Engineering Design (FEED) on the OSBL scope of the project. The project consists of one 2000 KTA Ethane Cracker unit, two 1000 KTA Polyethylene units, and OSBL support systems. The OSBL Utility Island systems include: three 500,000 pph package boilers, steam conditioning/attemperation, boiler feedwater pumps, deaerator, demineralized water treatment system, condensate treatment, compressed air, and boiler chemical feed. Mr. Gerondale is responsible for coordinating process deliverables such as: P&ID's, process flow diagrams, heat/material balances, hydraulic calculations, equipment sizing / performance datasheets. The project FEED is scheduled for completion in Q3 2020.

Nearman Creek 316(b) Compliance | Kansas City Board of Public Utilities

Kansas City, Kansas | August 2018 – June 2019

Lead Mechanical Engineer for the Nearman Creek 316(b) Retrofit Project. The project consists of replacing the 4 x 25% traveling raw water screens, providing water to the debris removal sprays, fish removal sprays, and fish survival sprays. The project also includes a fish-return trough with supplementary heated flush water and gravity chute to return aquatic organisms back to the Missouri River. Mr. Gerondale conducted all elements of the mechanical design including hydraulic analysis on the existing backwash systems to support re-purposing for fish sprays, heat-transfer modeling to size the anti-icing fish return trough heater, as well as preparing all mechanical construction specifications and drawings. The project is scheduled for substantial completion in Q2 2019.

Synchronous Condenser Conversion Feasibility Study | Confidential Client in WECC

Pacific Northwest | October 2018 – February 2019

Lead Study Author and ***Lead Mechanical Engineer.*** A utility operating in the Western Electricity Coordinating Council (WECC) region engaged Burns & McDonnell to evaluate the feasibility of converting a 690 MVA tandem-compound coal-fired generating unit into Synchronous Condenser operation. Burns & McDonnell's Study scope included conceptual design for Balance-Of-Plant systems modifications, concept contract execution scope delineation, and a bottoms-up project cost estimate. Burns & McDonnell also authored a White Paper providing a site-specific and Client-specific summary of potential revenue mechanisms for project justification. As lead mechanical engineer, Mr. Gerondale performed preliminary sizing of the generator starting system, condition assessment of existing mechanical utilities and concept mechanical system design to support the cost estimate deliverables. Mr. Gerondale was also responsible for contributing major portions of the final-deliverable cost-estimate Study and the White Paper.

Multi-Unit Synchronous Condenser Conversion Feasibility Study | Confidential Client in MISO

Central Michigan | September 2018 – January 2019

Lead Study Author and ***Lead Mechanical Engineer.*** A utility operating in the Midcontinent Independent System Operator (MISO) RTO engaged Burns & McDonnell to evaluate the feasibility of converting three unique fossil generating units into Synchronous Condenser operation. The units included one 378 MVA cross-compound generator, one 145 MVA tandem-compound generator, and one 595 MVA tandem-compound generator. Burns & McDonnell's Study scope included conceptual design for Balance-Of-Plant systems modifications, concept contract execution scope delineation, and a bottoms-up project cost estimate. As lead mechanical engineer, Mr. Gerondale performed preliminary sizing of the generator starting system, condition assessment of existing mechanical utilities and performed concept mechanical system design to support the cost estimate deliverables. Mr. Gerondale was also responsible for contributing major portions of the final-deliverable Study.

Bailly Generating Station Unit 8 Synchronous Condenser | NIPSCO

Chesterton, Indiana | May 2017 – November 2018

Owner's Engineer. The existing Bailly Unit 8 was a gross 421 MW fossil station, which ceased operation as a generating asset in Q1 2018. The Unit 8 Generator was converted into a +300/-200 MVAR Synchronous Condenser for use as a transmission asset in stabilizing grid voltage due to high industrial loads. The Generator Starting System consists of 5000 HP induction motor attached to the Generator, which is accelerated via Variable Frequency Drive. The station's Balance-of-Plant mechanical and electrical systems were modified and added as required for the Generator to run independently, including the addition of a glycol-based Closed Loop Cooling Water System. Burns & McDonnell performed Owner's Engineering Services for the project, including Major Equipment Procurement and EPC Contract management. Mr. Gerondale authored technical specifications for the Generator Starting System and provided Contract Engineer/Administrator services. First Synch for the Synchronous Condenser occurred in May 2018.

Multi-Unit Condition Assessment / Remaining Life Assessment Reports | Confidential Client in SPP

Great Plains | September 2016 – December 2017

Lead Study Author. A Cooperative operating the in the Southwest Power Pool engaged Burns & McDonnell to provide condition assessment reports of its major generating assets across multiple sites. The purpose of the assessment reports was to substantiate RUS loan applications for continued financing of assets. Each condition assessment report provided estimated cash-flow projections for an additional 30 years of maintenance costs and CAPEX projects based on a bottoms-up review of plant-specific equipment and systems. The generating assets included: one coal-fired station, three natural gas-fired CCGT units, three natural gas-fired steam turbine-generator units, and five GE LM6000 aero-derivative gas turbine generators. Mr. Gerondale served as lead mechanical engineer and lead study author for the effort, responsible for coordinating the content of other engineering disciplines (electrical, I&C) and business specialists (i.e. economists), and ultimately compiling the report and its cash-flow projections.

JOEY GERONDALE, PE

(continued)

Valley Power Plant 316(b) Compliance | We Energies

Milwaukee, Wisconsin | July 2014 – August 2016

Lead Mechanical Engineer. Valley Power Plant, a two-unit net 272 MW natural gas-fired steam generating station, is an important resource to the downtown Milwaukee area. It provides not only electrical generation but also 1.25 MPPH process steam to a variety of industrial users. The project scope included total replacement of the existing circulating water pumps, addition of motorized wedge-wire intake screens for 316(b) compliance, and replacement of the anti-ice inlet heating system for circulating water. Mr. Gerondale served as Lead Mechanical Engineer for the duration of the project. His responsibilities included hydraulic/thermal analysis of the anti-ice inlet heating system, process and detailed system design, production of construction drawings and specifications, and direct interface with the Client.

Wildcat Point Generation Facility Combined Cycle Project | Old Dominion Electric Cooperative

Cecil County, Maryland | 2013 – 2019

Owner's Engineer. The facility is a gross capacity 1000 MW natural gas fired 2-on-1 G-class combined cycle plant on a brownfield site consisting of Mitsubishi M501GAC Gas Turbines, and HRSG/STG Steam Tail by Alstom Power (General Electric). Burns & McDonnell performed Owner's Engineering Services for the project, including Major Equipment Procurement and EPC Contract management. Mr. Gerondale supervised technical specification and bid evaluation/negotiation for the Steam Turbine Generator and Gas Turbine Generators. In addition, he functioned as Contract Engineer/Administrator for the Gas Turbine Generators, Steam Turbine Generator, and HRSGs during the 9-month period after FNTP and prior to equipment assignment to the EPC Contractor. Also, Mr. Gerondale continues to serve as Project Engineer for ODEC, administering the EPC Contract. Commercial Operation of the Plant began in April 2018.

Wildcat Point Generating Facility Raw Water Project | Old Dominion Electric Cooperative (ODEC)

Lancaster County, Pennsylvania | April 2014 – August 2017

Lead Mechanical Engineer. The project's purpose is to provide Raw Water from the Susquehanna River in Lancaster County, Pennsylvania to the 1000 MW Wildcat Point CCGT station in Cecil County, Maryland. The project consists of six 50% wedge wire intake screens for 316(b) compliance, two 100% capacity Flowserve QL vertical turbine pumps, Hydro-pneumatic Surge Suppressor Tank, Variable Frequency Drives, Emergency Diesel Generator, clean agent fire protection, PLC-based controls, and 4.2 mile buried pipeline connecting to the power plant. The equipment is installed in a Pump House enclosure located over a 25-foot diameter, 60-foot deep wet well concrete caisson. The PLC was configured in a parallel control/full control scheme, with PLC graphics mimicked in the DCS, which allows the Operators full access to the PLC's function from the Control Room. Burns & McDonnell was the prime EPC Contractor providing a turnkey project, including procurement of Major Equipment, detailed design engineering, PLC programming, and Construction. Mr. Gerondale served as Lead Mechanical Engineer for the duration of the project. His responsibilities included specification and evaluation/purchase of all major equipment, all process and detailed mechanical system design, production of construction drawings, and direct interface with the Client. The Raw Water Project achieved Substantial Completion in February 2017.

Riverton Unit 12 | Empire District Electric Company

Riverton, Kansas | January 2013 – May 2013

Technical Specification Author. The facility is a gross capacity 250 MW natural gas fired 1-on-1 F-class combined cycle unit. The project consisted of augmenting the existing Siemens V84.3A2 Gas Turbine Generator with an HRSG, Steam Turbine Generator, Wet Surface Condenser, and plant auxiliaries. Burns & McDonnell was the prime EPC Contractor providing a turnkey project. Mr. Gerondale supervised technical specification and bid evaluation for the Steam Turbine

JOEY GERONDALE, PE

(continued)

Generator, including thermal performance calculations. Mr. Gerondale also performed hydraulic analysis on the Closed Loop Cooling Water System.

Warren County Power Station | Virginia Electric Power Company / Dominion

Front Royal, Virginia | August 2011 – August 2013

Contract Engineer and ***System Engineer.*** The facility is a gross capacity 1300 MW natural gas fired 3-on-1 G-class combined cycle generating station. Burns & McDonnell partnered in a joint-venture EPC Contract to deliver the station turnkey. Commercial operation began in late 2014. It consists of Mitsubishi M501GAC Gas Turbine Generators and Mitsubishi TC4F Steam Turbine Generator. Mr. Gerondale performed detailed design of the plant's glycol-based Closed Loop Cooling Water System (including a 99 MMBtu/hr fin-fan cooler). Mr. Gerondale's primary responsibility was as Contract Engineer/Administrator for the Gas and Steam Turbine Scope. He was responsible for coordinating various engineering reviews of all technical submittal drawings (over 2,100 total unique documents), drafting/responding to RFI's, coordinating design interface, and 3D model coordination. Mr. Gerondale was also responsible for contract administration of the Mitsubishi scope. This included ongoing activities such as: managing Action Item Lists, reviewing/ negotiating Change Orders, hosting weekly coordination calls, and drafting meeting minutes.

Land Based Steaming System | General Dynamics Electric Boat

Groton, Connecticut | January 2011 – August 2011

Lead Mechanical Engineer. General Dynamics Electric Boat is the sole designer and builder of nuclear submarines for the U.S. Navy. The propulsion commissioning process for each boat requires a dependable fossil-fueled source of steam in the shipyard. When the existing steaming system became no longer serviceable, GDEB turned to BMcD to provide a turnkey replacement. The Land Based Steaming System is a complete and independent project of several subsystems including: Packaged Boiler, Fuel Storage, Demineralized Water Storage, Packaged Feedwater/ Deaerator System, Condensate Return, and Blowdown. Mr. Gerondale served as Lead Mechanical Engineer for the duration of the project. His responsibilities included specification and evaluation/purchase of all major equipment, all process and detailed system design, production of construction drawings, and direct interface with the Client.

Fremont Energy Center | FirstEnergy

Fremont, Ohio | August 2008 – December 2011

Lead Site Engineer / Project Engineer. The facility is a gross capacity 700 MW natural gas fired 2-on-1 combined cycle plant designed by Burns & McDonnell; it consists of Siemens SGT6-5000F Gas Turbines and Siemens KN Steam Turbine. Mr. Gerondale served as Lead Site Engineer in a Project Engineer/Detailed Design Engineer role for a total of 18 months on-site. Mr. Gerondale was responsible for coordinating procurement, design and construction tasks between the field (both construction contractors and Client) and engineering, ultimately managing a team of 8 engineers of all disciplines.

Boswell Station Unit 3 Air Pollution Control Retrofit | Minnesota Power

Cohasset, Minnesota | June 2007 – July 2008

System Engineer and ***Contract Engineer*** for the Boswell Unit 3 Retrofit Project. The project consisted of adding a SCR, PJFF, WFGD system, and associated facilities. The unit is a gross capacity 355 MW tangentially-fired and balanced draft steam generator and burns subbituminous coal. Mr. Gerondale was responsible for system design of the Service Water, Auxiliary Circulating Water, Compressed Air, Sumps, and Bottom Ash Water. Mr. Gerondale was responsible for contract administration for Mechanical Agitators, Compressed Air Equipment, Sump Pumps, and Field Erected Tanks (including two slurry storage tanks and the WFGD Absorber Vessel).

TODD HALLING, PE

Electrical Engineer

Mr. Halling is an Electrical Engineer with over 8 years of experience in the Energy Division focusing on new generation and retrofit projects at fossil generation stations. His engineering responsibilities include project management, lead electrical engineer, electrical system design, electrical equipment specifications and contract management, construction specifications and contract management, load flow analysis, short circuit analysis, arc-flash studies and arc incident energy level mitigation, electrical system modeling, producing electrical one-lines, equipment and raceway plans, schematics and wiring diagrams, and attending factory witness testing. Mr. Halling also has field experience through serving as assistant project manager at the Elwood Energy Center Black Start Project in Elwood, Illinois, and field engineer at the Jeffrey Energy Center Unit 1 Selective Catalytic Reduction Project in St. Mary's, Kansas.

EDUCATION

- MS, Electrical Engineering
- BS, Electrical Engineering

REGISTRATIONS

- Professional Engineer (KS, IN, NC)

8 YEARS OF EXPERIENCE

American Electric Power CCR/ELG Compliance Program | American Electric Power

Multiple Facilities

Lead Electrical Engineer for a CCR/ELG compliance program including various combinations of bottom ash conversions, pond repurposing, reverse osmosis, and ultrafiltration system additions across three of American Electric Power's coal generation facilities. Project responsibilities included project development, maintaining schedule and budget while managing a team of electrical engineers in creating major electrical equipment specifications and contract engineering, one line development, electrical system modeling, load flow and short circuit analysis, and schematic and wiring diagram development.

Elwood Energy Black Start | J-Power

Elwood, Illinois

Assistant Project Manager/Field Engineer for a black start project including the addition of three, 3.9MW, diesel generators, switchgear and controls to provide to ability to black start four existing gas turbines. Project responsibilities included a three month field assignment. In the field responsibilities included managing multiple construction subcontracts, maintaining schedule and budget, administering RFIs and Change Orders, monitoring quality and enforcing the site safety plan. Additional responsibilities included keeping the Owner and Operators updated and facilitating quality and progress walkdowns.

DTE Monroe Fly Ash and Bottom Ash Conversion Projects | DTE Energy

Monroe, Michigan

Lead Electrical Engineer for a CCR/ELG driven fly ash and bottom ash conversion project at DTE Energy's Monroe Power Plant. Project responsibilities included project development, EPC specification development, Owner's engineer support, maintaining schedule and budget while managing a team of electrical engineers in creating major electrical equipment specifications and contract engineering, one line development, electrical system modeling, load flow and short circuit analysis, and schematic and wiring diagram development.

Rogers Energy Complex Process Water Redirection Program | Duke Energy

Cliffside, North Carolina

Lead Electrical Engineer for a process water redirection program including a flue gas desulfurization wastewater treatment plant upgrade, a water redirection program, and a final wastewater treatment plant to treat the redirected waters. Project

TODD HALLING, PE
(continued)

responsibilities included maintaining schedule and budget while managing a team of electrical engineers in creating major electrical equipment specifications and contract engineering, one line development, low voltage switchgear schematic development, electrical system modeling, load flow and short circuit analysis, and schematic and wiring diagram development for balance of plant electrical equipment.

Petersburg Station Wastewater Treatment Plant | Indianapolis Power & Light
Petersburg, Indiana

Lead Electrical Engineer for a zero liquid discharge flue gas desulfurization wastewater treatment plant. Project responsibilities included maintaining schedule and budget while managing a team of electrical engineers in creating major electrical equipment specifications and contract engineering, one line development, medium and low voltage switchgear schematic development using GE Multilin 850, 869, 745, and B90 relays, electrical system modeling, load flow and short circuit analysis, and schematic and wiring diagram development for balance of plant electrical equipment.

Oak Creek Power Plant East and West Spare Bus Replacement Study | We Energies
Oak Creek, Wisconsin

Project Manager/Lead Electrical Engineer for a non-segregated phase bus duct (NSPB) analysis. The analysis involved evaluating the condition and capabilities of the existing NSPB and providing a cost estimate for multiple replacement options. Evaluations and estimates were also provided for relay upgrades, breaker replacements, and additional ties between existing switchgear at the Plant. Project deliverables included a report summarizing the evaluations and cost estimates for the various options.

Seminole Generating Station Arc Flash Mitigation Project | Seminole Electrical Cooperative, Inc.
Palatka, Florida

Project Manager/Lead Electrical Engineer for an Arc Flash Mitigation Equipment Upgrade. Employ strategies including arc fiber detection and maintenance mode switch installations to reduce arc incident energy levels to 12 cal/cm2 on ten 6.9kV Switchgear lineups. Project included electromechanical relay to digital relay upgrades. Project deliverables included demolition and construction one-line diagrams, three-line diagrams, AC/DC schematics, wiring diagrams, switchgear door layouts, and construction cable schedule.

Holcomb Station Arc Flash Mitigation Project | Sunflower Electric Power Corporation
Holcomb, Kansas

Project Manager/Lead Electrical Engineer for an Arc Flash Mitigation Equipment Upgrade. Employ strategies to reduce arc incident energy levels to 8 cal/cm2 or lower on all electrical equipment at Holcomb Station, including 4,160V switchgear relay replacements, 480V switchgear maintenance mode switch installation, 480V switchgear trip unit upgrades, and 480V motor control center maintenance mode switch installations.

Arc Flash Mitigation Project Definition Reports | Sunflower Electric Power Corporation
Holcomb, Liberal, and Garden City Kansas

Project Manager/Lead Electrical Engineer for a series of Arc Flash Mitigation Project Definition Reports. Gathered information and developed strategies to reduce arc incident energy levels to 8 cal/cm2 or lower on all electrical equipment at Holcomb Station, Cimarron River Station, and Garden City Station. Provided a report containing strategies and an EPC cost estimate.

TODD HALLING, PE
(continued)

Queen Elizabeth Repower Project | SaskPower
Saskatoon, Saskatchewan, Canada

Contract and applications engineer. Electrical design engineer for a 6 x 1 combined cycle repowering project consisting of three existing Hitachi H25 Gas Turbines, three new Hitachi H25 Gas Turbines, six Innovative Steam Technologies Once Through Steam Generators, and one Fuji Electric 100MW induction condensing steam turbine. Project responsibilities included creating major electrical equipment specifications and contract engineering, one-line development, raceway design, load flow analysis, short circuit analysis, emergency generator sizing, isolated phase bus duct and non-segregated phase bus duct design, electrical system modeling, and schematic and wiring diagram development for various electrical equipment.

Jeffrey Energy Center Unit 1 Selective Catalytic Reduction Project | Westar Energy
St. Marys, Kansas

Field engineer for a selective catalytic reduction project on a 800MW coal unit with an existing electrostatic precipitator and wet limestone flue gas desulfurization system. Project responsibilities included managing electrical and multiple discipline RFIs, construction support, safety inspections, raceway design, schematic and wiring diagram development, and creating conformed to construction records.

Neal Station Unit 3 Scrubber and Baghouse Project | MidAmerican Energy
Sergeant Bluff, Iowa

Project engineer for the installation of a dry flue gas desulfurization system and pulse jet fabric filter system at a coal-fired power plant. Project responsibilities include duct bank design, conductor sizing, raceway design, electrical system modeling and schematic and wiring diagram development for various electrical equipment.

Neal Station Unit 4 Scrubber and Baghouse Project | MidAmerican Energy
Salix, Iowa

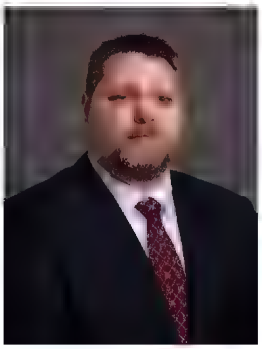
Project engineer for the installation of a dry flue gas desulfurization system and pulse jet fabric filter system at a coal-fired power plant. Project responsibilities include duct bank design, conductor sizing, raceway design, electrical system modeling, and wiring diagram development for various electrical equipment.

Oak Grove Electric Station Lignite Handling Switchgear and Conveyor VFD Improvement Project | Luminant

Project engineer for the Lignite Handling Switchgear and Conveyor VFD Upgrade at Luminant's Oak Grove Electric Station. Project responsibilities included producing demo drawings, switchgear schematics and wiring diagrams, VFD schematics and wiring diagrams, and a cable schedule.

DAN LEEPER, PE

Associate Instrument & Controls Engineer



Mr. Leeper is an associate instrumentation and control system engineer for Burns & McDonnell and is currently assigned to the Energy Division. His responsibilities include the design, specification, and implementation of industrial control systems for electric power and co-generation plants. He has experience with both greenfield and retrofit projects. Dan is a Principal on the NFPA Technical Committee on Heat Recovery Steam Generators.

EDUCATION

- BS, Electrical Engineering

REGISTRATIONS

- Professional Engineer (MO, SK)

20 YEARS WITH BURNS & MCDONNELL

21 YEARS OF EXPERIENCE

NNS Nancy Lee Natural Gas Conversion | Newport New Shipyard

Newport News, Virginia | 2018-2019

Lead Engineer for the NNS Nancy fuel conversion project. Newport News Shipbuilding (NNS) conducts test-steaming of aircraft carriers through their Floating Test Steam Facility, the Nancy Lee, which is a barge-mounted installation. The Nancy Lee contains two 158,000 lb/hr, three-burner steam boilers, each currently fueled by #6 diesel. The overall scope of the project is to convert the boilers to be fueled by natural gas and upgrade the existing DeltaV control system to Rockwell ControlLogix.

Rio Grande Unit 8 Controls Upgrade | El Paso Electric

El Paso, Texas | 2018-2019

Owners Engineer. Rio Grande Unit 8 is a 150MW gas fired boiler which was converted from Foxboro IA to a GE Mark VIe control system using a turn-key approach. Mr. Leeper performed logic reviews and provided on-site support for Factory Acceptance Testing and Startup. Mr. Leeper conducted functional testing for the equipment and supported initial boiler tuning efforts.

Newman Unit 4 Combined Cycle Controls Logic Review | El Paso Electric

El Paso, Texas | 2018

Mr. Leeper performed a logic review for the EPE Newman Unit 4 Foxboro IA DCS. BMcD provided recommendations for logic changes to increase unit reliability and operability. Mr. Leeper provided on-site programming, tuning and operational support during re-commissioning of the DCS logic.

Combined Cycle Controls Logic Reviews | Entergy

Various Locations | 2017-2018

Mr. Leeper performed a logic review for five Entergy combined cycle facilities. BMcD is provided recommendations for logic and graphics changes to increase unit reliability and operability. Mr. Leeper also provided on-site support for testing of new DCS logic. DCS platforms supported included ABB INFI 90 and Emerson DeltaV.

Thomas Hill Energy Center Unit 2 BMS Study | Associated Electric Cooperative Inc.

Pleasant Prairie, Wisconsin | 2018

Lead I&C engineer for an assessment for the BMS for Thomas Hill Energy Center and 2. The Units is a 300 MW B&W cyclone coal-fired unit. The projects included evaluating the existing DCS-based BMS, logic, and field devices. Recommendations to bring the BMS in line with current NFPA 85 requirements and industry best practices were provided.

DAN LEEPER, PE

Oak Creek Power Plant Unit 7 Steam Turbine Controls Upgrade | We Energies

Oak Creek, Wisconsin | 2018

Mr. Leeper provided consulting services for the OCPP U7 Steam Turbine controls upgrade project. BMcD provided a specification for a turnkey MHC to EHC upgrade, including new TCS hardware a mechanical upgrade of the HPU, actuators and replacement of the overspeed bolt with electronic overspeed protection. Mr. Leeper is responsible for review of the TCS vendor submittals.

Newman Unit 5 Steam Turbine Controls Upgrade | El Paso Electric

El Paso, Texas | 2018

Mr. Leeper provided consulting services for the EPE Newman Unit 5 Steam Turbine controls upgrade project. Newman Unit 5 is a 2x1 combined cycle with GE Frame 7EA Gas Turbines and a Fuji Steam Turbine. BMcD is providing a specification for a Turbine Control System upgrade, including new TCS and AVR hardware. BMcD is also responsible for detailed installation design for the TCS hardware and field wiring.

H.W. Pirkey Power Plant | American Electric Power

Hallsville, Texas | 2018

Mr. Leeper provided consulting services for the AEP Pirkey controls upgrade project. Services included review of the Burner Management System, and design services for the combustion control system and the unit master. Mr. Leeper performed a BMS assessment and provided recommendations to bring the BMS in line with current NFPA 85 requirements and industry best practices.

Newman Unit 5 Combined Cycle Controls Logic Review | El Paso Electric

El Paso, Texas | 2017

Mr. Leeper performed a logic review for the EPE Newman Unit 5 DCS. BMcD provided recommendations for logic and graphics changes to increase unit reliability and operability. Mr. Leeper provided on-site programming, tuning and operational support during re-commissioning of the DCS logic.

Pleasant Prairie Power Plant BMS Study | We Energies

Pleasant Prairie, Wisconsin | 2017

Lead I&C engineer for an assessment for the BMS for We Energies Pleasant Prairie Power Plant Units 1 and 2. The Units are each 595 MW Riley coal-fired units that were placed in service in the early 1980s. The projects included evaluating the existing DCS-based BMS, logic, field devices and gas supply. Recommendations to bring the BMS in line with current NFPA 85 requirements and industry best practices were provided.

Paris Generating Station | We Energies

Union Grove, Wisconsin | 2016

Lead engineer for a fuel oil heater controls upgrade of an existing system. Services included the electrical demolition of the existing fuel oil heater BMS control panels and design of the new BMS, adding an interface to a new DCS remote I/O cabinet and programming to interface the existing DCS to the new BMS.

Joliet Station Coal to Gas Conversion |NRG Energy

Joliet, IL | 2015-2017

Lead I&C engineer for the Coal to Gas conversion for NRG Joliet Units 6, 7, and 8. Mr. Leeper is responsible for overseeing the control system design for the conversion. Mr. Leeper wrote procurement specifications for igniter upgrades and reviewed submittals from the igniter, boiler and DCS vendors. Mr. Leeper also assisted the client with consolidating control rooms by relocating existing turbine benchboard components into the existing DCS, adding autosynchronizing and installing new HMIs to facilitate remote operation.

Sundt Station Unit 1 & 2 | Tucson Electric Power
Tucson, Arizona | 2016

Mr. Leeper provided consulting services for the TEP Sundt Station Unit 1 and 2 control logic rewrite project. Services included review of the Burner Management System, review of combustion control and unit master logic and supporting the Factory Acceptance Test.

Wilmington Cogeneration Project | Valero
Long Beach, CA | 2015-2017

Lead I&C engineer for the Valero Wilmington Cogeneration Project. The project includes phase 3 engineering and cost estimate (FEP-3) and EPC services for a gas-fired cogeneration project at the Wilmington Refinery. The project includes expanding the existing Honeywell network to accommodate the cogeneration control system and the addition of a Triconex Tri-GP PLC for compressor controls and unit safety interlocks. He is responsible for instrumentation and control system design and implementation, including SPI instrument datasheets, instrument installation, CEMS, loop drawings, cause & effect diagrams and control narratives.

New Madrid TWIPS Stage 1 Study |Associated Electric Cooperative Inc.
Marston, MO | 2015

Engineer of Record and Lead I&C engineer for the AECI New Madrid New Madrid TWIP Online testing Stage 1 study. Mr. Leeper evaluated the existing TWIP system and visited the site to gather information on the plant and interview plant personnel. Mr. Leeper provided a detailed report with options to incorporate online feedwater heater testing into the DCS per ASME TDP-1 and other applicable codes and standards.

Strathcona Cogeneration Project | ExxonMobil
Edmonton, Alberta, Canada | 2014-2015

Lead I&C engineer of the Strathcona Cogeneration Project. The project included implementation of the Front-End-Engineering Design (FEED) study and EPC services for a gas-fired cogeneration project at the Strathcona Refinery. The project included splitting and expanding the existing Honeywell network and the addition of a Triconex safety PLC. Mr. Leeper is responsible for control system, remote instrument enclosure, instrument and CEMS specifications. He was also responsible for development of the I/O list, cause & effect matrix, and control descriptions.

Queen Elizabeth Plant D Expansion | SaskPower
Saskatoon, Saskatchewan, Canada | 2013-2015

Lead I&C engineer for a 6x1 combined cycle facility. The project consists of the addition of three Hitachi H25 Gas Turbines, six once through steam generators from Innovative Steam Technologies, and one 100 MW induction condensing steam turbine from Fuji. Responsibilities included control system specifications, I/O lists, logic diagrams, and graphics design criteria for expansion of the existing DeltaV DCS to control new equipment and communicate with outlying systems. Mr. Leeper was also responsible for instrument procurement and installation design. Other tasks included DCS workstation and network equipment replacement, and renovation of the existing control room to accommodate a new control room console.

DAN LEEPER, PE
(continued)

Sundt Station Unit 3 | Tucson Electric Power
Tucson, Arizona | 2013

Mr. Leeper provided consulting services for the TEP Sundt Station Unit 3 controls replacement project. Services included review of the Burner Management System, attending design review meetings and supporting the Factory Acceptance Test.

Utility Production Upgrade Projects | Texas A&M
College Station, Texas | 2013

Mr. Leeper provided consulting services for the FY13/14 Utility Production Upgrade projects involving design and construction administration services. This project includes Emerson Ovation DCS design and integration for six total new/replacement chillers sized from 2,500 to 3,350 tons; a new 1,250 ton heat pump chiller; a 24,000 ton-hour thermal energy storage system, and 1000 BHP of heating hot water production capacity. Upgrades to cooling towers, pumping, electrical, and structural systems are also included.

Warrick Power Plant Burner Management System Study Project | ALCOA
Evansville, Indiana | 2012

Mr. Leeper provided consulting services for the ALCOA/Warrick Power plant Burner Management System study. He was responsible for evaluating the existing Burner Management System for conformance to current codes and best practices and making recommendations for modifications in conjunction with the BMS upgrade.

Samcheok Thermal Power Plants Units 1 & 2 | Korea Southern Power Co.
Samcheok, Republic of Korea | 2011-2012

Mr. Leeper provided on-shore consulting services for the Samcheok Green Power Project at KOSPO's offices in Seoul, South Korea. He was stationed at KOSPO's offices for one year. The project included two 1000MW supercritical units in a 2-on-1 configuration with each unit consisting of a 1000 MW steam turbine and two 500MWe CFB boilers using low-grade coal and biomass fuels. Services included review and recommendations for the boiler, turbine and balance of plant design.

Iatan Station | Kansas City Power & Light
Weston, Missouri | 2006-2011

I&C engineer on the Kansas City Power & Light (KCPL) Iatan project. Iatan Unit 2 is a new 850MW super critical pulverized coal plant with a Selective Catalyst Reduction (SCR), Baghouse and Wet Flue Gas Desulfurization (FGD) system. The unit had co-firing capability up to 30% on oil. As part of the project, KCPL also installed a new SCR, Baghouse and wet FGD on the existing 700MW Unit 1. KCPL also elected to upgrade the existing control systems on the Unit 1 turbine and boiler as part of this project.

Mr. Leeper was responsible for all boiler, burner management, turbine, and water treatment control systems. He was also responsible for management of the I/O list and development of all logics to be implemented in the DCS including Boiler Combustion Controls, Burner Management, Balance of Plant (BOP), SCR, Baghouse, Wet FGD, Lime Prep Equipment, Demineralizer, Raw Water, Polisher, Wastewater Treatment, Aux Electrical, and Sootblower. He was responsible for the specification, integration and validation of a high fidelity simulator for Unit 2 and provided on-site construction support, I/O checkout, Unit startup, tuning and commissioning. Mr. Leeper oversaw the implementation of several emerging technologies including Foundation Fieldbus, and Profibus. The project had 2100 foundation Fieldbus devices, 220 Fieldbus segments and 75 Profibus segments.

DAN LEEPER, PE
(continued)

Merom Generating Station | Hoosier Energy
Sullivan, Indiana | 2004-2006

Lead I&C engineer for the controls upgrade project for two 540MW units at Hoosier Energy's Merom Generating Station. The project consisted of replacing the following systems; burner management, turbine controls, combustion controls, motor controls, data acquisition, auxiliary boiler burner management and combustion controls, and scrubber controls. The project also involved upgrading and replacing obsolete field devices and adding field devices for enhanced control. He was responsible for developing the control system technical specifications, installation specification, IO list, logics and graphics. He was also responsible for validation of a high fidelity simulator for the unit. The project was executed in a phased approach.

Jack County Generation Facility Project | Brazos Electric Power Cooperative
Waco, Texas

Lead I&C engineer, providing Owner's Engineer services for the Jack County Generation Facility. The project is a nominal 620MW combined cycle plant, and consists of two GE 7FA gas turbines, EPTI triple pressure level HRSGs, and a GE D11 steam turbine.

Gerald Gentleman Station Unit 1 | Nebraska Public Power District
Sutherland, Nebraska

I&C engineer. For this project, Burns & McDonnell designed an automatic system and furnished the equipment for the burners, igniters and overfire air (OFA). Mr. Leeper was responsible for the design of the burner and overfire air controls.

Sugar Creek Combined Cycle Plant Project | Mirant
Terra Haute, Indiana

I&C engineer for the Mirant Sugar Creek Combined Cycle Plant Project. The plant included two GE 7FA's combustion turbines with power augmentation capability, Vogt HRSG's including duct burners, and a GE steam turbine. He was responsible for control system and instrumentation design and specification, as well as checkout and startup of the HRSG and balance of plant control system.

Fitzhugh Generating Station | Arkansas Electric Power Cooperative Corporation

Lead I&C engineer for repowering a 75 MW steam turbine with 100 MW Siemens 501D5A Econopac combustion turbine and Foster Wheeler heat recovery steam generator. He was responsible for the preparation of construction documentation and control logic design.

Bosque County Combined Cycle Plant Project | Mirant
Bosque Country, Texas

I&C engineer for the Mirant Bosque County combined cycle conversion project. The project was a 1 x 1 gas fired combined cycle power plant with a nominal output of 247 MW. The plant included a GE 7FA combustion turbine, an Alstom HRSG and an Alstom (formally ABB) VACS type axial exhaust steam turbine. He was responsible in the specification of instrumentation and development of construction documents. Mr. Leeper was responsible for checkout and startup of the HRSG and balance of plant control system.

DAN LEEPER, PE
(continued)

Hamakua Cogeneration Plant Project | Hamakua Power Partners, LLP
Hawaii

I&C engineer for a new 60MW cogeneration facility that consisted of two GE LM2500 gas turbines, and an MHI steam turbine. Mr. Leeper participated in the specification of instrumentation, development of construction documents, and the checkout of the control system.

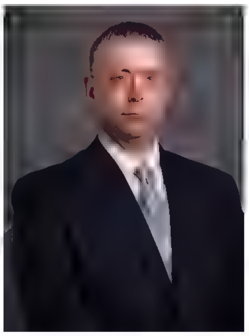
Other Experience
Mr. Leeper has worked on various studies and cost estimating projects. Projects include Burner Management System assessments, combined cycle control system assessments, and control system replacement cost estimating and justification.

Mr. Leeper performed field I/O checkout and commissioning services on two coal-fired controls upgrade projects. They were Utilicorp's Sibley Station (2x400 MW) and Duke Power Belews Creek (1x1200 MW).

Prior to joining Burns & McDonnell, Mr. Leeper designed hardware and firmware for custom electro-hydraulic control systems. He also supervised the manufacturing of custom electronic components for the control systems.

SHANE GARDEN, PE

Senior Associate Structural Engineer



As a Senior 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, CT, IA, MA, MN, MO, NY, ND, UT)
- Envision Sustainability Professional

22 YEARS WITH BURNS & MCDONNELL

22 YEARS OF EXPERIENCE

EPC Project Development & Plant Improvements

2019

Lead structural engineer assisting with developing EPC projects for 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. During plant improvement projects, duties include design of structural plant upgrades and assisting clients evaluate construction proposals.

NRG Canal 3 | NRG Canal 3 Development, LLC

Sandwich, Massachusetts | 2017 - 2019

Project lead structural engineer for an Engineer-Procure-Construct project consisting one GE 7HA.02 gas turbine generator operating in simple cycle (333 MW net) utilizing dual fuel facility for NRG Canal 3 Development, LLC. As Project Lead Structural Engineer, duties include the supervision of design engineers and CADD technicians for the design and detailing of all foundations and structural steel design various superstructures. Mr. Garden's duties also include 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 works directly with construction site to answer questions and look into construction challenges as they occur.

Valley Energy Center | CPV Valley, LLC

Orange County, New York | 2015-2018

Project lead structural engineer for an Engineer-Procure-Construct project consisting of two Siemens SGT6-5000F gas turbine generators in a 2x1 combined cycle (716 MW nominal), dual fuel configuration for CPV Valley, LLC. As Project Lead Structural Engineer, he was responsible for the layout of the 470'x 300'x 100' tall powerhouse/administration building and management of the design. Additional duties included the supervision of design engineers and CADD technicians for the design and detailing of all foundations, including the auxiliary boiler, 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.

SHANE GARDEN, PE

(continued)

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.

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 180'x370'x130' tall, multi-story steam 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.

Sheboygan Falls Energy Facility | Alliant Energy

Sheboygan Falls, Wisconsin | 2004-2005

Project lead structural engineer for an Engineer-Procure-Construct project consisting of two GE 7FA 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 550 MW two-on-one GE 7FA combined cycle project for Alliant Energy. Mr. Garden's duties included writing specifications, structural steel design, including the 124'x182'x 90'tall, multi-story steam turbine hall, 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 Merchant Service

Clarksdale, Mississippi | 2001

Project lead structural engineer for an Engineer-Procure-Construct 320 MW project consisting of four GE 7EA simple cycle combustion turbine units at Crossroads Energy Center and a 480 MW project six GE 7EA simple cycle combustion turbine units at Goose Creek Energy Center 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.

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.

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 assessment of two fiberglass absorber reaction tank covers at LG&E's Trimble County Unit. The purpose of the assessment 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 assessment 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.

ARLEN CHO ROOT, EIT

Mechanical Engineer

Mr. Root is a mechanical/process engineer with design and management experience in pollutant reduction technologies, combustion improvements, and gas conversion projects. He has been specifically involved in various NO_x, SO_x, and CO_2 reduction studies and projects. He has also written several multi-pollutant control studies to evaluate the costs and feasibility of compliance with potential future regulatory scenarios for units sized from 25 MW to 1200 MW.

EDUCATION

- BS, Chemical Engineering

REGISTRATIONS

- Engineer in Training (NE)

12 YEARS WITH BURNS & MCDONNELL

12 YEARS OF EXPERIENCE

Marshall Steam Station Duel Fuel Conversion Project | Duke Energy

Sherrills Ford, North Carolina | 2019 - Present

Engineering manager for a coal to dual fuel (coal/gas) conversion project for two 660-MW and two 380-MW tangentially fired units. Mr. Root is responsible for overseeing two (2) 5.8320 General Contractor cycles including developing bid packages, bid evaluation, specification conforming due to the initial GC being let go by the owner. Labor curves, and resource management had to be revised to maintain project's original deliverable deadlines and outage dates. He is the owner's primary technical contact regarding design, and construction support related matter. He is responsible for leading weekly meetings and is a primary contact for technical and equipment specification related communications.

Belews Creek Steam Station Natural Gas/Coal Co-fire Project | Duke Energy

Belews Creek, North Carolina | 2017 - Present

Engineering manager for a coal to dual fuel (coal/gas) conversion project for two opposed wall-fired 1170-MW units. He is responsible for development of burner equipment specifications, preliminary P&IDs, pipe routing, and the evaluation of existing plant conditions. Mr. Root provides technical direction for a team of 30+ members from development through field support, and is responsible for leading the owner's weekly project meetings and monthly on-site meetings

East Bend Station SFC and WR Project | Duke Energy

East Bend, Kentucky | 2015 - 2018

Lead mechanical engineer responsible for the under-boiler submerged flight conveyor and water redirections projects necessary to bring the plant in compliance with CCR and ELG regulations. He managed a group of multidisciplinary engineers to develop equipment procurement specifications, system P&IDs, piping plans, and associated quality control requirements. He was responsible for mechanical field support through construction of project.

Cayuga Steam Station SFC and WR Project | Duke Energy

Cayuga, Indiana | 2015 - 2017

Lead mechanical engineer responsible for the remote submerged flight conveyor and water redirections projects necessary to bring the plant in compliance with CCR and ELG regulations. He managed a group of multidisciplinary engineers to develop equipment procurement specifications, system P&IDs, piping plans, and associated quality control requirements. He was responsible for mechanical field support through construction of project.

ARLEN CHO ROOT, EIT

(continued)

Muskogee and Sooner Station CCR Study | Oklahoma Gas & Electric

Muskogee, Oklahoma | 2015 - 2016

Lead process engineer for coal combustion residuals (CCR) study for five 500-MW units across two stations. Development of material and water balances and technology evaluations for providing short-term and long-term alternatives to meet the EPA's CCR ruling.

A.B. Brown Station Gas Conversion Study | Vectren

Mount Vernon, Indiana | 2015

Lead mechanical engineer for a coal to gas conversion study for a 250-MW unit. Responsibilities include development of P&IDs and isometric drawings for the development of equipment and line lists utilized for cost estimates. Oversight of the boiler supplier's modification requirements and expected flue gas conditions.

1000MW Supercritical Samcheok Green Power Plant Project | Korea Southern Power Company

Seoul, Korea | 2013 - 2015

Lead mechanical engineer, contract manager for 2 x 1000-MW supercritical once-through circulating fluidized bed boiler units. Two-year overseas assignment, responsible for managing and administrating the boiler contract directly with the supplier on behalf of the owner. Coordinated with EPC contractor and owner on questions and clarifications during the project.

Wisdom Station Gas Conversion Project | Corn Belt Power Cooperative

Spencer, Iowa | 2013

Lead mechanical engineer for a coal to gas retrofit project for an existing coal boiler. He was responsible for evaluating the existing plant conditions and providing engineering and consulting support in the units' redesign to bring 100% gas/coal co-firing capability. Mr. Root also updated existing auxiliary systems to meet NFPA requirements.

Neal Station unit 3 Scrubber and Baghouse Project | MidAmerican Energy Company

Salix, Iowa | 2011-2013

Process engineer for the dry scrubber and baghouse system. His responsibilities included interdisciplinary project administration, drawing reviews, and weekly meetings with the scrubber vendor to coordinate submittal schedules. Mr. Root was also the acting mechanical and contract engineer for the fire protection contract for both the Neal 3 & 4 units. He provided site wide engineering and procurement of the fire protection equipment for the scrubber modules, baghouses, and transformers.

Chimney Corrosion Study | University of Missouri - Columbia

Columbia, Missouri | 2012 - 2013

Mr. Root was the ***lead investigator*** for a chimney retrofit study. The scope of the study includes performing a root cause analysis of corrosion occurring on the chimney surface and platforms. He was developing specifications, pricing options and solutions for mitigating future corrosion and extending the chimney life.

Wet Scrubber Operations Field Support | Confidential Client

2011 - 2012

Mr. Root assisted in the diagnosis of the poor operation of a single module wet scrubber for a 700 MW unit. Analysis of Plant Information data and particle size data allowed for a series of solutions to be implemented to increase scrubber efficiency and prevent scrubber blinding, originally resulting in unplanned outages.

ARLEN CHO ROOT, EIT

(continued)

NO_x Strategy Study for SMEC Unit 1 | San Miguel Electric Cooperative

Christine, Texas | 2011-2012

Mr. Root prepared a NO_x strategy report to evaluate potential NO_x reduction technologies for a lignite fueled high dust boiler. Selective non-catalytic reduction (SNCR), selective catalytic reduction (SCR), and hybrid technologies were evaluated for NO_x reduction efficiency, industry/vendor experience, and cost economics. This study led to the award of engineering project to BMCD.

Laramie River Station unit 3 NO_x Combustion Tuning | Basin Electric Power Cooperative

Wheatland, Wyoming | 2011

Lead combustion engineer for meeting the performance guarantees of the newly installed overfire air system for a 570 MW unit. Peak boiler output was maintained by achieving pipe to pipe and coal/air balance through the manual adjustment of burners for the reduction of NOx emissions.

Utility Fleet AQCS Retrofit Study | Luminant

2010

Mr. Root was the ***process engineer*** for an electric utility's fleet wide AQCS upgrade evaluation and study. The study included both 2400 MW and 2000 MW plant sites. The scope of the project included on-site evaluations and assisting in developing site specific scenarios for required AQCS upgrades to meet state and federal regulatory emissions. He developed models and flue gas calculations for sizing equipment to estimate capital, and operating and maintenance costs for NO_x, SO_x, and PM controls.

U.S. National Coal Fleet Unit and AQCS Study | Peabody Energy

St. Louis, Missouri | 2010

Mr. Root was the project engineer for a US coal fleet wide AQCS evaluation study for units ranging from 25 MW to 1300 MW. The scope of the project included collecting publicly available data and designing a comprehensive database at the aggregate unit level. Information in the database included plant identification geographic locations, unit attributes, fuel data, operating conditions, AQCS equipment, and high level equipment pricing. Equipment pricing was developed to determine the economic impact of future environmental regulations, evaluating the upgrade potential and considerations for unit retirement. Data and results from this study were utilized for the publication of "Predicting U.S. Coal Plant Retirements" in the May 2011 edition of *Power Magazine*.

Bio-Fouling Mitigation on Once-Through Cooling Loop, Samcheok Green Power Station Units 1 & 2 | KOSPO

Korea | 2010

Mr. Root was the ***process engineer*** in evaluating green bio-fouling remediation methods for a 2000 MW once through cooling system. Mechanical and chemical techniques in addition to coatings were evaluated to provide environmentally friendly and robust solutions to prevent buildup of macro and micro-organisms in the intake pipe, intake structure, condenser and discharge canal.

Sheldon Station | Nebraska Public Power District

Hallam, Nebraska | 2009

Mr. Root assisted in the investigation of biological growth in power plant wastewater discharge ponds. On site water sampling, pH testing, and visibility tests were conducted on discharge pond systems. Biological film samples were collected at effluent pump stations to determine water chemistry and biology.

ARLEN CHO ROOT, EIT

(continued)

Jeffrey Energy Center SCR PDR Units 1, 2, and 3 | Westar Energy

Marysville, Kansas | 2010

Mr. Root assisted in a comprehensive SCR project definition study to evaluate SCR retrofit technologies, vendors and economics for three (3) x 700 MW units. He prepared the gas flow calculations for sizing and pricing of the SCR, air heater, and retrofit ID fans.

Craig Unit 3 Low NO_x Retrofit Project | Tri-State Generation and Transmission Association

Craig, Colorado | 2008-2009

Mr. Root was a ***combustion engineer*** assisting in the installation and commissioning of low NO_x burner (LNB) and over fire air (OFA) system. The scope of the contract included flue gas analysis, technical review of contractor submittals, and assisting in combustion tuning.

Thomas Hill Units 1, 2, & 3 SCR Performance & Efficiency Testing | Associated Electric Cooperative Inc.

Thomas Hill, Missouri | 2009

Mr. Root was the ***test engineer*** overseeing and administrating SCR system and booster fan and unit performance testing. He coordinated performance testing to confirm that SCR reactors on Unit 1, 2 & 3 and the Unit 1 booster fan met guaranteed design & efficiency parameters. This work included managing the testing crew during the tests and reviewing the performance test report.

Craig Station Unit 3 FGD Upgrade | Tri-State Generation and Transmission Association

Craig, Colorado | 2008-2009

Mr. Root was a ***field engineer*** for the Craig Unit 3 dry FGD upgrade project. The project scope included upgrades to ball mills, limestone slurry preparation tanks, slurry mixing tanks, injections lances, balance of plant piping, and instruments and controls. He was responsible for conforming as built drawings, developing isometric drawings and P&ID drawings from walkdowns of the as-constructed system. In addition, Mr. Root was responsible for design, installation procedure, and submittal review of a contract for complete door replacement on a baghouse.

Gerald Gentleman Station Unit 1 Burner Optimization | Nebraska Public Power District

Sutherland, Nebraska | 2009

Mr. Root assisted in Unit 1 LNB and OFA system tuning for a 680 MW boiler. Scope of the project included installing testing grids, evaluating emissions from various mill configurations, and combustion tuning to reduce NO_x and CO. Total boiler efficiency calculations were evaluated with the newly installed low NO_x system and updated air preheaters.

Environmental Partners Crystal River Units 4 & 5 | Progress Energy Florida

Crystal River, Florida | 2008-2009

Mr. Root designed and developed a preliminary budget for the FGD blowdown dewatering system for two (2) x 750 MW units. The scope of the work included developing specifications and evaluating bids for clarifiers and belt filters, as well as design of a dewatering building.

ARLEN CHO ROOT, EIT

(continued)

Iatan Units 1 & 2 | Kansas City Power & Light

Iatan, Missouri | 2008

Mr. Root provided field support and quality control for the zero liquid discharge (ZLD) system installed at the 850 MW supercritical Iatan Unit 2. He was responsible for drawing reviews for the sites FGD, boiler blowdown/wastewater treatment system.

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)

21 YEARS WITH BURNS & MCDONNELL

21 YEARS OF EXPERIENCE

Ottumwa Generating Station - Waste Water Treatment and Pond Closure| Alliant Energy

Chillicothe, Iowa | 2018-Present

Project manager for detailed design to repurpose an existing Coal Combustion Residual (CCR) impoundment to a low volume wastewater treatment pond (LVWTP) and closure of an existing bottom ash pond. Mr. Owens was responsible for oversight to development scope to dewater an existing CCR impoundment, proper removal and disposal of existing CCR material in the pond. Once the CCR material is removed the pond will be repurposed into a low volume wastewater treatment pond by installing a composite liner consisting of a geosynthetic clay liner (GCL) and high density polyethylene (HDPE) lining system with cover system over HDPE to provide confining pressure of the GCL and protection of the HDPE. Project also included design to re-direct existing plant drains that current flow to the main bottom ash pond to the new LVWTP. Design also included closure of the main bottom ash pond which will be conducted after the LVWTP is operational and all flows are re-directed away from the main bottom ash pond. Work included development of design grading drawings and specifications to be produced into construction packages for Alliant to bid to contractors.

Ghent – CCR Rule Process Water System Project | Kentucky Utilities

Carroll County, Kentucky | 2017-Present

Lead civil engineer for design for grading, stormwater and 3,500-feet of underground pipeline design. Mr. Owens responsibilities included oversight of grading design for new tank farms and a new water treatment building constructed approximate 3,500-feet from the existing power station. The new water treatment building was constructed in an area utilized for coal storage. New grading and stormwater design were completed to route the new stormwater to the existing plant stormwater system. Other design activities included routing wastewater and fire protection piping underground from the existing plant facilities to the new water treatment building. This project was executed under and Engineer, Procure and Construct basis and Mr. Owens provided design oversight and specification preparation for construction documents to issue to Burns & McDonnell field personal and various subcontractors.

Duke Energy CCR/ELG Compliance | Duke Energy

Cayuga, Gibson and East Bend Generation Facilities | 2016-2019

Lead civil engineer for design to bring Duke Energy's Cayuga, Gibson and East Bend generation facilities into 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:

ROBERT OWENS, PE

(continued)

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. 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 shoreline 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.

ROBERT OWENS, PE

(continued)

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. Compliance review of Contractor

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.

ROBERT OWENS, PE

(continued)

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.

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.

ROBERT OWENS, PE

(continued)

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.

3.0 COMMERCIAL

COMMERCIAL

RESPONSIBILITIES OF MINNKOTA POWER

Minnkota Power will provide the following in connection with this project:

1. Provide access to plant site and facilities as required by Burns & McDonnell to perform work directed by Minnkota Power.
2. Provide copies of available information, documents, reports, and operating data pertinent to the assignment.

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 not-to-exceed price to perform the Owner's Engineers Scope of Services is $920,251. The cost is based on the following:

a. Development, Engineering, and Cost Estimating Services - $569,077
b. Owner's Engineer Services - $351,174

COMMERCIAL

Burns & McDonnell proposes to perform the Scope of Services described 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.

Burns & McDonnell will also perform the Scope of Services in accordance with the DOE vendor flow down provisions agreed to on February 27, 2020.

BURNS McDONNELL

CREATE AMAZING.

9400 Ward Parkway
Kansas City, MO 64114
burnsmcd.com

Revised Proposal
April 2020

Minnkota Power Cooperative, Inc.

Project Tundra

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Joseph Zator
Director, Sales
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April 12, 2020

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

Subject: **Support of Minnkota Power Cooperative's proposal submitted in response to: "Front-End Engineering Design Studies for Carbon Capture Systems on Coal and Natural Gas Power Plants", Funding Opportunity Announcement DE-FOA-0002058 – REV 3**

Dear Mr. Pfau:

On behalf of Fluor Enterprises, this letter expresses our support and commitment by providing a FEED phase engineering services estimate for Minnkota Power Cooperatives proposal to the U.S. Department of Energy submitted in response to the subject-line funding opportunity. Fluor is providing a Cost Reimbursement compliant proposal based on Minnkota's Request for Final Proposal with associated terms and conditions.

Fluor's estimate includes but is not limited to the following scope of work:

- Fluor will conduct a FEED study to prepare the necessary engineering deliverables to prepare a +/- 15% Cost estimate for the Minnkota Power Cooperative Carbon Capture facility to be located in Center, North Dakota.
- Fluor will also develop the basic FEED deliverables package to support the Engineering, Procurement, and Construction (EPC) phase of this project. This will include a level 1 and level 2 schedules for the overall facility.
- The FEED study will further define the process and equipment design, equipment and module layouts and constructability of the facility.

In addition, we offer the following information:

- **History:** Fluor is one of the world's largest publicly traded EPC companies in the world. For over a century clients have trusted Fluor as an industry leader to design and build projects safely, cost effectively and on schedule. Fluor Federal Services, Inc. has participated in Government funded projects for over twenty (20) years.
- **Proven Technology:** Fluor Econamine FG Plus is a proprietary carbon capture solution with more than thirty (30) licensed plants worldwide with applications for power plants, refineries, and chemical facilities.
- **Carbon Capture Experience:** Fluor is a global leader in carbon dioxide capture with over thirty (30) successful years of commercial operating experience in Co2 recovery from flue gas
- **Cost Efficient & Schedule Reliable:** Continual improvements in advanced solvents driving higher absorption capacity, lower energy consumption, and lower capital cost.
- **Innovative Project Execution:** Optimized designs utilizing Fluor's Advanced Modularization execution drives total cost and schedule savings. Fluor provides a one stop, integrated EPC solution for Carbon Capture plants, pipeline design and construction.

Again, we express our support of the proposed project and look forward to working with the Project Tundra team. If there are any questions related to this project, we can be reached at +1.281.263.4633.

Sincerely,

Joseph R. Zator
Director, Business Development & Strategy
Attachment(s)

Appendices

1.0 EXECUTION PLAN

Fluor is the Technology Provider and has performed the Pre-FEED phase of the project, Fluor believes that with this knowledge and our long history of executing projects that the following execution plan is the best solution for Project Tundra and Minnkota.

Fluor has a corporate wide standard set of systems and procedure used by all offices and allows it to transition team members from one office to another and from one project phase to the next. This not only provides consistency but also reduces interface issues that may arise on the project.

As part of this transition, FEED Engineering will be performed by Fluor’s Houston office. Fluor will maintain knowledge and continuity by receiving support from the Pre-FEED team and staffing key personnel from the Pre-FEED team with CO2 licensed technology experience. As you can see by the Organization Chart (Figure 1-1), Dr. Satish Reddy will continue to provide Process Technology guidance with Kash Afshar as the designated Process Lead. Both individuals were part of the Pre-FEED effort and will work on the FEED phase of the project. We have also added several other names to the org chart and will continue to do so as we approach a firm kickoff date. Team members are being selected based on their extensive experience in FEED and EPC execution on various types of projects with similar size and scope including modularization.

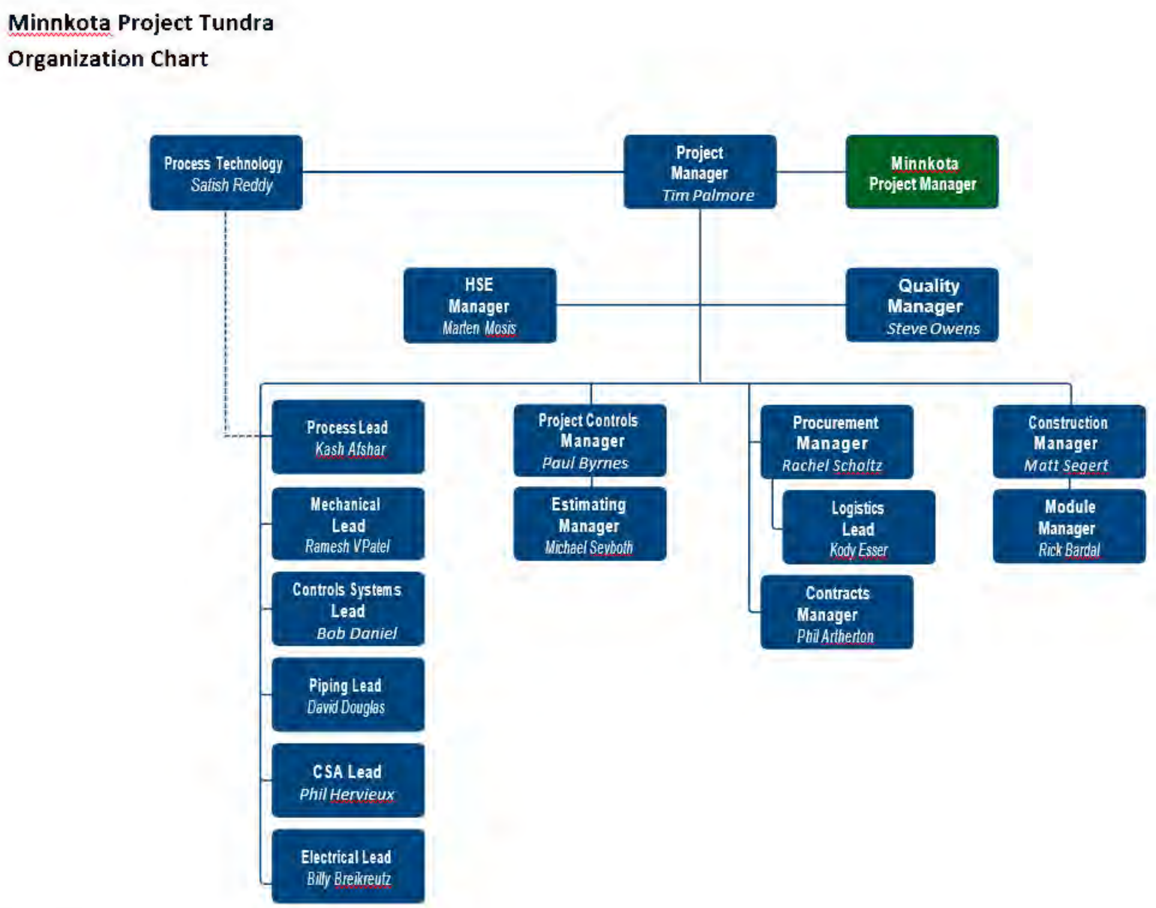

Figure 1-1. Minnkota Project Tundra Organization Chart.

The FEED schedule is based on a 9 ½ month duration to complete the FEED deliverables and produce the +/- 15% EPC estimate. We have developed this duration based on previously completed FEED projects and believe the duration represents an efficient and reasonable duration to complete this phase of the project.

One current concern with the schedule is the ongoing developments with the COVID-19 virus. Currently, Fluor is continuing work on other projects with most of our staff working remotely, so we remain confident that we can continue to execute projects such as this one. What remains to be seen is the potential impact from restricted travel (Fluor staff traveling to site and Minnkota traveling to Houston for kickoff meetings or reviews), ability of contractors to mobilize to site for Geotech Investigation, Topographical Survey, and or Route Study, and also any Minnkota restrictions or concerns at the plant or Minnkota office that we may be currently unaware of. Upon kickoff, we will need to discuss alternatives based on the situation at the time. The key will be to remain flexible, develop continuous communication, and exchange information efficiently, as we all work our way through this difficult and unpredictable situation.

Fluor welcomes and expects Minnkota's active involvement in the FEED phase; however, most of the work can be performed without Minnkota being present in the Houston Office, except for the following reviews:

- P&ID Review
- PHA
- Plot Plan Review
- Model Review
- Constructability Review

Fluor will establish a Baseline Schedule at the beginning of FEED, which will reflect these reviews and will work with Minnkota to make certain they are able to attend these review sessions. In addition to the schedule, Fluor will confirm the scope of work, budget, and project specific execution plan. These documents provide a basis for controlling the project and identifying any trends so that there are no surprises.

Fluor is not partnering with any other EPC contractors. However, to support the FEED, Fluor does plan to award certain scopes of work to specialty vendors and contractors:

- IES Inc. and Fox Equipment for Duct and Support Structure Design
- Heavy Haul and Heavy lift contractors for transportation and route study
- Geotechnical Investigation Contractor for soils investigation
- Surveying Contractor for topographic survey
- Facilitator for Level II PHA

From the inception of the FEED, Fluor will consider all cost cutting opportunities. Fluor believes strongly in providing our clients with a cost efficient solution that we have developed an in-depth value review process called Zero Based Execution (ZBE). ZBE seeks to maximize efficiency, eliminate waste, and increase productivity and affordability, which provides for a fit-for-purpose design. There are four main strategies of ZBE which include Reduced Quantities, Low-Cost Sourcing, Better Build, and Minimum Kit and Design Basis.

Since first quarter 2018, the U.S. government started adopting a series of tariffs that impact the importation of certain goods from certain origins into the United States. Tariffs included in U.S. Section 232 (Steel and Aluminum Tariff) and U.S. Section 301 (Chinese Goods) impact goods and equipment that is typically used in capital projects from several industries. During FEED, Fluor will utilize individuals from our Strategic Sourcing and Trade Compliance groups to develop a strategy, which will minimize the impact of applicable tariffs while meeting the Minnkota's capital efficiency goals.

Fluor has based its execution strategy on the assumption that the DOE will require Fluor and Minnkota to perform all engineering work within the U.S.; therefore, we will not be utilizing any of our wholly owned subsidiaries located overseas to perform any portion of the work.

In summary, Fluor will self-perform the FEED per our practices and procedures, which will prepare the project for successful execution of the EPC phase by utilizing Fluor's Integrated Solutions approach. For additional information, please refer to Section 2.0 Scope of Work.

2.0 SCOPE OF WORK

Please find the attached Fluor Scope of Work for this proposal's Scope of Facilities and Scope of Services in Attachment 2-1.

Minnkota Power Cooperative

Project Tundra

SCOPE OF WORK

PREFACE

Purpose of the SOW

The purpose of the Scope of Work (SOW) is to provide the following information about the project:

- **Scope of Facilities** – describes the design basis and the physical facilities to be provided to Minnkota Power Cooperative (MPC) for Project Tundra

- **Scope of Services** – describes the design approach, references, and standards to be used, and a list of deliverables.

The SOW, which is one of the seven Baseline elements, is the foundation of the project Baseline. (The other Baseline elements are the prime contract, project execution plan, management level schedule, project estimate, risk assessment, and the commercial basis.) The SOW documents provide enough detail to support the proposal estimate, form the basis of the contract, and serve as the touchstone for measuring project deviations.

Control and Revision of the SOW

The Project Manager is responsible for approval of the SOW and communicating its requirements to the project team. MPC also reviews and approves the SOW.

Electronic and hardcopy issue and distribution will be controlled by the Lead Project Administrative Assistant. A controlled electronic "read only" version will be provided on the network for access by project personnel. Electronic copies or hardcopy printouts made from this controlled version are considered to be "uncontrolled." Hardcopies issued by Project Administration will be logged. Subsequent revisions to the hardcopy manuals will be issued to the same distribution as the original.

The Project Manager will issue revisions to the SOW as necessary. Individual sections can be revised and re-issued independently, along with the SOW table of contents, which will indicate the current revision of each section. If revision marking is used, the location of the changes will be marked with a bar in the right or outer margin. Revision bars will be removed on subsequent revisions. Individuals receiving a revision should either destroy the previous version or prominently mark it "superseded."

This SOW is the property of Fluor and will not be reproduced, loaned, or given away without the specific permission of the Project Manager.

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TABLE OF CONTENTS

RECORD OF REVISION

E	11-Apr-2020	Updated with Scope Deletions	TEP
D	25-Mar-2020	Updated with Scope Changes	TEP
C	08-May-2019	Issued for Clarification (Base Scope + Incremental)	
B	30-Apr-2019	Issued for Proposal	
A	18-Apr-2019	Issued for Review and Comment	
Revision	**Date**	**Revision Description**	**Approved By**

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1.0 EXECUTIVE SUMMARY

The Fluor Scope of Work is divided into 2 parts: (1) a Scope of Facilities and (2) a Scope of Services.

The Fluor Scope of Facilities is the physical and functional description of the final constructed and delivered client facility.

The Fluor Scope of Services includes:

- Fluor's Execution Approach – How and with what tools, resources, standards, criteria, and techniques Fluor will use to execute engineering / design, procurement, and construction for the project.
- Roles and responsibilities of Fluor and all other major parties (client, partners, suppliers, subcontractors, etc.) on the project.
- Fluor's Activities and Deliverables – The drawings, specifications, and activities necessary for Fluor to execute the project.
- An overview of the activities and deliverables to be provided by all other major parties on the project.

2.0 PROJECT DESCRIPTION

Minnkota Power Cooperative (MPC) is the Fluor Client on Project Tundra. MPC is a not-for-profit electric generation and transmission cooperative headquartered in Grand Forks, North Dakota.

MPC is pursuing a Carbon Capture and Sequestration project (CCS) at MPC's 705 megawatt Milton R. Young Generating Station (MRY) located near Center, North Dakota (Project Tundra). Project Tundra will use a carbon capture technology to capture at least 90 percent of the CO_2 from Milton R. Young unit 2 (MRY2), a 455 MW coal fired electric generating unit. MRY2 is owned by Square Butte Electric Cooperative and operated by Minnkota Power Cooperative.

MRY2 has been selected as the existing coal-fired generating unit that would provide CO_2 containing flue gas to Project Tundra. MRY2 is a lignite fired cyclone unit operated on coal from the nearby Center Mine, owned and operated by BNI Coal. Flue gas for the CCS project will be extracted from the existing MRY2 ductwork upstream of the stack and downstream of the electrostatic precipitator (EP) and wet flue gas desulfurization (FGD) system.

In addition, a flue gas duct will be installed from MRY1 to the new MRY2 duct, in order to provide an alternate supply of flue gas, should MRY1 be out of service.

The project will also include natural gas fired boilers to provide steam to the CCS. Flue gas from the natural gas boilers will also be ducted to the CCS unit.

Scope Reduction:

After receipt of Fluor proposal, dated March 28, 2020, several meetings were held between Minnkota & Fluor to discuss the proposed budget and to explore opportunities to reduce the budget. The items below summarize the deletions and / or changes that have now been incorporated in the scope of work and budget.

1) Deleted Catox Unit (MX-601 A/B and R-601 A/B). This is deleted from the project scope completely, but space and connections for future installation will be provided by Fluor.

2) E-601 A/B & D-601 A/B remain in Fluor scope and will be incorporated into the compressor package for pricing for estimate.

3) Removed Fire Water Tank and Pumps from Fluor scope. This scope will be moved to Owners Engineer scope. Firewater loops, hydrants, and monitors remain in Fluor scope. Interface will be at CCS battery limits.

4) Removed Make Up Water intake structure, pumps, pump house, filtration equipment, and pipeline to CCS plant from Fluor Scope. This scope will be moved to Owners Engineer Interface will be at CCS battery limits.

5) Removed RO Water system from Fluor's scope. This scope will be moved to Owner's Engineer scope. This equipment is still expected to be located within the Process Building. Owners Engineer to provide space requirements. Interface will be within the Process Building.

6) Demin Water scope will be part of Owner's Engineers scope. Demin equipment is expected to be located within the Process Building. Owner's engineer to provide space requirements. Interface will be within the Process Building.

7) Removed Potable Water pipeline from Fluor scope. This scope will be moved to Owner's Engineer scope. Interface will be at the CCS battery limits.

8) Deleted requirement for preparation of Request for Proposal (RFP) for Field Fab Tanks. Field Fab Tanks will be priced with house cost data, for the FEED estimate.

9) Deleted Request for Quote (RFQ) for Catox Unit and RO Water Unit.

3.0 SCOPE OF FACILITIES

3.1 GENERAL

The facility will include the ISBL and Balance of Plant (BOP) to be designed to capture approximately 13640 tons/d of CO_2 from the flue gas generated by the Unit 2, a 455 MW coal fired power unit. Flue gas from Unit 1 will also be included to provide flue gas in the event that Unit 2 is off line. Boilers will provide steam required for operation of the plant and flue gas from the boilers will be ducted for CO_2 recovery.

3.1.1 Scope of Facilities

Inside Battery Limit (ISBL):

- Flue Gas Conditioning System: Provides flue gas cooling and trim SO2 removal. The system includes a column, heat exchangers, pumps and filters required for flue gas cooling and desulfurization
- Flue Gas Blower: A centrifugal or axial blower to overcome pressure drop of the flue gas through the CC plant
- Wet Electrostatic Precipitator (WESP): Packaged unit to remove alkali and alkaline earth based aerosols from flue gas before it is fed to the Absorber
- CO2 Absorption system: Column, heat exchangers, pumps, and filters
- Solvent Regeneration system: Column, vessels, compressor, exchangers, pumps,
- Solvent Maintenance Package (SMP): This package maintains the quality of the solvent and is supplied as a Fluor proprietary equipment package
- Solvent collection system that includes a solvent sump, pump and SMP sump
- CO2 Compression: Compressors, inter/aftercoolers, knockout drums and CO2 dehydration unit
- Storage Tanks: Tanks and pumps for solvent/chemical storage and dosing

Balance of Plant (BOP):

- Flue Gas Ducting: Ducting and support structure to convey flue gas from power plant and natural gas boilers, to the flue gas conditioning and CO2 absorption systems. The ducting system includes the tie-in to the power plant in Unit 2, as well as tie-in from Unit 1 to Unit 2 duct, to be utilized, when Unit 2 is offline. It also includes ducting and supports to tie-in the flue gas from the natural gas boilers.

- Cooling Water System: Cooling tower, cooling water chemical dosing system, circulation pumps and cooling water piping.

- Water Management System: DCC excess water and cooling tower blowdown handling and reuse with a Reverse Osmosis Unit. RO Unit moved to Owners Engineer scope

- Natural gas fired Steam Boilers with associated deaerator and boiler feed water pumps. Natural Gas pipeline will be provided by others. Interface will be at CCS battery limits.

- Electrical Distribution System: Independent Electrical distribution alternately switched from 230kV Overhead incoming lines by others will power new facility. A single radial 230kV feeder that is provided will bring power to a single three winding 230/13.8/13.8kV transformer powering two 13.8kV switchgear busses. From the 13.8kV busses, the rest of the new facility electrical distribution will be provided as required.

- Makeup Water: Water supply system consisting of suction caisson & inlet screens (Lake Nelson intake), pump house (heated) with 2x100% pumps and sand filtration package, and approximately 1.5 mile pipeline. Lake Nelson is the assumed water source. This scope has been moved to Owners Engineer. Interface will be at CCS battery limits

- Potable Water: Potable Water supply will come from a tie-in to Missouri West, which is expected to be within one mile from the CCS plant. This scope has been moved to Owner's Engineer. Interface will be at CCS battery limits

- Instrument Air: Supplementary plant air supply equipment consisting of 2x100% packaged air compressors, a single dryer/receiver package with associated distribution piping. This system will service the air distribution network for the project scope.

- Fire Detection & Suppression: A water based Unit fire-fighting system consisting of 2x100% fire pumps, storage tank, fire ring main system, and distribution system including monitors. Unit wide fire detection scheme (detector layout) and detector panels. Fluor scope includes ring main, hydrants, and monitors. Firewater tank and pumps scope has been moved to Owners Engineer. Interface will be at CCS battery limits.

General Facilities (Buildings):

(Note: although the occupancy/floor area and number of buildings will be determined early in FEED, the following buildings are included as a basis of the FEED man-hour estimate)

- Multi-Purpose Building (includes Administration, Warehouse, Maintenance Shop, Control Room & Lab)
- Process Enclosure (includes Water Treatment)
- Boiler Enclosure

- Pump House Enclosure
- Compressor Enclosure

3.1.2 Assumptions and Clarifications

- Design assumes available lake water from Lake Nelson and Client possession of permits required for taking lake water at required volume
- Demineralized Water Scope is by Owner's Engineer. Demineralizer plant is expected to be located within the Process Building.

The following items are excluded from the scope of facilities:

- New equipment or modifications to existing power plant equipment needed for bulk NOx or SOx removal from the flue gas prior to its entry into the Flue Gas Conditioning system.
- Deep well injection of RO reject water
- 230kV Overhead Power Line

The following Studies will be carried out by MPC:

- RO Waste Water Disposal/Injection System (by others)
- Absorber Outlet Icing Study (by owner)
- Air Dispersion Modeling (by owner)

4.0 SCOPE OF SERVICES

4.1 GENERAL

The purpose of the Scope of Services should present: (1) Fluor's project execution approach, activities and deliverables, (2) the activities and deliverables to be provided by the client, suppliers, subcontractors, etc., and (3) activities and deliverables normally provided that will not be provided by anyone.

4.1.1 Project Approach

Fluor will conduct a FEED study to prepare and document the necessary engineering deliverables for Fluor to prepare a +/- 15% estimate

Another objective of the FEED Study is to deliver a package that is basis of the EPC phase of the project. The package will include a Level 2 schedule for the overall facility.

Fluor's proprietary Econamine FG+^{SM} (EFG+) technology will serve as a basis for the FEED Study that will define process and equipment design, plant layouts, and constructability of the facility.

4.1.2 References and Standards

The project references and standards will be provided in the Discipline sections of the Scope of Services and will be in accordance to Fluor Standard Practices and Industry Standard Practices. Fluor specifications are in accordance with applicable industry standards such as ANSI, API, ASME, ASTM, and are also in compliance with all applicable state and local code requirements

4.1.3 Special Resources

There are no special resources required for this scope.

4.1.4 Client Interface

The Fluor Project Manager will interface with the Minnkota Project Manager and will be the primary channel for communication between Fluor and MPC.

During the project kickoff meeting, a division of responsibilities document will be developed, reviewed, and agreed on.

4.1.5 Assumptions and Clarifications

The following engineering assumptions and clarifications are associated with the FEED phase Scope of Services' design approach, activities and deliverables:

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- Manufacturers' standard pre-engineered equipment package designs will be used providing they are in alignment with functional requirements.

- The FEED Study deliverables and specifications will be sufficient detail for Fluor to produce the +/- 15% capital cost estimate.

- FEED budget and resulting capital cost estimate is based on a stick built, non-modular construction approach. This may change based on the results of an area labor availability study, route study, and modular analysis.

- Fluor's proposal is based on use of Intergraph Smart® 3D, Fluor's standard 3D design environment.

- In accordance with North Dakota code 43-19.1-21 and 8-06-01, engineering and architectural documents produced during FEED are considered preliminary and not for construction, and thus do not require PE stamping with a seal.

- Changes in Federal or State environmental regulations/requirements not in the public domain at the date of signing of this proposal are excluded from the scope of FEED services. However, any mandatory requirements that are subsequently enacted will be included as additional scope items if desired by Minnkota.

- Estimated trips to job site for Project Manager: two trips with one person, average for 3 days / trip. Discipline specified trips will be designated in specific scope of services.

- Pertinent documents provided by Fluor during the FEED may be used by MPC for permitting purposes.

- Fluor understands that the Owner's Engineer will provide engineering for assessment or modification of existing facilities based on Fluor provided and mutually agreed battery limit interface requirements. Tie-ins in the existing plant will be by Owners Engineer.

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4.2 PROCESS SCOPE OF SERVICES

4.2.1 Design Approach

The following outlines the activities for the Minnkota Project Tundra FEED.

Key activities during this FEED Phase include:

- Project Initiation Activities
- Process Design Criteria
- Meetings & Conference Notes
- Process Simulations
- Hydraulic Calculations
- P&ID development
- Process equipment datasheets
- Quality Activities
- Squad Checks / Discipline Support
- Cost Estimate Support
- Lead Engineer Supervision
- Director Supervision

4.2.2 References and Standards

Process Industry Practices and Fluor standard specifications will be used.

A detailed review of Minnkota's Design Manual will be conducted early in FEED and any differences impacting the design will be discussed and resolved.

4.2.3 Deliverables to Client

The following are considered to be the Process Engineering documents and deliverables that will be provided to the client during or at the end of the project:

- Process Design Basis
- Detailed Heat and Material Balances
- Block Flow Diagram (BFD)
- Process Flow Diagrams (PFDs)

- Material Selection Diagrams (MSDs)
- Process Equipment List (final issue by Mechanical)
- Process Description
- Piping and Instrument Diagrams (P&IDs): Issued for Design (IFD)
- Utility Flow Diagrams
- Utility Summary
- Emissions and Effluents Summaries
- Chemicals Summary
- Relief Load Summary
- Line and Flow Summary (final issue by Piping)
- Process Equipment Data Sheets for Mechanical (final issue by Mechanical)
- Process Instrumentation Data Sheets

4.2.4 Client Interface

The Fluor Process Engineering discipline will interface with the client representatives in the review and approval of project documents as required.

4.2.5 Assumptions and Clarifications

- Estimated trips to job site: 4 trips with 1 engineer, average for 3 days / trip
- The fire suppression system is assumed to be independent of the existing facility system. No hydraulic modelling is assumed of the existing system.
- Laboratory Equipment will be identified
- The storm water system is assumed to be independent of the existing facility system. No hydraulic modelling is assumed of the existing system. Fluor will provide information to MPC / BMCD for modeling of existing systems and impact of CCS on existing system

4.3 MECHANICAL EQUIPMENT SCOPE OF SERVICES

4.3.1 Design Approach

The following outlines the design approach and activities comprising the engineering design services, procurement services, and engineering support services provided by the Fluor Mechanical Engineering Group for the Carbon Capture Facility retrofit at the Milton R Young power plant.

- Technical documents (specifications and datasheets) will be developed to define the mechanical equipment associated with the project.

- Preparation of technical portions of requests for proposal (RFPs) and requests for quotations (RFQs) for major mechanical equipment. Major mechanical equipment will be grouped such that similar type equipment (i.e. vessels) may be released under a single RFQ or RFP. Fluor currently anticipates 8 RFQs (which would eventually lead to a purchase order during detailed design) and 4 RFPs (which would eventually lead to a purchase order during detailed design). Complete lists of RFQ's and RFP's is included in 4.12 Procurement and 4.13 Contracts

- Technical bid evaluation and bid tabs for formal RFQs and RFPs noted above. Technical evaluation will include initial review of bids for scope compliance and completeness.

- Support for the solicitation of budgetary pricing from suppliers of equipment not listed above. Some low value equipment may also be priced from in-house available information.

- The bids obtained will be from Fluor pre-qualified vendors. Before pricing is requested from vendors, Fluor will provide the list of recommended vendors for MPC review & approval. Fluor will also recommend single souring or sole sourcing where appropriate. Sole sourcing to be discussed and agreed with MPC before proceeding.

- Updated equipment list with preliminary sizes and weights for project cost estimate purposes.

- Preliminary design (modelling) of pressure vessel and shell & tube heat exchangers will be performed to support the project cost estimating efforts.

- Metallurgical support and input to the development of the Material Selection Diagrams.

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4.3.2 References and Standards

The mechanical equipment design will be based on the applicable Fluor standard specifications. In addition to these specifications, the project design documents will reference the applicable sections of the current industry codes and standards listed in the general section of this Scope of Services.

A detailed review of Minnkota's Design Manual will be conducted early in FEED and any differences impacting the design will be discussed and resolved.

Examples of these standards include but are not limited to the following:

- Vessels
  ASME Boiler and Pressure Vessel Code, Section VIII, Div. 1 & 2
  PIP VEFV1100 - Vessel Standard Details

- Tanks
  API-650 -Welded Steel Tanks for Oil Storage

- Exchangers
  API-660 - Shell and Tube Heat Exchangers
  API-662 - Plate Heat Exchangers for General Refinery Services
  TEMA - Standards of the Tubular Exchanger Manufacturers Association
  CTI - Cooling Tower Institute

- Boilers
  ASME Boiler and Pressure Vessel Code, Section I

- Pumps
  ANSI B73.1 - Horizontal End Suction Centrifugal Pumps for Chemical Process
  API-610 - Centrifugal Pumps for Petroleum, Heavy Duty Chemical and Gas Industry Services

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- Compressors
  API-617 - Centrifugal Compressors for General Refinery Service

- Fans
  Air Movement and Control Association, Inc. (AMCA)
  American Society for Testing and Materials (ASTM)
  American National Standards Institute (ANSI)
  Anti-Friction Bearing Manufacturers Association (AFBMA)

- <u>Air Compressors</u>
  American Gear Manufacturers Association (AGMA)
  American National Standards Institute (ANSI)
  American Petroleum Institute (API)
  American Society for Testing and Materials (ASTM)
  American Society of Mechanical Engineers (ASME)
  Anti-Friction Bearing Manufacturers' Association (AFBMA)
  Heat Exchange Institute (HEI)
  National Electrical Manufacturers Association (NEMA)
  Steel Structures Painting Council (SSPC)

- <u>Materials Handling and Conveying Systems</u>
  Conveyor Equipment Manufacturers Association (CEMA)
  American National Standards Institute (ANSI)
  Federal Specifications (FS)
  American Welding Society (AWS)
  Hoist Manufacturers Institute (HMI)
  American Society for Testing and Materials (ASTM)
  Crane Manufacturers Association of America (CMAA)

  Component equipment inside equipment packages such as boiler water treatment and wastewater treatment package will comply, as applicable, with the respective standards noted above

4.3.3 Special Resources

Special mechanical engineering resources, simulation, software or consultants are not anticipated to be necessary on this project. However, technical specialists for rotating equipment, tanks/vessels, and packaged equipment will be staffed on the project. Metallurgy (materials and welding), heat transfer, cathodic protection, and paint/insulation specialists will be supporting this project on an as-needed basis.

4.3.4 Installation Techniques / Philosophy

Where applicable, the following equipment engineering installation techniques / design philosophies will be utilized to implement this phase of the project:

- Equipment will be preassembled, to the extent possible, at supplier’s shop inclusive of final painting, insulation etc. (unless otherwise specified). Size constraints will be considered to facilitate transportation, lifting and installation.

- Modularization of equipment where possible to reduce field construction time.

- Vessels and tanks too large for shop fabrication and transport will be based on field fabrication and erection by sub-contractors.

- Cooling tower will be based on sub-contractor design, supply and installation.

- Number of Boilers to be evaluated based on capacity and shop fab vs field assembly.

4.3.5 Deliverables to Client

The following are considered to be the Mechanical Equipment Engineering documents and deliverables that will be provided to the client and construction during or at the end of the project:

Deliverables to Client:

- Equipment specifications
- Equipment procurement packages (est. pricing)
- Formal Equipment sub-contract packages (est. pricing)
- Formal Bid Tabulations
- Discipline Studies or Design Basis documents
- Special reports
- Equipment list
- Equipment data sheets
- Vessel standard detail drawings
- Existing equipment evaluations
- Bid analyses and purchase recommendations
- Supplier data (e.g. drawings, manuals)
- Supplier data reviews
- Inspection reports

4.3.6 Client Interface

The Fluor Mechanical Engineering discipline will interface with the client representatives in the review and approval of project documents.

The following are the types of documents planned to be submitted for review with the client for this phase of the project:

- Project specifications

The expected level of client involvement in the equipment design will be as follows:

- One review/approval cycle of the documents listed above will be provided to the Client representative prior to issue for design.

4.3.7 Inter-discipline Coordination

The Mechanical equipment engineering discipline will interface with the following Fluor engineering disciplines to provide and receive information, review, and coordinate the following listed interface points and documents:

Process

- PFDs / P&IDs
- Material Selection Diagrams
- Equipment Datasheets
- Equipment list

Civil / Structural

- Equipment weights and sizes
- Equipment support requirements

Electrical

- Equipment list
- Equipment electrical requirements

Procurement

- Procurement packages
- Sub-contract packages

Piping

- Equipment List
- Equipment sizes, O/L drawings

Control Systems

- Instrumentation requirements

4.3.8 Assumptions and Clarifications

The following Mechanical equipment engineering assumptions and clarifications are associated with the FEED phase Scope of Services' design approach, activities and deliverables:

- Trips to the job site, supplier shops or similar facilities are not required
- Inspection, evaluation, and integrity assessment of existing equipment is outside the scope of this project. Evaluation, modification and re-rating of existing equipment will be by others
- Equipment sizing and pricing will be solicited from qualified vendors. Inquiries to the vendors will be a blend of informal and formal requests. The selected blend and subsequent evaluation of proposals will be based Fluor’s identification of major

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equipment, supporting the FEED phase estimating and planning purposes of the project. These bids are not intended for purchase commitments.

- Fluor will provide process and equipment information to support a Reliability, Availability and Maintainability (RAM) conducted by a third party

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4.4 PIPING SCOPE OF SERVICES

4.4.1 Design Approach

The design approach for the Minnkota Project Tundra FEED is based on the typical Piping Engineering deliverables required to establish a cost estimate. The key Piping activities during this phase include:

- Develop Plot/ Equipment arrangement by utilizing preliminary equipment sizing, Process Flow Diagrams/ P&IDs for generating a S3D (Smart 3D) Model. 2D Plot Plan will be issued IFD at end of FEED.
- Modular study will be completed to determine the feasibility of implementing modular construction.
- 3” and larger piping will be modeled to support the preliminary bulk material take-off to Estimating and Fluor’s Quantification tool will be used to factor all 2 ½” and smaller piping bulk materials. P&IDs will be used to perform a piping valve material take-off.
- Piping bulks, valves and specialty items will be priced based on in house pricing or vendor quotes.
- Piping Material Engineer will support the Material Selection Process and MSD Review, and develop a Piping Line Class Index and required Line Class specifications to support S3D modelling.
- Piping will develop a Piping Line List based on Basis of Estimate P&IDs
- Preliminary pipe stress analysis will be performed on critical process piping and Engineered Supports will be quantified.

4.4.2 References and Standards

Fluor Piping Specifications and Standard will be used unless otherwise directed. These specifications are in accordance with ANSI B31.1 and B31.3 where appropriate.

A detailed review of Minnkota’s Design Manual will be conducted early in FEED and any differences impacting the design will be discussed and resolved.

4.4.3 Installation Techniques / Philosophy

Construction approach at this time is considered to be stick-built until the results of the Modular Study is completed.

4.4.4 Deliverables to Client

- Piping Design Criteria
- Inside Battery Limits 2D Plot Plans
- Updated existing Overall Site Plan with new facility
- Piping Line List
- Piping Tie-in List with defined locations
- 3D Model Rendering on a site aerial photograph
- Piping Line Class Index
- Specialty Items List
- Eye Wash/ Safety Shower and Utility Station Location Plan

4.4.5 Client Interface

- Plot Plan will be issued to the Client "IFR" (Issued for Review)
- 2 Joint Model Reviews
- Support Constructability Review
- Identify and location of Tie-Ins/ existing facility interface.

4.4.6 Interdisciplinary Coordination

Piping to participate and support P&ID and MSD Reviews.

Following interface points:

Process

- P&IDs
- Line List

Civil

- Site Plans
- Plot Plans
- Area Drainage

4.4.7 Assumptions and Clarifications

This list includes, but is not be limited to, the following:

- Assumed existing 2D Overall Site Plot Plan will be modified for the project
- Reliability of client documentation being used
- Assumed Plot Plan Reviews and Joint Model/ Constructability Review
- Assumed 1 Site visit to identify interface and tie-ins to existing facility
- Line Class specifications to be developed.
- NavisWorks review files of the 3D model can be made available at routine intervals for informal Client viewing. A rendered model overlay will be provided at completion of FEED.
- These assumptions are made as Basis of Estimate on equipment counts:
  - Added 3 boiler skids for steam generation
  - Added 1 deaerator skid
  - Added 2 boiler feed water pumps
  - Added new duct layout from Unit 1 chimney to main inlet duct
  - Added new duct layout from boiler stack to main inlet duct
  - Added 1 storm water sump
  - Added 2 storm water pumps

4.5 ELECTRICAL SCOPE OF SERVICES

4.5.1 Design Approach

Electrical deliverables and scope are based on document “Minnkota - Project Tundra - Fluor Proposal for Pre-FEED and FEED Services - October 2018”.

4.5.2 References and Standards

Fluor typical Electrical specifications and standards will be utilized.

A detailed review of Minnkota’s Design Manual will be conducted early in FEED and any differences impacting the design will be discussed and resolved.

4.5.3 Deliverables to Client

The following Electrical Engineering documents and deliverables will be provided to the client:

- Electrical Design Criteria
- Single Line Diagrams
- Major Electrical Equipment and Load List
- Electrical Equipment Specifications
- Hazardous Area Classification Drawing
- Preliminary Cable Schedule
- Electrical sketches as required to support the cost estimate

4.5.4 Assumptions and Clarifications

- Trips to the job site, supplier shops or similar facilities are not required.
- Interface with the local electric utility is the responsibility of the client and supported by Fluor as required.
- The ETAP model and calculations developed during pre-FEED will be updated during FEED

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4.6 CONTROL SYSTEMS SCOPE OF SERVICES

4.6.1 Design Approach

The Fluor Control Systems Group will be responsible for the FEED Stage design, engineering, and documentation of the Control System to provide process control for the new carbon capture and sequestration (CCS) and their accessory equipment. The Fluor Control Systems Lead Engineer will be responsible for the technical management of the Control Systems effort and will serve as the Engineer of Record for Control Systems Engineered Documents.

Minnkota Power Cooperative (MPC) will designate a single individual who will act as Project Manager and will have the authority to provide approval and direction to Fluor. Changes of scope or design basis decisions will require the explicit written approval of the MPC Project Manager before being incorporated into the design. All changes in scope or engineering design basis will be documented using Fluor's normal change control methods as defined in the Project Procedure Manual.

Fluor will be the principal Control Systems Design Authority with no subcontractors or consultants.

There will be no SmartPlant Instrumentation (SPI), DCS/SIS/PLC configuration, DCS/SIS/PLC programming, simulations, advanced controls or modelling during the FEED Stage of this project.

The following documentation will be delivered to MPC in the specified electronic format:

- Instrument Index – Microsoft Excel.
- Project Design Basis and Design Criteria – Microsoft Word.
- Control Room/Rack Room Layout (if required), System Architectural Diagrams – PDF mark-up.

4.6.2 References and Standards

MPC standards or other industry standard references will be used during the FEED Stage design.

A detailed review of Minnkota's Design Manual will be conducted early in FEED and any differences impacting the design will be discussed and resolved.

The current version or revision in effect at the time of issue of this scope document of the standards and codes published by the following professional organizations or government agencies shall form the reference set for the engineering and design of this project:

- ANSI- American National Standards Institute
- API - American Petroleum institute
- ASME - American Society of Mechanical Engineers
- ISA -The Instrumentation, Systems, and Automation Society
- IEC - International Electrotechnical Commission
- NEMA - National Electrical Manufacturers Association
- UL - Underwriters Laboratories
- FM - Factory Mutual
- IEEE - Institute of Electrical and Electronic Engineers
- NACE - National Association of Corrosion Engineers
- NFPA - National Fire Protection Association

4.6.3 Installation Techniques / Philosophy

The control philosophy of the project will be documented in the Project Design Basis and Design Criteria to be “IFD (Issued for Design)”.

As a minimum, the following philosophy will be considered:

- Use of 'Smart' transmitters to reduce calibration time
- Use of Universal I/O or other installation technique
- Consider the use of Vendor supplied PLC for mechanical vendor provided packages to minimize re-programming concerns on existing DCS/SIS systems

- Minimize constructability, maintainability, operability, and constructability concerns during design

4.6.4 Deliverables to Client

This documents listed below are for FEED Stage only

- Project Design Basis & Design Criteria
- Control Systems Network Architecture Diagram (mark-up's only)
- Technical Specification - Instrumentation & Control Systems Supplied with Mechanical Packaged Equipment
- Instrument Index
- Control Room and Rack Room Layout (mark-up's only)
- Telecommunication Functional Descriptions and System Block Diagrams
- Instrument Installation Details
- Instrument Location Plans
- Instrument Cable Schedule
- RFQ and technical bid tabulation for the process automation system

4.6.5 Client Interface

Fluor's Control Systems Lead Engineer will be the primary point of contact between Fluor and MPC on technical items concerning the Control Systems engineering and design efforts.

All communications and exchanges between Fluor's Control Systems personnel and MPC will be documented using the project approved methods as defined in the Project Procedure Manual.

All deliverables will be issued as Issued for Review (IFR) in Fluor document management system (Coreworx), to the designated MPC Representatives for a 5 day review to ensure MPC standard compliance. The review comments will then be incorporated into the final documents and issue to Coreworx as IFD documents.

4.6.6 Interdiscipline Coordination

Process

- P&IDs
- Sequence of operations
- Material compatibility
- Process instrument data

Electrical

- Power requirements
- Field wiring
- Control philosophy
- MCC
- Termination requirements

Mechanical Equipment

- Equipment Packages
- Supplier Documents

Architectural

- Control Room & Rack Room Requirements

Construction

- N/A

HSE

- N/A

Piping

- Preliminary In-line Instrument Dimensional Information
- Preliminary Instrument (JB) Location / Orientation

Procurement

- Automation Package RFQ

4.6.7 Assumptions and Clarifications

- No field survey trip is planned for the FEED phase. It is assumed that the project will only have limited communication requirements with the existing site.
- The following activities/documents are excluded from this FEED Stage:
    - As-built drawings, Construction Support, Commissioning and startup support.
    - Instrument Sizing Calculations and Instrument Datasheets.

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- Any safety related documents / activity such as Cause & Effect Diagrams and HAZOP participation

- Control Systems will provide input and information for the overall project schedule. It is assumed that the overall project schedule will be fully integrated with proper ties between activities to reflect phased engineering. Control Systems will not maintain a separate schedule.

- The project will consider Zero Base Execution (ZBE) approach and only one technical specification is to be developed. Project will consider applying technology that is readily available and no special design requirements. All other technical specifications are to be developed during bridging or detailed engineering.

- The pricing for all instruments, including bulk material, to support the end of FEED Stage Estimate are to be from Fluor in-house pricing. There will be only one RFQ package and Technical Evaluation (for DCS/SIS Automation Package) during the FEED and no others planned during this stage.

- Fluor Control Systems will support Fluor Process in the development of project P&IDs, including participating in P&ID Review and PHA. The estimated P&ID count is 80.

- This project includes third party mechanical vendor packages (such as compressors). The project will consider 3rd party PLC's for mechanical package controls. The communication protocol can be Modbus TCP/IP using redundant FO Cables. This is to be further determined after the field survey.

- The project will consider the Universal I/O technology with Smart I/O Junction Boxes (JB's) located around the facility to save project installation costs and tie-in efforts. The communication between the Smart I/O JB's and the Control Room are via redundant Fiber Optic Cables through different paths.

- The basic control philosophy for the project is as below. This is to be further reviewed with the MPC Control Systems Representative:

  - DCS – for basic process Control & monitoring.

  - SIS – for plant safety shutdown system.

  - PLC – for 3rd part mechanical vendor package control (such as compressor control)

  - The field instrumentation will be 4-20 mA, loop powered type with HART capability.

- The communication between DCS & PLC can be soft communication type using communication protocol such as Modbus TCP/IP. The number of hard-wired signals should be minimized.
- The shutdown signals from SIS to DCS and PLC's shall be hardwired signals.
- The project will consider MPC's approved vendors list for instrument selections.
- The project assumes no modification to the existing control room and rack room. The project plans to have its own stand-alone control room with minimum interfacing signals with the existing control room. This is to be determined during this FEED Stage.

- The installed location for the vendor provided PLC is to be determined during this FEED stage.
- For 3rd party mechanical packages, equipment, it is assumed that the mechanical vendors will provide/install all field instruments and terminate all signal wiring to local junction boxes located at the edge of the skid. Multi-pair homerun cables will be provided and routed by others to the PLC (whether in Control Room Rack Room or locally, TBD in the field stage).
- The scope for Telecommunication is communications systems only.
- The scope for Fire & Gas Monitoring System and Fire Protection System is to be reviewed and defined in this FEED Stage.
- No scope is considered for any demolition work.
- No SmartPlant Instrumentation (SPI) during the FEED stage.

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4.7 CIVIL SCOPE OF SERVICES

4.7.1 Design Approach

Civil scope of services is limited to FEED activities for the Minnkota Project Tundra to define the basis of design and construction for execution of the EPC phase and to support the FEED phase material estimate as follows:

- Civil will provide support for design development of plot plan, site preparation, drainage, roads and finish grading and paving in conjunction with other engineering disciplines
- Existing Civil Drawings, Specifications, Reports, Surveys, Geotechnical Reports and other documents that define the existing facilities will be provided by client for review by Fluor
- Project Specific Civil Design Criteria, Specification and Standards will be developed for the project
- SOW for Fluor subcontracts for Geotechnical Investigation and Topographical Surveys will be developed to obtain information required for design, including seasonal soil freeze depth. These subcontracts will be released by Fluor during the FEED study after obtaining and reviewing existing reports from MPC. Geotechnical Investigation Report and Topographical Surveys provided by third party contracts will be stamped in accordance with North Dakota requirements.
- S3D will be utilized for 3D modeling and optimization of the plot plans and preliminary site layout for drainage, roads, finish grading and paving. FEED level model review with client will be included.
- Sketches and/or preliminary drawings will be developed as required to supplement the S3D model in defining the scope and forming a basis for the FEED material estimate
- Preliminary calculations may be utilized to help establish material quantities for the FEED Estimate as required using standard Fluor Reference System Software such as Bentley InRoads and Bentley CivilStorm
- MTOs will be developed for the FEED material estimate
- Project will be executed entirely in the Fluor Houston office

4.7.2 References and Standards

Codes, Standards and References used for this project include but are not limited to those listed below.

A detailed review of Minnkota's Design Manual will be conducted early in FEED and any differences impacting the design will be discussed and resolved.

The current version of applicable codes and standards as of the award of contract will be used.

- ASTM
- ACI
- PCI
- OSHA
- AWWA
- AASHTO
- State Department of Transportation Standard Specifications
- Fluor/PIP Structural Specifications, Design Criteria and Design Standards
- Other Federal, State, and City Codes and Standards as applicable

4.7.3 Special Resources

Special resources that will be needed to perform the required work include:

- Interface with Geotechnical Engineering Contractor for Geotechnical Investigation
- Interface with Surveying Contractor for Topographic Surveys

4.7.4 Installation Techniques / Philosophy

Roadway, paving, and drainage design philosophy is assumed to be similar to existing facility.

Modifications of existing facilities to accommodate the new facilities beyond the limits of new facilities are assumed to not be required and are excluded from the Civil scope.

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4.7.5 Deliverables to Client

- Civil Specifications and Standards
- SOW for Geotechnical Investigation
- SOW for Topographical Surveys
- Preliminary Design Sketches/Drawings and S3D Model as a basis for the Civil FEED Estimate
- Civil Material Quantities and Basis for FEED Material Estimate
- Preliminary EPC Schedule
- EPC Civil Man-hour Estimate and Staffing Plan

4.7.6 Client Interface

- Existing Civil Drawings, Specifications, Reports, Surveys, Geotechnical Reports and other documents that define the existing facilities will be provided by client for review by Fluor.
- Client interface will be required to define design requirements and preferences for the project.
- Fluor Civil Deliverables will be client reviewed for comment only.
- Two FEED level model reviews with client will be included.
- One Civil site visit will be required.

4.7.7 Interdiscipline Coordination

Civil Group will have the following interface points:

Process

– Pressures, temperatures, flow rates and material types for underground piping

Architectural

– Exterior rainwater downspouts
– Door stoop / roll-up doors / ramp locations

Mechanical Equipment

– N/A

Plumbing / Utilities

– Lift stations / force mains
– Storm, industrial and sanitary sewers

Piping

- Plot plans and equipment location control plans
- Sizing / material selection for pressure piping
- Drain funnel locations

– Potable, river, filtered and cooling water systems

Fire Protection

- Underground fire protection piping

Electrical

- Electrical layouts
- Electrical ductbanks / manways
- Large conduit routing for controls and lighting
- Special gate controls for fencing

Procurement/Contracts

- Procurement packages
- RFQ/Contract packages

Structural

- Mass excavation requirements
- Exterior concrete structures
- Building footprints / foundations
- Sump piping
- Miscellaneous pipe supports

4.7.8 Assumptions and Clarifications

Civil Engineering assumptions, clarifications, and exclusions associated with the design approach, activities, and deliverables for the project are as follows:

- Civil Scope for FEED is based on preliminary plot plans, equipment list, and studies developed and performed during pre-FEED phase by Fluor
- It is assumed that there are no underground obstructions in the areas where new facilities will be installed. Fluor assumes MPC has maintained its drawings for underground structures, piping, duct banks, conduits, etc. and that these drawings will be available to Fluor upon request. Fluor does not anticipate the need for an underground investigation (GPR, hydrotrenching, etc.) during FEED but this will be included in the estimate for execution early in Detail Engineering
- No scope is included for demolition work

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- It is assumed that there are no contaminated soils, lead, asbestos, or other hazardous materials at the site in areas of new facilities. No scope is included for assessment, removal, abatement and/or disposal of any hazardous materials.

- Drainage design is limited to new facilities area with assumption that there will be a tie-in to exist drainage system for the facility that is adequately sized and designed for this addition.

- Scoping for temporary construction facilities will be developed by Fluor's Construction group

- Modifications of existing facilities to accommodate the new facilities beyond the limits of new facilities are assumed to not be required and are excluded from the Civil scope with the exception of tie-ins

- It is assumed that there is no upland watershed beyond overall site boundary that affects project drainage design and no natural storm water conveyances that require diversion

- Evaluation of borrow source, if needed, is assumed to be by others

- No Civil Scope is included for work related to fencing or special security requirements at site. Fencing and Security will be discussed during FEED.

- It is assumed that Fluor/PIP Specifications and Standards will be used for the project. (Incorporate "Design Manual for Project Tundra" Parts 1 through 5 during Feed, after discussion between MPC and Fluor determines merit).

- Existing Civil Drawings, Specifications, Reports, Surveys, Geotechnical Reports and other documents that define the existing facilities are assumed available and provided to Fluor by the Client. Existing facilities are assumed to be as represented on existing documents. No hours are included to obtain existing documents or to verify existing facilities during the FEED phase.

- Preliminary Design Sketches/Drawings and S3D Model will be utilized as a basis for the Civil FEED Estimate. No formal Civil Drawings will be issued during FEED

- No hours are specifically included to perform any Calculations and Calculations are not considered to be a deliverable to the client during the FEED phase. Preliminary calculations may, but not necessarily, be performed in the FEED phase as required to validate design and material estimate

- One site visit is included for Civil in the FEED phase

4.8 STRUCTURAL SCOPE OF SERVICES

4.8.1 Design Approach

Structural scope of services is limited to FEED activities for the Minnkota Project Tundra to define the basis of design and construction for execution of the EPC phase and to support the FEED phase material estimate as follows:

- Structural will provide support for design development of plot plan, structural layouts, modularization, and construction philosophies in conjunction with other engineering disciplines. Existing Structural Drawings, Specifications, Reports, Surveys, Geotechnical Reports and other documents that define the existing facilities will be provided by MPC for review by Fluor

- Support structures and foundations as required for BOP tie-ins are included in scope

- Project Specific Structural Design Criteria, Specification and Standards will be developed for the project

- SOW for Fluor subcontracts for Geotechnical Investigation and Topographical Surveys will be developed to obtain information required for design, including seasonal soil freeze depth. These subcontracts will be released by Fluor during the FEED study after obtaining and reviewing existing reports from MPC. Geotechnical Investigation Report and Topographical Surveys provided by third party contracts will be stamped in accordance with North Dakota requirements.

- Structural portion of Technical RFP and Bid Tabulation for Duct and Supporting Structures will be prepared

- Structural portion of Technical RFP and Bid Tabulation for Buildings and Enclosures will be prepared

- S3D will be utilized for 3D modeling and optimization of the plot plans and module arrangements. FEED level model review with client will be included.

- Sketches and/or preliminary drawings will be developed as required to supplement the S3D model in defining the scope and forming a basis for the FEED material estimate

- Preliminary calculations may be utilized to help establish material quantities for the FEED Estimate as required using standard Fluor Reference System Software such as RIS3D, RISA Foundation and Fluor proprietary foundation design software

- Modularization, Construction Sequencing and Precast Concrete Structures Feasibility Studies will be performed
- MTOs will be developed for the FEED material estimate
- Preliminary EPC Schedule and EPC Man-hour Estimate/Staffing Plan will be developed

4.8.2 References and Standards

Codes, Standards and References used for this project include but are not limited to those listed below.

A detailed review of Minnkota's Design Manual will be conducted early in FEED and any differences impacting the design will be discussed and resolved.

The current version of applicable codes and standards as of the award of contract will be used.

- ASCE
- ASTM
- ACI
- AISC
- AWS
- PCI
- IBC
- OSHA
- NFPA
- Fluor/PIP Structural Specifications, Design Criteria and Design Standards
- Other Federal, State, and City Codes and Standards as applicable

4.8.3 Special Resources

Resources that will be needed to perform the required work include:

- Consultation with specialty concrete precasting fabricators for feasibility of using precast fabrication and erection techniques in lieu of cast-in-place concrete for elevated concrete structures

- Interface with Duct Design Contractor
- Interface with Geotechnical Engineering Contractor for Geotechnical Investigation
- Interface with Surveying Contractor for Topographic Surveys

4.8.4 Installation Techniques / Philosophy

Structures in process areas and main pipe racks are assumed to be stick built. A modularization study will be performed in the FEED phase to determine the modularization execution plan.

Construction sequencing of process modules in process enclosure before or after enclosure construction will be studied during the FEED phase.

Feasibility of using precast fabrication and erection techniques in lieu of cast-in-place concrete for elevated concrete structures supporting C-101 (DCC), C-201/ME-802 (Absorber) and BL-201 (Blower) will be studied during the FEED phase.

4.8.5 Deliverables to Client

- Structural Specifications and Standards
- Modularization Study/Preliminary Modularization Execution Plan
- Construction Sequence Study for Process Enclosures/Modules
- Feasibility Study for Precast Concrete Structures
- Structural portion of Technical RFP and Bid Tabulation for Duct and Supporting Structures
- Structural portion of Technical RFP and Bid Tabulation for Buildings and Enclosures
- SOW for Geotechnical Investigation
- SOW for Topographical Surveys
- Preliminary Design Sketches/Drawings (including for intake structure) and S3D Model as a basis for the Structural FEED Estimate
- Structural Material Quantities and Basis for FEED Material Estimate
- Preliminary EPC Schedule
- EPC Structural Man-hour Estimate and Staffing Plan

4.8.6 Client Interface

- Existing Structural Drawings, Specifications, Reports, Surveys, Geotechnical Reports and other documents that define the existing facilities will be provided by client for review by Fluor

- Fluor Structural deliverables will be client reviewed for comment only

- Two FEED level model review with client will be included

- Two Structural site visits will be required

4.8.7 Interdiscipline Coordination

Structural Group will have the following interface points:

Mechanical Equipment

– Preliminary equipment sizes, weights, and center of gravities
– Equipment supplier drawings
– Foundation loads

Civil

– Grading and drainage plans
– Underground utilities

Piping

– Plot plans and equipment location control plans
– Piping layouts
– Stress loads

Plumbing

– Underground plumbing drawings

Architectural

– Code requirements
– Plans, elevations, sections
– Materials of construction

Procurement/Contracts

– Procurement packages
– RFP/Contract packages

Electrical

– Electrical layouts
– Substation size, weight, and foundation requirements
– Transformer size, weight and foundation requirements

Process

– N/A

4.8.8 Assumptions and Clarifications

Structural Engineering assumptions, clarifications, and exclusions associated with the design approach, activities, and deliverables for the project are as follows: Structural Scope for FEED is based on preliminary plot plans, equipment list, and studies developed and performed during pre-FEED phase by Fluor

- Flue Gas Ducts and Duct Support Structures are assumed to be designed by Duct sub-contractor with foundations by Fluor Structural. Hours are included for the structural portion of an RFP package and Technical Bid Evaluation.

- The Multi-Purpose Building is assumed to be designed and constructed as Pre-Engineered Metal Buildings by a building contractor including building and foundations. Hours are included for the structural portion of an RFP package and Technical Bid Evaluation.

- Substation is assumed to be a prefabricated building purchased by Electrical with foundation by Fluor Structural

- Process, Boiler, and Compressor Buildings are assumed to be simple enclosures, designed and constructed as Pre-Engineered Metal Buildings by building contractor with foundations by Fluor. Hours are included for the structural portion of an RFP package and Technical Bid Evaluation. Requirements for bridge cranes to be evaluated during FEED.

- It is assumed that there are no underground obstructions in the areas where new facilities will be installed. Fluor assumes MPC has maintained its drawings for underground structures, piping, duct banks, conduits, etc. and that these drawings will be available to Fluor upon request. Fluor does not anticipate the need for an underground investigation (GPR, hydrotrenching, etc.) during FEED but this will be included in the estimate for execution early in Detail Engineering.

- No scope is included for demolition work

- It is assumed that there are no contaminated soils, lead, asbestos, or other hazardous materials at the site in areas of new facilities. No scope is included for assessment, removal, abatement and/or disposal of any hazardous materials

- Scoping for temporary construction facilities will be developed by Fluor's Construction group

- Modifications of existing facilities to accommodate the new facilities beyond the limits of new facilities are assumed to not be required and are excluded from the Structural scope.

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- It is assumed that Fluor/PIP Specifications and Standards will be used for the project

- Existing Structural Drawings, Specifications, Reports, Surveys, Geotechnical Reports and other documents that define the existing facilities are assumed to be available and provided to Fluor by the Client. Existing facilities are assumed to be as represented on existing documents. No hours are included to obtain existing documents or to verify existing facilities during the FEED phase

- Preliminary Design Sketches/Drawings and S3D Model will be utilized as a basis for the Structural FEED Estimate. No formal Structural Drawings will be issued during FEED

- No hours are specifically included to perform any Calculations and Calculations are not considered to be a deliverable to the client during the FEED phase. Preliminary calculations may, but not necessarily, be performed in the FEED phase as required to validate design and material estimate.

- Two site visits are included for Structural in the FEED phase

4.9 ARCHITECTURAL SCOPE OF SERVICES

4.9.1 Design Approach

The following design approach outlines the Architectural design services, methods, activities and tools that will be utilized to provide the FEED design of the buildings, as listed below, associated with Minnkota Power Cooperative Project Tundra in Grand Forks, N.D.

Pre-engineered Metal Buildings:

- Boiler Enclosure
- Compressor Enclosure
- Process Enclosure

Pre-engineered Metal Building with interior fit-out referred to as the Multi-Purpose Building, which includes:

- Central Control Room
- Lab
- Maintenance Shop
- Administration
- Warehouse

Prefabricated Building Packages

- Substation

The Architectural Scope of Services include performing basic engineering that will segue into detailed design at the end of the FEED Phase.

The key activities of the Architectural Scope of Services include:

- Architectural Building Design Description. This document shall include applicable building material specifications
- Programming/Design Development
    - Control Room, Lab, Administration, Warehouse, and Maintenance Shop Building: identify area allocations, adjacencies, functionality, material handling equipment, finish requirements, egress, material hazards, height and area requirements, floor weight requirements
    - Boiler Enclosure, Compressor Enclosure, and the Process Enclosure: identify required operator areas (rest rooms, break rooms), egress, material handling

- Drawing Development
    - All Pre-engineered Buildings include the development of conceptual floor plans and exterior elevation drawings
    - The Multi-Purpose Building will also have a separate Wall Section / Room Finish Schedule Drawing developed.

- Prefabricated building drawing, specification, and RFQ review and input:
  Substation - provide drawing and specification review and input for material and code compliance for the Electrical bid package

- Preparation of one request for proposal and technical bid tabulation to cover the procurement and construction of

    - Multi-Purpose Building
    - Boiler Enclosure
    - Compressor Enclosure
    - Process Enclosure

- Preliminary building code review will be developed for all buildings with high level results indicated on the floor plans

- Development of the technical portions for building contracts and purchase orders

- Electronic Building Shell Model Development of:
    - Multi-Purpose Building
    - Boiler Enclosure
    - Compressor Enclosure
    - Process Enclosure

- Detailed Design engineering budget and schedule

Fluor Architectural is responsible for the design analysis and preparation of the FEED Conceptual Design documents including drafting of the Architectural component of the project.

The Architectural design will utilize good quality commercial construction practices to provide cost effective, safe and functional facilities.

The Architectural Group will coordinate with other disciplines to provide sufficient information for them to progress their activities.

The Fluor Architect will have full responsibility for all architectural building/materials design activities for buildings associated with the BOP portion of the project.

4.9.2 References and Standards

The Architectural design will be based on the current adopted edition of the Codes and Standards.

A detailed review of Minnkota's Design Manual will be conducted early in FEED and any differences impacting the design will be discussed and resolved.

In addition to the project design documents, the Architectural design will be based on the current adopted edition of the following Codes and Standards.

- International Building Code, 2018 edition
- North Dakota State Building Code
- Life Safety Code (NFPA 101)
- Americans with Disabilities Act
- Fluor Architectural Engineering Standards
- Fluor Architectural Standard Engineering Specifications
- Process Industry Practices (PIP) specifications, standards, and guidelines will be utilized where applicable.

4.9.3 Special Resources

Special resources include:

- S3D software will be utilized

4.9.4 Installation Techniques / Philosophy

The following installation methods will be performed:

- The Multi-Purpose Building shall be Pre-Engineered Metal Buildings (PEMB) shell with stick-built interiors.
- The Boiler Enclosure, Process Enclosure, and Compressor Enclosure will be pre-engineered metal building shells erected on a foundation/slab. No interior rooms are anticipated.
- The Substation will be purchased by Electrical as a pre-fabricated (Industrialized) Building. Architectural will perform drawing and specification review in of the bid package

4.9.5 Deliverables to Client

The following is a description of the Architectural engineering documents and other deliverables will be provided during or at the end of the project:

Technical RFP and Bid Tabulation

Provided for buildings and enclosures listed in key activities under section 4.9.1 above. Technical input will be provided for the prefabricated (industrialized) building packages

Architectural Drawings (CAD)

The preliminary design (FEED) issue of the drawings for the buildings will form the project approved Building Design Basis. These drawings will establish the approved functional layout of the buildings, and will be used in support of the Contracts and Purchase Orders. The drawings will indicate location of the construction materials, area sized for appropriate furnishings (furniture design not provided), requirements for fixtures and building equipment and will be the basis for later detailed engineering.

- Drawings
  - Floor Plans
  - Exterior Elevations
  - Typical wall sections will be developed for the Central Control Room / Lab Building, Admin / Warehouse Building and Maintenance / Shop Building

No architectural stamped drawings or documents will be developed during FEED.

Architectural Specifications

The preliminary design (FEED) issue of the specifications for the buildings and building materials will be included in the Building Design Basis. The building specifications will form the technical narrative for the contract documents. The specifications will be used in support of the Contracts and will indicate the quality, and finish of the construction materials for later detailed engineering.

- Building Specifications will be provided for: The Multi-Purpose Bldg. and all enclosure buildings
- Material Specifications will be based on single source specifications fit-for-purpose in support of the contract packages.

Deliverables to Construction (not during FEED Phase):

- Contract package: Buildings and enclosures
- PE stamped documents (by vendor and subcontractor)
- Building department permits shall be by the subcontractor.

4.9.6 Client Interface

The Architectural group will conduct Interdisciplinary and internal drawing quality review, coordination and revisions in accordance with streamlined Fluor procedures.

The Building Design Description and the Architectural FEED Design Drawings created for each building will be issued to the Client for review and approval. The approved Building Design Description and Architectural FEED Design Drawings will serve as the technical Architectural basis for the contract and purchase order packages.

4.9.7 Assumptions and Clarifications

The following are assumptions, clarifications, and exclusions to the Architectural Scope of Services.

- The Architectural drawings will be AutoCad (2D). Format will be client provided standard
- One client review cycle of design during FEED
- Additional design changes after client design review will be during the Design/Building sub-contractor reviews
- Process Enclosure requirements/assumptions:
  - This will be considered a process enclosure rather than a building
  - The Enclosure includes three (unoccupied) platform levels.
  - Includes a material/equipment elevator
  - Pre-engineered Metal Building designed to be built around process after process is installed
  - Assumed enclosure is non-hazardous
  - Includes a mezzanine or equipment (Unoccupied) platform level

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  - Assumed building is classified as Factory / Industrial (non-hazardous)
- Compressor Enclosure requirements/assumptions:
  - This will be considered an enclosure rather than a building
  - 30,000 sq. ft. of shell space
  - Compressor Enclosure includes (unoccupied) platform levels.
- Multi-Purpose Building requirements / assumptions:
  - Assumed 1-story
- No weight reports will be provided
- All buildings are located in non-hazardous areas and are not required to be blast resistant
- Buildings will meet ADA requirements
- Materials Takeoffs and Equipment Lists for office furniture, office/building equipment, and consumables, will not be provided
- Architectural specifications are included per the FEED Requirement Spreadsheet within the Building Design Basis.
- Only the Multi- Purpose Building will be "occupied" and will be the only new building with bathrooms
- Architectural will provide review and input to substation RFQ for FEED
- Client Model Review assumed for Process Enclosure, and Compressor Enclosure.
- 1 Layout review of the floor plans for the Multi-Purpose Building
- No Field Trips are required in the Architectural FEED. Review of the Process Enclosure and Compressor Enclosure with Code Official is recommended to streamline agreement of these structures as process enclosures rather than buildings. The intent of this agreement is to avoid unnecessary functionality and cost implications. During FEED, all Code Official communications will be via phone and email.

4.10 HSE SCOPE OF SERVICES

On all Fluor projects, Process Safety and Risk Management begin during the design process. Through adherence to codes and standards, provisions for maintenance and operations access, development of equipment specifications, and selection of appropriate vendors, Fluor assures that safety is "designed in" to each project. Other safety issues are routinely addressed as a part of flow diagram and P&ID development and review.

In addition, specialized studies will be conducted for the purpose of safety enhancement and risk mitigation. These studies include reviews for hazard identification as well as the evaluation (in terms of risk) of identified hazards. These studies tend to be stand-alone efforts that take place at particular project milestones or are designed to address individual issues as they arise during the design process.

Formalized techniques for safety reviews are used to audit designs that already meet the governing codes, standards, regulations, and engineering practices. The Project Safety Reviews are supplemental and provide a mechanism for the formal evaluation and verification of the integrity of the design. Safety in design is paramount, and revolves around the following concepts:

- Consistency in engineering to achieve low risk designs
- Designs that follow standards
- Adherence to regulations and codes
- Designs that minimize engineering oversights and errors leading to changes
- Satisfactory resolution of risk mitigation issues
- Safety in design according to a plan

4.10.1 Safety Reviews

The HSE in Design group will support the project team in the following safety reviews:

- Facility siting and plot plan review
- Process Hazards Analysis reviews:
    - Level I PHA/HAZID Summary Review
    - Level II PHA/HAZOP Methodology

- Flammable/toxic consequence reviews
- Other applications of risk analysis methods to
    - Assess the risks
    - Define mitigations
    - Meet regulatory requirements
- Support to RAM Scope of Work

4.10.2 Plans for PHA Reviews

This Scope will be executed (for FEED) using a modified two stage approach.

- Level I will be performed with the intent to identify process hazards, which will impact the budget estimate for FEED, using an inherently safe design or high level what-if methodology. Objective is to define the intrinsic and significant hazards.
- Level II is performed when project documentation includes at least approved Process Flow Diagram with heat and mass balance. A level II PHA will be carried out using HAZOP Methodology (typically referred to as a FEED Preliminary HAZOP).

4.10.3 Process Safety Management Practices

It is Fluor's policy to produce engineering designs that allow for the application of sound Process Safety Management practices during startup, commissioning, operation, maintenance, and turnaround. Safety is an inherent part of Fluor's culture in all areas. We will stress safety daily to all team members - not only in the study process, but also in the design and constructability of the project.

4.10.4 Capabilities, Resources and Plans

Fluor's commitment to Health, Safety, and Environmental issues is backed by the management of the corporation. The whole of the company takes a proactive approach to HSE and we are all accountable for promoting the program on all of our projects.
It is the function of the HSE (Health, Safety and Environmental) discipline and Process Safety Engineer to define and perform the necessary tasks to confirm the project safety goals are met and that Project Safety Management (PSM) elements, appropriate to the project scope of work and design stage, are implemented.

Fluor would typically expect to take a leadership role in the following areas related to the safe design and operation of the facilities:

- **Loss Prevention/Fire Protection** - Fluor Fire Protection and Loss Prevention specialists support the project teams during the preparation of the plot plan to provide loss prevention input into the relative location of the facilities to potential hazards. Typically, our specialists will identify the sources of potential hazards and provide input to the team as it is locating the equipment and the occupied buildings. Fluor's specialists are familiar with code requirements and requirements for Process Safety Management. These requirements are communicated to the team as it is making the critical decisions of how and where to locate equipment and buildings.

  - **Process Hazards Analysis Reviews** - Fluor typically provides three levels of PHA reviews as previously described. Reviews are initiated as early as information will allow the respective PHA review to start. Experience from previous projects can be shared and also incorporated into the design prior to the reviews. This will significantly reduce the number of PHA comments and changes to the design and equipment. All comments resulting from the reviews will be documented and closed out.

  - **Fire Protection Design** – Fluor's fire protection specialists will provide input to the Design Basis Memorandum, plot plan reviews, and 3D model reviews. They develop the sketches and technical input for the PFDs, P&IDs, fire water demand, deluge systems, hydraulics/line sizing, and fire and safety equipment MTO's. In addition, they provide input to control systems in the design of the Fire and Gas system. The Fire Protection Specialist works with Project Management, Engineering Management and engineering disciplines to incorporate requirements into the design to meet technical and regulatory requirements for all phases of the project.

  - **Environmental Support -** Fluor assist clients to prepare the necessary environmental approval submittals when requested. Currently permitting activities support is not included Fluor scope.

  The HSE in Design group's objective is to execute tasks in a manner that assists project management in meeting the overall goals of the project, with the foremost objective being to design safe and reliable facilities. The "keys to success," or objectives are seen as:

  - Reduction/elimination of re-work
  - Time/schedule efficiency
  - Satisfying the needs of the project - not more, not less - to reduce capital costs without compromising inherently safer design, project goals and objectives.

Fluor HSE personnel assist the project in meeting these objectives by structuring activities as follows:

- Identifying safety issues and hazards early in the design to lessen impact on the schedule
- Providing guidance to the disciplines so safety requirements can be included in the specifications, reducing/eliminating re-work
- Tracking and follow-up on recommendations for closure and consistency

4.10.5 HSE Interfaces

HSE Interfaces with project engineering disciplines as follows:

- Process engineering for P&ID development/review and PHA's;
- Piping engineering group for the definition of general layout in view of safety requirements and distances;
- Piping engineering group for the design of the Above Ground fire-fighting systems;
- Civil and Piping engineering group for the design of the UG (underground) fire water network;
- Civil engineering in development of drainage plans/requirements;
- Structural engineering group for definition of passive fire protection and overpressure analysis
- Instrument and Control Group for the design of the Fire & Gas Detection and Alarm systems;
- All engineering groups for incorporation of environmental and regulatory requirements into project documents/deliverables.

4.10.6 Deliverables and Activities

The following are deliverables derived from the HSE Scope of Work:

- Process Hazards Analysis (Level I/HAZID Summary and Level II PHA)
- PHA reports
- HSE/PHA Recommendations Tracking Register
- Noise Study/Plan

- Fire Protection Design Basis (to include hazard mitigation strategy, active and passive FP basis, codes and standards, fire hazard zones identification)
- Fire Protection Specification (equipment)
- Fire Protection Flow Diagram and supporting preliminary hydraulics
- Support to engineering disciplines as identified in above HSE Interfaces section.
- Support to RAM Scope of Work

4.10.7 Basis of Estimate

- Fluor standard practices, procedures and design specifications as provided in Fluor HSE Management System (HSE MS) for HSE Design Engineering are followed.

- HAZID basis is all areas are done in a single review workshop of technology based HAZID. Review facilitation is by in-house Fluor facilitator.

- Level II PHA procedure may be provided by client and benchmarked against Fluor HSE MS requirements for PHA Level II. Facilitation is planned by a 3rd party under contract to Fluor.

- SIL/LOPA not planned in FEED scope.

- Fluor regulatory and environmental scope is to support the engineering team regarding design and inputs of environmental and regulatory requirements into project documents/deliverables.

- Noise Study basis of estimate is to provide a FEED level project noise plan and preliminary review and evaluation of layout, equipment and interface with mechanical on requirements for inclusion in mechanical data sheets. Detailed report and noise contours are assumed to be generated in detailed design. Alternately, as an option/additional scope, Fluor can provide support for 3rd party noise modeling in FEED, prepare technical scope of work and interface with the 3rd party.

4.11 HVAC/PLUMBING/BUILDING FIRE PROTECTION SCOPE OF SERVICES

4.11.1 Design Approach

The following design approach outlines the HVAC/Plumbing/Building Fire Protection design services, methods, activities and tools that will be utilized to provide the HVAC/Plumbing/Building Fire Protection (FP) Engineering and Design for FEED for the following buildings:

- Multi-Purpose Building
- Process Enclosure (including Water Treatment)
- Compressor Enclosure
- Boiler Enclosure

The HVAC/Plumbing/Building FP Scope of Services will be to provide engineering activities required to support preparing information for the FEED estimate and for the FEED HVAC/Plumbing/Building FP Design Basis information.

The scope of services includes the following key activities:

- Preparation of a Project HVAC Design Criteria, HVAC Equipment Specifications, Building Plumbing System Specification, and Building Fire Protection/Fire Detection Specification

- 3D Modeling of HVAC Major Equipment and Major Ductwork for the Process Enclosure, Compressor Enclosure, Boiler Enclosure, and Pump House enclosure. S3D is assumed.

- Perform preliminary HVAC Calculations and Equipment Selections for the Process Enclosure, Compressor Enclosure, Boiler Enclosure, and Pump House. These will be used as a basis for the S3D HVAC modelling.

- Perform preliminary HVAC Calculations for the Multi-Purpose Building to determine preliminary HVAC space requirements and HVAC Electrical Loads.

- Perform preliminary Plumbing calculation for the Multi-Purpose Building to determine preliminary incoming plumbed utility line sizing.

The HVAC/Plumbing/Building FP Scope of Services will be limited to HVAC/Plumbing/Building FP items related to the buildings/enclosures listed in Section 4.11.1. There is no Plumbing work included in the HVAC/PL/FP scope for the Process Enclosure, Compressor Enclosure, and Boiler Enclosure.

The HVAC/Plumbing/Building FP Group will coordinate with other disciplines to provide sufficient information for them to progress their activities.

4.11.2 References and Standards

Unless otherwise noted, the HVAC/Plumbing/Building Fire Protection design will be based on the latest editions of the codes and standards after project award.

- Project HVAC/PL/FP Specifications:

  The following documents are anticipated to be prepared during FEED.

Document No.	Rev	Title
TBD	TBD	HVAC Design Criteria
TBD	TBD	HVAC Installation
TBD	TBD	HVAC Packaged Air Conditioning Units
TBD	TBD	HVAC Central Station Air Handling Units
TBD	TBD	HVAC Air Cooled Condensing Units
TBD	TBD	HVAC Fans
TBD	TBD	HVAC Control Systems
TBD	TBD	Building Plumbing Systems
TBD	TBD	Building Fire Protection and Detection

A detailed review of Minnkota's Design Manual will be conducted early in FEED and any differences impacting the design will be discussed and resolved.

4.11.3 Installation Techniques / Philosophy

The following philosophy is the basis of the scope of service in order to meet the schedule:

- An HVAC design basis/description for the Multi-Purpose Building will be determined during FEED.

- The HVAC for the Process Enclosure, Compressor Enclosure, and Boiler Enclosure, will be in-house design by Fluor. Preliminary sizing and space allocation for major HVAC equipment and major HVAC ductwork will be performed by Fluor HVAC during FEED.

- Technical HVAC/Fire Protection/Detection input will be provided to the Fluor Electrical group during FEED to include in the Substation package.

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4.11.4 Client Interface

HVAC/PL/FP specifications will be issued during FEED. One client review cycle is included.

4.11.5 Interdiscipline Coordination

The main HVAC/Plumbing/Building Fire Protection interdiscipline interface points are listed below:

Piping

- Utility piping

Architectural

- Building layout

Control Systems

- HVAC controls interface To DCS

Structural

- Equipment support

Procurement/Contracts

- Procurement package support
- Contract package support

Electrical

- Utility power
- BMS input into Substation RFQ

4.11.6 Assumptions and Clarifications

The following are the assumptions, clarifications and exclusions to the HVAC/Plumbing/Building Fire Protection Scope of Services. Also, refer to Architectural Scope of Services, Section 4.9.7 for additional assumptions and clarifications on the enclosures/buildings.

- Refrigerants specified will be in accordance with Montreal Protocol and all other applicable legal requirements. Proposed refrigerant types will be provided in the project HVAC specifications.
- One (1) client review cycle
- Does not include field visits
- Floor drains and solvent drains will be included in buildings and enclosures as required.

- The Process enclosure, Compressor enclosure, and Boiler enclosure construction type are assumed to be pre-engineered metal buildings (PEMB) and not modules.
- The Process enclosure, Compressor enclosure, Boiler enclosure, and Pump House are assumed to be process enclosures and not buildings
- FEED hours include HVAC input to architecture for space requirements
- HVAC/FP input is included to the Architectural group for the Multi-Purpose Building RFP including the technical SOW input, SDDC, and the Bid Evaluation input. The building RFP will also include the shell for all enclosures, but HVAC design is in-house.
- HVAC/FP input to Substation for FEED for Attachment C, SDDC, RFQ Bid Evaluation is included. Substation is led by Elec group
- No chemical filtration required for HVAC intake air assumed
- Fire Protection/Detection of buildings and enclosures will be coordinated with and reviewed by the HSE group. See section 4.10.
- Enclosure type buildings are assumed to be heated and ventilated only. No air conditioning included in the scope
- No plumbing is included in the estimate for the enclosure type buildings.
- DX cooling type systems for the substation and Multi-Purpose Building are assumed. No HVAC chilled water systems are included
- Heating and Ventilation is assumed for the Maintenance Shop. No air conditioning is included in the scope.
- Standard Fluor HVAC Design Criteria, Installation, Controls, Equipment, Plumbing and Fire Protection/Detection specs to be utilized with updates for project site conditions and local codes. One client review cycle included.
- No weight reports will be provided
- Main building incoming plumbing preliminary line size will be determined for buildings requiring plumbing. No internal plumbing line sizing included.
- No fire protection line sizing (if required) included
- No 3D modeling for the Multi-Purpose building, is included.

- 1 Client Model Review assumed for the Process Enclosure, Compressor Enclosure, and Boiler Enclosure.

- For heating and ventilation, it is assumed that there is enough space in the Process Enclosures, Compressor Enclosure, and Boiler Enclosure for the HVAC equip. Basic 3D modeling in S3D for major HVAC equipment (H&V Unit) and major duct (main run) is included for Enclosure type buildings.

- No HVAC drawings, airflow control diagrams, single line diagrams will be produced during FEED

- All buildings/enclosures in the scope are assumed located in unclassified areas and interiors are assumed unclassified also.

4.12 PROCUREMENT SCOPE OF SERVICES

4.12.1 Procurement Approach

The following outlines the activities for the Minnkota Project Tundra FEED which are based on construction and fabrication support by the Fluor Construction and Fabrication Group for the Carbon Capture Facility retrofit at the Milton R Young Generating Station located near Center, North Dakota.

The key activities during this FEED Phase include:

- Issuance of RFQ's and progress thru to Bid Tab for estimate.
    - K-601 A/B Compressors
    - K-301 Compressor
    - BL-201 Blower
    - PK-601 Dehydration Package
    - Plate & Frame exchangers
    - Shell & Tube exchangers
    - Boilers
    - Centrifugal Pumps
    - DCS/SIS
- Material Responsibility Matrix, Procurement Plan and any other Project document preparation activities are excluded.
- Logistics cost based on budgetary quotes and/or in-house benchmarks

4.12.2 Systems and Procedures

The RFQs will be issued in Fluor's system (Ariba or email). High-level bid clarifications would be carried out with shortlisted bidders.

4.12.3 Deliverables to Client

- RFQ Tracker
- Preliminary award recommendation

4.12.4 Client Interface

Discussions would be held around Client alignment sessions regarding:

- Client Approved Vendor/ Manufacturer List

- Client's existing Frame agreements and commercial Terms & Conditions for purchase.

4.12.5 Interdiscipline Coordination

Coordination would be done with relevant Engineering discipline (i.e. Mechanical, Electrical), to have complete RFQ package, technical clarifications and to complete Technical Bid evaluation.

4.12.6 Assumptions and Clarifications

- Overall FEED duration 9 1/2 months, starting from March 2020.
- Project is open for sourcing outside of North America.
- Only issuance of RFQ and high level bid evaluation are considered in effort estimate.
- Material Responsibility Matrix, Procurement Plan and any other Project document preparation activities are excluded.

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4.13 CONTRACTS SCOPE OF SERVICES

4.13.1 Contracting Approach

The following contracts have been identified to be awarded and executed during FEED phase of the project

- Soil Investigations / Geotechnical*
- Topographical Survey*
- Logistics / Route Survey*
- Duct & Duct Support Design and EPC estimate*
- HAZOP Facilitator*

The following contracts have been identified to be issued for pricing for the EPC Estimate:

- Column / Vessel Fabrication and Erection
- Column Internals Supply and Installation
- Cooling Tower
- Wet Electrostatic Precipitator
- Buildings
- Heavy Haul / Heavy Lift
- Electrical and Instrumentation Construction
- Civil / Earthwork

4.13.2 Systems and Procedures

All Subcontracts will be developed, issued, awarded, and administered in strict accordance with Fluor's proven global contract management practices and work processes using Fluor's proprietary contract management system, CMSi℠. This internet based system enables the contract management staff to plan, administer, track, and monitor contractor change proposals, site instructions, contract modifications and invoices.

4.13.3 Deliverables to Client

Project deliverables to the Client during FEED include (for contracts listed above with asterisk):

- Preliminary Project Bidders List

- Contract Execution Plan (Section 10 of the Project Execution Plan)
- Contract Development Schedule for FEED phase contracts identified above
- Commitment / Contract Registers for FEED phase contracts identified above
- Progress Reports

4.13.4 Client Interface

Client Interface for FEED contracts identified above will include monthly status updating and interfacing prior to the award of the FEED Contracts.

4.13.5 Interdiscipline Coordination

Fluor Contracts will interface and coordinate the work internally with Fluor Project Management, Procurement, Project Controls, Engineering disciplines, and Construction.

4.13.6 Assumptions and Clarifications

Assumptions include, but are not limited to, the following:

- Only Contracts listed in Section 4.13.1 above having an asterisk will be developed and awarded during the FEED phase of the Project. All other contracts listed will be developed through RFP phase to support the budgetary estimate provided at FEED completion and not awarded. Those RFP’s will not be subject to FARs audit provisions.
- All contracts are on Fluor forms and formats
- Fluor Terms and Conditions are used
- Fluor Contract system CMSi^{SM} will be used
- No Special Commercial requirements (i.e., Insurance, Indemnities, Warranties, Liquidated Damages, Bid Bonds, Performance Bonds, etc.) are required for FEED contracts.
- No Trips to/from Site are included
- Any subcontractors providing budgetary pricing for Fluor’s proposal are considered to be a condition of Fluor’s proposal. Alterations at Owner direction may impact price and schedule

4.14 CONSTRUCTION SCOPE OF SERVICES

4.14.1 Fabrication / Construction Approach

The following outlines the activities for the Minnkota Project Tundra FEED.

Key activities during this FEED Phase are related to establishing Constructability of the design and include:

Fabrication

- Module Execution Plan
- Desktop transportation study
- Module envelope size development
- Module contents evaluation.
- Module handling evaluation.
- Module shipping and installation sequencing.
- Weight control plan
- Preliminary testing / pre-commissioning strategy
- Plot plan optimization support

Construction

- Construction Execution Plan
- Staffing plan
- Temporary facilities layout
- Schedule input
- Cost input
- Productivity worksheets
- Contract and procurement support

4.14.2 References and Standards

Fluor typical Fabrication and Construction specifications and standards will be utilized.

4.14.3 Interdiscipline Coordination

The fabrication and construction team members will interface and coordinate work with other disciplines and functions on the project. Interface points relate to the deliverables highlighted in our approach. For most deliverables, the Construction Manager will interface and guide the engineering manager and individual discipline team members keeping construction driven execution at the forefront when creating each deliverable from the list.

4.14.4 Assumptions and Clarifications

This list should include, but should not be limited to, the following:

- For purposes of establishing the FEED budget, EPC execution is considered to be direct hire and stick built, until the routing study and modularization analysis has been completed.
- Estimated trips to job site: 2 trips with 1 person, average for 3 days / trip
- Estimated trips for transportation study: 1 trip for 1 person, average for 5 days / trip

4.15 PROJECT SUPPORT SCOPE OF SERVICES

The purpose of the Project Support Scope of Services is to present the activities and deliverables from Project Business Services, Project Controls & Estimating, Project Quality, Project Document Control, and Project Information Management.

4.15.1 Project Business Services

- Prepare monthly invoices to client in accordance with the contract terms, reviewed and approved by the Project Director or his delegate and formally transmitted.
- All direct supplier and contractor invoices will be received by Project Accounts Payable and verified against the applicable purchase order or contract where necessary. Properly approved invoices will be set up for payment in accordance with the terms of the purchase order or contract.
- Ensure that all internal controls are meet, SOX and internal audit compliance, reconciliations, segregation of duties
- Reporting to project management, project controls and client
- Prime contracts administration, understanding and US Government requirements included in the contract, checking flow down requirements coming from the prime contractor but originating with the US Government, helping assure we stay in compliance with regulations and requirements, etc.

4.15.2 Project Controls & Estimating

All Project Controls activities will be performed in accordance with the Fluor standards as described in the Standard PPM or Job Bulletins issued on the project and is the responsibility of the Project Controls Manager to execute within the specified guidelines. The scope for Project Controls & estimating includes the following:

Estimating

Preparation of a +/-15% cost estimate. The Estimating department, in conjunction with the Project Controls Manager, will be responsible for the preparation of this project estimate. This estimate will have internal reviews with Estimating department management and Project Management and Executive Management as required prior to issue to MPC.

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Scheduling

Development of an EPFC Schedule utilizing Primavera P6 CPM schedule software. There will be one Master Schedule for Engineering, Procurement and Construction produced for this phase of the project.

Cost Control

A detailed home office estimate will serve as the baseline for cost control base and will be loaded into the cost system at the appropriate level of detail. Budget and forecast will be input to the cost system by the Project Controls team from the estimate and deviations as required.

Progress Measurement and Reporting

The project will prepare a summary progress and performance report to the client and Fluor Office Management each month. These reports will summarize and consolidate the status of project costs progress and performance, including identification of any major items of concern.

Deliverables to Client

Project Deliverables Include:

- Mid Month Reports
    - Labor tracking reports
    - Current activities
    - Change Management (PDN) Log
    - Issues and Concerns

- Monthly Report:
    - Updated Schedule
    - Updated Progress and Performance Report w/ Three part curves
    - Cost Report
    - Change Management Log
    - Cash Flow Curves
    - Monthly Accruals

4.15.3 Project Quality

Each individual and supervisor is accountable for the quality of the work assigned to them. Each project team member is responsible for performing work in a quality manner. An off-taskforce Quality department representative will assist in the following activities:

- Implementation of Project Audit Plan
- Coordinate / facilitate and report Audits
- Follow-up on open audit actions items like corrective and preventive actions
- Supplier Quality Surveillance (SQS) working under the Quality Team will provide support to the Procurement (bidding) process through development of Inspection Test Plans (ITP's), and checking of RFQ packages.

4.15.4 Project Document Control

Fluor will develop and implement as part of the overall project execution plan, a document management plan covering all aspects of the management and control of the Project's documentation requirements. Fluor will execute using its electronic document management system (EDMS), Coreworx. As Fluor's communication and collaboration tool, it enables effective information sharing among the project entities. Coreworx allows engagement of the entire project team – home office and site personnel, clients, vendors, fabricators, and suppliers – regardless of the team members' locations. Coreworx's functional components, an Internet-based project collaboration system (PCS) integrated with a robust DMS (Document Management System), can be configured to meet the project business and execution requirements.

4.15.5 Project Information Management

Fluor will develop as part of the overall project execution plan an information management plan covering all aspects of the Work regarding execution and management of the Project. The plan will address the following:

- Provide and manage secure information technology (IT) facilities, including hardware, software, networks, applications and systems capable of supporting the Work
- Security for all information management aspects of the Work
- Provide and manage communications facilities required to support the Work
- Provide and manage an electronic document management system (EDMS) to support the Work
- Manage the development of engineering deliverables via the use of CAD applications
- Provide and manage two-dimensional (2D) drafting systems
- Provide and manage 3D plant modelling systems to develop the plant model

- Enable model reviews via the use of 3D viewing software

3.0 FEED SCHEDULE

3.1 INTRODUCTION

3.1.1 PURPOSE

The purpose of this document is to communicate the reasoning and methodology supporting the current Minnkota Project Tundra Level 1 Schedule structure and content. This document is intended to be utilized by any person(s) reviewing or analyzing the Level 1 Schedule in order to maintain a consistent schedule execution alignment across the program.

3.1.2 PROJECT OVERVIEW

The project scope is to provide Front End Engineering and Design (FEED) for a Carbon Capture and Sequestration project as well as the associated off sites and utilities at the Milton R. Young Generating Station located near Center, North Dakota. The capacity of the Carbon Capture System will be determined based.

The project proposed execution from Fluor Houston.

The technology proposed for this project is owned by Fluor.

3.1.3 PLANNING METHODOLOGY

The schedule was compiled utilizing historical data from previous similar projects. The resulting schedule was reviewed by Engineering Leads. Their comments have been incorporated. The schedule is an unconstrained, unmitigated schedule with a high degree of achievable probability and reasonable risk.

3.1.4 SCHEDULE OVERVIEW

The resulting overall schedule is nine and a half (9 1/2) months from Project Start and Award thru FEED Completion. The schedule assumes the following:

- Fluor Data Standards, Processes, and Procedures will be followed.
- Project Deliverables will be in accordance with Fluor’s FEED Minimal Deliverables List.
- Client will have resources to support Joint Reviews, PHAs, etc. in accordance with the schedule.
- The schedule is based on five (5) day work calendar with allowances for standard Fluor US Holidays.

- RFQ packages will be developed to obtain pricing for the estimate.
- Five (5) early contracts will have to be awarded and executed during FEED.

3.1.5 MAJOR MILESTONES

- Project Start – Month 1
- PHA – Month 5
- P&IDS IFD – Month 6
- Plot Plan IFD – Month 7
- FEED Complete – Month 10

3.2 REFERENCE PROJECTS

Carbon Capture Project Durations have ranged from 7 – 9 months

- SaskPower – 7 month FEED
- NRG – 9 month FEED
- ROAD – 7 month FEED

3.3 PROJECT RISKS AND MITIGATIONS

NO.	RISK	MITIGATION
1.	Delayed Client approval or decision making impacting schedule	Secure schedule alignment with the client. (Review and Approval Durations, Change mgmt. Process, etc.)
		Show Client Obligations in the schedule
		Include Client in Key Decisions
		Enforce Change Mgmt. Procedure
		Engage Fluor Executive Sponsor when Necessary
2.	Optimistic Schedule Expectations	Apply Benchmarks for Historical Database
		Mandate Schedule development Through Workshop-type Collaboration
3.	Impacts from COVID-19 virus	Develop alternative plans for face to face meetings if required
		Develop alternatives for gathering site information
		Over communicate information, needs, and status

Figure 3-1. Project Risks and Mitigations.

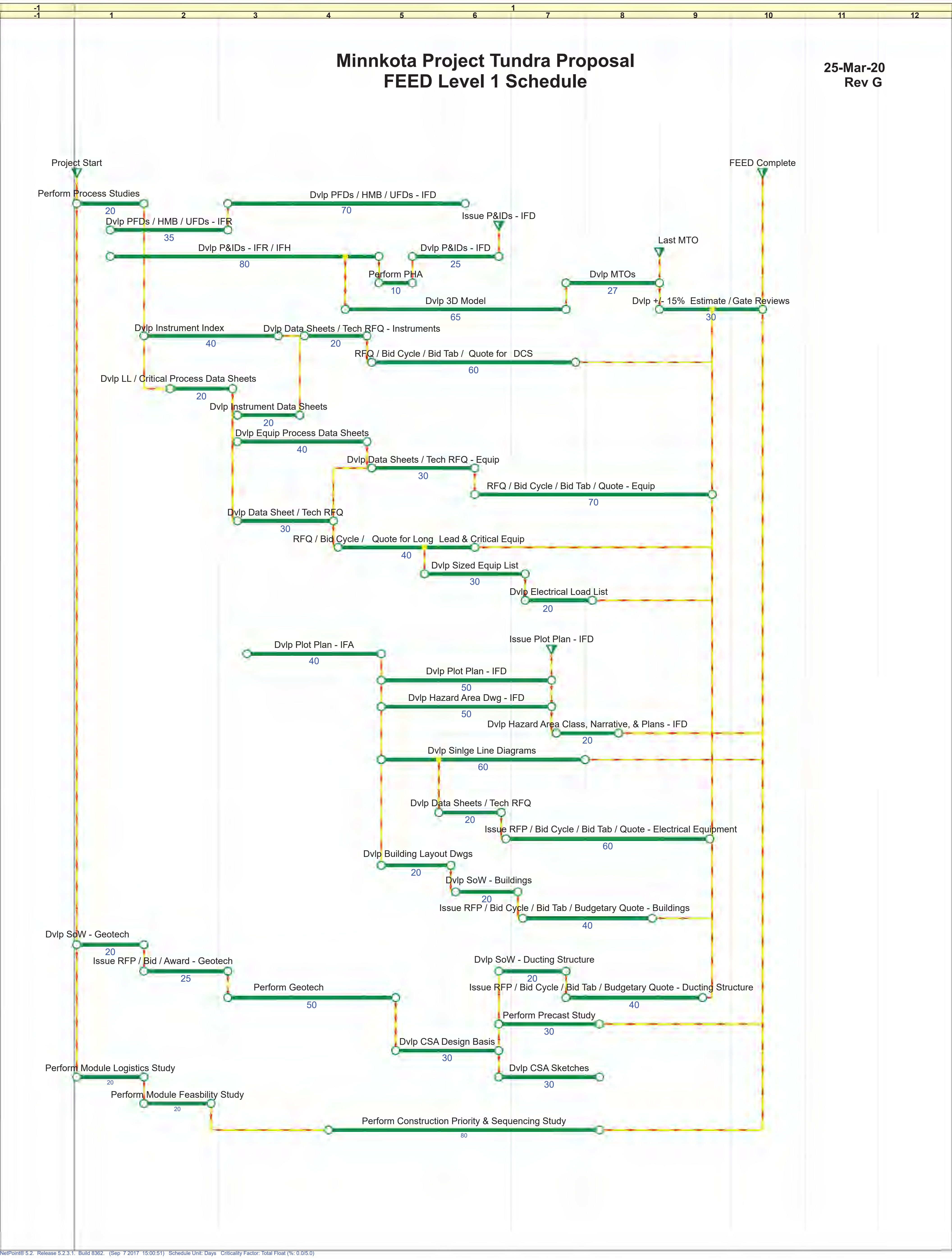
Attachment 3-1

Minnkota Power Tundra FEED

Level 1 Schedule

Minnkota Project Tundra Proposal
FEED Level 1 Schedule

25-Mar-20
Rev G



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HO20200146-004.pdf

5.0 COMMERCIAL PROPOSAL REVISION 03

FEED Services Estimate

Funding and Contract Cost Limitation

Fluor's FEED Services Estimate is based on cost reimbursable terms, with costs calculated according to the applicable requirements of 2 CFR Section 200. Contractor shall be paid on a cost reimbursable basis subject to a contract cost limitation of Eight Million Four Hundred Six Thousand Nine Hundred Forty Two United States Dollars ($8,406,942). This contract cost limitation consists of the estimated costs as identified in budget justification, Attachment 4-1 attached herewith. Fluor will utilize only its government indirect rates for the Tundra project.

The total Fee payable by Owner to Fluor will be Eight Hundred Forty Thousand Six Hundred Ninety Four United States Dollars ($840,694) which is in addition to the contract cost limitation.

Limitation of Cost

Fluor will notify Minnkota in writing whenever it has reason to believe that the costs it expects to incur in the next sixty (60) days, when added to costs previously incurred, will exceed seventy five percent (75%) of the contract cost limitation. If Fluor is unable to complete the work for the contract cost limitation, Minnkota may agree to (i) an increase in the Contract Cost Limitation; (ii) a de-scope of the remaining Work; or (iii) termination of this Contract pursuant to paragraph 16 of the DOE Vendor Flow Down Provisions (DE-FE0031845)

Cost Sharing for Completion of the Work for Costs Incurred in excess of the Contract Cost Limitation

In the event Minnkota and Fluor agree to exceed the Contract Cost Limitation,

(1) Fluor shall in no event be entitled to any additional Fee;

(2) Minnkota shall reimburse Fluor for the cost to complete the Work until such costs equal Four and One Half Percent (4.5%) of the Contract Cost Limitation.

(3) After the amount in item 2 has been reached, Fluor's Work shall be at Fluor's cost until such costs equal 50% of the amount of the total payable Fee.

(4) After the amount in item 3 has been reached, Minnkota shall reimburse Fluor for the remaining cost to complete the Work.

Total Estimated Cost Summary

ESTIMATED HOURS	ESTIMATED CONTRACT COST LIMITATION	FEE	ESTIMATED TOTAL COST
58,331	$8,406,942	$840,694	$9,247,636

Contract

Fluor has based our commercial proposal on the terms and conditions of the Contract set forth in Attachment 4-2. Fluor reserves the right to make changes to its commercial proposal in the event of any changes to this proposed contract.

Payment Terms & Invoicing

Payment terms shall be based on monthly progress payments as set forth in Attachment 4-3 Contract Price and Payment Provisions attached hereto.

Additional Commercial Information/Clarifications/Exceptions

1. The Fluor proposed rates shall apply for services provided by personnel working in Sugar Land or Aliso Viejo offices, or temporarily working or visiting the Minnkota Power Cooperative offices under the same name.

2. The proposed commercial terms are reimbursable where payment is made based upon hours worked and subject to the contract cost limitation and the Feed Service Estimate Section of these commercial terms.

3. All payments shall be in U.S. dollars. Should other reimbursable costs be incurred in other than U.S. dollars, such reimbursable costs shall be paid in U.S. dollars, converted at the currency exchange rate published in the U.S. Wall Street Journal on the date of the invoice.

4. One furnished client office in the available form in our Sugar Land offices is included in the proposed commercial provisions at no additional charge to Minnkota Power Cooperative. Additional furnished offices required are subject to an additional charge. It is assumed that Minnkota Power Cooperative will supply its own computers and long distance telephone calls charged by calling card or equivalent. Should custom furnishings, analog phone lines, or non-standard office appurtenances be required, such would be reimbursed at invoiced cost, without markup, or at some other mutually agreed rate.

5. This proposal is based upon work in accordance with Fluor's standard work policies and procedures.

6. The proposed rates are valid through 2020, after which time such terms may be revised as mutually agreed.

7. Travel costs are estimated, and would be reimbursed at actual cost per the Fluor Government Travel Policy HR-126 attached.

8. All third party costs needed to complete the work and any travel costs, shall be billable at cost plus a four percent (4.00 percent) mark-up in line with DOE approved rates.

Attachment 4-1

Revised Budget Justification

Instructions and Summary

Award Number:

Award Recipient: Minnkota Power Cooperative

Date of Submission: 4/9/2020

Form submitted by: Fluor Corporation

(May be award recipient or sub-recipient)

Please read the instructions on each worksheet tab before starting. If you have any questions, please ask your DOE contact!

1. If using this form for award application, negotiation, or budget revision, fill out the blank white cells in workbook tabs a. through j. with total project costs. If using this form for invoice submission, fill out tabs a. through j. with total costs for just the proposed invoice and fill out tab k. per the instructions on that tab.
2. Blue colored cells contain instructions, headers, or summary calculations and should not be modified. Only blank white cells should be populated.
3. Enter detailed support for the project costs identified for each Category line item within each worksheet tab to autopopulate the summary tab.
4. The total budget presented on tabs a. through i must include both Federal (DOE) and Non-Federal (cost share) portions
5. All costs incurred by the preparer's sub-recipients, vendors, and Federal Research and Development Centers (FFRDCs), should be entered only in section f. Contractual. All other sections are for the costs of the preparer only.
6. Ensure all entered costs are allowable, allocable, and reasonable in accordance with the administrative requirements prescribed in 2 CFR 200, and the applicable cost principles for each entity type: FAR Part 31 for For-Profit entities; and 2 CFR Part 200 Subpart E - Cost Principles for all other non-federal entities.
7. Add rows as needed throughout tabs a. through j. If rows are added, formulas/calculations may need to be adjusted by the preparer. Do not add rows to the Instructions and Summ tab. If your project contains more than three budget periods, consult your DOE contact before adding additional budget period rows or columns.
8. ALL budget period cost categories are rounded to the nearest dollar.

BURDEN DISCLOSURE STATEMENT

SUMMARY OF BUDGET CATEGORY COSTS PROPOSED

The values in this summary table are from entries made in subsequent tabs, only blank white cells require data entry

Section A - Budget Summary

	Federal	Cost Share	Total Costs	Cost Share %	Proposed Budget Period Dates
Budget Period 1	$9,247,636	$0	$9,247,636	0.00%	**Example!!!** 01/01/2014 - 12/31/2014
Budget Period 2	$0	$0	$0	0.00%	
Budget Period 3	$0	$0	$0	0.00%	
Total	$9,247,636	$0	$9,247,636	0.00%	

Section B - Budget Categories

CATEGORY	Budget Period 1	Budget Period 2	Budget Period 3	Total Costs	% of Project	**Comments** (as needed)
a. Personnel	$5,118,322	$0	$0	$5,118,322	55.35%	
b. Fringe Benefits	$2,501,143	$0	$0	$2,501,143	27.05%	
c. Travel	$18,300	$0	$0	$18,300	0.20%	
d. Equipment	$0	$0	$0	$0	0.00%	
e. Supplies	$5,833	$0	$0	$5,833	0.06%	
f. Contractual						
Sub-recipient	$0	$0	$0	$0	0.00%	
Vendor	$440,000	$0	$0	$440,000	4.76%	
FFRDC	$0	$0	$0	$0	0.00%	
Total Contractual	$440,000	$0	$0	$440,000	4.76%	
g. Construction	$0	$0	$0	$0	0.00%	
h. Other Direct Costs	$0	$0	$0	$0	0.00%	
Total Direct Costs	$8,083,598	$0	$0	$8,083,598	87.41%	
i. Indirect Charges	$1,164,038	$0	$0	$1,164,038	12.59%	
Total Costs	$9,247,636	$0	$0	$9,247,636	100.00%	

Additional Explanation (as needed):

Detailed Budget Justification

a. Personnel

INSTRUCTIONS - PLEASE READ!!!

1. List project costs solely for employees of the entity completing this form. All personnel costs for subrecipients and vendors must be included under f. Contractual.

2. All personnel should be identified by position title and not employee name. Enter the amount of time (e.g., hours or % of time) and the base pay rate and the total direct personnel compensation will automatically calculate. Rate basis (e.g., actual salary, labor distribution report, state civil service rates, etc.) must also be identified.

3. If loaded labor rates are utilized, a description of the costs the loaded rate is comprised of must be included in the Additional Explanation section below. DOE must review all components of the loaded labor rate for reasonableness and unallowable costs (e.g. fee or profit).

4. If a position and hours are attributed to multiple employees (e.g. Technician working 4000 hours) the number of employees for that position title must be identified.

5. Each budget period is rounded to the nearest dollar

SOPO Task #	Position Title	Budget Period 1			Budget Period 2			Budget Period 3			Project Total Hours	Project Total Dollars	Rate Basis
		Time (Hrs)	Pay Rate ($/Hr)	Total Budget Period 1	Time (Hrs)	Pay Rate ($/Hr)	Total Budget Period 2	Time (Hrs)	Pay Rate ($/Hr)	Total Budget Period 3			
1	Sr. Engineer **(EXAMPLE!!!)**	2000	$85.00	$170,000	200	$50.00	$10,000	200	$50.00	$10,000	2400	$190,000	Actual Salary
2	Technicians (2)	4000	$20.00	$80,000	0	$0.00	$0	0	$0.00	$0	4000	$80,000	Actual Salary
Task 1. Project Management & Planning													
				$0			$0			$0	0	$0	
				$0			$0			$0	0	$0	
				$0			$0			$0	0	$0	
				$0			$0			$0	0	$0	
				$0			$0			$0	0	$0	
				$0			$0			$0	0	$0	
				$0			$0			$0	0	$0	
				$0			$0			$0	0	$0	
				$0			$0			$0	0	$0	
				$0			$0			$0	0	$0	
				$0			$0			$0	0	$0	
				$0			$0			$0	0	$0	
				$0			$0			$0	0	$0	
				$0			$0			$0	0	$0	
				$0			$0			$0	0	$0	
Task 2. Engineering & Design													
	Process Director (E&C)	620	$151.65	$93,957			$0			$0	620	$93,957	Estimated base compensation
	Project Administrative Assistant (E&C)	147	$62.22	$9,130			$0			$0	147	$9,130	Estimated base compensation
	PCE Set Up (E&C)	122	$97.27	$11,895			$0			$0	122	$11,895	Estimated base compensation
	Cobra (E&C)	408	$55.68	$22,695			$0			$0	408	$22,695	Estimated base compensation
	Industrial Relations (E&C)	163	$131.08	$21,372			$0			$0	163	$21,372	Estimated base compensation
	Project Manager (FGG)	1549	$132.65	$205,473			$0			$0	1549	$205,473	Estimated base compensation
	Prime Contracts Administrator (FGG)	489	$64.26	$31,431			$0			$0	489	$31,431	Estimated base compensation
	Quality Manager (FGG)	326	$64.26	$20,954			$0			$0	326	$20,954	Estimated base compensation
	Project Information Manager (FGG)	1043	$65.33	$68,172			$0			$0	1043	$68,172	Estimated base compensation
	Project Controls Manager (FGG)	1549	$117.44	$181,909			$0			$0	1549	$181,909	Estimated base compensation
	Scheduler (FGG)	538	$64.26	$34,574			$0			$0	538	$34,574	Estimated base compensation
	Project Business Services (FGG)	293	$89.93	$26,392			$0			$0	293	$26,392	Estimated base compensation
	Procurement Manager (FGG)	1467	$97.27	$142,737			$0			$0	1467	$142,737	Estimated base compensation
	Procurement 1 (FGG)	1304	$68.72	$89,641			$0			$0	1304	$89,641	Estimated base compensation
	Contracts (FGG)	2853	$80.33	$229,211			$0			$0	2853	$229,211	Estimated base compensation
	Construction Manager (FGG)	1141	$134.17	$153,129			$0			$0	1141	$153,129	Estimated base compensation
	Logistics (FGG)	489	$68.72	$33,615			$0			$0	489	$33,615	Estimated base compensation
	Construction Module Adviser (FGG)	489	$97.27	$47,579			$0			$0	489	$47,579	Estimated base compensation
	Process Water Trt SME (E&C)	571	$118.27	$67,494			$0			$0	571	$67,494	Estimated base compensation

SOPO Task #	Position Title	Budget Period 1			Budget Period 2			Budget Period 3			Project Total Hours	Project Total Dollars	Rate Basis
		Time (Hrs)	Pay Rate ($/Hr)	Total Budget Period 1	Time (Hrs)	Pay Rate ($/Hr)	Total Budget Period 2	Time (Hrs)	Pay Rate ($/Hr)	Total Budget Period 3			
	Metallurgist (E&C)	147	$118.27	$17,356			$0			$0	147	$17,356	Estimated base compensation
	Welding Engineer (E&C)	82	$81.30	$6,628			$0			$0	82	$6,628	Estimated base compensation
	Paint & Insulation Engr (E&C)	114	$62.22	$7,101			$0			$0	114	$7,101	Estimated base compensation
	Cathodic Protection Engr (E&C)	98	$118.27	$11,570			$0			$0	98	$11,570	Estimated base compensation
	Tank/Vessel Engineer (E&C)	163	$97.27	$15,860			$0			$0	163	$15,860	Estimated base compensation
	Fired Equipment Engineer (E&C)	326	$81.30	$26,511			$0			$0	326	$26,511	Estimated base compensation
	Discipline Application Specialist (DAS) (E&C)	82	$90.18	$7,352			$0			$0	82	$7,352	Estimated base compensation
	Stress (E&C)	489	$81.30	$39,767			$0			$0	489	$39,767	Estimated base compensation
	Piping Material Control (E&C)	326	$55.68	$18,156			$0			$0	326	$18,156	Estimated base compensation
	HVAC Engineering (E&C)	448	$68.72	$30,814			$0			$0	448	$30,814	Estimated base compensation
	HVAC Design (E&C)	326	$56.42	$18,398			$0			$0	326	$18,398	Estimated base compensation
	Control Systems Engineer (E&C)	82	$117.14	$9,550			$0			$0	82	$9,550	Estimated base compensation
	Telecomm Engineer (E&C)	163	$105.10	$17,136			$0			$0	163	$17,136	Estimated base compensation
	Control Systems Design (E&C)	285	$96.77	$27,612			$0			$0	285	$27,612	Estimated base compensation
	S3D Coordinator (E&C)	277	$68.72	$19,049			$0			$0	277	$19,049	Estimated base compensation
	SP Lead/Data Integrator (E&C)	277	$62.22	$17,246			$0			$0	277	$17,246	Estimated base compensation
	S3D Material Coordinator (E&C)	147	$62.22	$9,130			$0			$0	147	$9,130	Estimated base compensation
	Engineering Manager (FGG)	489	$119.86	$58,629			$0			$0	489	$58,629	Estimated base compensation
	Technical Document Control (FGG)	505	$60.51	$30,583			$0			$0	505	$30,583	Estimated base compensation
	Process Engineer (FGG)	3587	$92.80	$332,879			$0			$0	3587	$332,879	Estimated base compensation
	Process WWT/Raw Watr/Storm Watr (FGG)	815	$81.30	$66,278			$0			$0	815	$66,278	Estimated base compensation
	Process Graphics 1 (FGG)	897	$62.22	$55,797			$0			$0	897	$55,797	Estimated base compensation
	Process Graphics 2 (FGG)	265	$62.22	$16,485			$0			$0	265	$16,485	Estimated base compensation
	Process Engineering Lead (shared) (FGG)	509	$93.89	$47,826			$0			$0	509	$47,826	Estimated base compensation
	Process Engineer (shared) (FGG)	509	$55.68	$28,360			$0			$0	509	$28,360	Estimated base compensation
	Lead Mechanical Engineer (FGG)	1467	$118.27	$173,556			$0			$0	1467	$173,556	Estimated base compensation
	Tank/Vessel Engineer (FGG)	1924	$119.92	$230,720			$0			$0	1924	$230,720	Estimated base compensation
	Heat Exchanger Engineer (FGG)	766	$81.30	$62,301			$0			$0	766	$62,301	Estimated base compensation
	Miscl / Pkg Engineer (FGG)	1353	$80.72	$109,231			$0			$0	1353	$109,231	Estimated base compensation
	Rotating Specialist 1 (FGG)	1141	$97.27	$111,017			$0			$0	1141	$111,017	Estimated base compensation
	Rotating Specialist 2 (FGG)	538	$97.27	$52,337			$0			$0	538	$52,337	Estimated base compensation
	Piping Lead Engineer (FGG)	734	$107.30	$78,724			$0			$0	734	$78,724	Estimated base compensation
	Piping Material Engineer (FGG)	929	$68.72	$63,869			$0			$0	929	$63,869	Estimated base compensation
	Piping Designer 1 (FGG)	978	$75.55	$73,904			$0			$0	978	$73,904	Estimated base compensation
	Piping Designer 2 (FGG)	897	$75.55	$67,746			$0			$0	897	$67,746	Estimated base compensation
	Piping Designer 3 (FGG)	815	$75.55	$61,587			$0			$0	815	$61,587	Estimated base compensation
	Piping Designer 4 (FGG)	652	$75.55	$49,270			$0			$0	652	$49,270	Estimated base compensation
	Piping Designer Supervisor (FGG)	1223	$75.55	$92,381			$0			$0	1223	$92,381	Estimated base compensation
	CSA Lead (FGG)	1467	$108.71	$159,518			$0			$0	1467	$159,518	Estimated base compensation
	Civil Engineering (FGG)	387	$81.30	$31,482			$0			$0	387	$31,482	Estimated base compensation
	Structural Design (FGG)	978	$56.42	$55,195			$0			$0	978	$55,195	Estimated base compensation
	Structural Engineer 1 (FGG)	1198	$81.30	$97,428			$0			$0	1198	$97,428	Estimated base compensation
	Structural Engineer 2 (FGG)	734	$62.22	$45,652			$0			$0	734	$45,652	Estimated base compensation
	Structural Engineer 3 (FGG)	734	$62.22	$45,652			$0			$0	734	$45,652	Estimated base compensation
	HVAC Engineering (FGG)	750	$81.30	$60,976			$0			$0	750	$60,976	Estimated base compensation
	Architectural Engineer 1 (FGG)	1243	$81.30	$101,074			$0			$0	1243	$101,074	Estimated base compensation
	Architectural Engineer 2 (FGG)	766	$68.72	$52,664			$0			$0	766	$52,664	Estimated base compensation
	Architectural Engineer 3 (FGG)	326	$68.72	$22,410			$0			$0	326	$22,410	Estimated base compensation

SOPO Task #	Position Title	Budget Period 1 Time (Hrs)	Budget Period 1 Pay Rate ($/Hr)	Total Budget Period 1	Budget Period 2 Time (Hrs)	Budget Period 2 Pay Rate ($/Hr)	Total Budget Period 2	Budget Period 3 Time (Hrs)	Budget Period 3 Pay Rate ($/Hr)	Total Budget Period 3	Project Total Hours	Project Total Dollars	Rate Basis
	Electrical Designer (FGG)	1891	$73.88	$139,734			$0			$0	1891	$139,734	Estimated base compensation
	Electrical Engineer (FGG)	1663	$130.00	$216,194			$0			$0	1663	$216,194	Estimated base compensation
	Control Systems Engr Lead (FGG)	1141	$102.25	$116,699			$0			$0	1141	$116,699	Estimated base compensation
	Control Systems Engineer (FGG)	878	$53.66	$47,116			$0			$0	878	$47,116	Estimated base compensation
	HSE Lead (FGG)	668	$87.05	$58,189			$0			$0	668	$58,189	Estimated base compensation
	HSE Fire Protection (FGG)	897	$81.30	$72,906			$0			$0	897	$72,906	Estimated base compensation
	Coreworx Global Support (FGG)	505	$64.26	$32,479			$0			$0	505	$32,479	Estimated base compensation
Task 3. Permitting Strategy													
Task 4. Cost Estimating													
	Estimator (E&C)	673	$55.68	$37,447			$0			$0	673	$37,447	Estimated base compensation
	Estimator (FGG)	1039	$68.72	$71,432			$0			$0	1039	$71,432	Estimated base compensation
	Total Personnel Costs	**58331**		**$5,118,322**	**0**		**$0**	**0**		**$0**	**0**	**$5,118,322**	

Proposed labor rates include employee salary plus time off with pay per and consistent with Fluor Federal Services (FFS) disclose accounting practices.

b. Fringe Benefits

INSTRUCTIONS - PLEASE READ!!

1. Fill out the table below by position title. If all employees receive the same fringe benefits, you can show "Total Personnel" in the Labor Type column instead of listing out all position titles.
2. The rates and how they are applied should not be averaged to get one fringe cost percentage. Complex calculations should be described/provided in the Additional Explanation section below.
3. The fringe benefit rates should be applied to all positions, regardless of whether those funds will be supported by Federal Share or Recipient Cost Share.
4. Each budget period is rounded to the nearest dollar.

Labor Type	Budget Period 1			Budget Period 2			Budget Period 3			Total Project
	Personnel Costs	Rate	Total	Personnel Costs	Rate	Total	Personnel Costs	Rate	Total	
EXAMPLE!!! Sr. Engineer	$170,000	20%	$34,000	$10,000	20%	$2,000	$10,000	20%	$2,000	$38,000
Fluor Government Group (FGG) Employees	4,555,095	52.16%	$2,375,937			$0			$0	$2,375,937
Fluor Energy & Chemicals (E&C) Employees	563,227	22.23%	$125,205			$0			$0	$125,205
			$0			$0			$0	$0
			$0			$0			$0	$0
			$0			$0			$0	$0
Total:	**$5,118,322**		**$2,501,143**	**$0**		**$0**	**$0**		**$0**	**$2,501,143**

A federally approved fringe benefit rate agreement, or a proposed rate supported and agreed upon by DOE for estimating purposes is required at the time of award negotiation if reimbursement for fringe benefits is requested. Please check (X) one of the options below and provide the requested information if not previously submitted.

___x___ A fringe benefit rate has been negotiated with, or approved by, a federal government agency. A copy of the latest rate agreement is/was included with the project application.*

______ There is not a current federally approved rate agreement negotiated and available.**

*Unless the organization has submitted an indirect rate proposal which encompasses the fringe pool of costs, please provide the organization's benefit package and/or a list of the components/elements that comprise the fringe pool and the cost or percentage of each component/element allocated to the labor costs identified in the Budget Justification.

**When this option is checked, the entity preparing this form shall submit an indirect rate proposal in the format provided in the Sample Rate Proposal at http://www1.eere.energy.gov/financing/resources.html, or a format that provides the same level of information and which will support the rates being proposed for use in the performance of the proposed project.

Additional Explanation (as necessary): Please use this box (or an attachment) to list the elements that comprise your fringe benefits and how they are applied to your base (e.g. Personnel) to arrive at your fringe benefit rate.

c. Travel

INSTRUCTIONS - PLEASE READ!!!

1. Identify Foreign and Domestic Travel as separate items. Examples of Purpose of Travel are subrecipient site visits, DOE meetings, project mgmt. meetings, etc. Examples of Basis for Estimating Costs are past trips, travel quotes, GSA rates, etc.

2. All listed travel must be necessary for performance of the Statement of Project Objectives.

3. Federal travel regulations are contained within the applicable cost principles for all entity types. Travel costs should remain consistent with travel costs incurred by an organization during normal business operations as a result of the organizations written travel policy. In absence of a written travel policy, organizations must follow the regulations prescribed by the General Services Administration.

4. Each budget period is rounded to the nearest dollar.

SOPO Task #	Purpose of Travel	Depart From	Destination	No. of Days	No. of Travelers	Lodging per Traveler	Flight per Traveler	Vehicle per Traveler	Per Diem Per Traveler	Cost per Trip	Basis for Estimating Costs
	Domestic Travel				**Budget Period 1**						
1	**EXAMPLE!!!** Visit to PV manufacturer			2	2	$250	$500	$100	$160	$2,020	Current GSA rates
1	Site Visit - Project Management	Houston, TX	Center, ND	3	2	$300	$600	$327	$165	$2,784	Indicative; Actual costs reimbursable
2	Site Visit - Construction Management	Houston, TX	Center, ND	3	2	$300	$600	$327	$165	$2,784	Indicative; Actual costs reimbursable
2	Site Visit - Process Engineering	Houston, TX	Center, ND	3	4	$300	$600	$327	$165	$5,568	Indicative; Actual costs reimbursable
2	Site Visit - Civil/Structural Engineering & Design	Houston, TX	Center, ND	2	2	$200	$600	$218	$110	$2,256	Indicative; Actual costs reimbursable
2	Identify Interface & Tie-ins - Piping	Houston, TX	Center, ND	2	1	$200	$600	$218	$110	$1,128	Indicative; Actual costs reimbursable
2	Transportation Study - Construction Management	Houston, TX	Center, ND	5	1	$500	$600	$545	$275	$1,920	Indicative; Actual costs reimbursable
2	Area Labor Survey - Construction Management	Houston, TX	Center, ND	3	1	$300	$600	$327	$165	$1,392	Indicative; Actual costs reimbursable
	Misc Reimbursable Expenses (i.e. mileage & tolls or taxi to/from airport, airport parking, baggage fees, etc) for travel shown above	Houston, TX	Center, ND	1	1					$468	Indicative; Actual costs reimbursable
										$0	
	International Travel										
										$0	
	Budget Period 1 Total									**$18,300**	
	Domestic Travel				**Budget Period 2**						
										$0	
										$0	
										$0	
										$0	
	International Travel										
										$0	
	Budget Period 2 Total									**$0**	
	Domestic Travel				**Budget Period 3**						
										$0	
										$0	
										$0	
										$0	
	International Travel										
										$0	
	Budget Period 3 Total									**$0**	
	PROJECT TOTAL									**$18,300**	

Additional Explanation (as needed):

d. Equipment

INSTRUCTIONS - PLEASE READ!!!

1. Equipment means tangible personal property (including information technology systems) having a useful life of more than one year and a per-unit acquisition cost which equals or exceeds the lesser of the capitalization level established by the non-Federal entity for financial statement purposes, or $5,000. Please refer to the applicable Federal regulations in 2 CFR 200 for specific equipment definitions and treatment.

2. List all equipment below, providing a basis of cost (e.g. vendor quotes, catalog prices, prior invoices, etc.). Briefly justify items as they apply to the Statement of Project Objectives. If it is existing equipment, provide logical support for the estimated value shown.

3. During award negotiations, provide a vendor quote for all equipment items over $50,000 in price. If the vendor quote is not an exact price match, provide an explanation in the additional explanation section below. If a vendor quote is not practical, such as for a piece of equipment that is purpose-built, first of its kind, or otherwise not available off the shelf, provide a detailed engineering estimate for how the cost estimate was derived.

4. Each budget period is rounded to the nearest dollar

SOPO Task #	Equipment Item	Qty	Unit Cost	Total Cost	Basis of Cost	Justification of need
				Budget Period 1		
3,4,5	**EXAMPLE!!!** Thermal shock chamber	2	$70,000	$140,000	Vendor Quote - Attached	Reliability testing of PV modules- Task 4.3
				$0		
				$0		
				$0		
				$0		
				$0		
				$0		
	Budget Period 1 Total			$0		
				Budget Period 2		
				$0		
				$0		
				$0		
				$0		
				$0		
				$0		
	Budget Period 2 Total			$0		
				Budget Period 3		
				$0		
				$0		
				$0		
				$0		
				$0		
				$0		
	Budget Period 3 Total			$0		
	PROJECT TOTAL			**$0**		

Additional Explanation (as needed):

e. Supplies

INSTRUCTIONS - PLEASE READ!!!

1. Supplies are generally defined as an item with an acquisition cost of $5,000 or less and a useful life expectancy of less than one year. Supplies are generally consumed during the project performance. Please refer to the applicable Federal regulations in 2 CFR 200 for specific supplies definitions and treatment. A computing device is a supply if the acquisition cost is less than the lesser of the capitalization level established by the non-Federal entity for financial statement purposes or $5,000, regardless of the length of its useful life.

2. List all proposed supplies below, providing a basis of costs (e.g. vendor quotes, catalog prices, prior invoices, etc.). Briefly justify the need for the Supplies as they apply to the Statement of Project Objectives. Note that Supply items must be direct costs to the project at this budget category, and not duplicative of supply costs included in the indirect pool that is the basis of the indirect rate applied for this project.

3. Multiple supply items valued at $5,000 or less used to assemble an equipment item with a value greater than $5,000 with a useful life of more than one year should be included on the equipment tab. If supply items and costs are ambiguous in nature, contact your DOE representative for proper categorization.

4. Add rows as needed. If rows are added, formulas/calculations may need to be adjusted by the preparer.

5. Each budget period is rounded to the nearest dolla

SOPO Task #	General Category of Supplies	Qty	Unit Cost	Total Cost	Basis of Cost	Justification of need
				Budget Period 1		
4,6	**EXAMPLE!!!** Wireless DAS components	10	$360.00	$3,600	Catalog price	For Alpha prototype - Task 2.4
1	Office supplies, courier/postage, etc.	1	$5,833.00	$5,833	Estimate	Misc. office expenses excluded from overhead multipliers
				$0		
				$0		
				$0		
				$0		
				$0		
				$0		
	Budget Period 1 Total			**$5,833**		
				Budget Period 2		
				$0		
				$0		
				$0		
				$0		
				$0		
				$0		
				$0		
				$0		
	Budget Period 2 Total			$0		
				Budget Period 3		
				$0		
				$0		
				$0		
				$0		
				$0		
				$0		
				$0		
				$0		
	Budget Period 3 Total			$0		
	PROJECT TOTAL			**$5,833**		

Additional Explanation (as needed):

f. Contractual

INSTRUCTIONS - PLEASE READ!!!

1. The entity completing this form must provide all costs related to subrecipients, vendors, and FFRDC partners in the applicable boxes below.

2. Subrecipients (partners, sub-awardees): Subrecipients shall submit a Budget Justification describing all project costs and calculations when their total proposed budget exceeds either (1) $100,000 or (2) 50% of total award costs.These subrecipient forms may be completed by either the subrecipients themselves or by the preparer of this form. The budget totals on the subrecipient's forms must match the subrecipient entries below. A subrecipient is a legal entity to which a subaward is made, who has performance measured against whether the objectives of the Federal program are met, is responsible for programmatic decision making, must adhere to applicable Federal program compliance requirements, and uses the Federal funds to carry out a program of the organization. All characteristics may not be present and judgment must be used to determine subrecipient vs. vendor status.

3. Vendors (including contractors) List all vendors and contractors supplying commercial supplies or services used to support the project. For each Vendor cost with total project costs of $250,000 or more, a Vendor quote must be provided. A vendor is a legal entity contracted to provide goods and services within normal business operations, provides similar goods or services to many different purchasers, op in a competitive environment, provides goods or services that are ancillary to the operation of the Federal program, and is not subject to compliance requirements of the Federal program. All characteristics may not be present and judgment must be used to determine subrecipient vs. vendor status.

4. Federal Funded Research and Development Centers (FFRDCs):FFRDCs must submit a signed Field Work Proposal during award application. The award recipient may allow the FFRDC to provide this information directly to DOE, however project costs must also be provided below.

5. Each budget period is rounded to the nearest dollar.

SOPO Task #	Sub-Recipient Name/Organization	Purpose and Basis of Cost	Budget Period 1	Budget Period 2	Budget Period 3	Project Total
2,4	**EXAMPLE!!!** XYZ Corp.	Partner to develop optimal lens for Gen 2 product. Cost estimate based on personnel hours.	$48,000	$32,000	$16,000	**$96,000**
						$0
						$0
						$0
						$0
						$0
						$0
		Sub-total	**$0**	**$0**	**$0**	**$0**

SOPO Task #	Vendor Name/Organization	Purpose and Basis of Cost	Budget Period 1	Budget Period 2	Budget Period 3	Project Total
6	**EXAMPLE!!!** ABC Corp.	Vendor for developing robotics to perform lens inspection. Estimate provided by vendor.	$32,900	$86,500		**$119,400**
						$0
2	To be determined	Geotechnical Survey	$150,000			**$150,000**
2	To be determined	Level II PHA	$70,000			**$70,000**
2	To be determined	IES Ducting Design Study	$145,000			**$145,000**
2	To be determined	Detailed Route / Transportation Study	$75,000			**$75,000**
						$0
						$0
		Sub-total	**$440,000**	**$0**	**$0**	**$440,000**

SOPO Task #	FFRDC Name/Organization	Purpose and Basis of Cost	Budget Period 1	Budget Period 2	Budget Period 3	Project Total
						$0
						$0
		Sub-total	**$0**	**$0**	**$0**	**$0**

	Total Contractual		**$440,000**	**$0**	**$0**	**$440,000**

The third party subcontract values shown above are indicative based on Fluor in-house estimates.

g. Construction

PLEASE READ!!

1. Construction, for the purpose of budgeting, is defined as all types of work done on a particular building, including erecting, altering, or remodeling. Construction conducted by the award recipient is entered on this page. Any construction work that is performed by a vendor or subrecipient should be entered under f. Contractual.

2. List all proposed construction below, providing a basis of cost such as engineering estimates, prior construction, etc., and briefly justify its need as it applies to the Statement of Project Objectives.

3. Each budget period is rounded to the nearest dolla

Overall description of construction activities: **Example Only!!! - Build wind turbine platform**

SOPO Task #	General Description	Cost	Basis of Cost	Justification of need
		Budget Period 1		
3	EXAMPLE ONLY!!! Three days of excavation for platform site	$28,000	Engineering estimate	Site must be prepared for construction of platform.
	Budget Period 1 Total	**$0**		
		Budget Period 2		
	Budget Period 2 Total	$0		
		Budget Period 3		
	Budget Period 3 Total	$0		
	PROJECT TOTAL	**$0**		

Additional Explanation (as needed):

h. Other Direct Costs

INSTRUCTIONS - PLEASE READ!!!
1. Other direct costs are direct cost items required for the project which do not fit clearly into other categories. These direct costs must not be included in the indirect costs (for which the indirect rate is being applied for this project). Examples are: tuition, printing costs, etc. which can be directly charged to the project and are not duplicated in indirect costs (overhead costs).
2. Basis of cost are items such as vendor quotes, prior purchases of similar or like items, published price list, etc.
3. Each budget period is rounded to the nearest dollar.

SOPO Task #	General Description and SOPO Task #	Cost	Basis of Cost	Justification of need
		Budget Period 1		
5	**EXAMPLE!!!** Grad student tuition - tasks 1-3	$16,000	Established UCD costs	Support of graduate students working on project
	Budget Period 1 Total	$0		
		Budget Period 2		
	Budget Period 2 Total	$0		
		Budget Period 3		
	Budget Period 3 Total	$0		
	PROJECT TOTAL	**$0**		

Additional Explanation (as needed):

i. Indirect Costs

INSTRUCTIONS - PLEASE READ!!!

1. Fill out the table below to indicate how your indirect costs are calculated. Use the box below to provide additional explanation regarding your indirect rate calculation.

2. The rates and how they are applied should not be averaged to get one indirect cost percentage. Complex calculations or rates that do not do not correspond to the below categories should be described/provided in the Additional Explanation section below. If questions exist, consult with your DOE contact before filling out this section.

3. The indirect rate should be applied to both the Federal Share and Recipient Cost Share.

4. NOTE: A Recipient who elects to employ the 10% de minimis Indirect Cost rate **cannot claim resulting costs as a Cost Share contribution, nor can the Recipient claim "unrecovered indirect costs" as a Cost Share contribution.** Neither of these costs can be reflected as actual indirect cost rates realized by the organization, and therefore are not verifiable in the Recipient records as required by Federal Regulation (§200.306(b)(1)).

5. Each budget period is rounded to the nearest dollar.

	Budget Period 1	Budget Period 2	Budget Period 3	Total	Explanation of BASE
Provide ONLY Applicable Rates:					
G&A Overhead	4.00%	0.00%	0.00%		**4.00% x Labor & Fringe, Supplies & Contractual**
Fee	10.00%	0.00%	0.00%		**10% x All Costs**
	0.00%	0.00%	0.00%		
	0.00%	0.00%	0.00%		
Indirect Costs (As Applicable):					
G&A Overhead	$323,344			**$323,344**	
Fee	$840,694			**$840,694**	
				$0	
				$0	
Total indirect costs requested:	**$1,164,038**	**$0**	**$0**	**$1,164,038**	

A federally approved indirect rate agreement, or rate proposed (supported and agreed upon by DOE for estimating purposes) is required if reimbursement of indirect costs is requested. Please check (X) one of the options below and provide the requested information if it has not already been provided as requested, or has changed.

___x___ An indirect rate has been approved or negotiated with a federal government agency. A copy of the latest rate agreement is included with this application, and will be provided electronically to the Contracting Officer for this project.

______ There is not a current, federally approved rate agreement negotiated and available*.

***When this option is checked, the entity preparing this form shall submit an indirect rate proposal in the format provided by your DOE contact, or a format that provides the same level of information and which will support the rates being proposed for use in performance of the proposed project. Additionally, any non-Federal entity that has never received a negotiated indirect cost rate, except for those non-Federal entities described in Appendix VII to Part 200—States and Local Government and Indian Tribe Indirect Cost Proposals, paragraph D.1.b, may elect to charge a de minimis rate of 10% of modified total direct costs (MTDC) which may be used indefinitely.As described in §200.403 Factors affecting allowability of costs, costs must be consistently charged as either indirect or direct costs, but may not be double charged or inconsistently charged as both. If chosen, this methodology once elected must be used consistently for all Federal awards until such time as a non-Federal entity chooses to negotiate for a rate, which the non-Federal entity may apply to do at any time.**

You must provide an explanation (below or in a separate attachment) and show how your indirect cost rate was applied to this budget in order to come up with the indirect costs shown.

Additional Explanation (as needed): *IMPORTANT: Please use this box (or an attachment) to further explain how your total indirect costs were calculated. If the total indirect costs are a cumulative amount of more than one calculation or rate application, the explanation and calculations should identify all rates used, along with the base they were applied to (and how the base was derived), and a total for each (along with grand total).

Cost Share

PLEASE READ!!!

1. A detailed presentation of the cash or cash value of all cost share proposed must be provided in the table below. All items in the chart below must be identified within the applicable cost category tabs a. through i. in addition to the detailed presentation of the cash or cash value of all cost share proposed provided in the table below. Identify the source organization & amount of each cost share item proposed in the award.

2. Cash Cost Share - encompasses all contributions to the project made by the recipient, subrecipient, or third party (an entity that does not have a role in performing the scope of work) for costs incurred and paid for during the project. This includes when an organization pays for personnel, supplies, equipment, etc. for their own company with organizational resources. If the item or service is reimbursed for, it is cash cost share. All cost share items must be necessary to the performance of the project. **Vendors may not provide cost share.** Any partial donation of goods or services is considered a discount and is not allowable.

3. In Kind Cost Share - encompasses all contributions to the project made by the recipient, subrecipient, or third party (an entity that does not have a role in performing the scope of work) where a value of the contribution can be readily determined, verified and justified but where no actual cash is transacted in securing the good or service comprising the contribution. In Kind cost share items include volunteer personnel hours, the donation of space or use of equipment, etc. The cash value and calculations thereof for all In Kind cost share items must be justified and explained in the Cost Share Item section below. All cost share items must be necessary to the performance of the project. If questions exist, consult your DOE contact before filling out In Kind cost share in this section. Vendors may not provide cost share. Any partial donation of goods or services is considered a discount and is not allowable.

4. Funds from other Federal sources MAY NOT be counted as cost share. This prohibition includes FFRDC sub-recipients. Non-Federal sources include any source not originally derived from Federal funds. Cost sharing commitment letters from subrecipients and third parties must be provided with the original application.

5. Fee or profit, including foregone fee or profit, **are not allowable** as project costs (including cost share) under any resulting award. The project may only incur those costs that are allowable and allocable to the project (including cost share) as determined in accordance with the applicable cost principles prescribed in FAR Part 31 for For-Profit entities and 2 CFR Part 200 Subpart E - Cost Principles for all other non-federal entities.

6. NOTE: A Recipient who elects to employ the 10% de minimis Indirect Cost rate **cannot claim the resulting indirect costs as a Cost Share contribution.**

7. NOTE: A Recipient **cannot claim "unrecovered indirect costs"** as a Cost Share contribution, **without prior approval.**

8. Each budget period is rounded to the nearest dollar.

Organization/Source	Type (Cash or In Kind)	Cost Share Item	Budget Period 1	Budget Period 2	Budget Period 3	Total Project Cost Share
ABC Company **EXAMPLE!!!**	Cash	Project partner ABC Company will provide 20 PV modules for product development at the price of $680 per module	$13,600			**$13,600**
						$0
						$0
						$0
						$0
						$0
						$0
						$0
						$0
						$0
						$0
		Totals	$0	$0	$0	$0

Total Project Cost: $9,247,636

Cost Share Percent of Award: 0.00%

Additional Explanation (as needed):

Applicant Name: Minnkota Power Cooperative Award Number: 0

Budget Information - Non Construction Programs

OMB Approval No. 0348-0044

Section A - Budget Summary

Grant Program Function or Activity (a)	Catalog of Federal Domestic Assistance Number (b)	Estimated Unobligated Funds		New or Revised Budget		
		Federal (c)	Non-Federal (d)	Federal (e)	Non-Federal (f)	Total (g)
1. Budget Period 1				$9,247,636.00	$0.00	$9,247,636.00
2. Budget Period 2				$0.00	$0.00	$0.00
3. Budget Period 3				$0.00	$0.00	$0.00
4.						
5. Totals				$9,247,636.00	$0.00	$9,247,636.00

Section B - Budget Categories

6. Object Class Categories	Grant Program, Function or Activity				Total (5)
	Budget Period 1	Budget Period 2	Budget Period 3		
a. Personnel	$5,118,322.00	$0.00	$0.00		$5,118,322.00
b. Fringe Benefits	$2,501,143.00	$0.00	$0.00		$2,501,143.00
c. Travel	$18,300.00	$0.00	$0.00		$18,300.00
d. Equipment	$0.00	$0.00	$0.00		$0.00
e. Supplies	$5,833.00	$0.00	$0.00		$5,833.00
f. Contractual	$440,000.00	$0.00	$0.00		$440,000.00
g. Construction	$0.00	$0.00	$0.00		$0.00
h. Other	$0.00	$0.00	$0.00		$0.00
i. Total Direct Charges (sum of 6a-6h)	$8,083,598.00	$0.00	$0.00		$8,083,598.00
j. Indirect Charges	$1,164,038.00	$0.00	$0.00		$1,164,038.00
k. **Totals** (sum of 6i-6j)	$9,247,636.00	$0.00	$0.00		$9,247,636.00
7. Program Income					$0

Appendix B

Personnel Résumés

Professional Summary

SATISH REDDY

Process Technology

Satish has more than 40 years of experience in the engineering, debottlenecking, troubleshooting, and start-up of carbon capture plants, gas processing, syngas, (hydrogen and ammonia), fertilizer, sulfuric acid, and inorganic chemical plants. He has substantial experience in the removal of carbon dioxide from gaseous streams including both post- and pre-combustion decarbonization. Satish also has extensive experience in carbon capture technology for carbon capture and storage (CCS) projects. Satish's gas treating experience with plants includes using Econamine FG PlusSM, Selexol, MEA, low pressure DGA, and generic MDEA in natural gas and syngas making facilities. He has considerable experience in simulation of processes using Selexol and aMDEA. He also has syngas making experience in hydrogen, ammonia, and gasification plants. Satish's experience in the sulfur area includes sulfuric acid plants and sulfur storage and handling. His fertilizer experience consists of designing plants making ammonia, urea, ammonium nitrate, UAN, sulfuric acid, and NPK. His experience in the chemical area includes P&G's Olestra, potassium carbonate, and sodium and potassium nitrates.

RELEVANT PROJECT EXPERIENCE

- **Abu Dhabi Gas Development Company Ltd., CO2 Recovery Project (Abu Dhabi, United Arab Emirates).** Vice president of process technology responsible for the Econamine FG Plus technology that is being applied to the project. Fluor will provide a technology license and supply proprietary equipment.

- **South Louisiana Methanol Co, Carbon Dioxide Recovery Unit (St. James Parish, Louisiana, United States).** Vice president of process technology responsible for a front end engineering and design (FEED) and the preparation of a LSTK offer for a carbon dioxide recovery unit designed to recover CO2 from a portion of flue gas generated by a methanol plant steam-methane reformer (SMR).

- **E.ON, CO_2 Demonstration Plant (Wilhelmshaven, Germany).** Vice president of process technology responsible for the design and operation of the plant. Facility was attached to a coal fired power plant; Fluor used the project to demonstrate EFG+ technology on coal fired flue gas.

- **NRG Energy, Inc., WA Parish 240 MW Demo, (Thompsons, Texas, United States).** Process technology director for project where scope was to complete FEED to capture 4,775 metric tons of carbon dioxide per day from a coal fired power generating unit, utilizing Fluor's proprietary Econamine FG Plus (EFG+) technology.

- **Maasvlakte CCS ROAD Project C.V., CO_2 Capture Unit (Rotterdam, Netherlands).** Process technology director for project during the conceptual, FEED, and detailed engineering phases. The purpose of the project was to demonstrate CCS on an industrial scale.
- **ENEL SaskPower, CO_2 Capture Unit (Porto Tolle, Italy).** Process technology director on a FEED to capture and compress CO2 from one of ENEL's three 660 MW refurbished bituminous coal fired units at its Porto Tolle' facilities.
- **SaskPower, Boundary Dam 3 ICCS (Saskatchewan, Canada).** Process technology director on a FEED for the addition of a CO_2 capture facility to an existing coal fired power plant.
- **Conoco Phillips, Rivers Terminal Acid Plant (United Kingdom).** Vice president of process technology and subject matter expert responsible for providing technical expertise to the study team and reviewing key deliverables.

EDUCATION

Bachelor's Degree, Chemical Engineering, India

Ph.D., Chemical Engineering, University of Bath, England

Professional Summary

KHASHAYAR VAHDAT AFSHAR

Process Lead

Khashayar has more than 11 years of experience as a process engineer with Fluor, with extensive experience in Fluor's Econamine FG Plus Carbon Capture Technology. More recent experience entails refinery revamp projects such as the Axion Campana Refinery FEED Project and Tesoro's Sulfuric Acid Alkylation Unit Compressor Replacement and Enhancement Projects. Khashayar also has project engineer experience gained from the Sasol Lake Charles Cracker Project and Life Sciences projects executed out of the Fluor South San Francisco office. He also has HSE experience in performing dispersion modeling and RAM analyses.

RELEVANT PROJECT EXPERIENCE

- **Amgen, B23 Continuous Manufacturing Project (Thousand Oaks, California, United States).** Project engineer responsible for technical coordination of the engineering disciplines at both the San Francisco and Aliso Veijo offices during both the BOD and Detailed Design phases.
- **NOVO NORDISK, DAPI Project – BD Ph2 (Clayton, North Carolina, United States).** Senior process engineer responsible for conducting a dispersion modeling analysis to track the dispersion of vapor emissions from emergency vents on the emergency header system and individual relief tanks in order to provide an understanding of how far an explosive or toxic (Ammonia) cloud could travel. Testing limits for the consequence modeling were based on 20% LEL and 50% IDLH concentration limits. The dispersion analysis was done use Phast v7.21.
- **Total E&P Uganda, Tilenga Project (Lake Albert Basin, Uganda).** Senior process engineer responsible for performing a RAM analysis for this project to determine the overall and individual availabilities and production profiles from 30 well pads feeding to a central processing facility. Each of the 30 well pads had a unique number of well heads, configuration, and production profile.
- **China Petroleum Engineering Construction Corporation, Amursky Gas Processing Plant (AGPP) Project – Non License Units (Far Eastern Federal, Siberia, Russian**

Federation). Senior process engineer responsible for developing a RAM model in Aspen Fidelis Reliability v10 to determine the expected overall availability of the Dehydration and Mercury Removal Unit (Unit 30), Gas Fractionation Unit (Unit 60), and the NGL Treatment Unit (Unit 70) in the AGPP.

- **South Louisiana Methanol, LP, Econamine Carbon Capture FEED (Confidential).** Senior process engineer responsible for preparing instrument data sheets and equipment data sheets for vessels, exchangers, pumps, and miscellaneous equipment for the Solvent Maintenance Package of the Econamine CO2 Capture Plant.

- **Maasvlakte CSS Project C.V., Rotterdam Storage and Capture Demonstration Project (Maasvlakte, Netherlands).** Senior process engineer responsible for preparing equipment data sheets for vessels, exchangers, pumps, and miscellaneous equipment for the Solvent Maintenance Package of the Econamine CO2 Capture Plant.

- **Tesoro Refining and Marketing Company, Alky Expansion (Anacortes, Washington, United States).** Senior process engineer responsible for supporting the process activities for this revamp project, developed datasheets for vessels, exchangers, and pumps as well instruments and control valves.

- **Axion Energy Argentina SA, Campana Refinery FEED (Campana, Argentina).** Senior process engineer responsible for leading the process PMC support work on a new Fuel Gas Treating Unit (Sulfur Block).

- **NRG Energy, Inc., WA Parish Expanded 240 MW Demonstration Project (Thompsons, Texas, United States).** Senior process engineer leading the effort for two carbon capture studies for NRG Energy. For each of these projects, developed heat and material balances, equipment lists, process descriptions, utility summaries, inputs for operating cost calculations, along with supporting the cost estimating effort.

- **Sasol North America, Inc., Sasol Lake Charles Cracker Project (Lake Charles, Louisiana, United States).** Technical coordinator responsible for the Low Density Polyethylene (LDPE) Unit on the LCCP project. Stationed in the engineering contractor's office in Japan, was the interface between Sasol, Fluor, and the engineering contractor, MES. He provided support for both process engineering and project management activities. He was responsible for the technical review of process documents such as P&IDs, equipment specifications, utility summaries, etc.

- **E.ON Kraftwerke GmbH, CO2 Capture Demonstration Plant (Wilhelmshaven, Germany).** Process engineer responsible for assisting in troubleshooting several operational problems that the plant was experiencing.

EDUCATION

Bachelor's Degree, Chemical Engineering, University of California at Berkeley

Master's Degree, Chemical Engineering (with emphasis in Biochemical Engineering), Stanford University

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FLUOR®

APPENDIX C – ORIGINAL NOVEMBER 2018 PROPOSAL TO NDIC

Minnkota Power
COOPERATIVE
A Touchstone Energy® Cooperative

5301 32nd Ave S
Grand Forks, ND 58201-3312
Phone 701.795.4000
www.minnkota.com

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

POC Telephone: (701) 794-7234

POC E-Mail: gpfau@minnkota.com

POC Address: 3401 24th Street Southwest
Center, ND 58530-0127

TABLE OF CONTENTS

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.

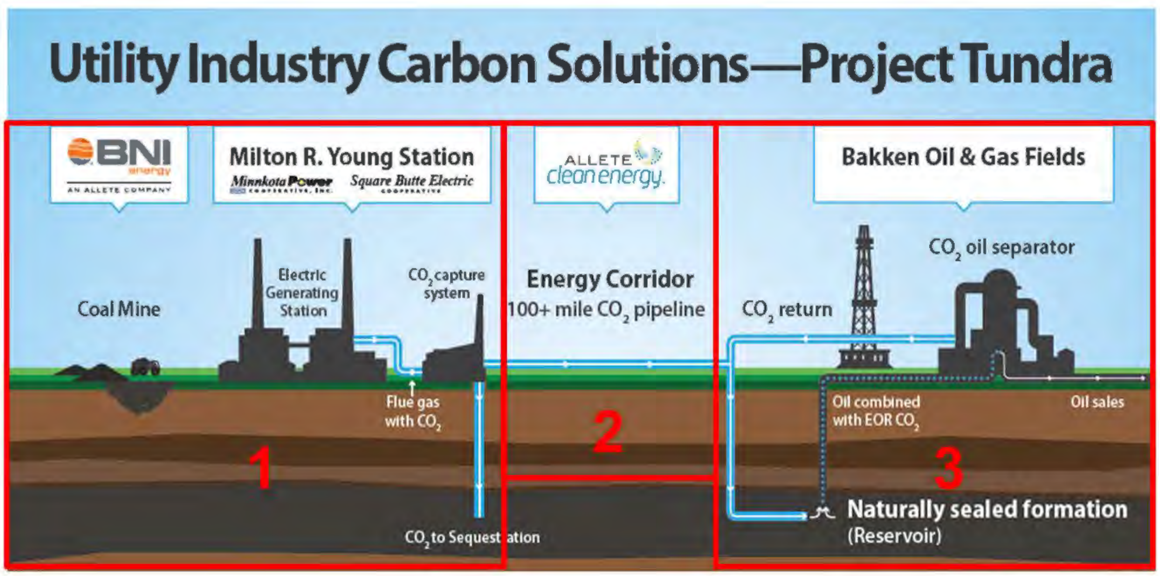


Figure 1. Project Tundra

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

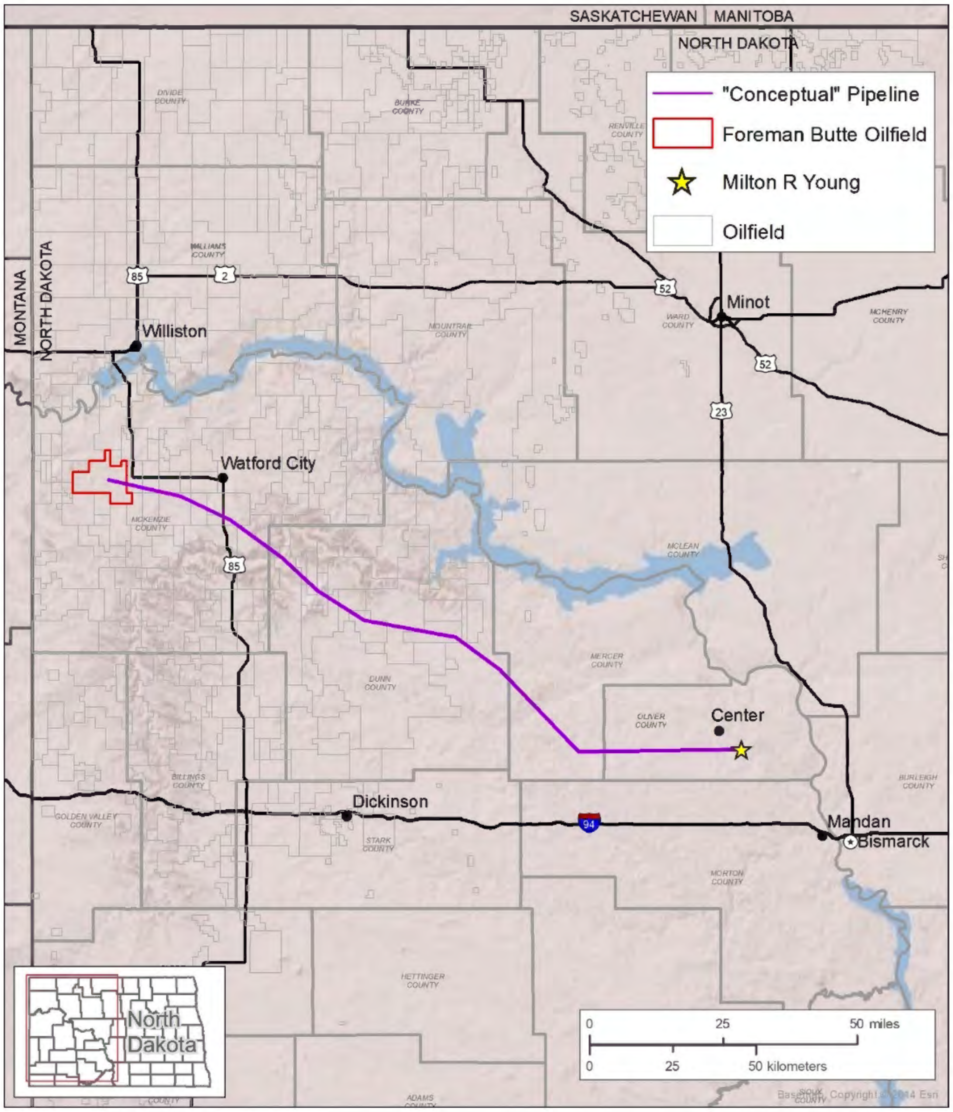


Figure 2. Conceptual pipeline route.

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.

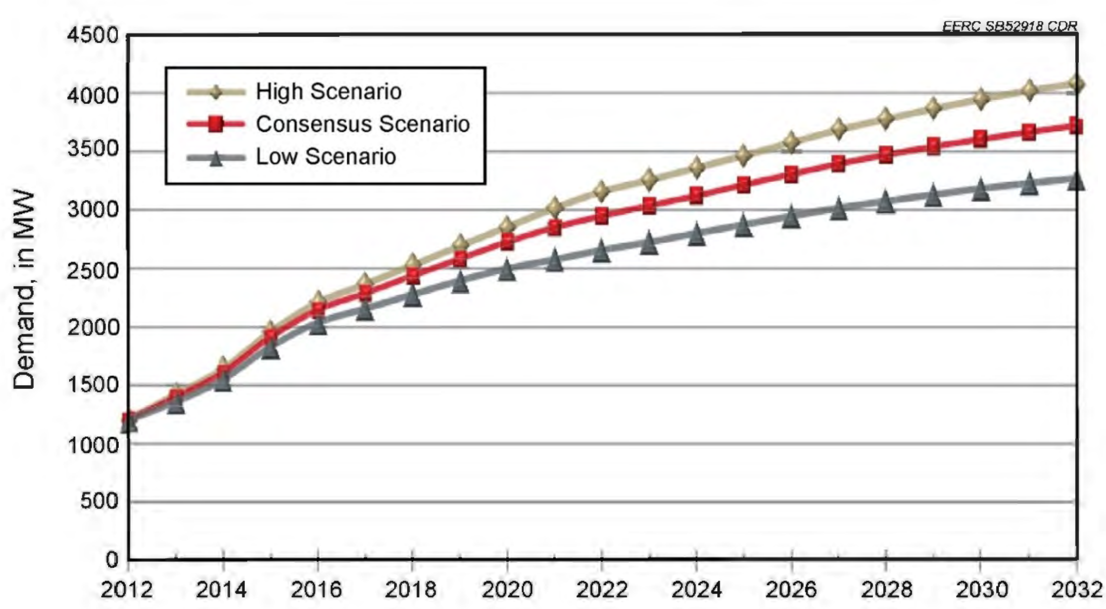


Figure 3. Williston Basin electrical demand for all regions (KLJ, 2012).

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.

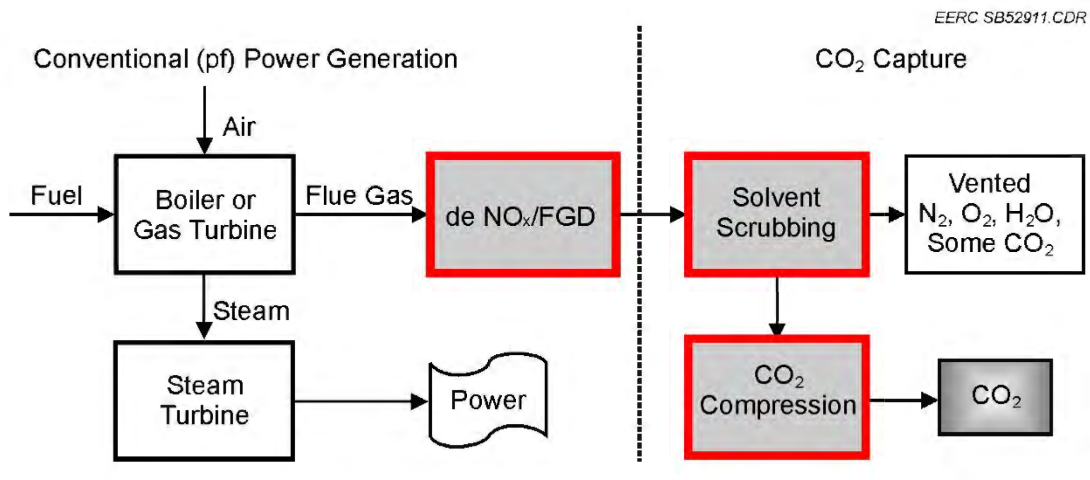


Figure 4. PCC systems (FGD is flue gas desulfurization).

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.

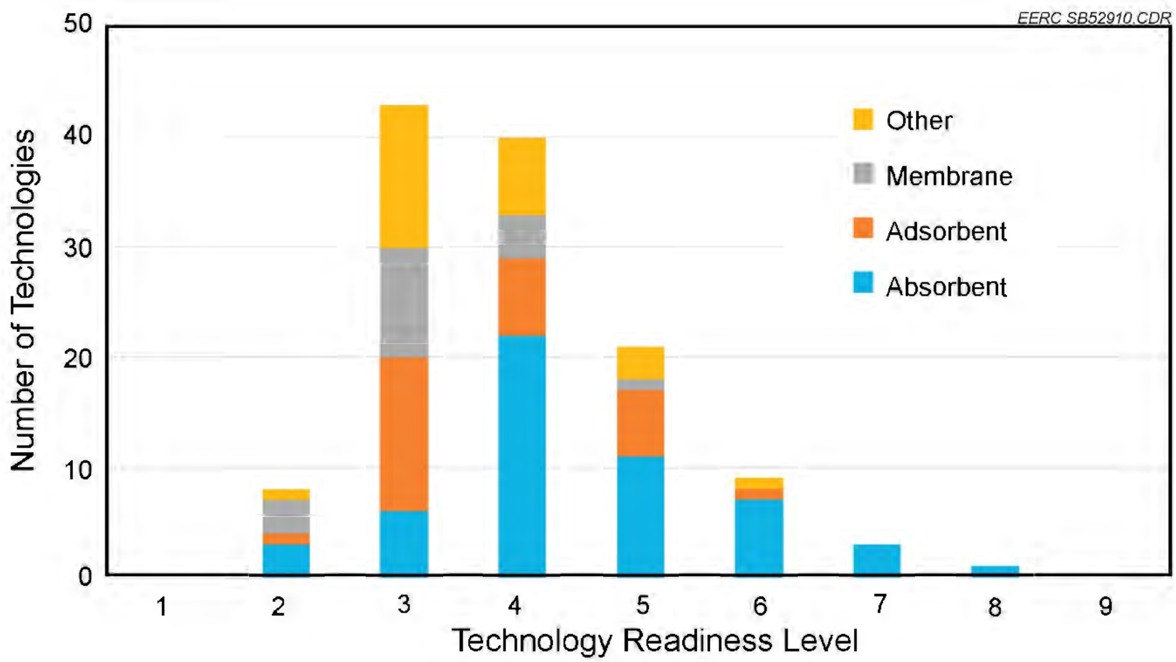


Figure 5. Histogram of the readiness of a technology (absorbent is the solvent-based technology).

- 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

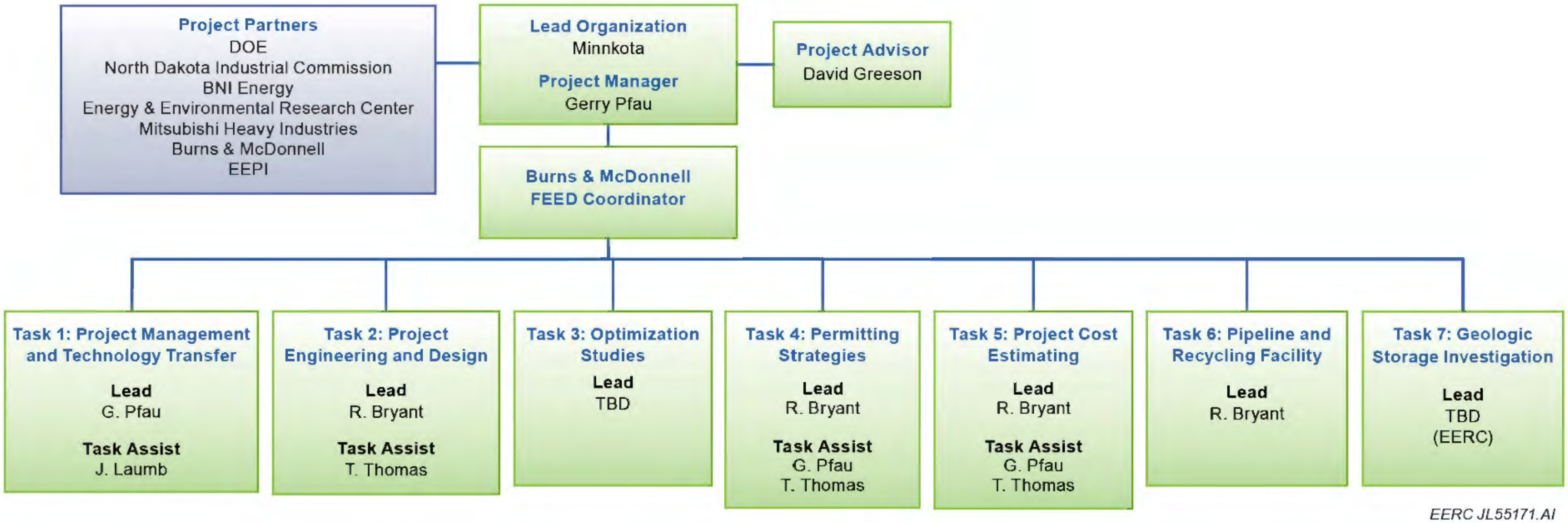


Figure 8. Simplified project management structure.

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

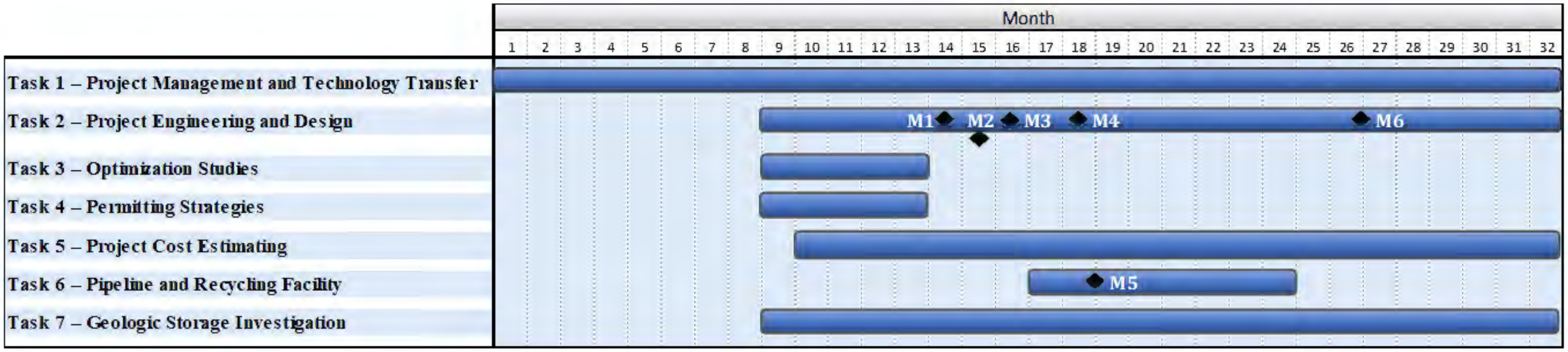
TIMETABLE AND DELIVERABLES

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



Milestones ◆	
M1 – CCS Finalized for BOP	M4 – CCS Piping Terminal Point List Available to BOP
M2 – CCS Electrical Load List Available to BOP	M5 – Fluid Rates Determined
M3 – CCS Foundation Information Available to BOP	M6 – FEED Study Report Submitted to Sponsors

LR 10/30/18

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

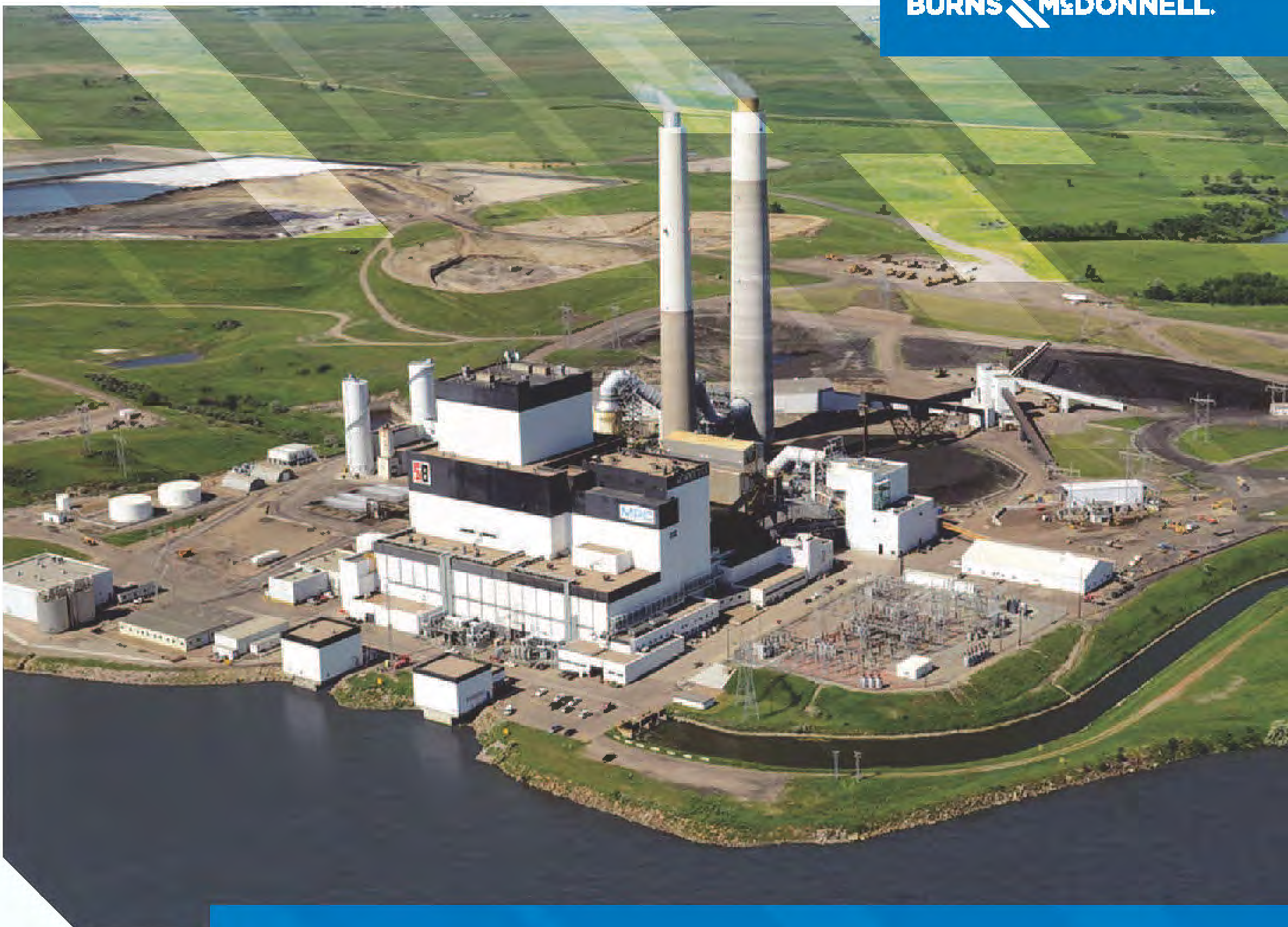
Burns & McDonnell proposes to perform the Scope of Services described above in accordance with the Professional Services Contract, dated July 26, 2005, and Amendment 2, dated November 3, 2015, currently in place between Minnkota Power and Burns & McDonnell.

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



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

TABLE OF CONTENTS

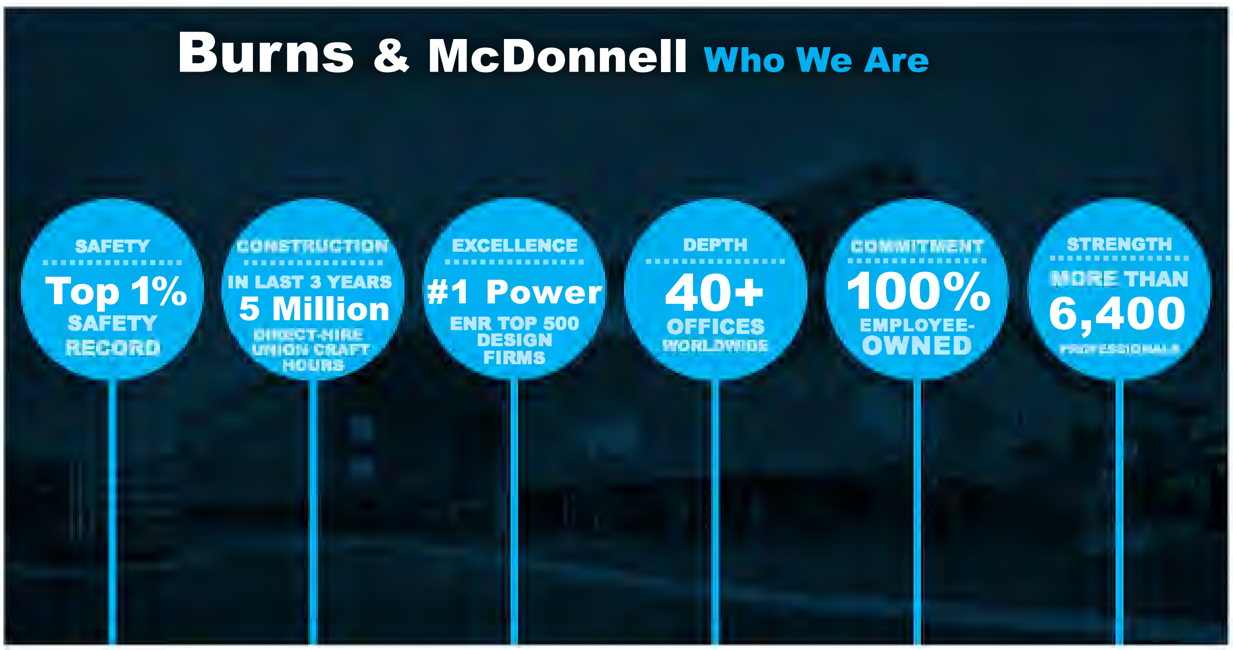
INTRODUCTION

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.

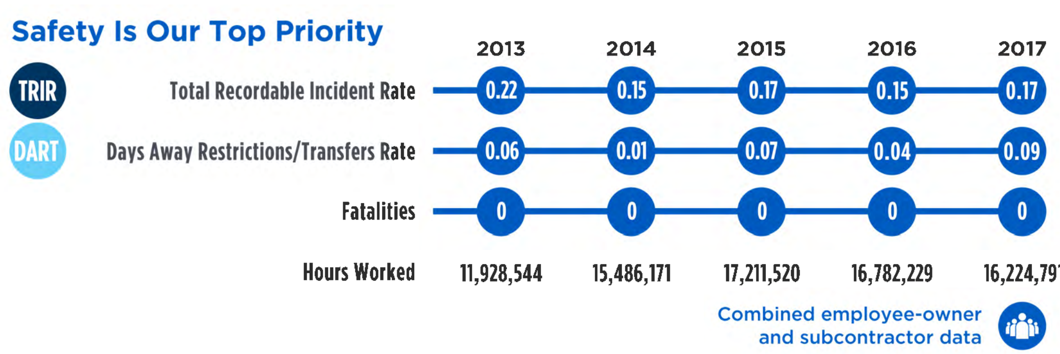
Burns & McDonnell has been involved in numerous projects at the MRY Station for more than 25 years, including a major rebuild of the Unit 1 and Unit 2 electrical system, refurbishment of the Unit 2 chimney, and new ductwork to the Unit 1 scrubber modules. One project in particular began in 2006 when 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 CO_2 capture facility at the MRY Station to remove approximately 95% of the CO_2 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.

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:

- 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

EDUCATION

- BS, Mechanical Engineering

REGISTRATIONS

- Professional Engineer (KS)

9 YEARS OF EXPERIENCE

9 YEARS WITH BURNS & MCDONNELL

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

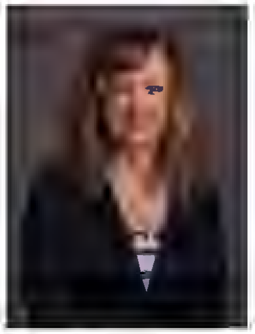
Lead mechanical engineer managing system design, procurement submittals, and final contract close-out of a project to add 150 MW of new generation capacity to the existing plant with two GE Frame 7EA combustion turbines connected to heat recovery units.

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

SHANE GARDEN, PE
(continued)

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.

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

ROBERT OWENS, PE

(continued)

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

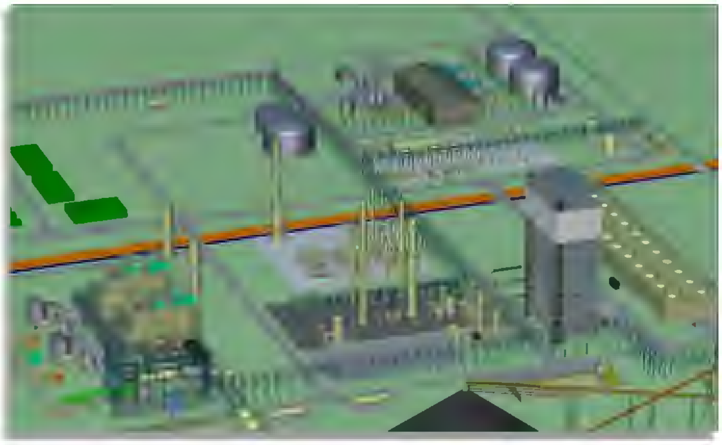
- 120 MW slip stream ECO2 pilot plant on existing lignite-fired coal plant
- CO2 transportation for Enhanced Oil Recovery use

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.

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

Line	Description	FEED Study Phase: 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")

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**
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	

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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**
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	

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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**					

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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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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**
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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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**
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	

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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**
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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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

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**
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	

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**
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**					

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

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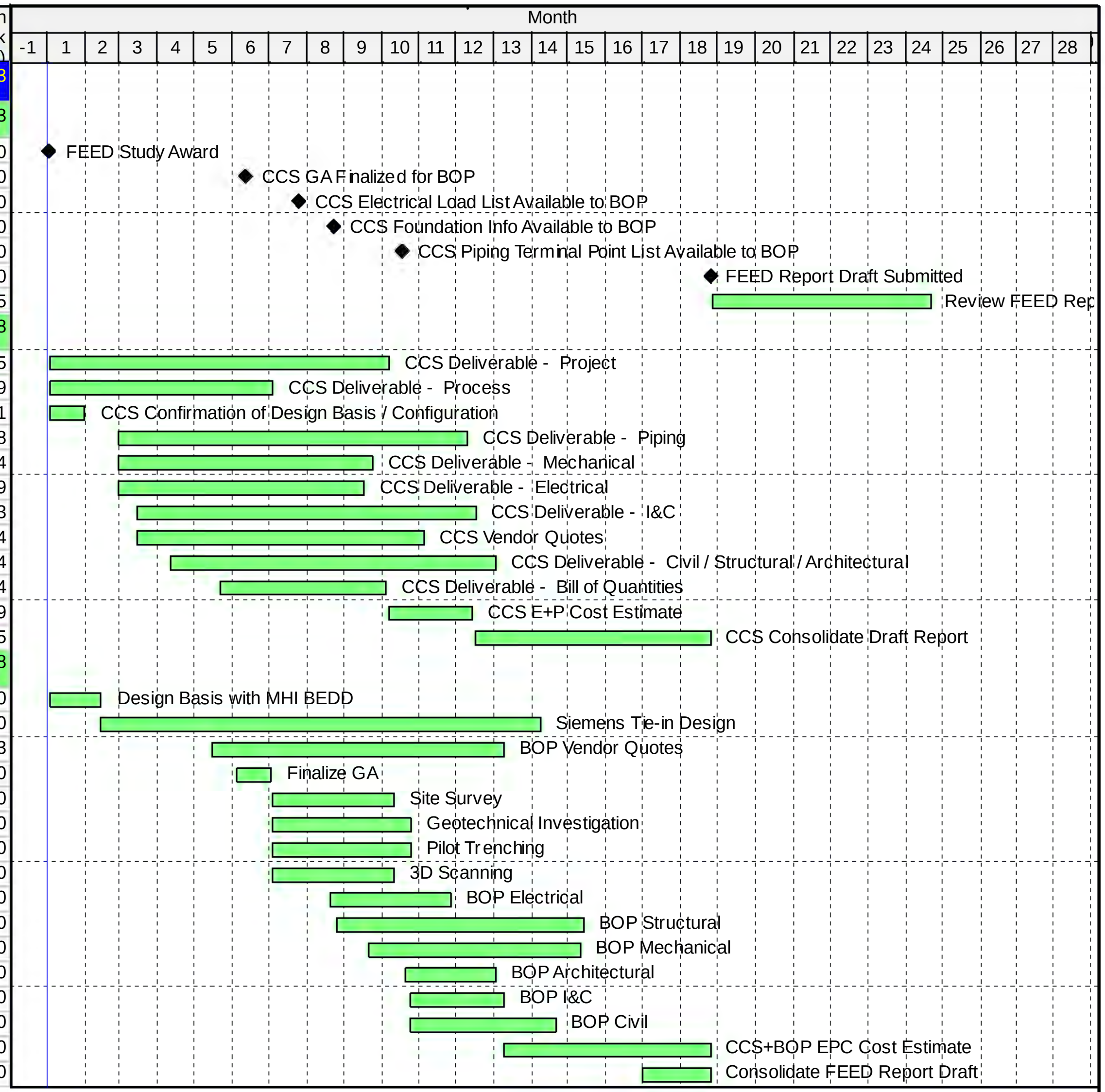
MHI	Mitsubishi Heavy Industries
B&Mc	Burns & McDonnell
NA	Not Applicable for this Project or Task

		FEED Study Phase				
Line	**Description**	**Conceptual Design**	**Bill of Quantity**	**Material Cost Estimating**	**Construction Estimate**	**Remarks**
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 Laumb

Jason D. Laumb
Principal Engineer, Advanced Energy Systems

Approved by:

Ed Steadman 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.

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,

Wade Boeshans

Mr. Wade Boeshans
President and General Manager
BNI Energy

BNI COAL
1637 Burnt Boat Dr. Bismarck, ND 58503

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

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

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

RON BRYANT, PE
(continued)

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

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

References

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APPENDIX D – PROJECT QUARTERLY REPORTS

- Q1 2019 (May 1, 2019)
- Q2 2019 (August 1, 2019)
- Q3 2019 (October 30, 2019)
- Q4 2019 (January 29, 2020)
- Q1 2020 (May 1, 2020)

NDIC DISCLAIMER

The following disclaimer applies to each of the above-listed quarterly reports that are provided in the subsequent pages of this appendix.

This report was prepared by Minnkota Power Cooperative, Inc. pursuant to an agreement with the Industrial Commission of North Dakota which partially funded the project through the Lignite Research Program.

Minnkota Power Cooperative, Inc. or any of its subcontractors, and the Industrial Commission of North Dakota, or any person acting on its behalf, do not;

A) Make any warranty or representation, express or implied, with respect to the accuracy, completeness, or usefulness of the information contained in this report, or that the use of any information, apparatus, method, or process disclosed in this report may infringe on privately-owned rights; or
B) Assume any liabilities with respect to the use of, or for damages resulting from the use of, an information, apparatus, method, or process disclosed in this report.

Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the North Dakota Industrial Commission. The views and opinions of authors expressed herein do not necessarily state or reflect those of the North Dakota Industrial Commission.

DOE DISCLAIMER

The following DOE disclaimer applies to reports submitted for the 4th quarter of 2019 and after, as provided in the subsequent pages of this Appendix.

This material is based upon work supported by the Department of Energy under Award Number DE-FE0031845.

This report was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government, nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or any agency thereof.

5301 32nd Ave S
Grand Forks, ND 58201-3312
Phone 701.795.4000
www.minnkota.com

May 1, 2019

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

SENT VIA EMAIL: *kfine@nd.gov*

Dear Ms. Fine,

Since January 1, 2019 Minnkota's project team has completed significant planning and development work furthering all aspects of Project Tundra and key components included under the Minnkota proposal to North Dakota Industrial Commission (NDIC). This letter serves as a status report updating the NDIC on the work performed and an accounting of applicable cost share to date.

First Quarter 2019 Activities:

Project Management

Proposal Development. Consistent with the NDIC proposal dated November 1, 2018, Task 1 was commenced on or about January 1, 2019. Minnkota engaged, through execution of a contract for services, the Energy Environmental Research Center at the University of North Dakota (EERC) to cover the scope of work proposed under the initial NDIC proposal, which included proposal development in pursuit of Department of Energy funding announcement No. FOA-DE0002058 released on March 13, 2019 (DOE FOA). Prior to the release of the DOE FOA, Minnkota, EERC, Mistubishi Heavy Industries America (MHIA), and Burns & McDonnell (BMcD) scheduled and held almost weekly proposal development and project management meetings. These meetings consisted of discussion surrounding timeline for proposal development and submission, necessary components of the proposal, responsibilities, review process, and strategy and approach to proposal success. Additionally, during this timeframe key findings from the ongoing CO_2 pre-FEED study of Project Tundra were compiled, analyzed, and compared to the objectives of this imminent DOE funding opportunity. The FOA proposal due date is May 13, 2019, Minnkota expects to have a complete proposal ready for submission on May 9, 2019. Pursuant to the published DOE FOA, the anticipated date of Selection Notifications is August 9, 2019.

Geologic Storage Investigation. Minnkota and EERC personnel held four in-person meetings to develop a strategy and discuss the technical and nontechnical components of Task 7 and to prepare a strategy for securing the geologic storage facility. Of a top priority was establishing a specific timeline to accomplish data collection in support of the permit and the timeline associated therewith, taking into account the need to meet 45Q commence construction requirement of 2023. MPC gathered preliminary information related to nontechnical aspects of geologic storage and the property surrounding the Milton R. Young Station. EERC developed timeline which took into consideration technical and nontechnical factors involved with securing a geologic storage facility.

Permitting Strategy. Minnkota commenced bi-weekly permit strategy meetings on February 6, 2019 in pursuance of objectives under Task 4. Preliminary information to (1) establish a timeline for permitting for all components of Project Tundra, (2) identify regulatory processes and material aspects of the permits, and (3) identify consultants and service providers.

First Quarter Cost Share Report:

Minnkota has realized a $339,211.65 cash outlay for cost share associated with the activities described above which corresponds to the consideration supporting the engagement of subcontractors. Additionally, since January 1, 2019 Minnkota has $15,688.43 of in-kind cost share towards the activities described above.

Minnkota's next status report is tentatively due on August 1, 2019. Minnkota anticipates continuing project management activities related to Tasks 1, Task 4, and Task 7.

If you have any questions in regard to the information contained in this letter or generally regarding the status of the project please contact the undersigned.

Sincerely,

Gerry Pfau
Senior Manager of Project Development
P: (701) 794-7234
E: GPfau@minnkota.com.

CC: Mike Holmes, *Vice President of Research and Development, Lignite Energy Council*

Via email: mikeholmes@lignite.com

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Minnkota Power COOPERATIVE
A Touchstone Energy® Cooperative

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August 1, 2019

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

SENT VIA EMAIL: *kfine@nd.gov*

Subject: Quarterly report for Minnkota's project entitled "Project Tundra FEED."

Dear Ms. Fine,

During this reporting period, Minnkota's project team has completed significant planning and development work furthering all aspects of Project Tundra and performed task activities included under the Minnkota proposal to the North Dakota Industrial Commission (NDIC). This letter serves as a status report updating the NDIC on the work performed and an accounting of total expenditures from April 1, 2019 through June 30, 2019.

Second Quarter 2019 Activities:

Project Management- Task 1

Proposal Development. Minnkota continued engagement with the Energy Environmental Research Center at the University of North Dakota (EERC) to cover the scope of work proposed under the initial NDIC proposal, which included proposal development in pursuit of Department of Energy funding announcement No. FOA-DE0002058 released on March 13, 2019 (DOE FOA). Minnkota, EERC, Mistubishi Heavy Industries America (MHIA), and Burns & McDonnell (BMcD) scheduled and held almost weekly proposal development and project management meetings. These meetings topics consisted of proposal development and submission, necessary components of the proposal. Further, Minnkota, EERC, MHIA and BMcD participated in the review process established by EERC, consisting of no fewer than three formal review meetings.

Additionally, during this timeframe, pre-FEED studies from Fluor Enterprises (Fluor) and MHIA were compiled, analyzed, and compared to the objectives of the imminent DOE FOA. Minnkota staff drafted, reviewed, and finalized a Fluor technology supported FOA proposal independent of EERC involvement. Minnkota assessed the pre-FEED studies, FEED proposals as a whole, technologies, projected capital and operations costs as proposed and presented by MHIA and Fluor. Based upon this assessment, Fluor was selected as the technology vendor for Project Tundra's FEED study. The FOA proposal due date was May 13, 2019; Minnkota completed and submitted the Fluor based proposal on May 9, 2019. Pursuant to the published DOE FOA, the anticipated date of Selection Notifications is August 9, 2019. We still believe the DOE is on schedule for notice of selection. A meeting was held with MHIA to review the proposal and offer feedback on Minnkota's analysis on why they were not selected.

Geologic Storage Investigation. Minnkota and EERC personnel continue to hold informal meetings to develop a strategy and discuss the technical and nontechnical components of Task 6 and to prepare a strategy for securing the geologic storage facility. One formal meeting was held in April for purposes of refining the permitting timeline and discussing activities to be performed May through July, namely a source test, which is needed to prepare for a future full seismic survey of the geologic storage area. Because the storage facility is likely to be at least partially placed underneath reclaimed coal mine land, there was some uncertainty regarding seismic survey design parameters. The source test will be used to ensure that the seismic survey is designed so that the data collected has adequate resolution and quality. This activity was of top priority to continue data collection in support of the Class VI permit and the timeline associated therewith, taking into account the need to meet the 45Q commence construction requirement of 2023.

Minnkota, in consultation with EERC, commenced planning and procuring vendors for performance of a source test ahead of the seismic survey, which is to occur towards the end of the third quarter of 2019. Procurement documents were developed and vendors were selected, Environmental Geophysical Investigations (EGI) was selected as the quality assurance and quality control vendor responsible for developing the source test strategy and plan. Breckenridge Geophysical was selected as the acquisition company responsible for fieldwork and collection of source test data via 2D line and 3D shots at two test site locations.

Permitting Strategy-Task 3

Permitting Strategy. Minnkota continued bi-weekly permit strategy meetings throughout the second quarter in pursuance of objectives under Task 3. Timeline for permitting continues to be refined. A meeting was held with the NDIC Class VI permitting unit in May for purposes of identifying and clarifying regulatory processes and approaches as related to multiple formation targets. Based on the discussion with NDIC, material aspects of Class VI permit process were identified and modeling and permitting strategy were refined. Minnkota's internal environmental team secured an opportunity to meet with the North Dakota Department of Environmental Quality (DEQ) for purposes of introducing Project Tundra, discussing, and clarifying the multiple permitting processes and timelines for the construction and operation of Carbon Capture Facility at the Milton R. Young station. During this reporting timeframe, Minnkota held internal meetings to discuss anticipated Air, Water, and Waste permitting processes. An outgrowth of such meetings were the identification of areas needing clarification and discussion with DEQ.

Geologic Storage Investigation-Task 6

Source test activities commenced in June. Minnkota procured landowner permits using Minnkota right of way agents, and Breckenridge worked with the NDIC to acquire the geophysical survey permit. The permit was completed June 28, 2019 and issued on or about July 1, 2019. EERC, BNI Coal, Minnkota, Breckenridge and EGI held a series of meetings throughout June to coordinate the source test activities schedule with mining operations, identify and comply with numerous regulatory obligations, and finalize an execution strategy. The source test operations occurred as planned and without issue or delay. We will report further detail in the third quarter report as the activities took place from July 8-July 23, 2019.

Second Quarter Reimbursement/Cost Share Report:

Minnkota has realized a total of $687,597.54 in expenditures associated with the activities described above. Please find enclosed the Second Quarter 2019 Invoice requesting reimbursement of 50% NDIC Share totaling $343,798.77. The remaining 50% of the total quarterly expenditures are a combination of Minnkota in-kind and cash cost share.

Minnkota's next status report is tentatively due on November 1, 2019. Minnkota anticipates continuing project management and activities related to Tasks 1, Task 3, and Task 6.

If you have any questions in regard to the information contained in this letter or generally regarding the status of the project please contact the undersigned.

Sincerely,

Gerry Pfau

Senior Manager of Project Development
P: (701) 794-7234
E: GPfau@minnkota.com

CC: Mike Holmes, *Vice President of Research and Development, Lignite Energy Council*
Via email: mikeholmes@lignite.com

RESEARCH PERFORMANCE PROGRESS REPORT

SUBMITTED TO

North Dakota Industrial Commission
Lignite Research, Development and Marketing Program

PROJECT TUNDRA FEED

PRINCIPAL INVESTIGATOR/PROJECT MANAGER
Gerry Pfau, Senior Manager of Project Development
Phone: 701-794-7234
Email: gpfau@minnkota.com

DATE SUBMITTED

October 30, 2019

SUBMITTED BY

Minnkota Power Cooperative, Inc.
5301 32nd Avenue South
Grand Forks, ND 58201

Quarterly Reporting Period Ending September 30, 2019

Signature of Project Manager: ______________________
Gerry Pfau

TABLE OF CONTENTS

1 Summary of Accomplishments during Current Reporting Period

In the quarter from July 1 to September 30, 2019, the following major works were completed:

- A source test was completed at a site near the Milton R. Young Station (MRYS) that was used for the selection of the appropriate source type for a full 3D seismic survey that will be required to support a Class VI permit for the CO_2 storage facility.
- After securing landowner permissions and permits and selecting contractors, drilling activities for the full 3D seismic survey were initiated on a 6.5 mi^2 plot just to the west of MRYS. The actual seismic survey acquisition will be completed during the next reporting period.
- Wet electrostatic precipitator (WESP) testing was performed onsite at MRYS at the pilot scale. This testing was aimed at examining the efficiency of a WESP in removing ultrafine particulate/aerosols that can create challenges for amine-based post-combustion capture systems.
- Minnkota was selected for award of ~$9.8 Million by the U.S. Department of Energy (DOE) for the completion of the front-end engineering and design (FEED) study of the carbon capture system for Project Tundra. The award negotiations with DOE will continue into the next reporting period, with an expected kickoff date of early November, 2019.

2 Accomplishments by Task

The following sections provide a more detailed description of the activities associated with each task in the project that were performed during this reporting period. Activities completed during previous reporting periods are found in the respective previous quarterly reports.

Task 1 – Project Management and Technology Transfer

As part of a separate cooperative agreement with DOE, the EERC secured $900,000 in federal funding to support advanced evaluation of aerosol mitigation methods for Project Tundra. To augment these funds, Minnkota agreed to provide $225,000 out of its total $15 Million approved by NDIC. These funds will be used under Task 3 of the NDIC grant (described later).

Minnkota was notified by DOE on August 23, 2019 that it was selected for award negotiation under funding opportunity DE-FOA-0002058 entitled “Front-End Engineering Design Studies for Carbon Capture Systems on Coal and Natural Gas Power Plants.” This award will support costs associated only with the FEED study for the carbon capture system (Task 2), permitting strategy development of the carbon capture system (Task 4), and cost estimating (Task 5). The total federal share of the award was proposed at $9,821,578. The total NDIC share of the award was proposed at $2,455,394, which equals 20% of the total project costs ($12,276,972).

Minnkota received DOE’s cooperative agreement on September 25, 2019. However, negotiation of the complete terms of the agreement with DOE is still ongoing and is anticipated to be complete by the end of October, 2019. A tentative date for the kickoff meeting with DOE has been scheduled for November 12, 2019. Contracting with vendors will be initiated following execution of the DOE cooperative agreement; however, draft contracts are in progress.

To support the Class VI permitting process, Minnkota engaged in discussions with Oxy Low Carbon Ventures (OLCV). Minnkota envisions OLCV playing a support/peer review role to augment the EERC’s work on this task (Task 6). Minnkota received a proposal from OLCV and is currently in the process of finalizing a master service agreement. Prior to executing a contract with OLCV, Minnkota will wait for NDIC approval for adding OLCV to the list of approved vendors.

Minnkota anticipates partnering with the EERC on a separate application to the DOE for Phase 3 of EERC's CarbonSAFE program. DOE released the FOA on September 12, 2019 (DE-FOA-0001999). We currently envision up to $5 Million of Minnkota's approved $15 Million NDIC funds to be directed to the CarbonSAFE program. The ultimate deliverable of Phase 3 Budget Period 1 of CarbonSAFE will be a final and complete Class VI permit application for the Project Tundra CO_2 storage facility. To date, Minnkota and EERC have had preliminary discussions on the proposal development, which is due January 15, 2020.

Task 2 – Project Tundra Engineering and Design

No activity. This task will initiate following execution of the DOE cooperative agreement during the next reporting period.

Task 3 – Identification and Performance of Optimization Studies

Very fine particulate (i.e. < 1 micrometer), both in liquid and solid forms, can cause significant challenges for post-combustion amine-based carbon capture systems (CCS). Fluor's Econamine FG Plus^{SM} technology, which was selected by Minnkota for Project Tundra, is no exception. Lignite-fired flue gas from MRYS is known to contain a concentration of such particulate that is anticipated to present challenges associated with excessive emissions of amine solvent as well as catalysis of solvent degradation reactions.

One potential option for mitigating the impact of ultrafine particulate on the CCS is to place a WESP upstream of the CO_2 absorber. The WESP is capable of removing the particulate of concern with a very high efficiency, thus reducing the concentration below a critical threshold prior to entry into the CO_2 absorber. Based on Fluor's previous experience and the literature data available for WESPs on similar applications, the Tundra team believes there is a high likelihood of success in reducing the ultrafine particulate sufficiently to prevent significant impacts to the CCS.

To that end, during the weeks of August 26-30 and September 2-6, Minnkota performed pilot scale testing of a WESP system on flue gas from the MRYS Unit 2. The purpose of this testing was twofold:

1. Determine the effectiveness of the WESP in removing the ultrafine particulate
2. Gather critical design information (i.e. flue gas velocity, power requirements, WESP sizing…etc.) that will be needed for the FEED study

A pilot-scale WESP test system was rented from MEGTEC TurboSonic, Inc – a vendor Fluor is interested in working with for the commercial system – and was installed on a slipstream of Unit 2 flue gas. During the first week of testing, EERC provided flue gas sampling/measurements to examine WESP performance. During the second week of testing, both EERC and Engie Laborelec – a commercial laboratory with experience working on Fluor projects – provided sampling/measurements simultaneously.

Two approximately 3-day continuous test periods were accomplished over the course of the 2 weeks. Measurements (both upstream and downstream of the WESP) included particulate size distribution (by mass and particle concentration), particulate concentration (number of particles per cm^3 of gas volume), and mass loading. Particle concentration and size distribution were determined via EERC's scanning mobility particle sizer (SMPS) systems and Engie Laborelec's electronic low pressure impactor (ELPI). Mass loading and size distribution were determined using EERC's Dekati low pressure impactor. In addition to these measurements, both EERC and Engie Laborelec will be performing composition analysis using scanning electron microscopy (SEM) and other analytical techniques.

The testing was successful from an operational standpoint, and the early indications are that the WESP was successful in reducing the concentration of the particulate in the size range of interest. However, the data analysis is ongoing and will be reported in full detail during the next reporting period.

Additionally during this reporting period Minnkota, EERC and Fluor initiated discussions about the possibility of performing a pilot-scale test using the Fluor Econamine FG Plus^{SM} process at MRYS. This would be accomplished using the existing EERC pilot scale CO_2 capture system, with modifications/additions representing process components unique to Fluor's technology. Discussions are preliminary currently, but the goal would be to perform the testing from January through February 2020 in order to provide meaningful data for the FEED study and subsequent costing efforts.

Task 4 – Development of Permitting Strategies

Permitting for the Class VI CO_2 storage facility is described later in Task 6.

Minnkota met with the North Dakota Department of Environmental Quality (DEQ) on July 8, 2019. The meeting provided DEQ with a general overview and status update on the project as well as provided the opportunity to discuss some high level permitting questions for the CCS. The meeting was very productive and resulted in a much clearer path forward on CCS permitting. Minnkota and DEQ both agreed to continued discussion and early engagement to facilitate a smooth permitting process.

Task 5 – Project Tundra Cost Estimating

No activity. This will be completed as a part of the FEED study for the CCS.

Task 6 – Pipeline and Recycling Facility Design

No activity. Project Tundra currently envisions financing the project based solely on geologic storage in a saline formation adjacent to MRYS. However, we are leaving open the possibility of expanding into enhanced oil recovery (EOR) at a future date. The need for this task will continue to be evaluated as the project develops.

Task 7 – Geologic Storage Investigation

Receiving the Class VI CO_2 storage facility permit continues to be the longest lead time item in Project Tundra development. Two major activities were completed or initiated during this reporting period: 1) Seismic Source Test, and 2) 3D Seismic Survey.

Seismic Source Test: As reported during the previous quarter, the source test was required because the anticipated location of the Project Tundra CO_2 storage facility at least partly lies over reclaimed mine land. The reclaimed soil has significantly different properties than virgin soil, and thus a source test was needed to determine the most effective source type (i.e. vibroseis trucks, dynamite, and dynamite charge depth).

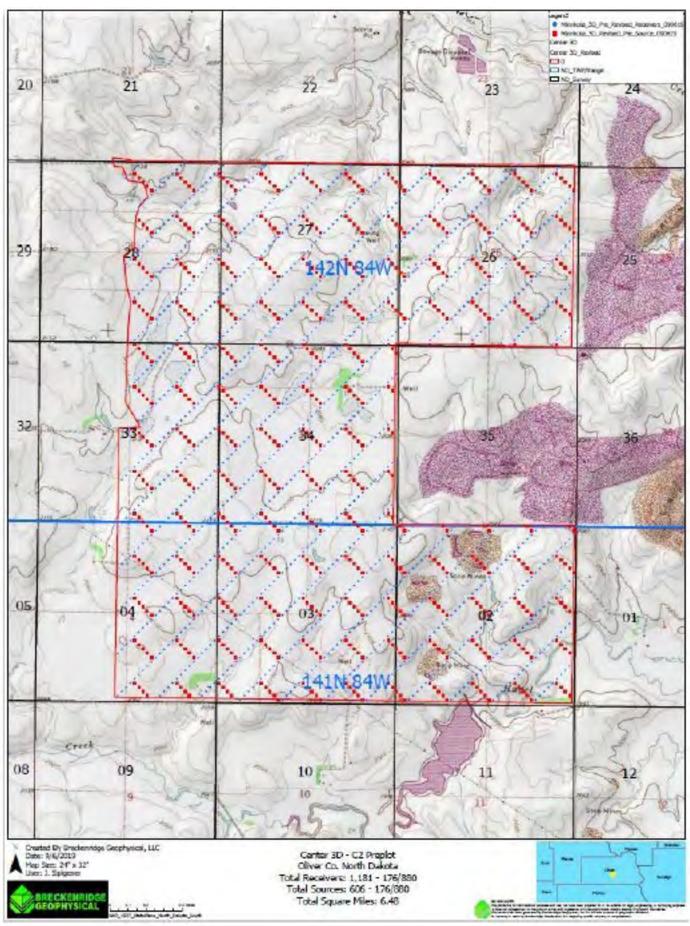
Minnkota secured a permit for the source test, which included full landowner consents, on July 1, 2019. Minnkota secured the services of source test vendors: Exploration Geophysics, Inc. (EGI) for quality control/quality assurance, and Breckenridge Geophysical for the source test fieldwork and acquisition. The EERC also provided field oversight and data interpretation and made the final selection on the type of source to be used for a future 3D Seismic Survey. The actual source test fieldwork and acquisition was performed during the timeframe of July 8 to July 23, 2019.

Based on the source test results, the EERC provided Minnkota with a list of the following key conclusions/recommendations:

- Dynamite sources were less affected by reclaimed mine land than vibroseis trucks
- The dynamite must be placed completely below the depth of the mine spoils (i.e. 120-200 ft)
- 11 lb dynamite shots provided best data
- A 6-7 mi^2 survey area will provide sufficient seismic data to support the Class VI permit

3D Seismic Survey: Based on the positive results of the source test, Minnkota continued its relationship with EGI and Breckenridge to perform a full 3D seismic survey. A description of the survey and the parameters are provided in Figure 1. The permit for the survey was acquired on September 17, 2019, which included all landowner access agreements. In support of this permit, Minnkota PI/PM, Gerry Pfau, gave an update to the Oliver County Commission on September 5, 2019.

At the time of this report submission, drilling activity is still ongoing. The original plan had been to perform the survey acquisition during early October, 2019. However, the unusually wet weather near MRYS, significantly delayed drilling shot holes. The team now expects to perform the acquisition in early November. Following acquisition, Minnkota will contract with a 3rd party data processing company to analyze and compile the data. EERC will then take the processed data and interpret it. It is currently expected that complete results of the 3D seismic survey will be fully detailed in the first quarter of 2020 report.



Survey Size	6.5 square miles
Source Type	11lb dynamite
Source Depth	120-200 feet
Receiver Line Spacing	880 feet
Receiver Spacing	176 feet
Total Number of Receivers	1,181
Source Line Spacing	880 feet
Source Spacing	176 feet
Total Number of Sources	606
Source Pattern	Brick

Figure 1. 3D Seismic Survey grid and parameters. The location is approximately 5 miles west of MRYS.

3 Budget Summary

In previous reporting periods, Minnkota has invoiced NDIC at an even 50/50 share of total expenses, with the non-NDIC funds being provided by Minnkota as cash and in-kind contributions. However, during this reporting period, since Minnkota was selected for award of $9.8 Million by DOE to support Tasks 2, 4 and 5, the following quarterly expense summary shows funds reimbursable by NDIC in excess of 50% of the total quarterly expenditures. This leaves total project cumulative expenditures under the NDIC share greater than 50%. Once the DOE cooperative agreement has been finalized, the NDIC share will be brought back to 50% or less of cumulative expenditures for the remainder of the project duration.

Table 1 below provides a summary of the total project budget and the current quarter and total cumulative expenditures to date. Full budget details are provided as an attachment to this report.

Table 1. Quarterly budget summary

Major Scope Category	Total Project Budgeted Amounts			Quarter Expenditures				Total Cumulative Expenditures			
	NDIC Share	DOE/MPC Share	Total	NDIC Share	MPC/DOE Share	MPC Share (in-kind)	Total	NDIC (cash)	MPC/DOE (cash)	MPC (in-kind)	Total
Project Management (Task 1)	2,000,000	-	2,000,000	12,499	-	-	12,499	107,249	45,157	49,592	201,998
FEED Study (Tasks 2, 4-5)	2,455,394	9,821,578	12,276,972	-	-	-	-	-	-	-	-
Pre-FEED & Optimization Studies (Task 3)	1,969,606	900,000	2,869,606	155,931	134,034	-	289,965	493,783	442,185	29,701	965,669
Pipeline and Recylcing Facility Design (Task 6)	575,000	-	575,000	-	-	-	-	-	-	-	-
Geologic Storage Investigation (Task 7)	8,000,000	20,000,000	28,000,000	238,985	-	-	238,985	245,756	1,708	5,063	252,527
TOTAL PROJECT	15,000,000	30,721,578	45,721,578	407,415	134,034	-	541,449	846,788	489,050	84,356	1,420,195
Total Percent of Project Costs	33%	67%	100%	75%	25%	0%	100%	60%	34%	6%	100%

Note: Minnkota is currently anticipating a $25 Million total project cost for EERC's CarbonSAFE Phase 3, of which $20 Million would be provided by DOE.

RESEARCH PERFORMANCE PROGRESS REPORT

SUBMITTED TO

North Dakota Industrial Commission
Lignite Research, Development and Marketing Program

PROJECT TUNDRA FEED

PRINCIPAL INVESTIGATOR/PROJECT MANAGER
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DATE SUBMITTED

January 29, 2020

SUBMITTED BY

Minnkota Power Cooperative, Inc.
5301 32nd Avenue South
Grand Forks, ND 58201

Quarterly Reporting Period Ending December 31, 2019

Signature of Project Manager: ______________________________
Gerry Pfau

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1 Summary of Accomplishments during Current Reporting Period

In the quarter from October 1 through December 31, 2019, the following major works were completed:

- A 3D seismic survey was completed on a ~6.7mi^2 plot northwest of the Young Station and south of the city of Center, ND. This survey gathered data on the subsurface and will support CO_2 storage facility permitting.
- Planning and procurement of long-lead items for a stratigraphic test well was initiated. The well, which will gather data needed for permitting of the CO_2 storage facility, will be constructed up to Class VI standards so that it can be used in the future (after commercialization of Project Tundra) as a CO_2 injection zone monitoring well. Minnkota secured the engineering services of Schlumberger to lead the design of the test well drilling and data collection program. The well drilling is planned to be initiated during the next reporting period.
- Minnkota and the U.S. DOE formally executed the cooperative agreement (DE-FE0031845) on December 19, 2019. Prior to that, on November 12, the Project Tundra team had a kickoff meeting at the DOE/NETL facility in Morgantown, WV. Work was initiated on the carbon capture system (CCS) front-end engineering & design (FEED) study with the goal of finalizing the last details of the design basis and design manuals that will set the stage for the full engineering and design work. Focus was on the sourcing of cooling water and the design of the cooling tower, and on the source of steam for the CCS – either steam extraction from the Unit 2 turbine, or auxiliary natural gas-fired boilers.
- Planning for pilot-scale testing of project team member Fluor's CCS technology was initiated. Testing will be kicked off during the next reporting period and will utilize EERC's existing pilot CCS currently located in the Unit 2 chimney at the Young Station. The focus of the testing will be on validating the performance of a wet electrostatic precipitator (WESP) in combination with Fluor's technology to mitigate challenges caused by ultrafine particulate created in the Young Station's combustion system.

2 Accomplishments by Task

The following sections provide a more detailed description of the activities associated with each task in the project that were performed during this reporting period. Activities completed during previous reporting periods are found in the respective previous quarterly reports.

Task 1 – Project Management and Technology Transfer

Minnkota formally executed the cooperative agreement with DOE to initiate work on the CCS FEED study (Tasks 2, 4 and 5) on December 19, 2019. The total estimated cost of the project is $12,276,972, with the DOE share at 80% ($9,821,578) and the NDIC share at ($2,455,394). Minnkota has also begun the process of executing contracts with all of our vendors/subcontractors and one subrecipient (EERC). Some of these were completed during this reporting period, the remainder are in progress and will be finalized early during the next reporting period.

Minnkota continued to work with the EERC on their Phase 3 application to DOE under the CarbonSAFE initiative (technical work to be completed under Task 7). The application was successfully submitted on January 15, 2020. Minnkota agreed to support the project with up to $5 Million cost share using NDIC funds, with DOE to provide an additional $15 Million. The anticipated notice of award is in April and tentative project start date in June, 2020.

During this reporting period, Minnkota added multiple new vendors/subcontractors after receiving approval from the NDIC. Schlumberger was contracted to lead the engineering work associated with a stratigraphic test well needed for data collection for the CO_2 storage facility permitting process. SAExploration was contracted for the 3D seismic acquisition after the original contractor (Breckenridge Geophysical) failed to substantially perform within the contracted performance deadline. Finally, Minnkota is working with Hamon Research-Cottrell (HRC) for the design and fabrication of a research-scale WESP that will be incorporated with EERC's pilot CCS. The WESP will be fabricated during the next reporting period. While Minnkota received formal approval from NDIC to add HRC to the approved vendor list, we are still awaiting final approval to include equipment purchase costs in the grant, as they were not originally proposed and may need approval from the Commission.

Task 2 – Project Tundra Engineering and Design

Engineering and design work during this reporting period focused on two major areas of the CCS: 1) cooling tower design and source of cooling water, and 2) steam source. While the DOE FEED study agreement does allow expenditures 90 days pre-award, the efforts during this reporting period were only preliminary. The focus during the early part of the next reporting period will be on finalizing the design basis and design manuals for the CCS, which will lay the groundwork for the full FEED study. The following sections discuss the work accomplished during this reporting period on each of the two areas identified above.

<u>Cooling Tower:</u> The water balance for the CCS is a critical component of the overall design. To select the most efficient source of cooling water and the design of the cooling tower required to facilitate the many heat exchange processes in the CCS, Minnkota and its team identified five main design parameters:

- Water source – Missouri River water or Nelson Lake water
- Cooler tower make-up and blowdown rates
- Infrastructure requirements
- Cooling tower blowdown location (i.e. Nelson Lake, deep well injection)
- Water treatment processes required

Minnkota is currently working with Burns & McDonnell (BMcD) to select an overall design and finalize details that must be provided to the FEED technical lead, Fluor, for their design work on the FEED study.

<u>Steam Source:</u> With amine-based carbon capture systems, a significant quantity of steam is needed to heat up the solvent in the regenerator to liberate the CO_2 and maintain the quality of the solvent. The source of the steam is a critical part of the CCS and can affect the costs and the complexity of the overall facility. Minnkota has identified and is evaluating two options for the steam source: 1) steam extraction from the existing Unit 2 turbine, and 2) supply of natural gas to the facility and installation of natural gas package boilers. As part of this engineering study, the impact and modifications to the existing steam turbine is being compared to the costs associated with installing natural gas package boilers and the cost of acquiring firm natural gas for the facility. During this reporting period, very preliminary information was gathered for each option, and Minnkota is working with BMcD and other team members to evaluate pros/cons and costs for each. A final selection and design basis will be completed early during the next reporting period.

Task 3 – Identification and Performance of Optimization Studies

As discussed in the previous quarterly report, very fine particulate (i.e. < 1 micrometer), both in liquid and solid forms, can cause significant challenges for post-combustion amine-based carbon capture systems. Fluor's technology is no exception. Lignite-fired flue gas from MRYS is known to contain a concentration of such particulate that is anticipated to present challenges associated with excessive emissions of amine solvent and solvent degradation. To mitigate these challenges, Fluor intends to use a WESP to eliminate a high percentage of the offending particulate upstream of the CCS absorber. The previous quarterly report detailed a pilot-scale test program that was completed at MRYS to investigate the effectiveness of a WESP on the MRYS flue gas. The key results of that testing program are presented in the following sections.

One particular challenge presented itself during the test; although the WESP was placed downstream the existing MRYS SO_2 scrubber and the concentration of SO_2 in the flue gas entering the WESP was ~10 ppm, oxidation of SO_2 into SO_3 within the corona of the WESP was apparent. This resulted in the formation of previously non-existing ultrafine particles in the form of sulfuric acid mist, which complicated the data analysis process. However, fortunately the size range of the sulfuric acid mist was substantially smaller than the majority of particles originating from the flue gas. Thus, for the most part, we were able to estimate the effectiveness of the WESP on the particles of interest. However, for future testing and for a commercial application, the WESP must be placed downstream an SO_2 polishing scrubber that will bring the concentration of SO_2 down to <1 ppm. Typical amine-based carbon capture systems, including Fluor's technology, have this capability.

The primary testing parameters of interest were flue gas velocity (i.e., residence time in the WESP) and the power/voltage supplied to the WESP. In general, there appeared to be little to no impact of velocity over the ranges tested. For power supply, at high power a larger number of sulfuric acid mist particles were formed, but there was improved removal efficiency for the larger particles (derived from coal combustion) that are of interest.

Figure 1 below shows the particle size distribution upstream and downstream of the WESP for one of the test periods. The results show that for particles <20 nm, sulfuric acid mist formation was occurring, and thus particle count (#/cm3) was higher downstream of the WESP. However, for larger particles that are of interest, the WESP was effective in reducing particle count. For most particle size ranges, the removal efficiency averaged 80-95%, which the project team considers promising considering the non-optimized nature of this test.

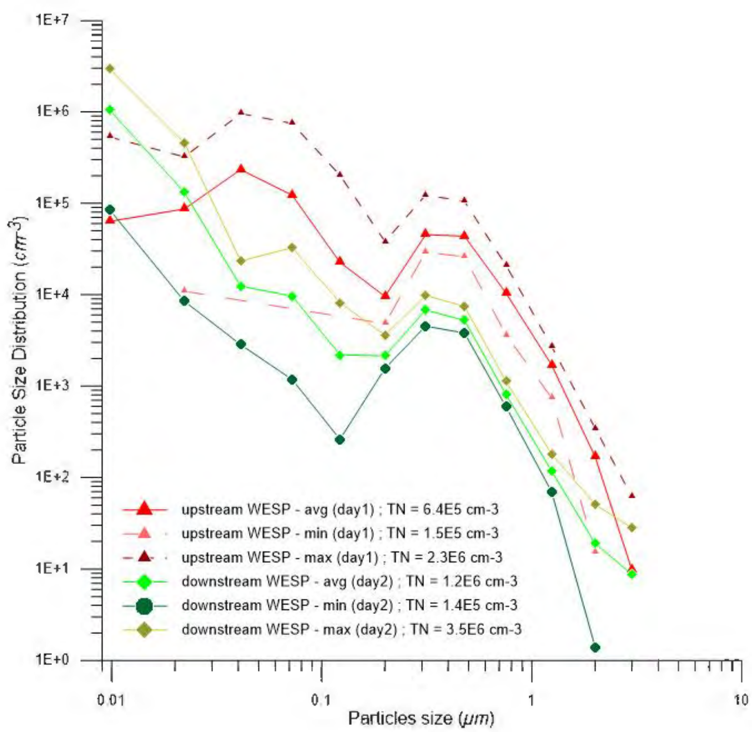

***Figure 1**. Results of WESP testing showing the particle size distribution in terms of particle count (number of particles per cm3 of gas volume). Results indicate that for particles larger than 0.02 microns, the WESP is effective. Figure courtesy of Engie Laborelec.*

In addition to particle removal efficiency in terms of particle count, the composition of the particles upstream and downstream the WESP were also evaluated (Figure 2). Based on these results it is difficult to draw any firm conclusions. However, from previous testing it is known that a significant fraction of the particle size range of interest contains alkali components. Therefore, if the WESP is successfully removing these particles, it would be expected that a corresponding reduction of alkali components would also be observed.

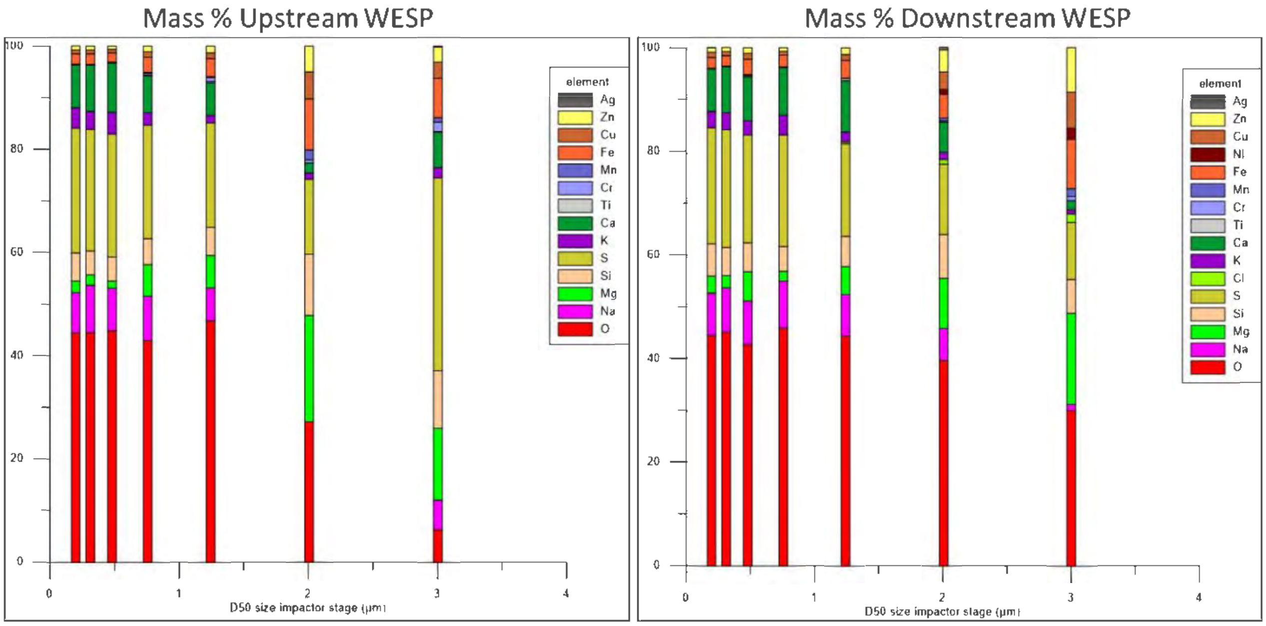

Figure 2. *Elemental composition of particulate collected upstream and downstream the WESP as determined by scanning electron microscopy with X-ray microanalysis. Figures courtesy of Engie Laborelec.*

In summary, although this first test was not fully optimized and the challenge of sulfuric acid mist formation was present, the results of the testing indicate that a WESP is capable of removing a large percentage of ultrafine particulate from the MRYS flue gas. The next step in the process is to validate the performance of the WESP in combination with Fluor's CCS technology to measure the impact of the WESP on amine solvent emissions and degradation.

During this reporting period, Minnkota, Fluor and EERC started planning for a pilot test program for March/April, 2020. The test program will utilize Fluor's proprietary CCS and CO_2 capture solvent along with EERC's pilot CCS that is currently housed in the Unit 2 chimney at the Young Station. A WESP will also be installed downstream the SO_2 polishing scrubber, but upstream the CO_2 absorber. Multiple meetings and discussions were held to discuss goals and details of the testing program. For Minnkota and Fluor, the primary goals of the testing are:

- Validate the performance of a WESP
- Measure the emission rate of amine solvent to project emission rate for the commercial system
- Evaluate solvent degradation processes and rates and determine the composition of any expected solvent waste streams. Use this information to inform the design of the commercial solvent maintenance systems and assist with planning for waste disposal at the commercial scale

While EERC's pilot CCS is fully operational and instrumented, a couple of additional items are needed to achieve the above goals. First, a research-scale WESP that is compatible in size to EERC's CCS will be purchased from HRC during the next reporting period. During this reporting period, Minnkota and EERC selected HRC as the fabrication vendor and initiated design work. Second, components of Fluor's proprietary solvent maintenance system will be procured and installed. This will ensure that the data received from the testing is representative of Fluor's actual process and that results obtained can be used to project to the commercial system for Project Tundra. Fluor will coordinate the procurement of these components.

Task 4 – Development of Permitting Strategies

Permitting for the CO_2 storage facility is described later in Task 7.

Internal discussions on permitting for the CCS have continued on a biweekly and ad hoc basis throughout this reporting period. The majority of this task will be performed in conjunction with the CCS FEED. However, the longest lead item identified was the permit for increasing Minnkota's allocation of Missouri River water. As such, efforts on the water allocation began in earnest in December. Based on the pre-FEED previously performed by Fluor, Minnkota estimated, with contingency, the amount of the new allocation and began evaluating the existing Missouri River intake structure, pumping systems, and pipeline to determine if any changes need to be made to accommodate the additional volume or any existing regulations. The Minnkota environmental team held meetings to review the current water permit file, identify permitting process questions, and develop a permitting timeline and approach. This work will continue into the next reporting period.

Task 5 – Project Tundra Cost Estimating

No activity. This will be completed as a part of the FEED study for the CCS.

Task 6 – Pipeline and Recycling Facility Design

No activity. Project Tundra currently envisions financing the project based solely on geologic storage in a saline formation adjacent to MRYS. However, we are leaving open the possibility of expanding into enhanced oil recovery (EOR) at a future date. The need for this task will continue to be evaluated as the project develops.

Task 7 – Geologic Storage Investigation

There were two major technical activities that were completed or initiated during this reporting period: 1) completion of the 3D seismic survey and initiation of the data processing and interpretation, and 2) initiation of planning, engineering, permitting, and procurement for a stratigraphic test well. Additionally, Minnkota collaborated with the EERC to prepare an application to DOE for the third phase of EERC's CarbonSAFE program.

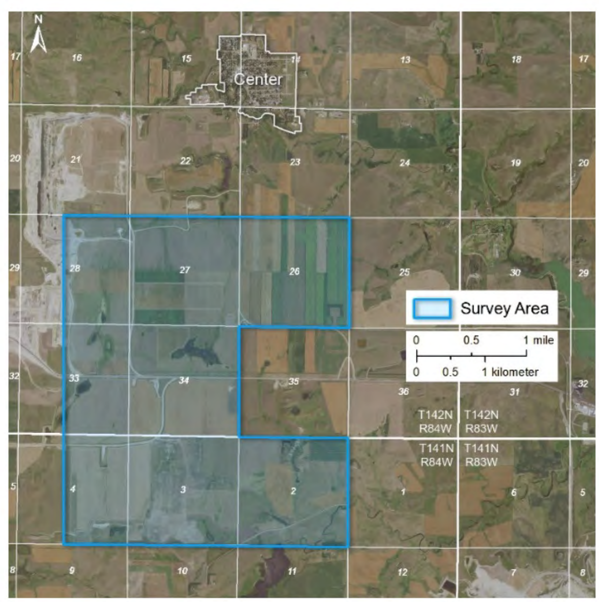

Figure 3. *3D seismic survey area located south of Center and northwest of MRYS. Figure courtesy of EERC.*

3D Seismic Survey: A 3D seismic survey was conducted during Fall 2019 as part of geologic site characterization efforts. The survey covered an area of approximately 6.7 sq. mi. south of Center, ND (Figure 3) and was carried out under a permit issued by the NDIC. The survey involved drilling, setting and detonating 11-lb charges of dynamite underground to generate a seismic signal that traveled deep into the earth and was reflected back to the surface. The reflected signal was recorded at the surface with an array of vibrational sensors, referred to as geophones.

Drilling, setting the charges, and backfilling the holes occurred September 23 – November 3. A total of 606 holes were drilled 120 to 180 ft deep and loaded with charges. The sensor array, consisting of 1182 geophones, was laid out November 14–15, and the charges were detonated individually on November 16. Due to the very wet weather in the fall of 2019, the drilling for the survey took longer than anticipated, pushing the acquisition back from the original plan in October to November, 2019. The original seismic acquisition contractor (Breckenridge Geophysical) notified Minnkota on October 31, 2019 that it would not perform within the contracted deadline for performance. Therefore, Minnkota contracted with SAExploration for the acquisition, which was successfully completed November 17, 2019. Of the 606 sources, one could not be detonated. After consulting with the State regulatory agency (NDIC/DMR) and BNI Coal (land owner), it was decided that the lead wires would be clipped and buried >5 feet deep. The precise location of the hole was recorded and provided to the agency, in accordance with NDIC Regulations.

Minnkota and its contractors have reclaimed all impacted land in and around the survey area, including all of the drill holes and ruts caused by the large trucks and drilling equipment. Minnkota also compensated landowners or lessees for damages from actual loss of crops due to activities or loss due to interference with harvest. Minnkota will assess additional damage from activities in the Spring and will continue to work with affected parties.

After completion of the acquisition, SAExploration provided the raw data to the contractor Minnkota selected for seismic data processing, Earth Signal Processing. Industry standard processing routines were applied to the raw data. A combination of algorithms was used to enhance the reflected seismic signal and to separate the desired reflected seismic signal from signal caused by cultural sources such as power lines and vehicle traffic. Prestack time migration algorithms were used to align the reflected seismic signal and generate a 3-D volume. Figure 4 shows the raw seismic data from a signal line of sensors and a cross section from the processed 3-D volume.

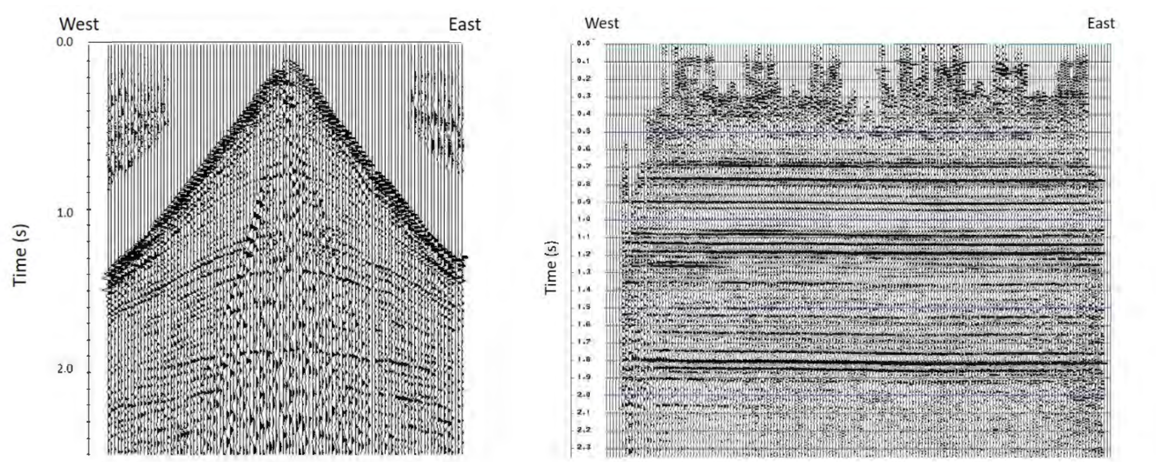

***Figure 4**. Raw seismic data from a single line of sensors (left) and a cross section from the processed 3-D volume (right). Figures courtesy of Earth Signal Processing*

The EERC was contracted to provide technical oversight of the processing efforts and analyze the processed data to evaluate the rock layers nearly 9600 feet below the surface. Analysis of the 3-D volume is currently under way. Geophysical logs from the BNI-1 stratigraphic test well, previously drilled and analyzed by EERC under a separate project, are being used to understand the seismic response of the different geologic formations and match the interpreted depths of the geologic formations to the seismic data which is recorded in time. The seismic data are being used to interpret the boundaries between the different geologic formations and generate layers by tracing the boundaries. Figure 5 shows a cross section from the 3-D volume that intersects the BNI well location. Depth conversion will be performed to convert the interpreted rock layer boundaries from the seismic data (time) into depth so they can be used to update the layers in the geologic model. Advanced calculations will be done to derive a porosity volume for several formations that can be used to update the property distribution in the geologic model.

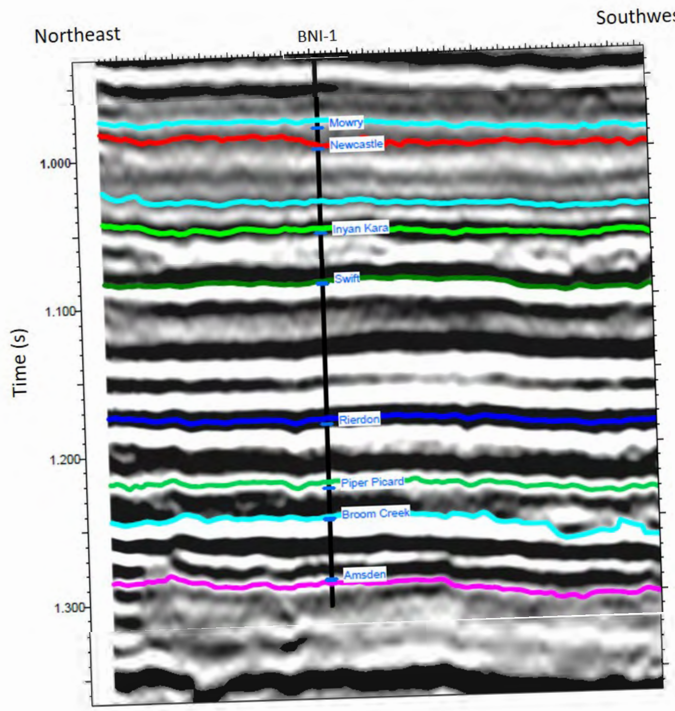

Figure 5. *Cross section from the 3-D volume of seismic data. The seismic data are represented by the gray-scale horizontal bands. The vertical black line represents the BNI-1 well, with interpreted geologic formations from the BNI-1 well (blue text). Preliminary interpretations of the layer boundaries from the seismic data are shown by the multicolored lines. Figure courtesy of EERC.*

Stratigraphic Test Well: The next set of characterization activities in furtherance of storage facility ~~permitting includes~~ gathering subsurface logging, and core data through the engineering and construction of a stratigraphic test well. The logging and core program will provide data, which, along with the 3D seismic survey data, will be used to update geologic models and will provide necessary data to satisfy N.D.A.C. § 43-05-01-05 permitting standards and requirements.

Minnkota held initial engineering and planning meetings with EERC which identified the parameters and scope of the drilling and logging program to achieve the above stated goals. Arising out of these initial planning sessions and because of the significant cost associated with the process/labor involved in drilling and gathering stratigraphic well data, Minnkota determined that for the incremental cost of added materials constructing the well to UIC Class VI standards provided significant future commercial utility beyond data and information gathering. Thus the team developed a well construction plan that meets UIC Class VI standards. Upon Project Tundra is commercialization Minnkota intends to convert the stratigraphic test well to a multi-zone CO_2 monitoring well through the storage facility/Class VI permitting process.

Next, Minnkota identified qualified subcontractor/vendors for services and supplies, and procured long-lead materials for the stratigraphic test well. Minnkota contracted with Schlumberger to lead the engineering and design of the test well drilling program and data acquisition plan. Minnkota also intends to contract with Schlumberger to manage the drilling and complete many of the services (i.e., cement, logging, tools…etc) once drilling is commenced during the next reporting period. The longest lead items for this well were identified to be the CO_2-resistant casing (chrome alloy) and CO_2-resistant cement. Minnkota and Schlumberger have located sufficient stock of each and initiated the procurement process.

The test well will be drilled all the way to the bottom of the Deadwood formation, with the focus of the data acquisition and coring being on the three potential CO_2 injection zones: 1) Inyan Kara (3,795-3,985'), 2) Broom Creek (4,853-5,125'), and 3) Deadwood (9,596-10,196'). Detailed logging will be completed throughout these zones and others. Coring will be completed throughout the full thickness of each of these zones as well as at least 50 feet of the cap and basement rocks for each zone, including the Precambrian rocks. The preliminary wellbore schematic is provided in Figure 6 and the preliminary logging/coring diagram is provided in Figure 7.

The permit to drill for this well is in progress and is expected to be submitted in late January, 2020. The EERC, using Schlumberger drilling, logging and coring program design, is developing the supporting materials for the stratigraphic test well permit application. Minnkota procured the well plat survey, local construction permits, and has initiated well pad construction planning (i.e., cut/fill diagram, pad layout, access routes…etc.). Minnkota is also in the process of finalizing an access agreement with BNI Coal, the landowner on which the well pad and well will be placed.

Minnkota and its team are planning to spud the well no later than March 15, but may speed up the process, if necessary, in order to move all drilling equipment on-site prior to spring thaw road restrictions. Well construction progress and details will be provided during the next reporting period.

<u>CarbonSAFE Phase 3:</u> During this reporting period, Minnkota worked with the EERC to prepare the application to DOE. The overall goal of CarbonSAFE Phase 3 is to gather, analyze and compile all technical data and submit permit applications for the CO_2 storage facilities and the Class VI drilling permits. To date, Minnkota has focused on one potential CO_2 storage site located south of the city of Center. A second storage site is also planned at the Young Station. Figure 8 provides current land owned either by Minnkota or BNI Coal and clearly shows the two separate blocks where the two storage sites are planned. CarbonSAFE will involve new site characterization at the MRYS site (3D seismic, stratigraphic test well) and will analyze all data and drill cores collected from both of the sites.

The CarbonSAFE application was successfully submitted on January 15, 2020 and has an estimated start date of June 1, 2020. Minnkota will be a subrecipient of the award and will provide cost share up to $5 Million using NDIC grand funds. The DOE will provide $15 Million, if awarded.

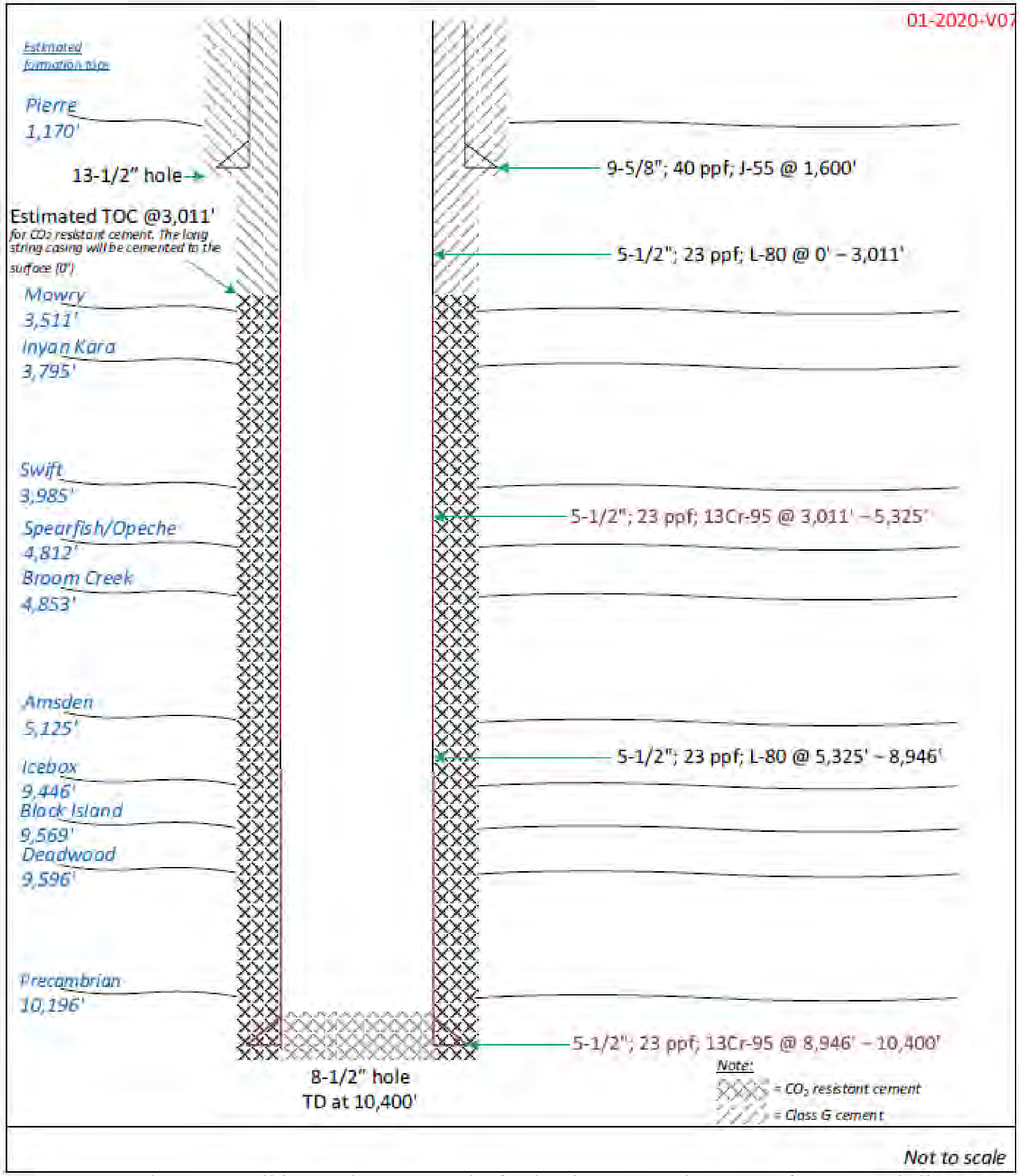

Figure 6. *Preliminary well bore schematic. To be finalized prior to submission of permit to drill. Figure courtesy of EERC.*

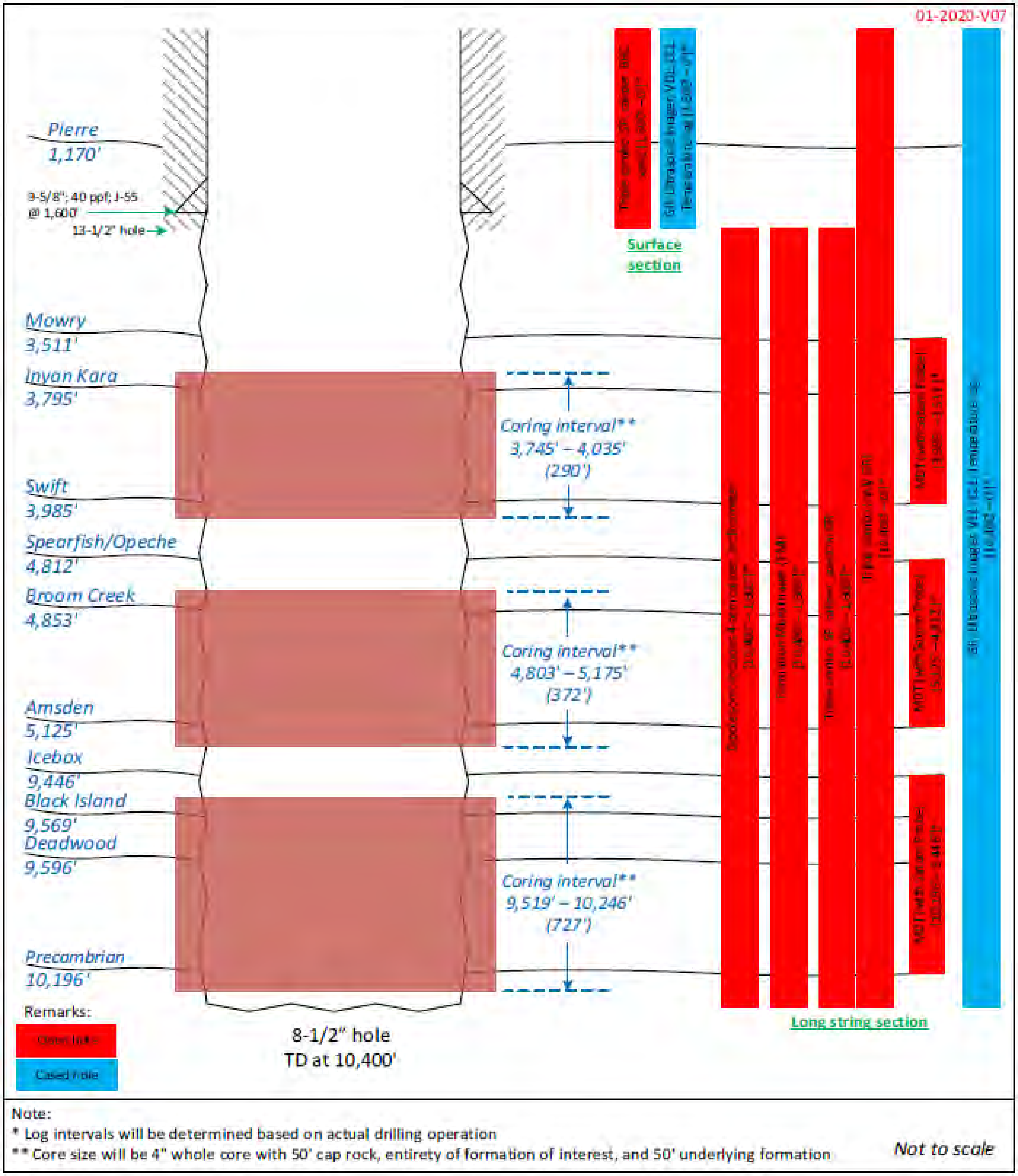

***Figure** 7. Preliminary logging and coring plan. To be finalized prior to submission of permit to drill. Figure courtesy of EERC.*

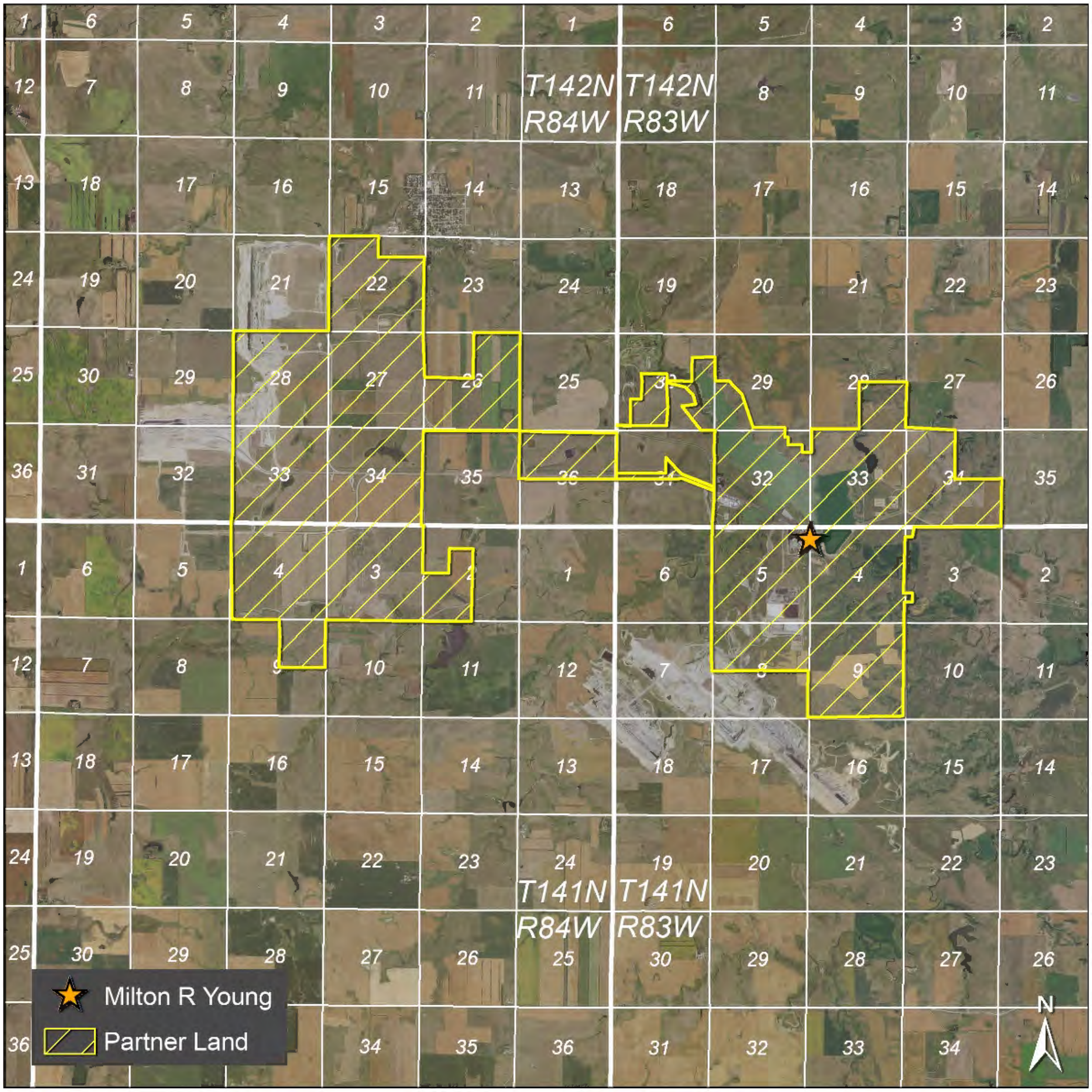

Figure 8. *Map showing land ownership of Minnkota and BNI Coal (Partner Land). Minnkota is planning for two separate storage sites, one south of Center (western block) and one at MRYS (eastern block). Site characterization and storage facility permits will be prepared separately for each site. Figure courtesy of EERC.*

3 Budget Summary

Table 1 below provides a summary of the total project budget and the current quarter and total cumulative expenditures to date. Based on preliminary discussion with NDIC, indirect costs have been included in this reporting period's expenditures, whereas indirect costs were not included in previous reporting periods. Full budget details are provided as an attachment to this report.

Table 1. Quarterly budget summary

Major Scope Category	Total Project Budgeted Amounts			Quarter Expenditures				Total Cumulative Expenditures			
	NDIC Budget	DOE/MPC Budget	Total Budget	NDIC Share	MPC/DOE Share	MPC Share (in-kind)	Total	NDIC (cash)	MPC/DOE (cash)	MPC (in-kind)	Total
Project Management (Task 1)	500,000	-	500,000	89,008	-	-	89,008	196,256	45,157	49,592	291,005
FEED Study (Tasks 2, 4-5)	2,455,394	9,821,578	12,276,972	5,189	20,756	-	25,945	5,189	20,756	-	25,945
Pre-FEED & Optimization Studies (Task 3)	969,606	900,000	1,869,606	58,425	228,859	-	287,284	552,208	537,010	29,701	1,118,919
Pipeline and Recylcing Facility Design (Task 6)	575,000	-	575,000	-	-	-	-	-	-	-	-
Geologic Storage Investigation (Task 7)	10,500,000	15,000,000	25,500,000	322,237	-	-	322,237	567,993	1,708	5,063	574,764
TOTAL PROJECT	15,000,000	25,721,578	40,721,578	474,859	249,614	-	724,473	1,321,646	604,631	84,356	2,010,633
Total Percent of Project Costs	37%	63%	100%	66%	34%	0%	100%	66%	30%	4%	100%

Note: Once full details of the CarbonSAFE application were developed and available, Minnkota realigned its project budget among the major scope categories to make available additional budget for Task 7. To accommodate this change, budget was reduced from Task 1 and Task 3, as compared to the previous quarterly financial report.

RESEARCH PERFORMANCE PROGRESS REPORT

SUBMITTED TO

North Dakota Industrial Commission
Lignite Research, Development and Marketing Program

PROJECT TUNDRA FEED

PRINCIPAL INVESTIGATOR/PROJECT MANAGER
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DATE SUBMITTED

May 1, 2020

SUBMITTED BY

Minnkota Power Cooperative, Inc.
5301 32nd Avenue South
Grand Forks, ND 58201

Quarterly Reporting Period Ending March 31, 2020

Signature of Project Manager: ______________________________
Gerry Pfau

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1 Summary of Accomplishments during Current Reporting Period

In the quarter from January 1 to March 31, 2020, the following major works were completed:

- Received and initiated installation of the pilot-scale wet electrostatic precipitator (WESP) to be tested under Task 3 along with Fluor's Econamine FG+ solvent and process at the Milton R. Young Station (MRYS). Planning for the upcoming pilot test – scheduled May/June 2020 – continued with project partners Fluor and Energy & Environmental Research Center (EERC).
- Selected a steam source for the carbon capture system (CCS). Natural gas auxiliary boilers will be included in the design, as opposed to the alternative option of extracting steam directly from the MRYS Unit 2 steam turbine. The auxiliary boilers option provides a lower technical risk profile and improves overall CCS and MRYS operational flexibility.
- The overall CCS design manuals were completed and submitted to project partners for review.
- Significant progress was made regarding the CCS FEED study contract with Fluor. Based on the choice of the auxiliary natural gas boilers for the steam source, Minnkota provided Fluor the opportunity to re-bid the project and update their scope of work and cost estimate accordingly. As of April 17, 2020, the final contract with Fluor was executed and a FEED study kickoff meeting is scheduled for April 30, 2020.
- Also based on the change in scope for the CCS FEED study, owner's engineer (OE) Burns & McDonnell, was provided the opportunity to re-bid the project. Their final proposal was received on April 22, 2020 and an amended contract was processed April 26, 2020.
- All other vendors and project partners on the CCS FEED study are now under contract and ready to begin with the exception of the stack icing study contractor.
- Minnkota began the process of increasing its Missouri River water allocation to account for the increased need due to addition of the CCS. A water allocation permit and sovereign lands permit were submitted on February 18 and March 25, 2020, respectively.
- Minnkota received the final results and interpretation from the 3D seismic survey conducted in Fall 2019. The results support there being multiple suitable geologic horizons beneath MRYS and the adjacent lignite mine for large-scale storage of CO_2.
- EERC, with assistance from Minnkota, on January 15, 2020, submitted an application to the U.S. Department of Energy (DOE) for Phase 3 of North Dakota CarbonSAFE initiative. The DOE announced on April 24, 2020 that the EERC project was selected for award of about $17 Million.
- Minnkota submitted a permit to drill for a Stratigraphic Test Well, named J-LOC1, to the North Dakota Department of Mineral Resources Oil & Gas Division on January 29, 2020, which was subsequently approved on February 7, 2020 as File No. 37380.
- The well pad for the J-LOC1 well was completed in February/March, 2020 and additional planning and procurement for the well continued throughout the reporting period. At the time of this report submission the drilling rig is completing final installation at the site, with spudding of the well set to be on or before May 14, 2020.
- Minnkota participated in the kick off for the Class 1 injection well for waste water with Golder & Associates. Golder has since requested site specific information on Minnkota to aid in the design of the injection well.

2 Accomplishments by Task

The following sections provide a more detailed description of the activities associated with each task in the project that were performed during this reporting period. Activities completed during previous reporting periods are found in the respective previous quarterly reports.

Task 1 – Project Management and Technology Transfer

During this reporting period, there was significant efforts spent on negotiating and executing contracts associated both with the CCS FEED study and the stratigraphic test well. Those efforts are briefly summarized below.

CCS FEED: The study was originally set to begin in January. However, delays were experienced due to challenges in negotiating the commercial terms for the contract with Fluor. Additionally, with the change in steam source for the CCS (described in Task 2 later), Minnkota gave both Fluor and BMcD the opportunity to re-bid the project. During this reporting period, significant progress was made both on the commercial terms for Fluor and on updating the scope of work and cost estimates for Fluor and BMcD. Both proposals and contracts with finalized and executed subsequently to the end of this reporting period in April 2020. The FEED study is now officially ready to begin, with an internal kickoff meeting with all of the technical team members scheduled for April 30, 2020.

Test Well: During this period, contracts were finalized between Minnkota and key contractors on the test well including:

- Cyclone Drilling – The drilling/rig provider
- Schlumberger – Tools/services provider
- GeothermEx (a Schlumberger Company) – Providing project management/consulting and site supervision for the drilling operation

In addition to the above, procurement of various materials and services continued to support the test well. Due to the coronavirus pandemic, there have been delays in commencing the drilling, which was originally scheduled for March 2020. At the time of this report submission, the drilling rig is set up and ready to go and crews are scheduled to begin mobilizing to the site beginning May 1, with drilling to begin no later than May 14.

During this reporting period, multiple project presentations were given as listed below:

- Energy Generation Conference (Jan 29-30), Bismarck ND
    - Project Tundra Overview; Gerry Pfau (Jan 29)
    - Project Tundra – Opportunities & Challenges; Dan Laudal (Jan 30)
- MN Senate Energy Committee Hearing on Carbon Capture & Storage Technology (March 3, 2020)
    - Project Tundra Update; Dan Laudal

Minnkota worked with the EERC to successfully submit EERC's Phase 3 application for the North Dakota CarbonSAFE initiative on January 15, 2020. The application was subsequently selected for award on April 24, 2020. The CarbonSAFE funds will be used to support work under Task 7 of this project, with approximately $17 Million being awarded by the DOE. EERC will be the lead organization on the project, and Minnkota will be a subrecipient and will dedicate up to $5 Million cost share.

Task 2 – Project Tundra Engineering and Design

Minnkota worked with Hunt International and BMcD to develop a design manual that will be incorporated into the design of the CCS and the balance of plant (BOP) interconnects. The design manual was developed to ensure the current MRYS standards are integrated into the design of the CCS. In addition, specific requirements for cold weather based on Minnkota's previous experience and projects were included in the design manual. The design manual will be used by Fluor to integrate the requirements into the design for the CCS equipment. In addition, BMcD will utilize the design manual for their scope of work on water treatment design and costing as well as BOP design and costing.

Additionally, in order to provide the framework for the FEED study, Minnkota and its team must make some key decisions on the overall design of the facility. Engineering and design work focused on three major areas of the CCS: 1) water source selection, 2) steam source selection, 3) oxygen levels in CO_2 product specification

<u>Water Source Selection:</u> Minnkota developed a line of water treatment selections that will be used as the basis for the FEED. The various items that were selected and brief description for each selection is described below:

- Water Source – Nelson Lake was chosen as the water source for the FEED study and the water parameters will be used for selection and sizing of water treatment equipment. Lake Nelson water was chosen as the water source as compared to Missouri River water as there is more water in retention in Nelson Lake and requires a shorter pipeline to get to the CCS boundary limits
- Water Pre-Treatment – Cold lime softening was chosen as the water pre-treatment philosophy for the raw water treatment. Cold lime softening was chosen by the ability to lower the amounts of cooling tower make-up and eventual cooling tower blowdown rates.
- Cooling Tower Blowdown – Cooling tower blowdown was selected to be deep well injected (Class I) as the design basis for the FEED. Deep well injection was chosen as it is currently anticipated as the lowest cost for water treatment options.

<u>Steam Source Selection:</u> During this period the technical and cost evaluation of two potential options for providing steam to the CCS was completed. The options evaluated were: 1) direct extraction from the MRYS Unit 2 steam turbine, and 2) installation of auxiliary natural gas package boilers and supply of natural gas to the facility. The evaluation showed that the natural gas boilers is the best option for Project Tundra, primarily for the following reasons:

- Significantly lower technical risk
- Improved CCS and MRYS operational flexibility
- Potentially improved economics

The original proposal to DOE allowed for the flexibility to evaluate both of these options; however, the steam turbine extraction was considered the most likely option, and thus was used as the basis for cost estimating for the budgets for project team members Fluor and BMcD. With the selection of the natural gas boilers, the following items needed to be added to the overall scope, and thus necessitated a re-bid of both proposals (as described above in the Task 1 summary). Removal of the steam supply piping from the existing turbine and required turbine modifications to accommodate the extraction steam also necessitated a re-bid.

- Natural gas pipeline from an as yet to be determined tie-in point to the CCS boundary limits.
- A cost comparison of field erected package boilers vs shop fabricated boilers.

- Flue gas ducting and associated dampers to the CCS boundary limits for both the natural gas boilers and Unit 1, which is now able to be tied into the CCS since steam supply is independent of Unit 2 operation.
- Demineralized water treatment system

Oxygen Levels in CO_2 Specification: Another key decision needed is the oxygen specification in the CO_2 product. Oxygen impurity in the CO_2 product can have impacts both in the pipeline (i.e., corrosion or compression requirements) and in the subsurface. Specifically, the level of allowable oxygen in the CO_2 product will impact the level of or need for deoxygenation.

Based on the review (summarized in subsequent bullets), the project team has concluded that catalytic deoxygenation (CATOX) is not required, since for the geologic storage option, the pipeline length is short and there are no concerns about oil miscibility in an enhanced oil recovery (EOR) scenario. However, since EOR may be a future possibility, the team will be building in the flexibility in the design to add a CATOX system at a later date.

- Compression requirements: The IEA-GHG (2004) reports that the presence of a combined total of any lighter gases such as nitrogen, oxygen, or CO in excess of 5% could result in a much higher pressure to keep the CO_2 in the dense phase. This impact would significantly increase both compression and transmission costs, because of the higher pressures required to maintain the dense phase, or larger pipelines if the stream is transported as a gas instead. Visser and others (2008) report that the increase in compression work depends linearly on the concentration of the gaseous impurity and it is approximately 2.5%, 3.5%, and 4.5% for a concentration of 1% of O2, N2, and H2, respectively. Therefore, impurities, including oxygen, should be kept as low as practical in order to minimize compression costs.
- Subsurface/Pipelines: While oxygen presence can create oil miscibility and other issues for EOR applications, Visser and others (2008) report that there are no widely accepted standards for the purity of CO_2 for the purpose of transport and geological storage. However, individual business guidelines set specific CO_2 qualities for pipeline transportation, typically between 10-100 ppm oxygen limit.

As noted above, the project team does not believe CATOX is required for the geologic storage scenario currently being pursued for Project Tundra. Elimination of the CATOX is a significant capital and O&M savings. However, work is still in progress to finalize the oxygen specification (in ppm) and will be reported during the next reporting period.

Task 3 – Identification and Performance of Optimization Studies

As discussed in the previous quarterly report, very fine particulate (i.e. < 1 micrometer), both in liquid and solid forms, can cause significant challenges for post-combustion amine-based carbon capture systems. Fluor's technology is no exception. Lignite-fired flue gas from MRYS is known to contain a concentration of such particulate that is anticipated to present challenges associated with excessive emissions of amine solvent and solvent degradation. To mitigate these challenges, Fluor intends to use a WESP to eliminate a high percentage of the offending particulate upstream of the CCS absorber. An initial test was completed during summer 2019, which successfully validated the efficacy of a WESP to reduce the particulate concentrations to an acceptable level.

Subsequent to the initial validation test, Minnkota, Fluor and EERC began planning for a follow up pilot test that would involve installation and testing of a WESP upstream of EERC's pilot scale CCS that is currently installed at the MRYS. The testing will use Fluor's Econamine FG+ process and solvent and has the following major goals:

- Validate the performance of a WESP in conjunction with Fluor's CCS technology
- Measure the emission rate of amine solvent to project emission rate for the commercial system
- Evaluate solvent degradation processes and rates and determine the composition of any expected solvent waste streams. Use this information to inform the design of the commercial solvent maintenance systems and assist with planning for waste disposal at the commercial scale

During this reporting period, planning and procurement for this pilot test continued as summarized in the following paragraphs.

Minnkota Power issued a purchase order to Hamon Research-Cottrell (HRC) for a pilot scale WESP to integrate into EERC's CCS. HRC completed the manufacturing and shipment of the WESP to the MRYS. Upon receipt of the WESP (Figure 1), Minnkota completed the rough installation. The final plumbing of the WESP and the commissioning has been delayed due to the coronavirus pandemic and changes in the Unit 2 outage schedule.

Simultaneously to the construction and installation of the WESP, the testing plan was developed for the specific requirements of Fluor's process and solvent. The testing will be conducted using Fluor's solvent formulation, but with solvent reclaiming done off-site in an existing system. Analysis and samples of process streams associated with the reclaiming process will be provided to aid in the FEED study and future permitting.

Currently, the project team is planning for final installation and shakedown of the WESP and integration into EERC's CCS to be completed during the first two weeks of May 2020, with at least one month of 24/7 operations to commence following the Unit 2 outage currently scheduled for May 13-17, 2020.

Figure 1*. Photo of the pilot-scale WESP.*

Task 4 – Development of Permitting Strategies

This task is focused on permitting for the CCS. Permitting activities that support the CO_2 storage facility are described later in Task 7.

<u>Air Emissions:</u> During this reporting period, Minnkota identified that installation of the natural gas boilers will significantly complicate the air emissions monitoring requirements for the combined MRYS and CCS. A simplified schematic of the overall concept is provided in Figure 2. A preliminary discussion with NDDEQ was held on February 19, 2020 to identify monitoring requirements for this type of configuration. To assist with developing a monitoring strategy/plan, Minnkota contracted with RMB Consulting. This work will initiate during the next reporting period.

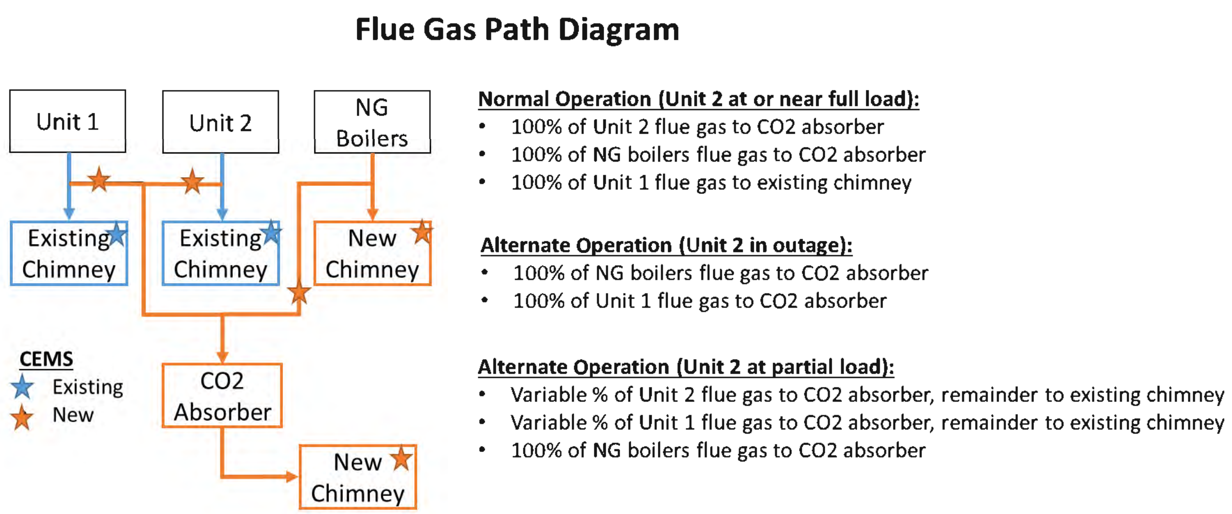

Figure 2*. Simplified and preliminary schematic of multiple potential operating scenarios, which creates a complex emissions monitoring system that needs to be further detailed. Minnkota has hired a specialist in this area, RMB Consulting, to assist with development of an emissions monitoring plan.*

Water Effluents: During this reporting period, Minnkota finalized all information required for the water appropriation permit for increasing the allocation of Missouri River water. Additionally, it was identified that a Sovereign Lands permit was required in addition, and information to support that permit was compiled and prepared.

Also during this period, work on the Class I wastewater injection well was initiated with Golder. Specifically, Golder initiated their Feasibility Study, and with assistance from Minnkota and EERC began compiling all technical information available for the subsurface properties near the MRYS, with a focus on the Inyan Kara formation (~3600-3800 ft depth), which is the target formation for the water injection. Fortunately, much of this data gathering is highly complementary with previous and ongoing work by Minnkota and EERC in characterizing the potential of this formation and others for CO_2 geologic storage. Therefore, much of the required information is already site specific.

Task 5 – Project Tundra Cost Estimating

No activity. This will be completed as a part of the FEED study for the CCS.

Task 6 – Pipeline and Recycling Facility Design

No activity. Project Tundra currently envisions financing the project based solely on geologic storage in a saline formation adjacent to MRYS. However, we are leaving open the possibility of expanding into enhanced oil recovery (EOR) at a future date. The need for this task will continue to be evaluated as the project develops.

Task 7 – Geologic Storage Investigation

Major technical activities occurring in this reporting period included: 1) completion of the 3D seismic survey data processing and interpretation; 2) engineering and permitting of the stratigraphic test well drilling program; 3) procurement of vendors and contractors for construction of the stratigraphic test well. Additionally, during this first quarter the technical and project management team worked to navigate and prepare health and safety protocols to address the dynamic coronavirus pandemic.

~~3D Seismic Survey:~~ The 6.7 square-mile 3D seismic survey (Figure 3) was completed in November 2019. Earth Signal Processing was selected for seismic data processing, completed in Q4 of 2019. The EERC was contracted to provide interpretation of the processed data and a final report was provided to Minnkota on March 20, 2020. The interpretation will be used to update the geologic model and better understand the structural character of the target formations, which will further develop the understanding of the formations' influence on CO_2 migration. Additionally, the information allows for porosity volumes to be calculated for the Inyan Kara and Broom Creek formations, leading to improved accuracy in the reservoir injection simulations and visualizations of the distribution of injected CO_2 in the target formations. Ultimately, the interpretation provides for a better-informed injection site selection. Most important, the seismic data allowed for interpretation and identification of potential hazards in the subsurface. The following paragraphs summarize the key interpretations from the survey.

Figure 3. *Survey area, sensor locations and dynamite shot hole locations*

No structural features, faults or discontinuities were observed that would cause a concern about seal integrity in the strata above the Inyan Kara, Broom Creek, or Black Island/Deadwood Formations, which are the three porous formations that are of focus for CO_2 injection/storage. The seismic attributes show linear trends in the Precambrian basement that were also observed in the Deadwood and overlying Winnipeg Group, which the geometry suggests the presence of basement block joints in the seismic survey area. The EERC notes that these data do not suggest that these features will impact the integrity of the Ice Box seal.

Additionally, the interpretation provides insight into the continuity of the sand intervals in each target storage formation. EERC was able to correlate the seismic data gathered with the BNI-1 stratigraphic test well core and data (drilled and analyzed in EERC's previous CarbonSAFE Phase 2 effort). The correlated well log and core data suggest that the sand intervals identified in the BNI-1 well are laterally continuous throughout the survey area and suggest that these sand intervals are viable candidates for CO_2 injection. While no well logs or core data from the Black Island/ Deadwood Formation were gathered from the BNI-1 well, the seismic data show the intervals within the Deadwood are similarly laterally continuous and have consistent thickness throughout the study area. The coring and well logging planned in the J-LOC1 stratigraphic test well will provide the data set for further conclusions to be developed about the Black Island/Deadwood Formation.

An example of some of the interpreted data is provided in Figure 4, which highlights the Broom Creek formation.

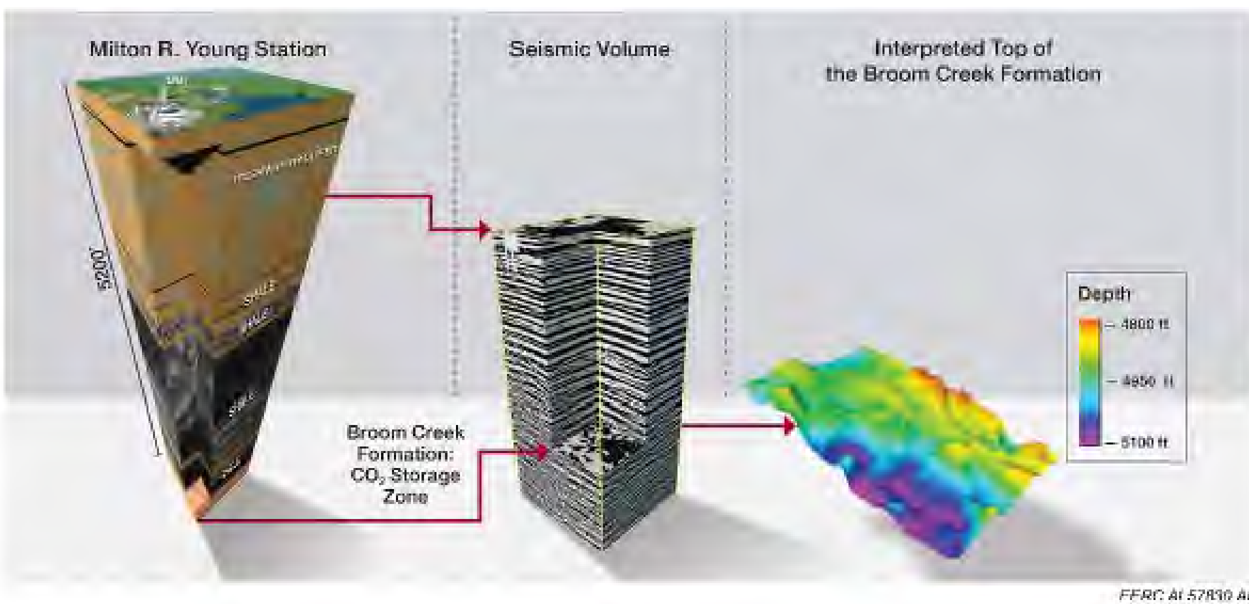

Figure 4. *Conceptualized image of the subsurface geometry near MRYS (left). The 3D seismic volume generated from processing the survey data (middle). The interpreted surface for the top of the Brook Creek formation, with the depth scale exaggerated to highlight the structural highs and lows (right).*

The interpretation report concludes that there were no hazards observed, with no concerns about seal integrity in the strata above the Inyan Kara, Broom Creek or Black Island/Deadwood Formations. There is a note that the linear trends observed were likely associated with the basement block joints in the Precambrian basement and in the Deadwood and the overlying Winnipeg group. There were, however, no discontinuities associated with these features that would suggest they may have an impact on the integrity of the Ice Box seal. Generally, the interpretation of the seismic data will provide additional insight and will be used to update the geologic model, mapping of various target formations and seals, and calculate the target formation porosity volumes.

Stratigraphic Test Well: Minnkota contracted with Schlumberger to lead the engineering and design of the test well drilling program and data acquisition plan. Minnkota also selected Cyclone Drilling as the rig contractor, based out of Gillette, Wyoming. Cyclone came with not only the technical experience in drilling wells for CO_2 operations but had an exemplary safety record. The long-lead items for this well, the CO_2-resistant casing (chrome alloy) and CO_2-resistant cement, were ordered. Schlumberger through its affiliated entity GeothermEx provided pre-mobilization project management support. The Authorization for Expenditure (AFE) was completed and submitted to Minnkota on January 15, 2020 and came with an initial estimate of $7 Million for labor and materials for the stratigraphic test well as designed. At the time of submission Schlumberger identified a few interval errors, which when corrected reduced the overall cost of the drilling program to $6.2 Million. Neset Consulting was hired to provide Mud Logging services, and Wyoming Casing, who has experience in running and handling chrome casing, was selected to provide casing-run services. Schlumberger will be providing tool and cementing services through their affiliated entities. Reservoir Group was recommended from the BNI-1 well coring program and was selected to perform the coring services. All contractors and vendors providing these essential services as well as the miscellaneous site support services were procured and contracts were finalized during the first quarter of 2020.

The permit to drill for this well was submitted on January 29, 2020 through NDIC's new NorthStar permit management system. The permit file 37380 for the J-LOC1 stratigraphic test well was approved on February 7, 2020. Minnkota hired Baranko Brothers to construct the well pad and access roads for the well, which was completed during this reporting period.

The test well will be drilled all the way to the bottom of the Deadwood formation, with the focus of the data acquisition and coring being on the three potential CO_2 injection zones: 1) Inyan Kara (3,795-3,985'), 2) Broom Creek (4,853-5,125'), and 3) Deadwood (9,596-10,196'). Detailed logging will be completed throughout these zones and others. Coring will be completed throughout the full thickness of each of these zones as well as at least 50 feet of the cap and basement rocks for each zone, including the Precambrian rocks.

Minnkota had to reassess and postpone the spud date initially due to road restrictions from March 15 to April 10, 2020. Minnkota aligned the historical averages for removal of road restrictions against a 45-day proposed drilling program and determined a delay would save upwards of $100,000 in permitting costs. A second delay in spud date occurred due to the coronavirus pandemic. In an effort to comport with federal, state and Minnkota guidelines addressing pandemic protocols, the spud date was postponed to May 14, 2020. The Minnkota team along with the GeothermEx project manager and site supervisors worked to develop an optimized well site plan and layout to facilitate and implement social distancing guidelines. Health and safety protocols were developed and vendor/contractors were put on notice and required to have all personnel quarantine during the delay period to avoid further delay in program commencement.

During the delay period, road restrictions were lifted and Cyclone and GeothermEx were authorized to commence rig and major equipment mobilization to the well site. Additional living quarters were procured to provide all personnel with individual and isolated living arrangements and professional sanitizing and cleaning services were secured for weekly cleaning of the living quarters. Minnkota was pleased with the cooperation from all vendors/contractors during the delay period and believes all steps and protocols taken put the health and safety of the personnel and community at the forefront of the J-LOC1 drilling program.

At the time of this report submission, the Cyclone rig has completed final setup and crews are set to begin mobilization to the site on May 1, 2020. Progress/status of the drilling program will be reported during the next reporting period.

3 Budget Summary

Table 1 below provides a summary of the total project budget and the current quarter and total cumulative expenditures to date. Full budget details are provided as an attachment to this report. The below summary shows the NDIC share of expenditures as significantly greater than 50%. This is due to delays in initiating the FEED study because of the Fluor contract delay. It is expected that with the FEED study commencing in May that the non-NDIC share of expenditures will quickly come into alignment with the minimum 50% of total costs.

Table 1. Quarterly budget summary

Major Scope Category	Total Project Budgeted Amounts			Quarter Expenditures				Total Cumulative Expenditures			
	NDIC Budget	DOE/MPC Budget	Total Budget	NDIC Share	MPC/DOE Share	MPC Share (in-kind)	Total	NDIC (cash)	MPC/DOE (cash)	MPC (in-kind)	Total
Project Management (Task 1)	500,000	-	500,000	4,634	-	-	4,634	200,890	45,157	49,592	295,640
FEED Study (Tasks 2, 4-5)	2,455,394	9,821,578	12,276,972	26,600	106,401	-	133,001	31,789	127,156	-	158,945
Pre-FEED & Optimization Studies (Task 3)	969,606	900,000	1,869,606	176,514	146,442	-	322,956	728,722	683,452	29,701	1,441,875
Pipeline and Recylcing Facility Design (Task 6)	575,000	-	575,000	-	-	-	-	-	-	-	-
Geologic Storage Investigation (Task 7)	10,500,000	15,000,000	25,500,000	1,119,890	-	-	1,119,890	1,687,883	1,708	5,063	1,694,654
TOTAL PROJECT	**15,000,000**	**25,721,578**	**40,721,578**	**1,327,638**	**252,843**	**-**	**1,580,481**	**2,649,284**	**857,474**	**84,356**	**3,591,114**
Total Percent of Project Costs	**37%**	**63%**	**100%**	**84%**	**16%**	**0%**	**100%**	**74%**	**24%**	**2%**	**100%**