Energy & Environmental Research Center
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April 14, 2023

Mr. Reice Haase
Deputy Executive Director
ATTN: Lignite Research Program
North Dakota Industrial Commission
State Capitol – 14th Floor
600 East Boulevard Avenue, Department 405
Bismarck, ND 58505-0840

Dear Mr. Haase:

Subject: EERC Proposal No. 2023-0146 Entitled "Redundancy Study for CO_2 Capture at Coal Creek Station"

The Energy & Environmental Research Center (EERC) of the University of North Dakota is pleased to submit the subject proposal in partnership with Rainbow Energy Center (REC), Mitsubishi Heavy Industries, Burns & McDonnell, and Kiewit. The application solicits the support of the Lignite Research Program for the execution of a redundancy study effort to complement the current front-end engineering design (FEED) study currently being conducted for the planned carbon capture plant at the REC Coal Creek Station. This proposal focuses on providing critical cost-benefit data for utilizing targeted equipment redundancy to reduce the technological risk associated with investing in a postcombustion capture retrofit project.

The $100 application fees for this proposal and EERC Proposal No. 2023-0147 are provided through ACH transaction number 252483. The EERC is committed to completing the project as described in the proposal if the Commission makes the requested grant. If you have any questions, please contact me by phone at (701) 777-5114 or by e-mail at jlaumb@undeerc.org.

Sincerely,

DocuSigned by:
Jason Laumb
2898A1DC4D60449...

Jason D. Laumb
Director of Advanced Energy Systems Initiatives

Approved by:

DocuSigned by:
Tami Votava
E7468BBB3DE440E...

for

Charles D. Gorecki, CEO
Energy & Environmental Research Center

JDL/kal

Attachment

Lignite Research, Development and Marketing Program

North Dakota Industrial Commission

Application

Project Title: Redundancy Study for CO_2 Capture at Coal Creek Station

Applicant: University of North Dakota Energy & Environmental Research Center

Principal Investigator: Jason D. Laumb

Date of Application: April 14, 2023

Amount of Request: $837,313

Total Amount of Proposed Project: $1,674,627

Duration of Project:

July 1, 2023 – March 31, 2024

Point of Contact (POC): Jason D. Laumb

POC Telephone: (701) 777-5114

POC Email: jlaumb@undeerc.org

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ABSTRACT

Objective: The objective of this project by the Energy & Environmental Research Center (EERC) is to support Rainbow Energy Center's (REC) Coal Creek Station carbon capture plant front-end engineering design (FEED) study through incorporation of redundant pieces of equipment. This first-of-kind, at-scale North Dakota plant brings with it a higher degree of operational risk in an industry where supplying baseload power depends on high reliability and availability. The FEED study, commenced on February 1, 2022, has identified several drivers that necessitated a redundancy study to reduce risk.

Expected Results: Key outcomes from this focused study will highlight the impacts to 1) cost and reliability and 2) the project execution schedule for the proposed REC capture plant. The results of the study are expected to provide REC with essential information to perform a cost-benefit analysis for design with equipment redundancy. This effort also supports the original REC Coal Creek Station carbon capture project intent to 1) reduce the technological and economic risks associated with investing in a postcombustion capture retrofit project and 2) provide information and learnings that will enable evaluation and deployment of similar North Dakota facilities.

Duration: 9 months (July 1, 2023 – March 31, 2024).

Total Project Cost: The proposed total cost is $1,674,627, with REC contributing $837,314 as cash cost share and $837,313 requested from the Lignite Research Program (LRP).

Participants: The project lead is the EERC, with the project conducted in partnership with the North Dakota Industrial Commission (NDIC) through LRP, REC, Mitsubishi Heavy Industries America (MHIA), Burns & McDonnell (BMcD).

PROJECT SUMMARY

The Energy & Environmental Research Center (EERC) proposes a redundant equipment design study to complement the ongoing front-end engineering design (FEED) underway at Coal Creek Station. This project will support Rainbow Energy Center's (REC) Coal Creek Station carbon capture plant FEED study through incorporation of redundant pieces of equipment. This first-of-kind, at-scale North Dakota plant brings with it a higher degree of operational risk in an industry where supplying baseload power depends on high reliability and availability.

The FEED study that is currently underway commenced on February 1, 2022. The basic engineering design document (BEDD), generated as part of the FEED study, specified that each carbon capture train follow its boiler's operations while maintaining high CO_2 capture efficiency. During the hazard and operability (HAZOP) review, the team identified potential single points of failure that must be addressed through equipment redundancy, also known as sparing.

PROJECT DESCRIPTION

Objectives

The objective of this project is to support REC's Coal Creek Station carbon capture plant FEED study through incorporation of redundant pieces of equipment. This first-of-kind, at-scale North Dakota plant brings with it a higher degree of operational risk in an industry where supplying baseload power depends on high reliability and availability. The FEED study, commenced on February 1, 2022, has identified several drivers that necessitated a redundancy study to reduce risk.

Redundancy will use an n+1 approach to sparing. Furthermore, a 2× 100% configuration scenario will be used at single points of equipment failure that have been identified. The resulting carbon capture system (CCS) design and, where appropriate, balance-of-plant (BOP) integration and design will reflect the updated redundant equipment. Specifically, changes will occur to the CCS plant layout, piping and supports, electrical design (power distribution center), design of the structural/building steel and,

possibly, the plant footprint and foundation. These changes will also be reflected in an updated design package that includes general arrangement drawings; process flow diagrams; P&IDs (piping and instrumentation diagrams); electrical diagrams; tie-in list; equipment list; and preliminary structural, civil, and architectural drawings.

Methodology

Three tasks have been identified for this proposed equipment redundancy study. The results will dovetail with the current FEED study. This proposed study has a modest 9-month performance period. Additional details can be found in Appendix A, which contains proposals from Mitsubishi Heavy Industries (MHI) and Burns & McDonnell (BMcD).

Task 1.0 – Management, Planning, and Reporting

This task will be performed by EERC personnel over the project period of performance and includes communication of project activities and direction to the project team and providing updates and obtaining inputs to maintain project focus. Specific activities will include task coordination, risk management/mediation, planning and executing project status meetings, managing the study budget resources, and preparation of a redundancy study focused final report according to North Dakota Industrial Commission (NDIC) requirements.

Task 2.0 – Design Redundancy (Sparing) of Carbon Capture Plant Equipment

This task will focus on modifying the CCS plant layout, and associated engineering, to incorporate redundant equipment into the CCS inside the battery limits. The bulk of this design work will be performed by MHI with design reviews performed by REC, the EERC, and BMcD (where appropriate). Keiwit will provide high-level guidance on constructability. Findings from this subtask will be used in Task 3.0.

Task 3.0 – BOP Impacts

This task will focus on the impact of CCS plant redundancy design on the BOP with work performed by BMcD. At this time, electrical switchgear connecting to the substations is the only equipment outside the battery limits identified for redundancy.

While plant layout and support infrastructure will be modified, the implementation of redundant equipment will not impact the following FEED study inputs or outputs:

- The fundamental design, function, and operation of the CO_2 capture technology.
- The steam cycle configuration, integration, or efficiency.
- Permitting strategies for air emissions, water discharges, or waste disposal planning.
- Heat and material balances.

Anticipated Results

The CCS design packages to be revised include 1) site plan: civil and architectural, 2) electrical, 3) instrumentation, 4) controls, 5) machinery, 6) piping, 7) structural, 8) tie points, 9) cost, and 10) schedule. Key outcomes from this focused redundancy study will highlight the impacts to cost, reliability, and the CCS project execution schedule which will allow REC to move forward swiftly upon commencement of the redundancy study and existing FEED. As with the current CCS FEED study, results from this study will support the mission of the Lignite Research Program (LRP) to concentrate on near-term, practical research and development projects that provide the opportunity to preserve and enhance development of our state's abundant lignite resources. A final report and quarterly reports will summarize the findings of this study.

Facilities

The EERC has over 254,000 square feet of facilities for technology demonstration, process modeling, and project execution. Subcontractors BMcD and MHI maintain office and computing facilities in Kansas City,

Kansas, and Houston, Texas, respectively. REC maintains offices in Bismarck, North Dakota, and at the Coal Creek Station between Underwood and Washburn, North Dakota.

Resources

The FEED study team of industry experts, BMcD (the plant owner's engineer) and MHI (the CCS technology owner), will perform all project design activities. Industry sponsor and plant owner REC will provide review of designs and advisory services. The primary project administrative services will be provided by the EERC. The project team is committed to providing all necessary personnel and resources to ensure the timely completion of all activities outlined in this proposal.

The EERC's engineering and scientific research staff is equipped with state-of-the-art analytical, modeling, and engineering facilities to address a wide variety of energy, environmental, and mineral resource research topics.

MHI and BMcD have been a part of project teams that have executed similar project scopes of work focused on North Dakota utilities. MHI (with assistance from Kiewit, the designated CCS detailed engineering, procurement, and construction contractor) brings experience gained from design and construction of the 240-MW system at the Petra Nova facility in Texas as well as another dozen commercial projects around the world.

Techniques to Be Used, Their Availability, and Capability

The primary technique for data generation under this project will be to use recognized and generally accepted good engineering practices (RAGAGEP) and costing techniques. The individual partners and subcontractors mentioned within the proposed project represent decades of experience in CO_2 capture and coal plant operations. All project participants have committed the necessary resources to execute this project, as evidenced by the letters of support in Appendix B. These same industry experts have been a part of several pre-FEED and FEED projects on similarly sized systems within the state of North Dakota.

Environmental and Economic Impacts While Project Is Underway

The proposed work is a paper study and will not change any of the environmental impacts of the FEED to the study area or partner facilities. The proposed work will, however, change economic impacts through increased reliability and availability.

Why the Project Is Needed

The 2019 Polar Vortex (which caused severe limitations of wind power generation capacity and natural gas availability) that swept through the Midwest in early 2019 and the 2021 ERCOT challenges are profound reminders of why we need to keep our entire power generation mix on the table; CCS can serve as a long-term solution to carbon emissions, while also provide firm baseload generation to mitigate the impact of intermittent renewables on grid reliability. The Coal Creek Station can serve as a model and learning opportunity for the rest of the nation's existing coal fleet and provide baseload power with reduced CO_2 emissions.

Ultimate Technological and Economic Impacts

The proposed redundancy/sparing study is a necessary due diligence process in project development and will provide information to secure financing for CO_2 capture at the Coal Creek Station. Financing and CCS project business cases continue to be reliant on federal 45Q tax incentive programs that require projects must begin construction by January 1, 2033. Continued investment in this project ensures that this initiative can successfully move along the project development path and subsequent demonstrations will be better informed and more likely to succeed and make progress toward Governor Burgum's goal of North Dakota carbon neutrality by 2030. The cost of later projects will benefit by being provided key information relating to considerations for redundancy and sparing, as well as information on specific carbon capture technologies. By seeking a way to cost-effectively use lignite in a carbon-constrained world, this project supports the core mission of the LRP to develop large-scale commercial

projects that reduce environmental impacts and increase sustainability of energy production and delivery.

Maintaining and adding jobs will also be a key economic factor for long-term implementation of CCS in North Dakota. The power industry and a newly created CCS industry will preserve and gain new jobs as a result of the proposed project. If North Dakota can produce a lower-carbon-intensity power product by implementing CCS at utilities, the state will be able to maintain a reliable baseload power source that can be used to complement existing wind/renewable generation in the state, adding thousands of direct, long-term jobs in the process. If the proposed work moves into construction and deployment phases, Coal Creek Station and the Falkirk Mine will keep the current 700 direct/indirect jobs and add approximately 35 to 40 direct jobs. Additionally, short-term construction jobs are likely to be over 2000 direct/indirect jobs.

STANDARDS OF SUCCESS

This project is a necessary next step on the development path for CO_2 capture at Coal Creek Station. Successful outcomes for the project include a design that incorporates sufficient redundancy to address possible single-point failures within each capture island and provide critical input to calculate a detailed project cost for 95% CO_2 capture at the Coal Creek Station. The project team's vision is that recommendations provided by the proposed project will influence the current FEED, improving the long-term reliability and availability of the CCS. In doing so, the team will have sufficient detail to support a final investment decision (FID) and immediate procurement of critical, long lead-time equipment whose costs are especially susceptible to price increases and maintain a timeline required to be eligible for 45Q tax incentives.

BACKGROUND/QUALIFICATIONS

Background

The EERC previously led a retrofit pre-FEED study and is leading the current FEED study of installing a CCS at Coal Creek Station. As with the pre-FEED, MHI is the technology provider in the current FEED study and in the proposed redundancy study. MHI is a globally recognized expert in amine-based carbon capture and was the technology provider for the Petra Nova project at the WA Parish plant in Texas, which is the world's largest postcombustion carbon capture facility installed on an existing 240-MW coal-fueled power plant. The lessons learned from this full-scale experience have proved invaluable for assessing best methods and control technologies for use at Coal Creek Station.

The pre-FEED study for Coal Creek Station included design packages, cost and performance estimates, and a process hazard analysis (PHA, commonly called HAZOP) for both the capture facility and for BOP systems, including, among others, the following:

- Flue gas extraction and handling
- Steam extraction and power recovery
- Cooling water supply
- Electrical distribution systems
- Fire protection
- Plant and instrument air
- Process control systems
- Demineralized water supply

The results from the pre-FEED study provided a solid foundation for the project team to build directly into the current FEED study. The proposed redundancy study will support efforts to improve reliability/availability of the carbon capture facility and will run concurrently with the current FEED study.

Along with the pre-FEED design package, the EERC independently developed a process model for Coal Creek Station to use for quick analysis of different capture and steam integration options. This model can be used to generate high-level performance and cost data in a matter of hours to rapidly assess the feasibility of different capture scenarios. This tool will allow the project team to evaluate potential changes to the design at a high level without impacting the project timeline or budget.

Slipstream Capture Testing

Although solvent-based carbon capture is common in gas processing, postcombustion carbon capture from low-rank coal-fired power stations remains a very new technology at the scale proposed in the ongoing FEED study. With any new technology, there is always a risk that full-scale performance will not be as expected. The EERC and MHI have previously demonstrated long-term solvent performance at Coal Creek Station using a slipstream system installed on Unit 1 of the plant. During this testing, solvent was sampled weekly and analyzed for a wide variety of materials known to be concerns for solvent degradation. Over the course of more than 2 months of continuous operation, accumulation of these materials was within expected bounds and was not of concern. The solvent performance also remained steady without indications of any significant loss of capture capacity. This experience lends assurance that MHI's KS1™ and KS-21™ solvent technology is likely to perform as expected at Coal Creek Station and that the unique flue gas from this plant does not contain levels of problematic contaminants that might lead to accelerated solvent degradation.

One key factor that has arisen as a concern for postcombustion carbon capture at coal-fired power plants in recent years is solvent loss to aerosol formation. Although this is not a major source of amine loss in traditional CO_2 capture units for natural gas, the very fine fly ash from coal-fired power plants provides surface area where volatile amines can condense to form submicron aerosols. This aerosol mist is difficult to recover using conventional methods. In flue gas from low-rank coals, this

aerosol formation can lead to amine losses that are much higher than would be expected from traditional vaporization losses.

During on-site slipstream testing at Coal Creek Station, the EERC worked with MHI to test MHI's amine emission reduction (AER) technology for minimizing aerosol losses. During operation with the AER unit, amine was below the 0.1-ppm detection limit at the system outlet, and daily sampling of the solvent over the course of more than 2 months of operation showed that amine content was stable within the expected range. By contrast, during short-term operation with conventional demisting technology, the aerosol and amine contents were significantly higher. Moreover, measurements conducted on the same system using a conventional monoethanolamine (MEA) solution and a traditional water wash section showed large increases in aerosol content through the capture system. These results demonstrate that MHI's proprietary combination of solvent and AER technologies are likely to be highly effective at limiting amine losses to aerosols at Coal Creek Station.

Together, the combination of long-term solvent testing and long-term aerosol emission monitoring using the slipstream system provides assurance that MHI's technology is likely to perform as expected at Coal Creek Station. This experience using actual flue gas, solvent, and aerosol control technologies at the site of choice is unique to the EERC and MHI and demonstrates that this team is qualified to conduct the FEED study and a redundancy study at the Coal Creek Station with a level of assurance in expected performance that cannot be offered by any other group.

Qualifications

As lead for the current FEED project, the EERC will serve as the lead organization for the proposed project, with Mr. Jason Laumb as the overall project manager. Mr. Jason Laumb, Director of Advanced Energy Systems Initiatives, will focus on ensuring the overall success of the project by providing experienced management and leadership to all activities within the project. Mr. Laumb will ensure that the project is carried out within budget, schedule, and scope. Mr. Laumb will also be responsible for

communication with project partners and EERC project personnel. Qualifications of key personnel can be found in Appendix C. The organizational chart for the redundancy study is shown in Figure 1.

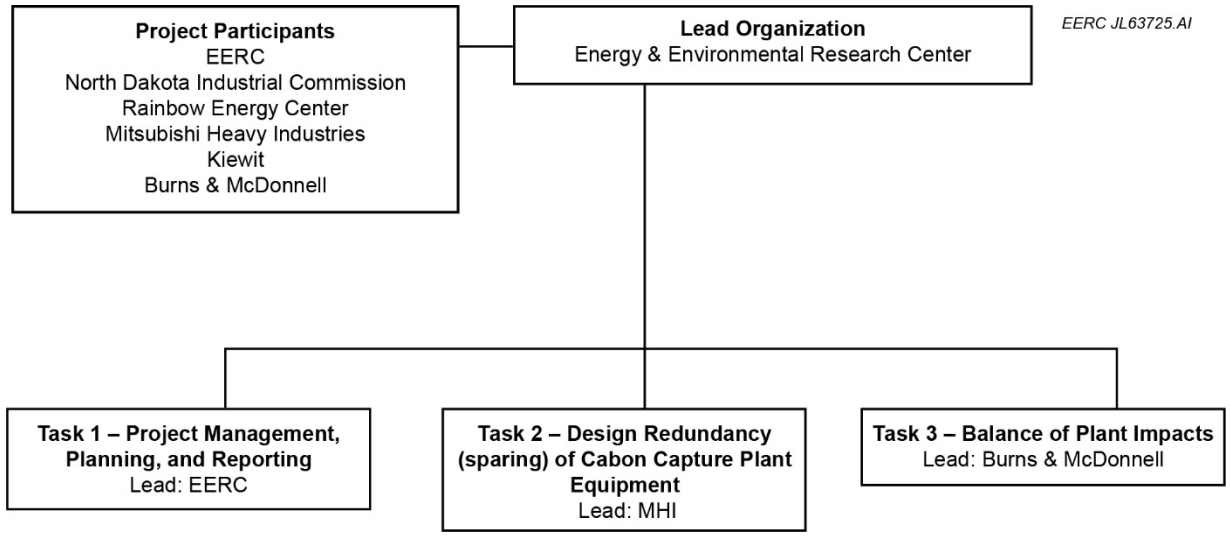

Figure 1. Project organizational chart.

Mitsubishi Heavy Industries America, Inc., and Mitsubishi Heavy Industries Engineering, Ltd., are subsidiaries of Mitsubishi Heavy Industries, Ltd., of Japan (together referred to as MHI). MHI will be responsible for the CCS scope. Starting in the early 1990s, MHI jointly developed with Kansai Electric Power Company (KEPCO) the proprietary Kansai Mitsubishi Carbon Dioxide Recovery Process (KM CDR Process™) for carbon dioxide removal from combustion gas exhaust streams. MHI's KM CDR Process™ is an amine-based CO_2 capture process that uses MHI proprietary solvents. The CO_2 capture system is capable of recovering 95% of the CO_2 from the flue gas and compressing the treated CO_2 to adequate pipeline conditions. MHI has provided 13 commercial CO_2 capture systems around the world, including the world's largest postcombustion system capturing 5265 stons/day from a coal-fired power plant in Thompsons, Texas (Petra Nova) for EOR. Key personnel from MHI include Mr. Tim Thomas (Senior Vice President and Deputy General Manager), Mr. Shingo Watanabe (Project Manager), and Mr. Atsushi Yoshitomi (Engineering Manager).

BMcD will be responsible for BOP engineering. BMcD is a fully integrated engineering, architecture, construction, environmental, and consulting firm with a multidisciplinary staff of more than 7600 professionals. Founded in 1898, its singular mission has been to make its clients successful. Because BMcD is relationship-focused and dedicated to creating amazing success for its clients, it has a 90% repeat-business rate and client partnerships that span multiple decades. Being 100% employee-owned means that everyone has an ownership stake in the success of the clients and all team members are driven to find great solutions. Key personnel from BMcD include Mr. Aaron Bennett, Project Manager, and Ms. Patricia Scroggin-Walker, Carbon Capture Director.

REC is the proud owner and operator of Coal Creek Station. The REC team works to maximize efficient energy production and sound energy management to unlock the energy sector's full potential. REC is working diligently to capitalize on innovative technologies so that future generations have sustainable energy solutions. REC is committed to providing reliable, low-carbon, baseload power to North Dakota and the region. Carbon capture is vital to the success and continued operation of Coal Creek Station, and REC is committed to delivering carbon capture that will serve as a showcase for future projects around the world. Key personnel from Rainbow Energy include Stacy Tschider (President), Jeff Jonson (Executive Vice President), Chris Faul (VP Operations), Lyndsey Roemmich (VP Finance), Ryan Davis (Energy Director), and John Bauer (current Plant Manager).

VALUE TO NORTH DAKOTA

The proposed redundancy and the ongoing FEED projects primary value to North Dakota will be maintaining and adding new jobs to the state and local economies in areas where current and new regulation threaten to significantly reduce activity in coal utilization, one of the state's most vital resources. The power industry and a newly created CCS industry will preserve and gain new jobs as a result of these projects. If North Dakota can produce a lower-carbon-intensity power product by implementing CCS at utilities, the state will be able to maintain a reliable baseload power source that

can be used to complement existing wind/renewable generation in the state, adding thousands of direct, long-term jobs in the process. If the proposed work moves into construction and deployment, Coal Creek Station and the Falkirk Mine will keep the current 700 direct/indirect jobs and add approximately 35 to 40 direct jobs. Additionally, short-term construction jobs are likely to be over 2000° direct/indirect jobs.

Beyond the plant, the lignite-fired power plants in North Dakota present an opportunity to economically demonstrate the large-scale feasibility of CCS for the existing domestic coal fleet. The North Dakota plants are optimally located near both appropriate geologic storage and fields amenable to EOR operations. The economic health of the central region of North Dakota is tied to energy jobs in the area. Currently, the lignite industry directly employs 3623 people, with another 9500 indirect employees supported by the industry, accounting for over $5.4 billion in economic impact. Technology advances that continue the responsible use of lignite and bring new industries to the region are critically needed to sustain and grow these jobs. Based on a recent study by the EERC, the economic impact to a state such as North Dakota from development of a new carbon capture and EOR industry would be tremendous if deployed statewide: $2.5 billion to $3.0 billion in annual economic activity, state revenue increase of $160 million per year, and creation of approximately 8000 (Stanislowski et al., 2019) long-term jobs.

At a project level, the cost and benefits of a redundancy/sparing approach to the ongoing FEED project will benefit the entire lignite fleet. The project will also provide a basis for identifying and evaluating those systems, equipment, and parts essential to maintaining high availability and reliability of the installed CO_2 capture system. Because space limitations exist at all utility sites, results from this study will identify probable changes to the support structure and overall equipment layout required to implement a redundancy/sparing approach to the completed design. This project will reduce risks: both technological and economic risk associated with investing in a postcombustion capture retrofit project.

MANAGEMENT

The EERC is the lead organization for this project and will oversee all tasks and management activities associated with this project. The EERC will schedule regular internal and external meetings with project staff and advisors to ensure that the project is conducted using acceptable scientific methodologies and practices in accordance with the project plan (budget, schedule, deliverables, and milestones) and is meeting quality objectives. The EERC will keep all partners informed of project progress and coordinate activities as necessary for the execution of a successful project and will be responsible for timely submission of all project deliverables and transfer of data and products to the team.

Once the project is initiated, the project team will engage in weekly conference calls to review project status and future directions. Quarterly reports and a final report will be prepared and submitted to project sponsors for review.

The primary deliverable for the project will be a completed evaluation of equipment needs and the costs associated with implementing an N+1 redundancy to the current FEED project. The evaluation will include, but not be limited to, finalization of the redundant equipment list, a revised plant layout, process flow diagrams, P&IDs, pipe routing, potential changes to electrical equipment and power distribution, an evaluation of possible civil and structural changes required to support the additional equipment recommended within each CCS island, tie points and BOP changes to accommodate the redundancy recommendations, impacts on scheduling, and the cost data associated with these changes to the current design. It is expected that the tasks associated with the proposed study may be accomplished over a 6-month period running concurrently with the ongoing FEED project.

Project milestones include completion of 1) redundant equipment layout and redesign of the capture system inside the battery limits, 2) redesign of the BOP equipment, and 3) cost estimates and schedule impacts to incorporate the N+1 strategy.

Project progress will be measured by completion of milestones and deliverables as noted in the project timeline in Figure 2. The milestones and deliverables are at key times during the project design, permitting, and costing components of the project. The deliverables are indicated where key design documents and reports are noted, while the milestones are noted as key accomplishments during the project's progress.

TIMETABLE

The overall project timeline can be found in Figure 2. The proposed redundancy study is expected to require 9 months, with a projected start date of July 1, 2023. Work would begin prior to the start of NDIC's July 1 funding to maintain the project momentum and schedule. This funding will be provided by REC matching funds, in advance of the official NDIC start of funding. This timeline is necessary to maintain a schedule that could allow for construction activities to begin before January 1, 2033. The team anticipates the redundancy project reports will be available from MHI and BMcD by the end of Month 8 of the project.

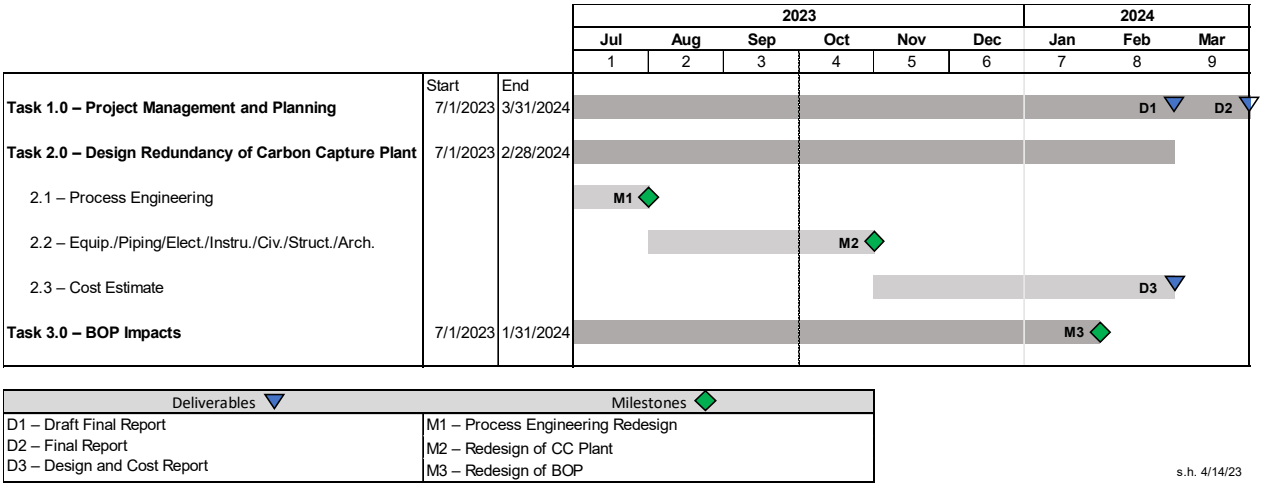

Figure 2. Project Gantt chart.

BUDGET

The proposed budget is $ 1,674,627, with $837,313 from NDIC and $837,314 cash from REC. The budget includes subcontracts for MHI and BMcD as well as funds to the EERC for project management. Funding for one conference to present results of this redundancy study are included. The detailed breakdown is shown in Table 1. Budget notes can be found in Appendix D.

MATCHING FUNDS

Cash cost share in the amount of $837,314 will be provided by REC.

Table 1. Redundancy Project Budget

Project Associated Expense	NDIC Share (Cash)	REC Share (Cash)	Total Project
Labor	$187,596	$0	$187,596
Travel	$3,515	$0	$3,515
Supplies	$250	$0	$250
Subcontractor – MHIA	$421,613	$837,314	$1,258,927
Subcontractor – Burns & McDonnell	$115,700	$0	$115,700
Communications	$90	$0	$90
Printing & Duplicating	$131	$0	$131
Laboratory Fees & Services			
EERC Document Production Services	$4,746	$0	$4,746
EERC Engineering Services Fee	$2,347	$0	$2,347
Total Direct Costs	$735,988	$837,314	$1,573,302
Facilities & Administration	$101,325	$0	$101,325
Total Cash Requested	**$837,313**	**$837,314**	**$1,674,627**

TAX LIABILITY

The EERC, a department within the University of North Dakota, is a state-controlled institution of higher education and is not a taxable entity; therefore, it has no tax liability to the state of North Dakota or any of its political subdivisions.

CONFIDENTIAL INFORMATION

No confidential information is contained in this proposal.

REFERENCES

Stanislowski, J.J.; Folkedahl, B.C.; Jensen, M.D.; Musich, M.A. *Regional Impacts of Carbon Capture and Sequestration in the State of North Dakota*; Final Report for Lignite Energy Council; EERC Publication 2019-EERC-02-07; Energy & Environmental Research Center: Grand Forks, ND, Feb 2019.

APPENDIX A

SUBCONTRACTOR PROPOSALS/LETTERS OF COMMITMENT

April 13, 2023

Jason Laumb
Project manager
Energy and Environmental research Center (EERC)
jlaumb@undeerc.com

Re: Professional Engineering Services for Carbon Capture Island Redundancy at Coal Creek Station and Extended Project Schedule (Rev 1)

Dear Mr. Laumb:

Burns & McDonnell is proposing to provide the following scope of services to support additional redundancy evaluations and pricing for the Carbon Capture Project at Rainbow Energy Center.

SCOPE OF SERVICES:

EERC (PRIME CONTRATOR) requests Burns & McDonnell (SUBCONTRACTOR) to provide Services as follows:

Task 1: Modify Electrical Feed to Carbon Capture Island to Accommodate Revised Redundancy Approach for Carbon Capture Island Equipment

Burns & McDonnell will re-evaluate the electrical feed to the Carbon Capture Island based on updated Inside Boundary Limits (ISBL) electrical one-line diagrams and electrical load lists from Mitsubishi Heavy Industries America (MHIA). Burns and McDonnell with then update the Outside Boundary Limits (OSBL) electrical one line diagrams, modify the Power Control Module (PCM) enclosure sizing to accommodate additional equipment as required, revise PCM foundation sizing as required, shift the OSBL transformer and PCM locations to accommodate revised ISBL arrangement, and revise electrical cable and duct bank quantity and sizing between the OSBL PCM and ISBL substation area. The addition of a firewall at the transformers is included due to the expected tighter spacing of the transformer and PCM. The project cost estimate will then be updated based on the revised design.

It is assumed that while the connected load for the ISBL equipment will likely increase, the operating electrical load of the ISBL will be unchanged from the current design. Subsequently, changes to substation equipment and the 230kV:13.8kV transformers and associated cable selection and sizing are not included.

Based on preliminary layout information for the revised ISBL equipment, it is assumed that the PCM and transformer will need to be shifted north for Unit 1 and south for Unit 2. It is assumed that the final location will

be near the current location and not require demolition or relocation of existing major equipment such as the fuel oil tank and backup generators and associated equipment.

Updates to the Load Flow Study are not anticipated to be required and are not included.

Task 2: Technical support for the project during the extended schedule period

Burns and McDonnell's project manager and key project personnel will participate in project meetings and phone calls during the 6.5-month schedule extension. Two-hundred thirty (230) engineering hours are included to support the project during this period.

RESPONSIBILITIES OF PRIME CONTRACTOR:

PRIME CONTRACTOR (with assistance from OWNER) will provide assistance by placing at SUBCONTRACTOR'S disposal all available information pertinent to the Scope of Services on this Project. SUBCONTRACTOR shall rely on information made available by PRIME CONTRACTOR as accurate without independent verification.

TERMS AND CONDITIONS:

SUBCONTRACTOR proposes to perform this Scope of Services via a Change Order to the subcontract agreement between Burns & McDonnell and EERC.

COMPENSATION:

As consideration and compensation for the Scope of Services defined herein, PRIME CONTRACTOR agrees to pay SUBCONTRACTOR total estimated costs not to exceed US$115,700. Labor and expenses shall be reimbursed in accordance with the rate sheet from Appendix E of the Subcontract Agreement.

Sincerely,

Aaron Bennett
Project Manager
Burns & McDonnell Engineering Company, Inc.

cc: Dalton Norton
Derek Laning
Scott Tolbert
Tisha Scroggin

April 12th, 2023

Sheryl A. Eicholz – Landis, CRA
Director of Contracts and Intellectual Property
University of North Dakota Energy & Environmental Research Center
15 North 23rd Street,
Grand Forks, ND 58202-9018

Re: REC CCS – Change Order Request #1(R1) for 100% Redundancy

With reference to the captioned subject, MHI is please to proposes the following:

1. **Basis of Change Proposal:**
   To add 100% redundancy to various pieces of key equipment as identified by the project team.

2. **Schedule to Carry Out the Scope Change:**
   Total 6.5 months (R0 plus 3.5 months this time R1) extension is expected from the original FEED schedule to complete this redundancy study.

   This schedule is based on the condition that the Change Order is issued by April 30th, 2023. Start date of this Scope Change is expected on May 1st, 2023.

3. **Price:**
   US$1,258,927 (in full letters United States Dollars one million two hundred fifty eight thousand nine hundred twenty seven only)* as an adder to the estimated costs in the amount not to exceed on a cost reimbursable basis as the original SUBCONTRACT dated May 16, 2022. Approximately 3,600 engineering hours are estimated.

   * increased from R0 by US $158,927

4. **Payment Terms:** Per the original SUBCONTRACT.

5. **Validity of this Change Proposal:** This estimate is valid until April 30th, 2023.

Sincerely,

Timothy E Thomas

Tim Thomas
Senior Vice President, Engineered Systems Division
Mitsubishi Heavy Industries America, Inc.
Engineered Systems Division
Direct: (512) 954-1964 / email: timothy.thomas@mhia.com

APPENDIX B

LETTER OF COMMITMENT

RAINBOW
ENERGY CENTER

2875 Third Street SW
Underwood, North Dakota 58576
701.207.9988
rainbowenergycenter.com

April 13, 2023

Mr. Jason Laumb
Director of Advanced Energy Systems Initiatives
University of North Dakota
Energy & Environmental Research Center
15 North 23rd Street, Stop 9018
Grand Forks, ND 58202-9018

Dear Mr. Laumb:

Subject: EERC Proposal No. 2023-0146 Entitled "Redundancy Study for CO_2 capture at Coal Creek Station"

I am writing to confirm Rainbow Energy Center's commitment to support the Energy & Environmental Research Center (EERC) in its pursuit of funding from the Lignite Research, Development and Marketing Program (LRDMP) to perform a redundancy study for CO_2 capture equipment as part of commercial-scale CO_2 storage in central North Dakota. Rainbow Energy Center purchased Coal Creek Station and is the proud owner and operator of the facility.

Rainbow Energy Center plans to focus on baseload energy from Coal Creek Station with carbon capture and incremental generation from renewables to fully utilize the capacity of the high-voltage direct current (HVDC) transmission system. Carbon capture and storage is vital to continued operation of Coal Creek Station and is an important step toward Governor Doug Burgum's goal for the state to reach carbon neutrality by 2030. Implementing carbon capture technology allows fossil fuel to continue to meet the nation's energy demand, while also reducing CO_2 emissions.

As North Dakota's largest power plant, Coal Creek Station supports over 700 jobs: at the plant, at Falkirk Mine, and at other supporting industries. Implementing new technologies saves existing jobs, creates new jobs, and serves as an economic backbone for the area communities, county, and state. In support of Coal Creek Station and these communities, Rainbow Energy Center is committing $837,318 cash funding to this proposed redundancy project. Rainbow Energy Center verifies that this committed funding is not being shown as cost share to any other state programs.

We believe carbon capture and storage at Coal Creek Station meets the Lignite Research Program's mission to deploy large-scale commercial technologies that produce reliable, dispatchable, low-carbon electricity, while also sustaining jobs, tax revenue, and the economic vitality of the state. We welcome the opportunity to work with the EERC, Mitsubishi Heavy Industries, and Burns & McDonnell on this effort.

Sincerely,

Stacy L. Tschider
President

APPENDIX C

QUALIFICATIONS OF KEY PERSONNEL

JASON D. LAUMB
Director of Advanced Energy Systems Initiatives
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, jlaumb@undeerc.org

Principal Areas of Expertise

Mr. Laumb's principal areas of interest and expertise include renewable energy, CO_2 capture, techno-economic modeling, extraction of critical materials, environmental control systems, supercritical CO_2 power cycles, and advanced gasification technologies. His experience includes biomass and fossil fuel conversion for energy production, with an emphasis on ash effects on system performance; trace element emissions and control for fossil fuel combustion systems, with a particular emphasis on air pollution issues related to mercury and fine particulates; and design and fabrication of bench- and pilot-scale combustion and gasification equipment.

Education and Training

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

Research and Professional Experience

May 2021–Present: Director of Advanced Energy Systems Initiatives, EERC, UND. Mr. Laumb provides leadership on projects related to advanced energy systems and leads a multidisciplinary team of scientists and engineers working on advanced energy technologies from pollution control to new energy platforms.

September 2019–April 2021: Assistant Director of Advanced Energy Systems, EERC, UND. Mr. Laumb assisted the EERC executive team by providing leadership on projects related to advanced energy systems. Mr. Laumb led a multidisciplinary team of scientists and engineers working on advanced energy technologies from pollution control to new energy platforms. Specific areas of interest included CO_2 capture, techno-economic modeling, environmental control systems, supercritical CO_2 power cycles, and advanced gasification technologies. Research activities focused on low-carbon-intensity power cycles for fossil fuel-fired systems.

2008–August 2019: Principal Engineer, Advanced Energy Systems Group Lead, EERC, UND. Mr. Laumb led a multidisciplinary team of 30 scientists and engineers 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 focused on development of multiclient jointly sponsored centers or consortia funded by government and industry sources. Research activities included computer modeling of combustion/gasification and environmental control systems, performance of SCR 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.

2001–2008: Research Manager, EERC, UND. Mr. Laumb led projects involving bench-scale combustion testing of various fuels and wastes as well as a laboratory that performs bench-scale combustion and

gasification testing. He served as principal investigator and managed 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 wrote proposals and reports focused on energy and environmental research.

2000–2001: Research Engineer, EERC, UND. Mr. Laumb assisted in the design of pilot-scale combustion equipment and wrote computer programs to aid in the reduction of data, combustion calculations, and prediction of boiler performance. He was also involved in the analysis of combustion control technologies' ability to remove mercury and the suitability of biomass as boiler fuel.

1998–2000: SEM Applications Specialist, Microbeam Technologies, Inc., Grand Forks, North Dakota. Mr. Laumb gained experience in power system performance including conventional combustion and gasification systems; 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 Activities
Member, American Chemical Society

Publications
Mr. Laumb has coauthored numerous professional publications.

SCOTT G. TOLBERT
Senior Engineer, Conversion Systems Team Lead
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA
701.777.5096, stolbert@undeerc.org

Principal Areas of Interest and Expertise

Mr. Tolbert's principal areas of interest and expertise is in the design, construction, and operation of bench- and pilot-scale equipment for testing various fuel conversion and environmental control processes, advanced multipollutant control and gas cleanup, hydrogen/CO_2 separation, hybrid electric vehicle drive systems, fuel cells, photovoltaics, and fuel cell technologies. He has worked on design, construction, and operation of small-scale combustion and gasification systems as well as gas cleanup systems. He has worked on processes for sulfur control for gasification systems that have been focused on providing a clean gas stream for hydrogen production and utilization. Mr. Tolbert has over a decade of experience with advanced vehicular photovoltaic, proton exchange membrane (PEM) fuel cell energy systems, and advanced hybrid electric vehicle drive systems.

Education and Training

M.S., Industrial Technology, University of North Dakota, 1990.
B.S., Industrial Technology, University of North Dakota, 1985.

Research and Professional Experience

2006–Present: Senior Engineer, Conversion Systems Team Lead, EERC, UND. Mr. Tolbert's responsibilities include supervising laboratories and projects involving bench-scale gasification and combustion testing of various fuels, emissions, and wastes; managerial and principal investigator duties for projects related to the inorganic composition of coal, coal ash and slag formation, deposition of ash and slag in conventional and advanced power systems, and mechanisms of trace metal transformations during coal or waste conversion carbon dioxide and hydrogen separation and capture; and writing proposals and reports applicable to energy and environmental research. His work also focuses on hybrid electric vehicles, their energy storage and conversion subsystems such as fuel cells, batteries, ultracapacitors, and advanced electric motors. He has also worked with on-demand hydrogen reformer and dispenser systems for vehicle refueling.

1990–2006: Assistant Professor, Department of Mechanical Engineering, UND, Grand Forks, North Dakota.

1992–2006: Consultant. Mr. Tolbert provided expertise on electrohydraulic machinery and ISO certifications to Toro Company Inc., Mayo Manufacturing Inc., and Hawkes Manufacturing Inc.

1998–2002: Assistant to the Dean, School of Engineering and Mines, UND, Grand Forks, North Dakota.

1997–2002: System Administrator, Computer-Aided Engineering Network, School of Engineering and Mines, UND, Grand Forks, North Dakota.

1988–1990: Instructor, Department of Mechanical Engineering, UND, Grand Forks, North Dakota.

Publications

Mr. Tolbert has authored or coauthored several publications.

JAY R. GUNDERSON
Principal Engineer, Combustion Processes
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA
701.777.5258, jgunderson@undeerc.org

Principal Areas of Expertise

Mr. Gunderson's principal areas of interest and expertise include fireside performance testing, mercury sampling, design of pilot-scale equipment, and full-scale performance evaluation for coal-, oil-, and biomass-fired boilers.

Education and Training

B.S., Chemical Engineering, University of North Dakota, 1987.

Research and Professional Experience

1988–Present: Principal Engineer, Combustion Processes, EERC, UND. Mr. Gunderson's responsibilities involve pilot-scale combustion projects for residential-, commercial-, and utility-scale applications of coal-fired combustion systems, including fuel characterization, emission monitoring and testing, evaluation of flame stability, evaluation of ash-fouling potential, and evaluation of fuel and fireside additives to improve fireside performance and reduce emissions of regulated pollutants. His duties include documentation and reporting of pilot-scale testing results and relating these results to the operation of full-scale units. Mr. Gunderson has also managed numerous pilot-scale projects investigating ash fouling and gaseous emissions for oil-fired and biomass-fired systems.

1988: Research Assistant, Combustion and Environmental Systems Research Institute, Energy and Mineral Research Center, UND. Mr. Gunderson's responsibilities involved the development of a coal–water fuel-fired residential- and commercial-scale furnace.

Professional Activities

Member, American Institute of Chemical Engineers

Publications

Mr. Gunderson has authored and coauthored numerous publications, with several presentations made at national and international conferences.

MARK A. MUSICH
Senior Research Engineer
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA
701.777.5263, mmusich@undeerc.org

Principal Areas of Expertise

Mr. Musich's principal areas of interest and expertise are the development and operation of high-pressure/high-temperature processes; gasification processes for syngas, hydrogen, and liquid fuels production; oxy-fuel and liquid and solid sorbent systems for CO_2 capture and purification; beneficiation processes including torrefaction, pyrolysis, agglomeration, hydrothermal and thermal treatment; chemical and physical cleaning for carbonaceous fuel upgrading; and the application of ionic liquids and deep eutectic solvents for production of value added products from coal, ash, and biomass residues.

Education and Training

M.S., Chemical Engineering, University of North Dakota, 1986.
B.S., Chemical Engineering, University of North Dakota, 1983.

RESEARCH AND PROFESSIONAL EXPERIENCE

2000–Present: Senior Research Engineer, EERC, UND. Mr. Musich's responsibilities include design, procurement, construction, and operation of advanced systems for the conversion of carbonaceous fuels into hydrogen, chemicals, and power. His responsibilities also include experimental design and data evaluation, economic analysis of processes, preparation of reports and proposals, and preparation and presentation of papers.

1996–2000: Research Manager, Systems Analysis, EERC, UND. Mr. Musich's responsibilities included supervision of Systems Analysis personnel; applying software engineering tools for the simulation and economic evaluation of chemical processes; performing critical review of SE studies; and applying SE methodology and decision-making tools to the design, development, and implementation of chemical processing technologies and systems.

1991–1996: Research Engineer/Supervisor, EERC, UND. Mr. Musich's responsibilities included experimental design and data evaluation, supervision of beneficiation and briquetting test programs, development of beneficiation processes, analytical and product evaluation techniques, beneficiation personnel supervision, preparation of reports and proposals, and preparation and presentation of papers.

1989–1991: Research Engineer, Fuels Beneficiation/Fuels Preparation, EERC, UND. Mr. Musich's responsibilities included the operation and maintenance of bench- and pilot-scale hydrothermal drying processes; operation of pilot-scale coal cleaning processes; design, performance, and evaluation of beneficiation experiments; report writing; and proposal solicitation.

1988–1989: Research Engineer, Mild Gasification, EERC, UND. Mr. Musich's responsibilities included the design and material specifications for the construction of a 100-lb/hr spout-fluid-bed reactor for the low-temperature gasification of carbonaceous feedstocks.

1986–1988: Contract Research Engineer, Great Plains Coal Gasification Company, Beulah, North Dakota. Mr. Musich's responsibilities included the operation and maintenance of a demonstration scale sour-gas scrubbing unit for the removal of SO_2, design of test matrices, evaluation of the test data, and preparation of reports.

1986–1987: Research Engineer, EERC, UND. Mr. Musich's responsibilities included the design, construction, and operation of a pilot-scale fluid-bed catalytic gasifier for the production of hydrogen from carbonaceous fuels.

1986: Engineering Research Technician, Combustion Division, EERC, UND. Mr. Musich's responsibilities included the operation of pilot-scale pulverized coal and fluidized-bed combustion units.

1985–1986: Engineer, EG&G Washington Analytical Services Center, Inc., Grand Forks, North Dakota. Mr. Musich's responsibilities included reviewing fluidized-bed combustion test data, isolating and evaluating steady-state performance periods, and performing mass and energy balances for the test periods.

Professional Activities

Member, American Institute of Chemical Engineers

Publications

Mr. Musich has coauthored over 50 publications in the area of fuels beneficiation.

Patents

Musich, M.A.; Potas, T. Low-Rank Coal Oil Agglomeration Product and Process. U.S. Patent 5 162 050, 1992.

Timothy E Thomas

Senior Vice President & Deputy General Manager
Engineered Systems Division
Mitsubishi Heavy Industries America

Overview

Mr. Thomas is currently Senior Vice President & Deputy General Manager for the Engineered Systems Division of Mitsubishi Heavy Industries America (MHIA) in Houston, TX and oversees MHIA's CO_2 capture business for North America. He is responsible for safety, business development, project development and implementation from initial concepts, feasibility studies, and FEED studies through project completion. Mr. Thomas has over 38 years of related experience including CO_2 capture systems (CCS), flue gas desulfurization (FGD) systems, material handling systems, wastewater treatment systems, and particulate removal systems.

Project Specific Experience

Directs and oversees the preparation of multiple detailed studies for the application of MHIA's CCS including FEED studies for Prairie State and San Juan power plants. Primary focus on the application and feasibility of installing CCS on power and industrial flue gas sources.

· Project Director from 2002 to 2013 for the design, procurement, construction, and commissioning of FGD systems at multiple TVA fossil fuel power plants. These installations completed on schedule and within budget and valued at over $1 billion were provided to TVA through Advatech, a joint venture of URS and MHIA.

· Project Engineering Manager during the $340 million FGD system retrofit for Pennsylvania Electric's Conemaugh Station Units 1 and 2. Managed development of systems design; design criteria; process and instrumentation diagrams; design calculations and equipment optimization; operating procedures and system descriptions.

· On-site Resident Engineer for the construction of JEA/FPL's St. Johns River Power Park, two 600 MW coal-fired generating units. Oversaw the installation of the FGD systems, electrostatic precipitators, and a wastewater treatment facility.

Specialized Training

BS / 1983 / Mechanical Engineering / University of Florida

Chronology

Mitsubishi Industries America, Inc. – Senior Vice President, Vice President, Deputy General Manager, Engineered Systems Division, 2013 to present
URS Corp. and Advatech LLC, Vice President, Project Director, Project Manager, 1996 – 2013
URS - Raytheon Engineers and Constructors – Ebasco Services, Project Engineering Manager, Principal Mechanical Engineer, Senior Mechanical Engineer, Mechanical Engineer, Sr. Associate Engineer, 1983 - 1996

Professional Summary

Name : **Shingo Watanabe**

Position in this Project : **Project Manager**

He will be responsible for:

- Overall Project Control such as
  - Cost control
  - Project schedule control
  - Project risk control
  - Resource control
  - Change order control
- Project Estimation

Criteria for Qualification

- Project Management Professional (PMP) in 2017
- Fundamentals of Engineering ("FE") in 2000
- Project Management Specialist (PMS), P2M based Project Management Professionals Certification by Project Management Association of Japan in 2003

Summary of Experience

Twenty-seven (27) years experiences with Mitsubishi Heavy Industries Group, served as Piping Engineer and Project Management for chemical plant.

Languages

Japanese	:	Native
English	:	Business-level

Professional Summary

Education

Education	:	Yokohama National University
Qualification	:	Master of Mechanical Engineering
Joined MHI	:	April 1, 1994

Personal Data

Nationality	:	Japanese
Date of Birth	:	October 3, 1969

Position in MHI's Organization **: Project Manager,**

Mr. Watanabe's Significant Experience

Project Manager (GCGV)

- Polyethylene
  650,000T/Y x 2

  2018 - present
  Capacity : 650,000 T/Y × 2 (PE)
  450,000 T/Y (PP)

TX USA

for Gulf Coast Growth Ventures LLC

Basic design, detail design, procurement and construction.

Group Manager, Plant Layout & Piping Engineering Group

- Responsible for all Plant Layout & Piping Engineering Activities, including authorization of documents, cost estimation for bidding projects, personnel's mobilization, etc.

  2013 - 2016

Management in MCEC

Lead Piping Engineer(SAMUR)

- Fertilizer Complex
  - Ammonia
  - Urea and Granulation

  2011 - 2013

  Capacity : Ammonia: 2,100T/D
  Urea (Synthesis): 3,500T/D
  Granulation Urea: 3,850T/D
  & Urea Export Jetty

Sipitang, Sabah, Malaysia

for PETRONAS Chemical Fertilizer Sabah Sdn. Bhd. (PCFSSB)

Lump Sum Turn Key Basis, including Engineering, Procurement and Construction Works.
MHI, as leader of the consortium, is responsible for the basic and detailed design work, the procurement of equipment and the dispatch of technical advisors for installation and test operation.
APEX Energy and PT Rekayasa Industri (REKIND) take charge of a portion of the equipment procurement and construction work.

Professional Summary

Lead Piping Engineer(SPOX)

- Polyethylene (LDPE)
  (LLDPE / Metallocene LLDPE): Poly & Fin
  Polypropylene (PP)
  (Homo Polymer): Fin only

  2007 - 2011

  Jurong Island, Singapore

  for ExxonMobil Chemical Company

  Capacity : 650,000 T/Y × 2 (PE)
  450,000 T/Y (PP)

  Detailed Engineering, Procurement, Civil Works and Construction Works

Piping Engineer(OSF)

- Fertilizer Complex
  - Ammonia
  - Urea

  2005 - 2007

  Sohar Industrial Area, Oman

  for Sohar International Urea & Chemical Industries S.A.O.C. (SIUCI)

  Capacity : 2,000 T/D (Ammonia Plant)
  3,500 T/D (Urea Plants)

  Lump Sum Turn Key Basis, including Engineering, Procurement, Civil Works and Construction Works.

Assistant Engineering Manager (SMAG-2)

- Methyl Methacrylate (MMA) & SCO-2 Plant (Utility)

  2003 - 2005

  Sakura, Singapore

  for Sumitomo Chemical Co., Ltd.

  Capacity : 75,000 T/Y

  Lump Sum Turn Key Basis, including Basic / Detailed Engineering, Procurement, Construction and Commissioning

Assistant Piping Engineer (Kaltim-4)

- Fertilizer Complex
  - Ammonia

  Bontang, Kalimantan, Indonesia

Mitsubishi Heavy Industries Engineering, Ltd.

- Urea

1999 – 2003

For P.T. Pupuk Kalimantan Timur

Capacity : 1,000 T/D
1,725 T/D

Lump Sum Turn Key Basis, including Engineering, Procurement, Civil Works and Construction Works.

Assistant Piping Engineer (NRT-II/Phase-II)

- LNG Receiving Terminal (Expansion/Phase-II)
  Capacity:4,000,000 T/Y

1998 – 1999

Niigata, Japan

for Nihonkai LNG Company Ltd.

Lump Sum Turn Key Basis, including following facilities:
- LNG Tanks (100,000 Kl x 2)
- LNG Vaporizer / LNG Pumps
- LNG Piping / others

Assistant Piping Engineer (PFK)

- Fertilizer Complex
  - Ammonia
  - Urea (Granulated)
  - Methanol
  - Urea Formaldehyde

1996 - 1997

Gurun & Butterworth, Malaysia

for Petronas Fertilizer (Kedah) Sdn. Bhd.

Capacity : - 1,125 T/D (Ammonia Plant)
- 1,800 T/D (Urea Plant, Granulated)
- 200 T/D (Methanol Plant)
- 17 T/D (Urea Formaldehyde)

Grass-Roots Lump Sum Turn Key Basis
Facilities consisting of Fertilizer Plant, Urea Export Terminal and Railway

Assistant Piping Engineer (NRT-II/Phase-I)

- LNG Receiving Terminal (Expansion)

1995 - 1996

Niigata, Japan

for Nihonkai LNG Company

Professional Summary

Ltd.

Capacity : 4,000,000 T/Y

Lump Sum Turn Key Basis, including Basic / Detailed Engineering, Procurement, Construction and Commissioning

Lump Sum Turn Key Basis, including following facilities:
- LNG Tanks (100,000 kL x 2)
- LNG Vaporizer / LNG Pumps
- LNG Piping / others

Professional Summary

Name : **Atsushi Yoshitomi**

Position in this Project : **Engineering Manager in this Project**

The Engineering Manager will be responsible for :

- Coordinate with Owner's engineers etc.
- Manage discipline lead engineers
- Maintain Engineering data base

Criteria for Qualification

- Four (4) year experience of Project Engineer
- Eleven (11) year experience of Civil, Structural & Architectural Engineering on several Chemical Plants

Summary of Experience

Eleven (11) years experience with Mitsubishi Heavy Industries Group, served as Civil, Structural & Architectural Engineer on several Chemical Plants and Four (4) years experience with Mitsubishi Heavy Industries Group, served as Project Engineer on a Chemical Plant.

Languages

Japanese	:	Native
English	:	Business-level

Education

Education	:	Osaka University
Qualification	:	Master of Civil Engineering
Joined MHI	:	April 1, 2006

Professional Summary

Personal Data

Nationality : Japanese

Position in MHI's Organization **: Project Department**

Mr. Yoshitomi's Significant Experience

Project Engineer (GCGV)

- Polyethylene (LDPE) — Copus Christi, Texas, USA

  2018 - present — for Gulf Coast Growth Ventures

  Capacity : Polyethylene Polymerization : 650,000 ton/year x 2 trains
  Polyethylene Finishing: 650,000 ton/year x 2 trains

  Lump Sum Mechanical Completion, Scope of Work is Basic Design, Detail Design, Procurement and Construction. (Consortium formation: Engineering and Procurement by MHI-A, Construction by the consortium partner Zachry)

Civil & Structural Engineer (NAG)

- Polyethylene (LDPE) — Mont Belvieu, Texas, USA

  2013 - 2017 — for ExxonMobil Chemical Company

  Capacity : Polyethylene Polymerization : 650,000 ton/year x 2 trains
  Polyethylene Finishing, Packaging, and Shipping: 650,000 ton/year x 2 trains

  Lump Sum Turn Key Basis, including Engineering, Procurement and Construction Works. (Consortium formation: Engineering and Procurement by MHI-A, Civil and Construction by the consortium partner PCI and ISC)

Civil & Structural Engineer (NAG-FEED)

- Polyethylene — USA

  2011 - 2013 — for A Company

  Capacity : N.A.

  FEED (Front End Engineering Design)

Professional Summary

HVAC Engineer (TAF)

- Fertilizer Complex
  - Ammonia
  - Urea
  - Methanol
  - Utility & Offsite

Mendeleev city , Tatarstan Republic, Russia

for Ammoni (Joint Stock Company Ammoni)

2011 – 2012

Capacity : 2,050 T/D (Ammonia)
2,050 T/D (Urea)
668 T/D (Methanol)

Lump Sum Turn Key Basis collaborating with China National Chemical Engineering Corporation, CNCEC (China)

MHI's Scope of Work: Engineering, Off-shore Procurement and Supervision

Civil & Structural Engineer (SPOX)

- Polyethylene (LDPE)
  (LLDPE / Metallocene LLDPE): Poly & Fin
  Polypropylene (PP)
  (Homo Polymer): Fin only

Jurong Island, Singapore

for ExxonMobil Chemical Company

2008 - 2011

Capacity : 650,000 T/Y × 2 (PE)
450,000 T/Y (PP)

Detailed Engineering, Procurement, Civil Works and Construction Works

Assistant Civil & Structural Engineer (METOR-EXPANSION Project)

- Methanol Plant (Expansion)

Jose, Venezuela

2007 – 2008

for Methanol De Oriento, METOR, S.A.

Capacity : 2,500 T/D

Lump Sum Turn Key Basis, consortium with INELECTRA

Professional Summary

Assistant Civil & Structural Superintendent (AR-RAZI-V Plant Project)

- Methanol Plant — Al-Jubail, Saudi Arabia

  2007 — for Saudi Methanol Company (AR-RAZI)

  Capacity : 5,000 T/D

  Lump Sum Turn Key Basis, including Basic / Detailed Engineering, Procurement, Construction and Commissioning Supervision

Assistant Civil & Structural Engineer

- Various Chemical Plants

  2006 - 2007

  Capacity : NA

AARON BENNETT, PE

Project Manager

Aaron serves as a Project Manager in the Burns and McDonnell Energy Global Practice. In recent years, Aaron has been responsible for Project and Engineering Management on projects including two LNG peak shaver projects, wastewater treatment projects at coal fired power plants, and air quality control projects at coal fired power plants. These multi-discipline projects required coordination between multiple engineering disciplines, procurement, and construction professionals to achieve safe and successful projects. In addition to project and engineering management activities, Aaron has been responsible for structural steel, ductwork, and turbine crane design and procurement contracts and the piling construction contract a site with karst geology and significant subsurface challenges. He has also been responsible for layout and design of new structural framing systems, analysis of existing structural framing systems, design and coordination of foundation systems, analysis and design of ductwork, and connection design for Selective Catalytic Reduction reactors.

EDUCATION

Masters, Civil Engineering, 2004;
Bachelors, Civil Engineering, 2002

REGISTRATIONS

Professional Engineer
(MS, OH, WY)

17 YEARS WITH BURNS & MCDONNELL

18 YEARS OF EXPERIENCE

RAINBOW ENERGY CENTER | RAINBOW ENERGY / EERC

Underwood, North Dakota | July 2022 - Present

Project Manager. FEED Study for outside boundary limits systems and equipment for a Carbon Capture Facility at both Units at Rainbow Energy Center. The project includes preliminary design, model development, procurement and construction package development, and cost estimate development for the outside boundary limit systems and equipment for the Project. The systems and equipment include modifications to the river water system; a new cooling water loop, cooling tower, and circulating water pumps; steam lines and condensate return lines between the existing facility and carbon capture island; flue as ductwork and ductwork support structures; warehouses; and connection of multiple plant utility systems.

RHINELANDER GAS COMPRESSOR | WEC ENERGY GROUP

Rhinelander, Wisconsin | Nov 2020 - Aug 2022

Project Manager. Natural gas compressor station for peaking service during peak gas usage periods. The project includes project development, site selection, cost estimate development, and permitting for the compressor station. The station will include a reciprocating natural gas compressor, vent gas recovery system, electrical and control equipment, pre-engineered metal building, and site development. Project manager supporting siting the proposed Gas Compressor Station, development of the Certificate of Authority Application for the Project. Work to date include preliminary engineering for site layout and cost estimate development as well as site surveys to support permitting. These surveys include wetland surveys, sound surveys, and a geotechnical investigation. BMcD is currently developing procurement specifications for long-lead time equipment with the intent of proceeding with the project on an EPOC basis once the project is approved by the Wisconsin Public Service Commission.

AARON BENNETT, PE
(continued)

Wisconsin LNG | WEC ENERGY GROUP
Milwaukee, Wisconsin | Apr 2019 - Apr 2023

Project Manageer. EPC project to install Liquified Natural gas (LNG) peak-shaving facilities at two sites in southeast Wisconsin. Supported client in siting the proposed facilities, performing wetland, cultural, and land surveys as well as permitting with local, county, and state agencies. Performing Owner's Engineer type role for Owner Supplied Equipment (LNG Tank and LNG Process Equipment). Executing the remainder of the scope on an EPC basis including purchasing gas compressors, electrical and control equipment, construction of the facility with the exception of the LNG Tanks, and commissioning and startup of the LNG Facilities.

Multiple Steam Stations | DUKE ENERGY
North Carolina | Oct 2015 - Jul 2019

Project Manageer. The program involved developing the scope, design, schedule, and cost estimates to bring multiple sites into compliance with the EPA effluent limitations guidelines and CCR rule. In general, the scope included closing the ash pond and redirecting flows to a treatment plant. Duties included erosion & sediment control plans, hydrologic & hydraulic calculations, drainage design, site grading, road design, development of contract drawings and specifications. Three sites as part of a program focused on CCR and ELG compliance at 10 operating plants. The scope of work consisted of dry bottom ash conversions, wastewater treatment of FGD blowdown and plant process water and retention basins for treatment of plant process water. The project included preliminary engineering, detailed design, permitting support, equipment procurement and field engineering support. Responsibilities include scope definition with client during initial phase, coordination of engineering design activities, procurement of major engineered equipment, and development of construction contracts.

Four Corners SCR Project | Arizona Public Service
Fruitland, New Mexico | Apr 2014 - Jan 2019

Project Manager and Engineering Manager. Project to support APS as Owners Engineer for the Units 4 & 5 SCR Project. Mr. Bennett led the engineering team in evaluation of the EPC contractor's open-book proposal. This included review of multiple SCR system arrangement options, OEM proposal evaluation, and detailed review the contractor's proposal and cost estimate. After EPC contract award, Mr. Bennett has continued to lead the technical team in evaluation of the EPC contractor's technical submittals, schedule, and installed equipment and material. The project consists of new SCR's, economizer waterside bypass system, air preheaters, urea to ammonia conversion equipment, and dry sorbent injection system for two 770 MW coal fired units.

Ghent Generating Station Units 1, 2, 3, & 4 | LG&E AND KU SERVICES COMPANY
Ghent, Kentucky | Oct 2014 - Dec 2016

Project and engineering manager. Project to capture and transport stormwater that potentially contains CCR material to a designated CCR treatment basin. The project included significant modifications to site grading and underground stormwater piping. New pumps along with corresponding new electrical and control equipment were utilized to convey water from the CCR area to the treatment basin several thousand feet away.

Sibley Generating Station Car Shaker Building | EVERGY METRO INC
Sibley, Missouri | Oct 2014 - Dec 2016

Project and engineering manager. Multiple structural upgrade projects at Sibley Station. Projects include a clarifier enclosure and foundation, electrical building, various monorails, access modifications, and miscellaneous foundations.

AARON BENNETT, PE
(continued)

Allen Steam Station | DUKE ENERGY
Belmont, North Carolina | Oct 2015 - Oct 2016

Project and engineering manager. Project to install a redundant gray water tank. Project includes design of a new field erected tank, new pile supported foundation, and interconnecting piping and control valve. BMcD performed the detailed design and assisted OG&E with procurement of the field erected tank, foundations and earthwork construction contract, and mechanical construction contract.

Muskogee 4,5, 6 Bottom & Waste Ash Stackout Pad | OGE ELECTRIC SERVICES CORPORATION
Fort Gibson, Oklahoma | Jun 2015 - Apr 2016

Project and engineering manager. Project to achieve compliance with CCR regulations prior to the compliance deadline. Mr. Bennett led the team in evaluation of the various compliance options and development of the detailed design packages to support to implement the compliance plan. Mr. Bennett and several design engineers participated in commissioning of the modified systems to facilitate completion prior to the deadline.

SOONER STATION CCR UPGRADES | OGE ELECTRIC SERVICES CORPORATION
Red Rock, Oklahoma | Jun 2015 - Apr 2016

Project and engineering manager. Project to achieve compliance with CCR regulations prior to the compliance deadline. Mr. Bennett led the team in evaluation of the various compliance options and development of the detailed design packages to support to implement the compliance plan. Mr. Bennett and several design engineers participated in commissioning of the modified systems to facilitate completion prior to the deadline.

Ghent Generating Station | LG&E AND KU SERVICES COMPANY
Ghent, Kentucky | Mar 2013 - Apr 2016

Engineering Manager and Lead Structural Engineer. Responsible for design review, schedule review, and project oversight of work performed by the EPC contractor and equipment suppliers. The project consists of new pulse jet fabric filters, ash handling equipment, ID fans, activated carbon injection, interconnecting ductwork, and associated structural steel and foundations at four units on site. In addition, Mr. Bennett performed inspections of existing ductwork and developed contract documents for reinforcing and modification of the existing ductwork to meet increased design pressures.

Ghent CCR Warehouse | LG&E AND KU SERVICES COMPANY
Ghent, Kentucky | Jul 2014 - Mar 2016

Project and engineering manager. Project to improve operability of the CCR material handling area. The project included demolition of existing drag chain conveyors and installation of new bottom ash bunkers in their place. Installation of the bottom ash bunkers required significant modifications and resupport of the existing submerged chain conveyor building as well as relocation of underground duct bank and associated electrical and control cables. The project also included a new elevator, new storage warehouse, and multiple access platforms.

Warren County Power Station | WARREN COUNTY ENERGY PARTNERS
Front Royal, Virginia | Jun 2011 - Oct 2012

Structural engineer. Project was a joint venture with Zachry. Hired by Dominion Virginia Power to perform engineering, procurement and construction Services for a 1,300+ MW Gas Fired power facility. Project consisted of three MHI 501G gas turbines and a MHI TCF4 Steam Turbine. Responsible for various aspects of structural design and contract management on a new 3-on-1 Combined Cycle Power Plant that was constructed on an EPC basis. Mr. Bennett was responsible for the steam

AARON BENNETT, PE
(continued)

turbine crane procurement package and the micropiling construction subcontract. The micropiling construction contract was complicated by karst geology, including sinkholes and highly variable rock depths, and a subsurface endangered species. Mr. Bennett was responsible for concrete foundation and piling design for the Heat Recovery Steam Generator, Pipe Rack, Boiler Feed Pump, and multiple other equipment and structures. He was also responsible for coordination of structural aspects on multiple mechanical and electrical equipment contracts.

Musheireb Downtown Doha | MSHEIREB PROPERTIES
| Oct 2010 - Dec 2011

Structural engineer. Provided Design/Bid/Build services and constructed reinforced concrete buildings. Responsible for design of four story underground reinforced concrete parking structures and interconnecting service tunnels as part of a large development project in Doha, Qatar. The parking structures supported above grade, multistory, multiuse reinforced concrete structures from transfer slabs at ground level and utility rooms located throughout the lower levels. In addition, Mr. Bennett coordinated structure interface and expansion joint details between multiple architectural and engineering entities.

Units 3 and 4 AQCS Retrofit | NRG Energy, Inc.
Delaware | Jun 2009 - Sep 2010

Lead Ductwork and Structural Steel Engineer. Air quality upgrade project on Unit 4 of the Indian River Generation Facility. The project included new flue gas ductwork and corresponding support steel, utility racks, platforms, and evaluation and repair of existing ductwork. Mr. Bennett was responsible for procurement packages and structural design of ductwork, structural steel, and fabric expansion joints.

MSAT II Reformate Stripper Project | Valero Energy Corporation
Multiple Locations | Mar 2009 - Aug 2009

Structural engineer. Provided engineering, procurement, and construction services for new heart-cut reformate splitters at three refineries. Units reduced the benzene content of reformate to comply with Environmental Protection Agency Mobile Source Air Toxics Tier 2 (MSAT2) regulations. Responsible for design of reformate splitter baffle wall for vessels associated with benzene reduction projects at multiple refineries. Mr. Bennett also coordinated and designed radial access platforms for new vertical vessels at the various project sites.

Crystal River SCR and FGD Upgrade | Environmental Partners Crystal River
Florida | Jun 2007 - Apr 2009

Structural engineer. Clean Air EPC project for Progress Energy. Included the addition of two SCRs, two wet scrubbers, ID fans, reagent prep, limestone and gypsum material handling, related equipment and modifications to two ESPs for the two 750 MW units. Included retrofitting two 750MW coal fired power plant units with SCR and wet FGD systems. Responsible for analysis and design of ductwork support and utility support steel as well as coordination of structural issues with Burns and McDonnell's EPC partners. Additionally, Mr. Bennett designed support saddles for large diameter FRP ductwork and assisted in SCR support truss erection planning.

Thomas Hill Environmental Controls Retrofit Project | Associated Electric Coop Inc
Missouri | Feb 2006 - Dec 2007

Structural engineer. Responsible for analysis and design of ductwork; ductwork, SCR, and air preheater support structures; and SCR connections. Mr. Bennett designed drilled shaft and micropile supported foundations. He also served contract engineer for fabrication of the structural support steel and fabric expansion joints

PATRICIA (TISHA) SCROGGIN-WICKER, PE

Director of Process Technology

Patricia is the Director of Process Technology for our power generation business working with Energy clients at Burns & McDonnell. Her team's responsibilities today include the Hydrogen, Carbon Capture, Liquified Natural Gas (LNG), Flow Battery and other process-oriented technology applications within the power generation industry.

Her career has included from the outset experiences with air quality control, chemical feed, water treatment and other process-oriented technologies. She's had experiences with numerous first of a kind installations including engineering, construction and startup experiences.

EDUCATION

Bachelors, Chemical Engineering, 2002

REGISTRATIONS

Professional Engineer (GA, IL, MO, NH)

19 YEARS WITH BURNS & MCDONNELL

19 YEARS OF EXPERIENCE

Hydrogen and Carbon Capture

Process Technology Director. Assist clients with identifying applicable technology that meets project needs from a scope, schedule and budget perspective. Provide direction to project teams as they are executing technology reviews, scale up evaluations, pilot projects and grid scale projects.

LNG Industry Lead

Multiple Locations | 2019 - Present

Business Manager. Responsible for market understanding, OEM relationships and technical applications around the peak shaving LNG market with respect to the power generation market.

Flow Battery Industry Lead

Multiple Locations | 2019 - Present

Business Manager. Responsible for market understanding, OEM relationships and technical applications for the evolving flow battery industry. Submitted on over 100 MWhr of flow battery project opportunities.

Water Redirection Program | Duke Energy Corp

Multiple Locations | Oct 2015 - Sep 2020

Process consultant. Worked on multiple process wastewater facilities at twelve stations. FGD wastewater treatment system includes clarification, filtration, biological and final polishing.

FGD Physical/Chemical & ZLD Wastewater Treatment | Indianapolis Power & Light Company

Petersburg, Indiana | May 2014 - Jul 2020

Process consultant. IP&L's waste-water treatment plant project, an EPC project, included the addition of a water treatment plant with a zero-discharge facility, thermal evaporation system, and a distillate stream for reuse in the FGD and other systems as permitted in order to discontinue the discharge of bottom ash, fly ash, FGD, and other waste-water materials into their existing ash ponds. The proposal includes as an option the installation of a bottom ash dewatering system allowing for the dewatered ash to be transported to a permitted landfill for disposal. Worked on multiple process wastewater facilities at a

PATRICIA (TISHA) SCROGGIN-WICKER, PE
(continued)

1,760-MW coal-fired facility. FGD wastewater treatment system includes clarification, softening and thermal evaporation using falling film evaporators. Remaining plant wastewater flows are treated within an enhanced heavy metals precipitation process followed by a mercury reduction filtration system.

High Desert Power Project | Tenaska, Inc.
Kansas City, Missouri | Mar 2015 - Feb 2017

Process engineer. Worked on optimization of existing Zero Liquid Discharge system on combined cycle cooling tower blowdown system. Coordination with existing plant operations while optimizing various systems.

Mustang | OGE Energy Corp.
Oklahoma City, Oklahoma | May 2014 - Sep 2016

Process engineer. Worked on FEED study to develop new generation simple cycle and combined cycle site. System design including raw water treatment, demineralization, sampling and cooling tower and cycle chemical feed systems.

Confidential Client | Big Rivers Electric Corporation
Henderson, Kentucky | Jul 2013 - Dec 2014

Project team. Multiple facility review of existing plant water balances for identification and implementation of water reuse and wastewater minimization technologies. Determine potential compliance requirements associated with upcoming proposed National Effluent Limitation Guidelines.

Frank A. Tracy Generating Station | NV Energy, Inc.
Nevada | Feb 2012 - Dec 2013

Process engineer. Worked to review the plant water usage and treatment capabilities to develop a comprehensive water management plan. The plan improved water usage and optimize the use of water treatment equipment to maintain zero liquid discharge operation. This facility is a multi-unit station with oil and gas fired units.

Iatan 2 | Evergy, Inc.
Kansas City, Missouri | Dec 2005 - Jul 2013

Process engineer. Worked on design, procurement and 2.5-year assignment onsite for construction oversight and startup of water related systems at a new 900-MW coal-fired power plant. Systems include wastewater treatment system, condensate polishing, raw water treatment, boiler cycle, sampling and demineralized water. New unit, including scrubber blowdown, is a Zero Liquid Discharge (ZLD) site.

Merrimack Station - Zero Liquid Discharge | Eversource Energy
New Hampshire | Oct 2010 - Apr 2013

Process engineer and Project Manager. Worked on fast track technology selection, design, procurement, and startup of an evaporator/crystallizer Zero Liquid Discharge system for FGD wastewater. System has ability to produce a concentrated stream for landfilling with fly ash, or a fully dry waste product suitable for landfill.

PATRICIA (TISHA) SCROGGIN-WICKER, PE
(continued)

Council Bluffs Unit 3 | MidAmerican Energy
Iowa | Nov 2006 - Dec 2011

Process engineer. MidAmerican Energy's Council Bluffs Unit 3 AQCS project, an EPC project, included the addition of two SDAs, two fabric filters, ID fans and related equipment for the 700 MW unit. Worked on air pollution control upgrade at 690-MW coal-fired power plant. Duties included design review, drawing review, equipment checkout, water balance design and interfacing with other disciplines and contracts. Equipment included dry scrubbers, fabric filters, ductwork, lime slakers and recycle slurry ash systems.

Louisa Scrubber Project | MidAmerican Energy
Iowa | Nov 2005 - Dec 2011

Contract engineer. Worked on air pollution control upgrade at 700-MW coal-fired power plant. Duties included design review, drawing review, equipment checkout, water balance design and interfacing with other disciplines and contracts. Equipment included dry scrubbers, fabric filters, ductwork, lime slakers and recycle slurry ash systems.

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| Oct 2003 - Dec 2007

Process engineer. Worked on design, specification, procurement and submittal reviews for water system equipment upgrades at 500-MW combined cycle power plant. Wrote equipment procurement contracts, performed bid evaluations and reviewed drawing submittals for additional lime slaker, silo, and redundant pressure filter and demineralizer system.

Emery Generating Station | Alliant Energy
| Apr 2002 - Jul 2007

Process engineer. The Power Iowa project included two General Electric 7FA combustion turbine-generators (CT) coupled with two heat recovery steam generators (HRSG) and a single common steam turbine-generator (ST) to operate in combined cycle mode. Worked on design, procurement, and construction of water related systems at 550-MW combined cycle power plant. Systems include cycle chemical feed, circulating water chemical feed, raw water chemical feed, demineralized water, potable water, sampling and analysis, service water, raw water, and well water. Design involved use of reclaimed water and well water for primary cooling water makeup needs. Preparation of fully comprehensive life cycle cost analysis and plant water balance.

Sheboygan Falls Energy Station | Alliant Energy
| Jan 2004 - Sep 2006

Process engineer. Worked on design, procurement, and construction of water related systems at 350-MW simple cycle power plant. Wrote equipment procurement contracts, performed bid evaluations and reviewed drawing submittals for both the service water chemical feed and potable water systems.

Meramec, Rush Island & Sioux Power Plants | Ameren Corporation
| Mar 2003 - Mar 2004

Process engineer. Worked on primary water treatment and potable water system studies. Studies included existing equipment assessment, design basis review in terms of performance, functionality, reliability, and redundancy, identification of required equipment replacements and significant maintenance expected during the next 10 years, assess current and future compliance with EPA and MO-DNR drinking water regulations, propose modifications and upgrades to existing systems,

PATRICIA (TISHA) SCROGGIN-WICKER, PE

(continued)

evaluate alternatives for potable water supply. Preparation of anticipated capital expenditures and operating and maintenance expenses to keep system operating. Life cycle cost analysis for alternative water treatment options.

John Bauer

jbauer@grenergy.com, Office (701) 442-7000, Cell (701) 897-1853

Summary

As Director of North Dakota Generation for Great River Energy I have oversight of Great River Energy's Coal Creek Station. With over 40 years of experience in the industry, I possess a wealth of power and process knowledge and strive to enhance culture, teamwork, and leadership to maintain a highly engaged work force.

The honor to serve as a member of the Bismarck State College foundation board and as chair of Electric Power Research Institute's operations management technology program provides an opportunity to offer input that creates a well-trained workforce ensuring we improve operations and achieve safe, reliable, cost-effective and environmentally responsible power generation.

This first-hand knowledge and experience allow me to effectively contribute to the overall success of GRE's ND operation regardless of the situation.

EXPERIENCE:

Director, North Dakota Generation
March 2017 – current
Lead, plan and direct the operation and maintenance of North Dakota generating facilities in accordance with Great River Energy's (GRE) values, mission, and strategic imperatives, to achieve safe, reliable, efficient and environmentally sound production of electricity.

Manager, ND Operations Services
April 2015 – March 2017
Provide management oversight for plant operations, fuel operations and utility groups at Great River Energy's Coal Creek, Stanton and Spiritwood facilities. Provide overall site management for Spiritwood Station. Current Alternate Designated Responsible person for ND environmental compliance.

Leader, Plant Operations (day coordination) Great River Energy, Coal Creek Station
Oct 2005 – April 2015
Act as the Operating Authority and provide daily coordination for Coal Creek Station Plant Operations, Facilitate hiring and training for new hires (Operators / Operator Technicians), Mentor the 60 member Operations Team, coordinate new projects affecting the station, system start-up commissioning, work around guidance and emergent response to limit generation loss, Incident Commander for HazMat, fire and unit incidents, Provide leadership to the Operator Technician, Building Maintenance Utility and Temp Labor groups.

Leader, Plant Operations (shift coordination) Great River Energy, Coal Creek Station
Sept 2001 – Sept 2005
Act as the Operating Authority of Coal Creek Station, coordinate shift operation of a 12 member self-directed work team at Coal Creek Station, provide maintenance guidance on short outage and emergent situations to limit generation losses.

Control Room Operator Great River Energy, Coal Creek Station
July 1994 – Aug 2001
Operate Coal Creek Station from the central control room, coordinate maintenance efforts to support maintenance teams with clearances and equipment outage scheduling.

John Bauer

jbauer@grenergy.com, Office (701) 442-7000, Cell (701) 897-1853

Train other levels of plant operations to ensure qualified members for advancing positions.

Additional operations positions, Great River Energy, Coal Creek Station
Mar 1981 – June 1994
Monitor equipment, provide clearances, perform minor maintenance and provide troubleshooting support for Assistant Control Operator, Auxiliary Operator and Equipment Operator plant systems at Coal Creek Station. Provide job leader support for unit outages.

EDUCATION:

Great River Energy Leadership Training, Great River Energy
Foundational Leadership and Leadership in Action
MARC – Managers Guide to Employee Relations Leadership Training

Bismarck State College, Bismarck ND
Power Plant Technology

LEADERSHIP IN OTHER ORGANIZATIONS:

Bismarck State College Foundation board member

Program Chair for Electric Power Research Institute Plant Management Essentials Program

President, Ridgefield Condominium Association, Bismarck

SKILLS AND ABILITIES

Leadership Operations
Project Coordination
Mentoring
Safety
Expertise
Project Commissioning
Teamwork

Ethan Vaagene

evaagene@grenergy.com, Office (701) 442-7066, Cell (701) 460-7390

Summary

As Principal Engineer at Great River Energy's Coal Creek Station I am responsible for the technical research and analysis for the major plant electrical and protective systems. I have been responsible for large and complex projects at the plant in order to improve reliability and maximize efficiency. My experience has allowed me to obtain a vast knowledge of electrical and power plant knowledge.

I actively participate in outside organizations and committees with direct impact to the power industry. I have taken advanced courses to further my education and have expanded on this education to instruct college students at Bismarck State College.

My knowledge and expertise allow me to contribute to the overall success of Coal Creek Station and provide value to the industry outside of Great River Energy.

EXPERIENCE:

Principal Engineer, Coal Creek Station
January 2020 – current
Subject matter expert on electrical systems, electrical distribution, electrical apparatus, and relaying. Manage complex technical projects with critical financial and technical significance to Great River Energy. Present proposals and technical information to plant staff, leadership and corporate leadership with the responsibility to make timely, effective decisions with direct impact to Great River Energy.

Maintenance Supervisor, Coal Creek Station
February 2013 – January 2020
Responsible for the budget, management, and direct supervision of mechanics and E&I personnel at Coal Creek Station. Analyze data and reports to recommend and implement plant improvements. Develop procedures, standards and goals, in addition to preparing reports, that align with the vision of the company and regulatory directives.

Senior Systems Engineer, Coal Creek Station
November 2005 – February 2013
Responsible for the design, specifications, schedule, budget and project management of projects at Coal Creek Station. Manage and direct contractors and plant personnel for medium and large size projects. Provide daily plant support for operations and maintenance and conduct analysis, reports, and recommendations to plant staff and leadership.

EDUCATION:

University of North Dakota, Grand Forks ND
Bachelor of Science Electrical Engineering
Minor Mathematics

University of Mary, Bismarck ND
Master Business Administration w/Energy Management Focus

Ethan Vaagene

evaagene@grenergy.com, Office (701) 442-7066, Cell (701) 460-7390

CERTIFICATIONS and LEADERSHIP IN OTHER ORGANIZATIONS:

Engineer in Training Certification
Professional Engineer (PE-6878)
Professional Project Manager Certification
Member of IEEE
Member of DOBLE
Member of Society of Engineers
Adjunct Instructor for Bismarck State College I&C Department

SKILLS AND ABILITIES

Leadership
Project Management
Electrical Testing and Analysis
NEC, IEEE, ANSI, ASME Standards
Primavera, Maximo, Microsoft Office
Employee Development
NERC Compliance
Communication

APPENDIX D

BUDGET NOTES

BUDGET NOTES

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: EERC fringe benefits consist of two components which are budgeted as a percentage of direct labor. The first component (26%) 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. The approved rate will be charged to the project. The second component (30%) 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. These benefits will be charged based on expenses actually incurred and will vary by individual.

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, ground transportation, and miscellaneous costs are based on a combination of historical costs and current market prices. Miscellaneous travel costs may include 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.

Subcontractor – MHIA: MHIA will redesign the carbon capture plant to increase the redundancy of equipment to 100% (n+1).

Subcontractor – Burns & McDonnell: Burns & McDonnell will redesign the balance of plant equipment up to the tie points.

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. 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 and approved by the university.

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.

Document production services 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.

Engineering services recharge fees cover specific expenses related to retaining qualified and certified design and engineering personnel. The rate includes training to enhance skill sets and maintain certifications using Webinars and workshops. The rate also includes specialized safety training and related physicals. The estimated cost is based on the number of hours budgeted for this group of individuals.

Geoscience services recharge fees are discipline fees for costs associated with training, certifications, continuing education, and maintaining required software and databases. The estimated cost is based on the number of hours budgeted for this group of individuals.

Software solutions services recharge fees are for development of customized Web sites and interfaces, software applications development, data and financial management systems for comprehensive reporting and predictive analysis tools, and custom integration with existing systems. The estimated cost is based on prior experience with similar projects.

Field safety fees cover safety training and certifications, providing necessary PPE, and annual physicals. The estimated cost is based on the number of days individuals are budgeted to work in the field.

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.

Cost Share: Cash cost share is being provided by Rainbow Energy Center in the amount of $837,314.