EERC
Energy & Environmental Research Center

UNIVERSITY OF NORTH DAKOTA
15 North 23rd Street — Stop 9018 / Grand Forks, ND 58202-9018 / Phone: (701) 777-5000 Fax: 777-5181
Web Site: www.undeerc.org

January 6, 2010

Ms. Karlene Fine
Executive Director
North Dakota Industrial Commission
ATTN: Renewable Energy Development Program
600 East Boulevard Avenue
State Capitol – Fourteenth Floor
Bismarck, ND 58505

Dear Ms. Fine:

Subject: EERC Proposal No. 2010-0137 Entitled "Renewable Oil Refinery Pilot Plant Construction"

Enclosed please find an original and one copy of the proposal entitled "Renewable Oil Refinery Pilot Plant Construction." Also enclosed is the $100 application fee.

The Energy & Environmental Research Center (EERC) of the University of North Dakota is pleased to submit the subject proposal. The EERC is committed to completing the project as described in this proposal if the Commission makes the requested grant and the requested allocations from the other two project cost-share providers—the U.S. Department of Energy and Accelergy Corporation—are granted.

If you have any questions regarding this proposal, please contact me by phone at (701) 777-5273, by fax at (701) 777-5181, or by e-mail at cwocken@undeec.org.

Sincerely,

Chad A. Wocken
Senior Research Manager

Approved by:

Dr. Barry I. Milavetz, Associate VP for Research
Research Development and Compliance

CAW/jae

Enclosures

c/enc: Mike Jones, NDIC

EERC
Energy & Environmental Research Center

# RENEWABLE OIL REFINERY PILOT PLANT CONSTRUCTION

EERC Proposal No. 2010-0137

*Submitted to:*

**Karlene Fine**

**North Dakota Industrial Commission**
**ATTN: Renewable Energy Development Program**
**600 East Boulevard Avenue**
**State Capitol – Fourteenth Floor**
**Bismarck, ND 58505**

Amount of Request: $500,000
Total Amount of Proposed Project: $6,500,000
Duration of Project: 18 months

*Submitted by:*

Chad A. Wocken
Ted R. Aulich
Benjamin G. Oster

Energy & Environmental Research Center
University of North Dakota
15 North 23rd Street, Stop 9018
Grand Forks, ND 58202-9018

Chad A. Wocken, Project Manager

Dr. Barry I. Milavetz, Associate VP for Research
Research Development and Compliance

**January 2010**

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# RENEWABLE OIL REFINERY PILOT PLANT CONSTRUCTION

## ABSTRACT

**Objective:** To construct a 1.7-million-gallon/year renewable oil refinery pilot plant in partnership with Accelergy Corporation, an advanced fuels developer with technologies exclusively licensed from ExxonMobil. Construction will utilize a bid-ready design being developed by the Energy & Environmental Research Center (EERC). Funding for the $1 million design effort was provided at a level of $500,000 each from the North Dakota Renewable Energy Program and the U.S. Department of Defense. With assistance from WorleyParsons, an international oil industry engineering services company with offices in Bismarck, North Dakota, and Billings, Montana, the pilot plant is being designed for integration with operations at the Tesoro petroleum refinery in Mandan, North Dakota, and will be used to optimize EERC refining technologies developed for conversion of renewable oils to specification-compliant fuels and other products. The refining technologies represent unit operations of the EERC catalytic hydrodeoxygenation–isomerization (CHI) fuel production pathway, which comprises 1) feedstock hydrodeoxygenation (HDO), 2) propane and other light gas recovery, 3) HDO product water removal, 4) HDO product isomerization and cracking, and 5) distillation to yield desired products. A key feedstock for the pilot plant will be oil extracted from North Dakota-grown crambe, a low-input crop with a successful commercial history in western North Dakota that is currently undergoing seed supply expansion by the North Dakota State University Carrington Research Extension Center. Additional feedstocks include low-cost waste grease and animal fats and oil extracted from regionally produced camelina, canola, soy, and corn.

**Expected Results:** A state-of-the-art fully functioning renewable oil refinery pilot plant that is optimally integrated with operations at the Tesoro Mandan petroleum refinery.

**Duration:** 18 months.

**Total Project Cost:** $6.5 million, with $3.75 million requested from Accelergy, $2.25 million from the U.S. Department of Energy through the EERC's Center for Biomass Utilization Program, and $500,000 from the North Dakota Renewable Energy Program.

**Participants:** EERC, Accelergy, Tesoro.

# RENEWABLE OIL REFINERY PILOT PLANT CONSTRUCTION

## PROJECT DESCRIPTION

### Objective

The Energy & Environmental Research Center (EERC), in partnership with Accelergy Corporation of Houston, Texas, proposes to construct a renewable oil refinery pilot plant with a feedstock processing capacity of 1.7 million gallons a year. Accelergy is an advanced fuels developer with coal- and biomass-based fuel production technologies licensed exclusively from ExxonMobil. The pilot plant will be constructed based on a bid-ready "front-end engineering design" (FEED) currently being developed by EERC under a $1 million project cofunded at $500,000 each by the North Dakota Renewable Energy Program and the U.S. Department of Defense and supported by Tesoro Corporation. The pilot plant will be sited at the Tesoro Mandan petroleum refinery and fully integrated with refinery operations, which will expedite permitting and enable minimum-cost access to required utilities, including hydrogen, steam, and electricity. Other collocation advantages include access to Tesoro capabilities in refinery systems operation and product off-take, marketing, and distribution.

For assistance in developing the pilot plant design and integration scenario, EERC followed the recommendation of Tesoro Mandan management and contracted with WorleyParsons, an international petroleum industry engineering services company with offices in Bismarck, North Dakota, and Billings, Montana, and a long history and intimate familiarity with the Mandan refinery. Following construction and shakedown, the pilot plant will be used to optimize EERC refining technologies developed for conversion of renewable oils to oxygen-free specification-compliant jet and diesel fuels that are functionally indistinguishable from their petroleum-derived counterparts, naphtha (a light hydrocarbon mixture with applications as a gasoline blendstock or chemical feedstock), and propane. The refining technologies represent unit operations of the EERC catalytic hydrodeoxygenation–isomerization (CHI) fuel production pathway, which was developed by EERC through recent and ongoing contracts with the U.S. Defense Advanced Research Projects Agency (DARPA) and the U.S. Army Corps of Engineers Construction Engineering Research Laboratory (CERL) at Champaign, Illinois. EERC has successfully demonstrated the viability of the CHI technology in producing renewable JP-8 jet fuel from vegetable and

algae oils, as confirmed by the U.S. Air Force Research Laboratory (AFRL) at Wright–Patterson Air Force Base in Dayton, Ohio. As shown in Figure 1, the CHI pathway comprises:

- Catalytic hydrodeoxygenation (HDO) to convert oxygen-containing renewable oil feedstocks—including triacylglycerides (TAGs), free fatty acids, and/or any-proportion mixtures of these—to oxygen-free straight-chain hydrocarbons referred to as normal paraffins.
- Recovery of propane and other light hydrocarbon gases.
- Water removal from the HDO product to ensure against next-stage catalyst contamination.
- Catalytic isomerization and cracking of the HDO product to achieve maximum yield of jet fuel- or diesel fuel-grade branched hydrocarbons referred to as isoparaffins.
- Distillation to yield jet fuel, diesel fuel, and naphtha products.

As shown in Figure 1, the CHI technology results in production of a jet fuel-grade synthetic paraffinic kerosene (SPK). The U.S. Air Force has demonstrated the viability of SPK blended at a 50–50 ratio with petroleum-derived jet fuel in flight tests with a B52 aircraft, and EERC renewable SPK has been validated by AFRL as meeting all key requirements of ASTM D7566 (Aviation Turbine Fuel Containing Synthesized Hydrocarbons). In addition to blending with petroleum-derived JP-8, SPK can be blended with a mixture of appropriate cycloparaffins and aromatics (derived from renewable or fossil fuel resources) to yield a jet fuel that fully complies with MIL-DTL-83133F, the U.S. military specification for JP-8. Analytical data for EERC renewable SPK and JP-8 fuels are provided in Appendix A.

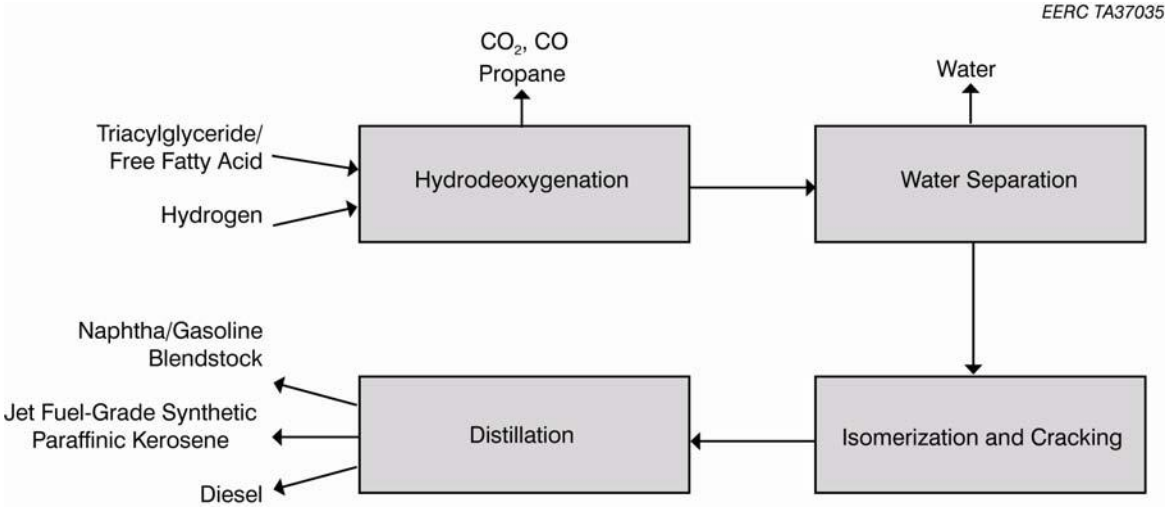


Figure 1. EERC CHI technology pathway.

## METHODOLOGY

The U.S. Air Force currently fuels the majority of its aircraft with JP-8 and has been researching possibilities for acquiring non-petroleum-derived JP-8 to comply with an internally promulgated mandate to procure 50% of its fuel requirement from domestically produced resources with life cycle carbon footprints equal to or less than petroleum. Accelergy Corporation and EERC recently formed a strategic partnership to develop fuels that can both meet the Air Force mandate and compete in commercial jet fuel markets. Under the terms of the partnership agreement, Accelergy will license the EERC proprietary CHI technology for commercialization. In commercializing the technology, Accelergy will receive support from members of the Accelergy Alliance, which includes Montana State University in Bozeman, Montana, where an algae production and algae capture program is being conducted; A2BE Algae at Work Corporation; Raytheon Corporation; and Becht Engineering of Liberty Corner, New Jersey.

The first major step of the Accelergy–EERC commercialization plan is the construction of a 100-barrel-per-day (B/D) CHI-based renewable oil refinery pilot plant integrated with the Tesoro Mandan petroleum refinery. The pilot plant will be built based on the FEED currently being developed by EERC in collaboration with WorleyParsons and Tesoro. The FEED is scheduled for completion by the second quarter of 2010. At a capacity of 100 B/D (equivalent to 1.7 million gallons/year), the pilot plant will be large enough to conduct pre-commercial-scale testing and optimization of the CHI process, develop the performance data needed for CHI scale-up to a commercial capacity of at least 100 million gallons/year, and produce fuel and chemical products in quantities suitable for military and commercial evaluation and certification programs. In addition to providing a design of sufficient detail to enable constructing the pilot plant, the completed FEED will enable calculation of a construction cost estimate with a precision of 20%, versus the approximate 30% precision of the EERC-developed preliminary cost estimate of approximately $6 million. As detailed in the budget, $2.25 million of the $6.5 million will be provided by the U.S. Department of Energy (DOE) through the DOE-sponsored EERC Center for Biomass Utilization Program, and $3.75 million will be provided by Accelergy. As described in the letter of commitment provided in Appendix D, Accelergy anticipates securing the required $3.75 million by the second or third quarter of 2010.

Following FEED completion, EERC and Accelergy will conduct a formal bid process for selection of a general contractor to construct the pilot plant. Prior to receipt of a bid request, prospective contractors will be required to sign a nondisclosure agreement. Because of the confidential nature of the design, public reading of the bid request will be dismissed. Bids received will be reviewed on the basis of responsiveness and responsibility. The review process will be conducted by EERC in collaboration with Accelergy, Tesoro, and Raytheon. Bids deemed technically nonresponsive and/or irresponsible will be dismissed. The right to reject any and all bids will be retained. Technically responsive and responsible bids will be reviewed in accordance with applicable laws and policies. All bidders—successful (if any) and unsuccessful—will be notified in writing of their status following completion of the review process. The winning bidder will be rigorously vetted to assess its qualification for conducting the required scope of work. Following successful qualification assessment, a contract will be entered into between EERC and the selected general contractor, and engineering procurement and construction will commence.

The $500,000 requested from the North Dakota Industrial Commission—the subject of this proposal—will be allocated to EERC to cover EERC costs associated with conducting the bid process and overseeing and facilitating construction of the pilot plant. During construction, EERC will work closely with the general contractor to monitor day-to-day progress and consult on design and fabrication questions to ensure that the resulting pilot plant meets all performance requirements. Over the course of the 12–15-month construction phase, EERC anticipates the need to have appropriate personnel present on the construction site for 2–4 days a week for 2–4 weeks a month. In addition to on-site consulting, liaising with technical personnel at EERC to resolve questions and develop contingencies as needed, and reporting on progress, on-site personnel will take advantage of opportunities during construction to acquire detailed photographs of unit operations and auxiliary systems (prior to their encapsulation in insulation and enmeshment in piping and electrical circuitry) and develop system operation manuals and troubleshooting guides. Pilot plant construction will take 1 year.

### Anticipated Results

The proposed project will result in a fully functional 1.7-million-gallon/year-input-capacity renewable oil refinery integrated with operations at the Tesoro Mandan petroleum refinery.

### Facilities

EERC has the accounting and contracting facilities needed to administer the bid process and the technical facilities needed to oversee, monitor, and consult on construction progress. EERC also has appropriate analytical instrumentation and bench-scale process equipment to develop the data needed to resolve any process-related questions that may arise during construction and develop contingencies as needed. Accelergy has offices in Houston, Texas, and has access to research and development laboratories at Yashentech in Shanghai, China; at Montana State University in Bozeman, Montana; and at A2BE in Golden, Colorado. Accelergy will also have access to the engineering facilities of its Accelergy Alliance partners Raytheon and Becht Engineering and to the research facilities of AFRL through a recently formalized Cooperative Research and Development Agreement with the U.S. Air Force.

### Resources

EERC personnel who will be responsible for on-site progress monitoring and consulting and off-site consulting and contingency planning have extensive and wide-ranging experience in fuels process development and reactor systems design. Key personnel specialties to be employed include general plant and systems layout, piping and plumbing, reactor system and pressure vessel design and fabrication, electrical and process control system design and programming, water separation and gas handling and processing system design and fabrication, distillation system design and fabrication, and process chemistry development and troubleshooting. Accelergy has access to a wide range of catalysis science and process engineering experts via its Accelergy Alliance partners and from advisors and outside experts under contract to Accelergy. Over eighty (80) senior engineering experts with background in all aspects of catalytic process engineering and catalysis science, computational fluid dynamics, engineering design and modeling, reaction kinetics, and process engineering are available on an as-needed basis. This group represents some of the most prominent scientists and engineers who were employed at ExxonMobil and other leading engineering companies. Resumes for key Accelergy personnel are provided in Appendix C.

### Techniques to Be Used, Their Availability and Capability

The techniques to be used in constructing the pilot plant will be the province of the general contractor

ensure that the bidder is fully capable of executing the construction project prior to awarding a contract. If the bidder is deemed incapable of completing the project satisfactorily, other bidders will be vetted as needed to secure a qualified contractor.

### Environmental Impacts While Project Is under Way

The pilot plant will be constructed at the Tesoro refinery, and the project team will work with the selected general contractor to ensure compliance with all environmental regulations. The project team will also work with the North Dakota Department of Health during the construction phase to ensure that—following construction completion—all operational aspects of the pilot plant comply with applicable state and federal regulatory requirements.

### Ultimate Technological and Economic Impacts

Following construction of the pilot plant, it will be used to further optimize the CHI renewable oil refining technologies and develop the critical operating data needed to scale the technologies to a commercial capacity of up to 100 million gallons/year or more. Because the CHI technologies were developed by tailoring petroleum refining technologies for application to renewable oils and care was taken to ensure their operability within standard petroleum refinery physical plant limitations, once the CHI technologies are fully optimized and scaled up, their economic viability should be roughly equivalent to the viability of their baseline petroleum technologies. The major difference in comparing the economics of renewable oil refining versus petroleum refining is likely to be the higher price of the renewable oil feedstock. However, as annual production of lower-input nonfood crops like crambe and camelina increases, these feedstocks will become increasingly competitive with petroleum. In addition, the CHI technologies are compatible with the use of low-cost, high free-fatty-acid-content, non-food-grade materials recovered as wastes from a variety of commercial food and biodiesel production processes. Regardless of the near-term cost of feedstocks, the project team of EERC, Accelergy, and Tesoro is committed to developing, demonstrating, and improving the CHI technologies today with the view that as algae and other renewable oils become increasingly cost-competitive, CHI-produced renewable jet and diesel fuels will become increasingly cost-competitive with their petroleum-derived

counterparts and the CHI-based refinery will emerge with a significant competitive advantage over other renewable oil refineries.

On a commercial scale, the CHI-based refinery will have the potential to compete economically with petroleum-derived fuels and chemicals and simultaneously develop a new renewable hydrocarbon industry that supports domestic and local agriculture, reduces carbon emissions, and improves energy security. According to a U.S. Department of Agriculture estimate, a 50-million-gallon/year renewable oil refinery would create a demand for 500,000 to 1,000,000 acres of crambe and/or other oil seed crops based on typical North Dakota yields. Additionally, contingent on pilot plant success, there appears to be sufficient market potential to warrant building additional 50-million-gallon/year, and larger, refineries in North Dakota and worldwide, with estimated per-refinery local economic impacts of greater than $50 million annually, including 40 direct jobs and up to 600 indirect jobs.

### Why Project Is Needed

The project objective is to construct a renewable oil refinery pilot plant in North Dakota, with the intention of using the plant to validate the economic viability of the CHI technologies and develop the operational data needed to design a commercial-scale CHI-based refinery. Assuming success in these efforts, the proposed project would represent the critical first stage of a process that results in a nationwide network of renewable oil refineries capable of producing “drop-in-compatible” renewable jet and diesel fuels that are functionally indistinguishable from their petroleum-derived counterparts and thereby economically integrated into existing production, distribution, and marketing infrastructure.

## STANDARDS OF SUCCESS

The primary deliverable of the project is a 1.7-million-gallon/year renewable oil refinery pilot plant. Success will be achieved if the pilot plant is completed on schedule and within budget and is demonstrated to perform as designed, as measured by its ability to produce specification-compliant jet and diesel fuels in standard CHI yields, using standard CHI inputs and operating conditions over a minimum 120-hour continuous operational cycle, with no significant degradation in performance.

Data generated from operation of the pilot plant will be used by Accelergy and EERC to do commercial-scale design and process economics modeling to satisfy commercial project finance criteria.

Jet fuels generated from pilot plant operations will be evaluated by the U.S. Air Force and by commercial aircraft and engine manufacturers for certification purposes and to provide data for developing formulas and production strategies for fully (100%) synthetic military specification-compliant JP-5, JP-8, and JP-9+ series fuels for AFRL testing and certification. These studies will validate the development of a formal process engineering design specification for commercial production facilities with 50+-million-gallon/year capacity and will also validate the product streams from such operations so that long-term purchase agreements can be secured with various U.S. government and other commercial parties. Accelergy has initiated discussions with the Defense Energy Supply Center (DESC), the fuel purchaser for all branches of the U.S. military, to determine if a 5-year purchase agreement can be secured for outputs of the 1.7-million-gallon/year pilot plant. Formal negotiations will commence in January 2010 if DESC expresses sufficient interest in such an agreement.

Tesoro's commitment to hosting the renewable oil refinery pilot plant derives from a corporate goal to develop capacity for producing renewable fuels that are 100% fungible with their petroleum-derived counterparts, thereby enabling commercially competitive blending, distribution, and marketing of renewables via existing petroleum infrastructure, including pipelines. Following construction, Tesoro will play an intimate role in operating and evaluating the performance of the renewable oil refinery, with the objective of establishing the commercial viability of the CHI technologies and how they could best be integrated with Tesoro operations, not only at the Mandan refinery, but at the other six Tesoro refineries located throughout the western United States. Success in building and operating the pilot plant will be achieved if Tesoro sees sufficient commercial potential in its performance and output to invest in construction of commercial-scale CHI-based renewable oil refining capacity at its Mandan petroleum refinery or other Tesoro facility locations. In addition to creating new jobs in renewable refining, other benefits to North Dakota and the region include the development of nonfood energy crops for use as refinery feedstocks. Chief among feedstock candidates are crambe and camelina, oil seed crops with low-input requirements that are well suited for cultivation in western North Dakota and other regions with low annual moisture and marginally productive soils. Development of refinery feedstock crops that do not

compete with food crop cultivation will help maintain and expand agricultural sector employment and bring outside investment to rural North Dakota.

## BACKGROUND AND QUALIFICATIONS

In 2003, the EERC—in partnership with regional oil seed grower associations and DOE—initiated development of a thermocatalytic process for conversion of soybean and canola oils to jet fuel. This research effort was motivated by results of prior EERC work done in collaboration with AFRL in which soy methyl ester biodiesel was mixed with JP-8 and evaluated for performance and emission impacts using the AFRL T63-A-700 turboshaft engine test stand. Results of this work were published in the July 2005 issue of the *Journal of the Air & Waste Management Association* and showed that while biodiesel addition to jet fuel can yield a significant particulate emission benefit at high-power settings, it can also result in significant negative impacts on fuel freeze point and other key properties. Based on these findings, the EERC developed a catalytic process for converting vegetable oils to fuels with improved cold-flow performance. This work led to the DARPA-funded project in which EERC developed and optimized the CHI technologies. The EERC team is currently engaged in two DARPA-funded process development projects focused on conversion of algae oils to renewable specification-compliant jet fuels.

Key EERC personnel who will work on the proposed project are Chad Wocken, Ted Aulich, and Ben Oster. Mr. Wocken, EERC Senior Research Manager – Renewables, has 14 years of experience in process engineering and project management and specific expertise in fuel chemistry and renewable fuel production. Ted Aulich, EERC Senior Research Manager – Process Chemistry, has over 15 years of experience in renewable fuels process chemistry development and expertise in fuel chemistry, fuels analysis, analytical program management, data reduction, and reporting. In addition, he has authored numerous publications on fuel chemistry and environmental effects, waste plastics decomposition for recycling, and coal conversion. Ben Oster, Research Engineer – Renewables and Hydrogen, has over 5 years experience in developing renewable fuels and hydrogen production reactor systems. Resumes for these key project personnel are provided in Appendix C

The Accelergy Alliance has been involved in several alternative fuel development programs at ExxonMobil and with other commercial parties and has been directly involved in commercial scale-up

and process design specification development programs on a range of alternative fuel projects over the past two decades. The Accelergy Alliance is a group of companies focused on the successful commercial development of renewable and carbon-neutral fuel technologies. The team members are highly experienced energy professionals well known in the energy industry with a very wide variety of skills and an incredible depth and length of job experiences. Qualification summaries of some of the key players are provided in Appendix C and include relevant experience and publication and patent histories.

## MANAGEMENT

EERC will manage the proposed project in close collaboration with Accelergy and Accelergy Alliance partner Raytheon. Chad Wocken of EERC will serve as project manager. Mr. Wocken and other EERC personnel will work with Accelergy to develop a project management plan (PMP) based on a Raytheon-developed template that has been demonstrated in numerous large-scale research and fabrication projects as an effective means of tracking completion of work; keeping activities on schedule; controlling costs to remain within budget; and identifying, tracking, and managing program risks. With the pilot plant FEED (currently being developed) as a basis, the PMP will comprise a summary of major bid process and construction objectives—along with methods for their achievement—described and organized in an 18-month schedule that will be used to evaluate actual progress against planned progress. In developing and executing the PMP, Mr. Wocken will serve as primary liaison between EERC and the Accelergy Alliance and will be responsible for tracking and keeping the Alliance informed on the completion and cost status of all PMP objectives and fulfilling all reporting requirements. Any significant changes in PMP objectives, methods, or scope will be made in consultation with the Accelergy Alliance. Mr. Wocken will be assisted by Ted Aulich of EERC. Ben Oster of EERC will be the primary construction site liaison, responsible for day-to-day progress monitoring and reporting to the project manager. Mr. Oster will be assisted by EERC specialists working both on the construction site and at EERC.

## TIMETABLE

The project duration will be 18 months. Quarterly progress reports will be submitted no later than 2 weeks following the conclusion of each quarter. A final project report will be submitted no later than 30 days following project conclusion. Major project milestones are delineated in Table 1.

**Table 1. Major Project Milestones**

| Milestone | Q1 | Q2 | Q3 | Q4 | Q5 | Q6 |
|---|---|---|---|---|---|---|
| Request for Bids Issued | ▼ | | | | | |
| Winning Bidder Contracted | | ▼ | | | | |
| Construction Initiated | | | ▼ | | | |
| Construction Complete | | | | | | ▼ |

## BUDGET

**Table 2. Project Costs**

| Project Associated Expense | NDIC's Share | Accelergy | Applicant's Share In-Kind | EERC CBU | Project Total |
|---|---|---|---|---|---|
| Personnel | 178,356 | | | | 178,356 |
| Fringe Benefits | 95,777 | | | | 95,777 |
| Travel | 31,374 | | | | 31,374 |
| Equipment | | | | | - |
| Supplies | 1,538 | | | | 1,538 |
| Contractual | | 3,735,000 | | 2,250,000 | 5,985,000 |
| Construction | | | | | - |
| Other | 5,455 | | | | 5,455 |
| Indirect Charges | 187,500 | 15,000 | | | 202,500 |
| Total | 500,000 | 3,750,000 | - | 2,250,000 | 6,500,000 |

The proposed budget was developed using EERC experience and actual costs accrued in constructing major fuel processing reactor systems similar in function and capacity to the CHI-based pilot plant. Further budget detail and explanations are provided in Appendix B.

## CONFIDENTIAL INFORMATION

This proposal contains no confidential information.

## PATENTS/RIGHTS TO TECHNICAL DATA

- Aulich, T.R.; Heide, C.; Timpe, R.C.; Wocken, C.A. Aviation-Grade Kerosene from Independently Produced Blendstocks. U.S. Patent Application 12/147,783 (US 2009-0000185A1) and PCT Application No. PCT/US08/068622, filed June 27, 2008.

- Aulich, T.R.; Pansegrau, P.D.; Timpe, R.C.; Wocken, C.A. Optimal Energy Pathway to Renewable Domestic and Other Fuels. U.S. Patent Application 11/840,191 (US 2008-0052983A1) and PCT Application No. PCT/US2007/018300, filed August 17, 2007.

- Aulich, T.R.; Oster, B.G.; Pansegrau, P.D.; Strege, J.R.; Wocken, C.A. Process for the Conversion of Renewable Oils to Liquid Transportation Fuels. U.S. Patent Application 12/264,689 (CIP).

- Aulich, T.R.; Kurz, M.D.; Oster, B.G.; Pansegrau, P.D.; Strege, J.R.; Wocken, C.A. Process for the Conversion of Renewable Oils to Liquid Transportation Fuels. U.S. Patent Application 12/493,193.

# APPENDIX A

# ANALYTICAL DATA

## Analytical Data for EERC Renewable SPK and JP-8 Fuels

Figure A-1 compares EERC renewable synthetic paraffinic kerosene (SPK) to an SPK made by Syntroleum Corporation from natural gas via a Fischer–Tropsch process. Although produced from different feedstocks using different technologies, both fuels comprise the same normal paraffins and isoparaffins in nearly identical proportions.

Table A-1 and Figure A-2 provide data for and illustrate key properties of EERC 100% renewable specification-compliant JP-8 produced by blending SPK with a jet fuel-grade cycloparaffin–aromatics mixture, both of which were produced by EERC from low-cost waste yellow grease. All data in the table and figure were acquired by the U.S. Air Force Research Laboratory (AFRL) at Wright–Patterson Air Force Base, Dayton, Ohio.

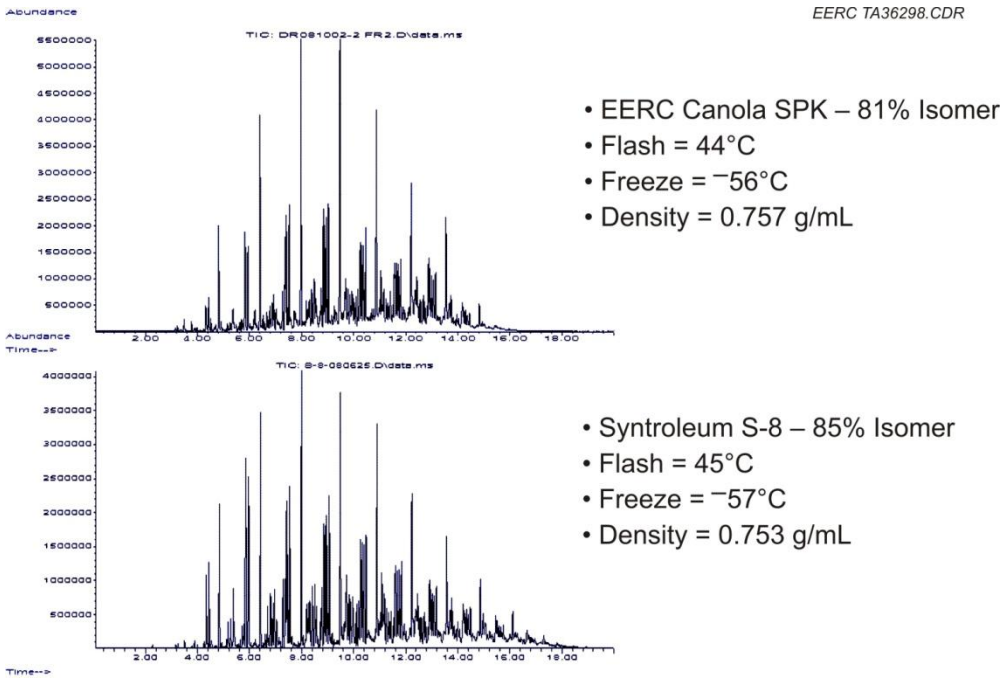


Figure A-1. Gas chromatography comparison of EERC renewable and natural gas-derived SPK.

**Table A-1. EERC 100% Renewable JP-8 Versus Petroleum JP-8 – All Data Courtesy of AFRL**

| Specification Test | EERC JP-8 | JP-8 Average | MIL-DTL-83133F JP-8 Specification |
|---|---|---|---|
| Aromatics, volume% | 19.8 | 17.9 | ≤ 25.0 |
| Olefins, volume% | 1.9 | 0.8 | ≤ 5.0 |
| Specific Gravity | 0.805 | 0.803 | 0.775–0.840 |
| Flash Point, °C | 49 | 49 | ≥ 38 |
| Freeze Point, °C | –52 | –51.5 | ≤ –47 |
| Heat of Combustion, MJ/kg* | 42.9 | 43.2 | ≤ 42.8 |

* Megajoules per kilogram.

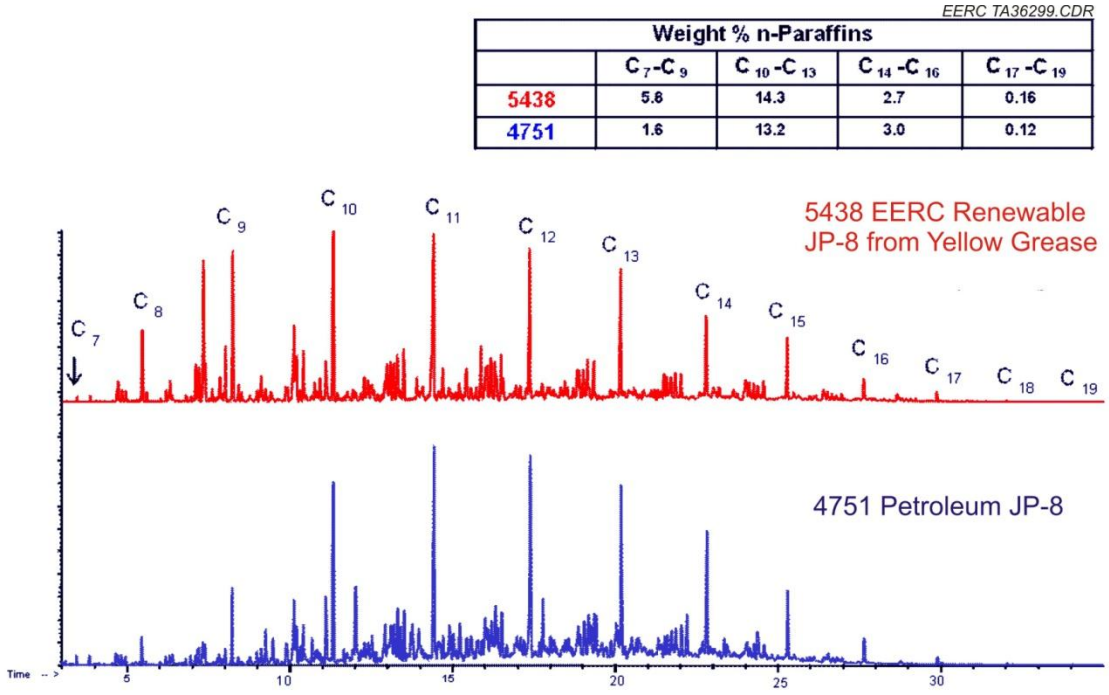


Figure A-2. AFRL gas chromatography comparison of EERC renewable and petroleum-derived JP-8.

# APPENDIX B

# BUDGET AND BUDGET NOTES

RENEWABLE OIL REFINERY PILOT PLANT CONSTRUCTION
NORTH DAKOTA RENEWABLE ENERGY COUNCIL (NDREC)
PROPOSED PROJECT START DATE: 7/1/2010
EERC PROPOSAL #2010-0137

**BUDGET**

| CATEGORY | | Rate | TOTAL Hrs | TOTAL Cost | NDREC SHARE Hrs | NDREC SHARE Cost | ACCELERGY SHARE Hrs | ACCELERGY SHARE Cost | DOE-CBU SHARE Hrs | DOE-CBU SHARE Cost |
|---|---|---|---|---|---|---|---|---|---|---|
| **LABOR** | | | | | | | | | | |
| Wocken, C. | Project Manager | $ 51.42 | 600 | $ 30,852 | 600 | $ 30,852 | - | $ - | - | $ - |
| Aulich, T. | Principal Investigator | $ 54.30 | 500 | $ 27,150 | 500 | $ 27,150 | - | $ - | - | $ - |
| Oster, B. | Principal Investigator | $ 30.38 | 1,000 | $ 30,380 | 1,000 | $ 30,380 | - | $ - | - | $ - |
| ---------- | Senior Management | $ 70.17 | 137 | $ 9,613 | 137 | $ 9,613 | - | $ - | - | $ - |
| ---------- | Research Scientists/Engineers | $ 38.29 | 1,578 | $ 60,422 | 1,578 | $ 60,422 | - | $ - | - | $ - |
| ---------- | Research Technicians | $ 25.08 | 234 | $ 5,869 | 234 | $ 5,869 | - | $ - | - | $ - |
| ---------- | Technical Support Services | $ 20.02 | 120 | $ 2,402 | 120 | $ 2,402 | - | $ - | - | $ - |
| | | | | $ 166,688 | | $ 166,688 | | $ - | | $ - |
| Escalation Above Base | | 7% | | $ 11,668 | | $ 11,668 | | $ - | | $ - |
| **TOTAL DIRECT HRS/SALARIES** | | | 4,169 | $ 178,356 | 4,169 | $ 178,356 | - | $ - | - | $ - |
| **TOTAL FRINGE BENEFITS** | | | | $ 95,777 | | $ 95,777 | | $ - | | $ - |
| **TOTAL LABOR** | | | | $ 274,133 | | $ 274,133 | | $ - | | $ - |
| **OTHER DIRECT COSTS** | | | | | | | | | | |
| **TRAVEL** | | | | $ 31,374 | | $ 31,374 | | $ - | | $ - |
| **SUPPLIES** | | | | $ 1,538 | | $ 1,538 | | $ - | | $ - |
| **SUBCONTRACT - GENERAL** | | | | $ 5,985,000 | | $ - | | $ 3,735,000 | | $ 2,250,000 |
| **COMMUNICATION - PHONES & POSTAGE** | | | | $ 700 | | $ 700 | | $ - | | $ - |
| **PRINTING & DUPLICATING** | | | | $ 750 | | $ 750 | | $ - | | $ - |
| **FOOD** | | | | $ 300 | | $ 300 | | $ - | | $ - |
| **OPERATING FEES & SVCS** | | | | | | | | | | |
| Graphics Support | | | | $ 2,611 | | $ 2,611 | | $ - | | $ - |
| Shop & Operations Support | | | | $ 1,094 | | $ 1,094 | | $ - | | $ - |
| **TOTAL DIRECT COST** | | | | $ 6,297,500 | | $ 312,500 | | $ 3,735,000 | | $ 2,250,000 |
| **FACILITIES & ADMIN. RATE - % OF MTDC** | | VAR | | $ 202,500 | 60% | $ 187,500 | 60% | $ 15,000 | 49% | $ - |
| **TOTAL PROJECT COST - US DOLLARS** | | | | $ 6,500,000 | | $ 500,000 | | $ 3,750,000 | | $ 2,250,000 |

Due to limitations within the University's accounting system, bolded budget line items represent how the University proposes, reports and accounts for expenses. Supplementary budget information, if provided, is for proposal evaluation.

RENEWABLE OIL REFINERY PILOT PLANT CONSTRUCTION
EERC PROPOSAL #2010-0137

**BUDGET - TRAVEL**

| RATES USED TO CALCULATE ESTIMATED TRAVEL EXPENSES | | | |
|---|---|---|---|
| DESTINATION | PER MILE | LODGING | PER DIEM |
| Bismarck, ND | $ 0.33 | $ 70 | $ 25 |

| | NUMBER OF | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| PURPOSE/DESTINATION | TRIPS | PEOPLE | MILES | DAYS | MILEAGE | LODGING | PER DIEM | MISC. | TOTAL |
| Site Supervision/Bismarck, ND | 54 | 1 | 700 | 4 | $ 12,474 | $ 11,340 | $ 5,400 | $ 2,160 | $ 31,374 |
| **TOTAL ESTIMATED TRAVEL** | | | | | | | | | $ 31,374 |

RENEWABLE OIL REFINERY PILOT PLANT CONSTRUCTION
EERC PROPOSAL #2010-0137

**DETAILED BUDGET - EERC RECHARGE CENTERS**

| | | | TOTAL |
|---|---|---|---|
| Graphics Support | Rate | # | $Cost |
| Graphics (hourly) | $61 | 40 | $ 2,440 |
| Subtotal | | | $ 2,440 |
| Escalation | | 7% | $ 171 |
| Total Graphics Support | | | $ 2,611 |

| | | | |
|---|---|---|---|
| Shop & Operations Support | Rate | # | $Cost |
| Technical Development Hours | $1.46 | 700 | $ 1,022 |
| Subtotal | | | $ 1,022 |
| Escalation | | 7% | $ 72 |
| Total Shop & Operations Support | | | $ 1,094 |

# 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 receives no appropriated funding from the state of North Dakota and 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

If federal funding is proposed as part of this project, the applicable federal intellectual property (IP) regulations may govern any resulting research agreement. In addition, in the event that IP with the potential to generate revenue to which the EERC is entitled is developed under this agreement, 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.) is for planning purposes only. The project manager may, as dictated by the needs of the work, incur costs in accordance with Office of Management and Budget (OMB) Circular A-21 found at www.whitehouse.gov/omb/circulars. If the Scope of Work (by task, if applicable) encompasses research activities which may be funded by one or more sponsors, then allowable project costs may be allocated at the Scope of Work or task level, as appropriate, to any or all of the funding sources. Financial reporting will be at the total-agreement level.

Escalation of labor and EERC recharge center rates is incorporated into the budget when a project's duration extends beyond the current fiscal year. 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:** The EERC employs administrative staff to provide required services for various direct and indirect support functions. 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 current average rate of a personnel group with a similar job description. Salary costs incurred are based on direct hourly effort on the project. Faculty who work on this project will be paid an amount over their normal base salary, creating an overload which is subject to limitation in accordance with university policy. Costs for general support services such as contracts and intellectual property, accounting, human resources, purchasing, shipping/receiving, and clerical support of these functions are included in the EERC facilities and administrative cost rate.

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

**Travel:** Travel is estimated on the basis of UND travel policies which can be found at www.und.edu/dept/accounts/policiesandprocedures.html. Estimates include General Services Administration (GSA) daily meal rates. Travel may include site visits, field work, meetings, and conference participation as indicated by the scope of work and/or budget.

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

**Supplies – Professional, Information Technology, and Miscellaneous:** Supply and material estimates are based on prior experience and may include chemicals, gases, glassware, nuts, bolts, and piping. Computer supplies may include data storage, paper, memory, software, and toner cartridges. Maps, sample containers, minor equipment, signage, and safety supplies may be necessary as well as other organizational materials such as subscriptions, books, and reference materials. General purpose office supplies (pencils, pens, paper clips, staples, Post-it notes, etc.) are included in the facilities and administrative cost.

**Subcontract:** As described in this proposal, the total cost to construct the 100-barrel-per-day catalytic hydrodeoxygenation–isomerization-based renewable oil refinery pilot plant at the Tesoro Mandan petroleum refinery is estimated at approximately $6 million. Because this cost is based on a preliminary pilot plant design developed by EERC, its accuracy is estimated at 30%. As described in the proposal, EERC subcontractor WorleyParsons—an international petroleum industry engineering services company with vast experience in refinery systems design and a long mutually satisfying history with the Tesoro Mandan refinery—is currently developing a front-end engineering design (FEED) and construction cost estimate for the pilot plant. The accuracy of the FEED-based cost estimate will be 20%. As proposed, EERC and Accelergy will conduct a formal bid process for selection of a general contractor to construct the pilot plant. As the basis for preparing a bid, each prospective bidder will be provided with the FEED (without the accompanying cost estimate).

**Professional Fees/Services (consultants):** Not applicable.

**Other Direct Costs**

**Communications and Postage:** Telephone, cell phone, and fax line charges are generally included in the facilities and administrative cost. Direct project costs may include line charges at remote locations, long-distance telephone, postage, and other data or document transportation costs.

**Printing and Duplicating:** Photocopy estimates are based on prior experience with similar projects. Page rates for various photocopiers are established annually by the university's duplicating center.

**Food:** Food expenditures for project meetings, workshops, and conferences where the primary purpose is dissemination of technical information may include costs of food, some of which may exceed the institutional limit.

**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 development and execution of the project by the research team.

**Fees and Services – EERC Recharge Centers, Outside Labs, Freight:** EERC recharge center rates for laboratory, analytical, graphics, and shop/operation fees are anticipated to be approved for use beginning July 1, 2009. Only the actual approved rates will be charged to the project.

Laboratory and analytical fees are charged on a per sample, hourly, or daily rate, depending on the analytical services performed. Additionally, laboratory analyses may be performed outside the university when necessary.

Graphics fees are based on an established per hour rate for production of such items as report figures, posters, and/or PowerPoint images for presentations, maps, schematics, Web site design, professional brochures, and photographs.

Shop and operation fees are for expenses directly associated with the operation of the pilot plant facility. These fees cover such items as training, personal safety (protective eyeglasses, boots, gloves), and physicals for pilot plant and shop personnel.

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

**Facilities and Administrative Cost:** Facilities and administrative (F&A) cost is calculated on modified total direct costs (MTDC). MTDC is defined as total direct costs less individual items of equipment in excess of $5000 and subawards in excess of the first $25,000 for each award. The F&A rate for commercial sponsors is 60%. This rate is based on costs that are not included in the federally approved rate, such as administrative costs that exceed the 26% federal cap and depreciation/use allowance on buildings and equipment purchased with federal dollars.

# APPENDIX C

# RESUMES OF KEY PERSONNEL

**CHAD A. WOCKEN**
Senior Research Manager
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA
Phone: (701) 777-5273, Fax: (701) 777-5181, E-Mail: cwocken@undeerc.org

***Principal Areas of Expertise***

Mr. Wocken's principal areas of interest and expertise include the development of alternative energy technologies and renewable fuels. He is also involved in projects researching liquid reforming for hydrogen production, hydrogen utilization, systems engineering, and energy efficiency. He is currently involved in the development of liquid fuels and chemicals from renewable resources, hydrogen production and purification technologies, energy conversion and technology integration, and hydrogen education and outreach activities.

***Qualifications***

B.S., Chemical Engineering, University of North Dakota, 1994.
**Certifications:** E.I.T. Chemical Engineering, U.S. Army Corps of Engineers Construction Quality Management; 40-hour OSHA Health and Safety; 8-hour HAZWOPER Supervisor; and 10-hour Construction Safety and Health.

***Professional Experience***

**2009–Present:** Senior Research Manager, EERC, UND. Mr. Wocken is involved in several program areas focusing on renewable energy development, technology development for renewable liquid fuels, systems integration of alternative energy technology, and hydrogen production from both renewable and fossil-based feedstock. Currently, he is managing projects focused on distillate fuel and chemical production from crop oil and other renewable oil feedstock as well as projects investigating alternative energy conversion technology. Specific responsibilities include preparing proposals, managing projects and researchers, preparing and reviewing research reports, presenting research information, compiling and reviewing research data, and managing EERC research in laboratory and pilot-scale reactor systems.

**2005–2009:** Research Manager, EERC, UND. Mr. Wocken's responsibilities included managing tasks and serving as principal investigator in a variety of renewable energy program areas including renewable fuel development and hydrogen production and use. Specific responsibilities included preparing proposals, interacting with industry and government organizations, researching the literature, designing and conducting effective experiments as a principal investigator, performing calculations and interpreting data, writing technical reports and papers, and presenting research results.

**2001–2005:** Research Engineer, Environmental Technologies, EERC, UND. Mr. Wocken's responsibilities included environmental control research focused on energy systems, mercury measurement and control, and fine particulate measurement and control, including the

development of methods to determine the fate and transport of trace elements associated with coal combustion processes. Specific responsibilities included preparing proposals, interacting with industry and government organizations, researching the literature, designing and conducting effective experiments as a principal investigator, performing calculations and interpreting data, writing technical reports and papers, and presenting research results.

**1995–2001:** Project Engineer, URS/Radian International, Salt Lake City, Utah (1997–2001), and Milwaukee, Wisconsin (1995–1997). Mr. Wocken's responsibilities included the following:

- Designed groundwater remediation systems to remove BTEX compounds and chlorinated solvents from groundwater. The projects consisted of site evaluation, technology selection, and design of several groundwater circulation wells and air sparge/soil vapor extraction treatment systems, and groundwater extraction with air stripper treatment technology. Design aspects included mass balance calculations, equipment design (pumps, pipe sizing, blowers, filters, etc.), equipment selection and specification, bid/construction specifications, and design drawing development.
- Performed start-up and long-term operations for a variety of groundwater remediation systems. Responsibilities included troubleshooting equipment/system malfunctions, process optimization, development of operations and maintenance manuals, establishment of performance verification criteria, operational cost evaluation, developing routine maintenance schedules, and directing technicians' work activities.
- Conducted detailed reviews of industrial wastewater treatment systems to identify alternative treatment technologies, process optimizations, cost-saving measures, water reuse/zero discharge alternatives, and review regulatory considerations.
- Provided on-site quality control oversight for several construction projects consisting of mechanical equipment installation, instrumentation and process control, facility and road construction, excavation, and underground utility installation. Daily responsibilities included evaluating work for conformance with construction drawings and specifications, conducting progress meetings, coordinating subcontractor work activities, and facilitating communication between the design firm, client, and subcontractors.
- Served as project manager for several large projects which were completed successfully. Activities included developing cost proposals, managing budget and schedule, equipment and subcontractor acquisition, and maintaining effective communication with the client.

**1994–1995:** Process Engineer, Archer Daniels Midland, Clinton, Iowa. Mr. Wocken's responsibilities included supervising operations and personnel at a wet corn mill and corn oil extraction and refining plant. Tasks consisted of prioritizing work activities, scheduling maintenance and repairing process equipment, reviewing quality control, and extensive system troubleshooting and failure analysis.

***Publications and Presentations***

Has authored or coauthored numerous publications.

**TED R. AULICH**
Senior Research Manager, Process Chemistry
Energy & Environmental Research Center (EERC), University of North Dakota (UND)
15 North 23rd Street, Stop 9018, Grand Forks, North Dakota 58202-9018 USA
Phone: (701) 777-2982, Fax: (701) 777-5181, E-Mail: taulich@undeerc.org

**1989–Present, Senior Research Manager, Process Chemistry, EERC**

- Partnered with the U.S. Air Force in utilizing a test stand-mounted jet aircraft engine to assess performance and emission effects of blending biodiesel into military jet fuel.
- Designed and administered surveys of commercial ethanol and nonethanol gasolines to provide statistically defendable data for assessment of fuel-related air quality effects and health risks.
- Currently chair the Research Committee of the Governors' Ethanol Coalition, an international group dedicated to increasing the presence of ethanol in the world transportation fuel market.
- Formulated a high-performance ethanol- and biodiesel-based aviation fuel certified by the U.S. Federal Aviation Administration as an alternative to lead-containing aviation gasoline.
- Designed and conducted a North Dakota statewide ethanol plant site assessment focused on evaluation of economics-enhancing collocation opportunities with energy and ag facilities.
- Designed and conducted an economic and regulatory compliance evaluation of steam generation options for a 40–60-million-gallon/year ethanol production facility.
- Designed and conducted an emissions-, fuel economy-, and performance-based evaluation of diesel fuels blended with varying levels of biodiesel and ethanol.
- Negotiated, developed, and directed a collaboration to assess the technical and economic feasibility of bus fleet-scale hydrogen generation (from natural gas) and refueling stations.
- Designed, administered, and reported results of a commercial fuel contamination analysis that enabled resolving a legal responsibility dispute prior to trial.
- Prepared an EPA-approved quality assurance plan for a $200,000 project to optimize thermal depolymerization processes for recovery of oil refinery feedstocks from waste plastics.

**1987–1989, Technical Editor, EERC**
**1985–1987, Analytical Chemist, EERC**
**1983–1985, Quality Control Manager, H.B. Fuller Industrial Coatings, St. Paul, Minnesota**

**Education**
B.S., Chemistry, University of North Dakota, Grand Forks, North Dakota, 1986.
B.S., Biology, University of St. Thomas, St. Paul, Minnesota, 1982.

**Selected Publications**
Corporan, E.; Reich, R.; Monroig, O; DeWitt, M.J.; Aulich, T.; Seames, W. Impacts of Biodiesel on Pollutant Emissions of a JP-8-Fueled Turbine Engine. *J. A&WMA* **2005**, *55* (July).

Olson, E.S.; Sharma, R.K.; Aulich, T.R. The Higher-Alcohols Biorefinery: Improvement of the Catalyst for Ethanol Conversion. *Appl. Biochem. Biotechnol.* **2004**, *113–116*, 913–932.

Olson, E.S.; Sharma, R.K.; Aulich, T.R.; Timpe R.C. Ester Fuels and Chemicals from Biomass. *Appl. Biochem. Biotechnol.* **2003**, *105–108*, 843–851.

**BENJAMIN G. OSTER**
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
Phone: (701) 777-5203, Fax: (701) 777-5181, E-Mail: boster@undeerc.org

***Principal Areas of Expertise***
Mr. Oster's principal areas of interest and expertise include converting crop oils into military-grade jet fuel, reforming ethanol for renewable hydrogen production, and reforming tactical fuels into high-pressure hydrogen for military fuel cell applications.

***Qualifications***
B.S., Chemical Engineering, University of North Dakota, 2005.

***Professional Experience***
**2006–Present:** Research Engineer EERC, UND. Mr. Oster's responsibilities include designing effective experiments, designing and procuring equipment for thermocatalytic reactor systems, conducting laboratory tests, reducing experimental data, and preparing final reports.

**2005–2006:** Production Assistant/Engineer, Soybean Division, Archer Daniels Midland Company, Lincoln, Nebraska. Mr. Oster worked in the area of solvent extraction at a 150,000-bushel-per-day soybean-processing facility. Duties included supervising personnel and designing and implementing process improvements.

**2002–2002:** Process Engineer/Cooperative Education Student, Dakota Gasification Company, Beulah, North Dakota. Mr. Oster worked in the process engineering department at the nation's only commercial-scale coal gasification facility that manufactures natural gas.

**1998–2004:** North Dakota Army National Guard, Fargo, North Dakota/Baghdad, Iraq. Mr. Oster was deployed for Operation Iraqi Freedom January 2003 – March 2004.

***Publications and Presentations***
Has coauthored several publications.

# APPENDIX D

# LETTERS OF COMMITMENT

ACCELERGY
CORPORATION

December 29, 2009

Ms. Karlene K. Fine
Executive Director and Secretary
North Dakota Industrial Commission
State Capitol, 10th Floor
600 East Boulevard Avenue, Dept. 405
Bismarck, ND 58505-0840

RE: Commitment to EERC Project: Renewable Oil Refinery Pilot Plant Construction

Dear Ms. Fine:

As a global leader in ultra-clean fuel production technologies, Accelergy is committed to working with EERC to help finance, build and operate the renewable oil refinery pilot plant described in the referenced proposal. We will initiate fund raising activities in January 2010 to secure the $3.75 million cost share required for pilot plant construction as a component of our overall 2010 fund raising campaign. We hope to complete this effort sometime during second-third quarter 2010.

We understand that award of the NDIC grant is contingent upon our ability to secure the $3.75 million in matching funds.

Sincerely,

Timothy Vail
President and CEO

18000 GROSCHKE ROAD, SUITE D-1
HOUSTON, TEXAS 77084
(281) 944-3680
(281) 944-3687 fax

EERC
Energy & Environmental Research Center

UNIVERSITY OF NORTH DAKOTA
15 North 23rd Street — Stop 9018 / Grand Forks, ND 58202-9018 / Phone: (701) 777-5000 Fax: 777-5181
Web Site: www.undeerc.org

January 6, 2010

Ms. Karlene Fine
Executive Director
North Dakota Industrial Commission
600 East Boulevard Avenue
State Capitol – Fourteenth Floor
Bismarck, ND 58505

Dear Ms. Fine:

Subject: North Dakota Renewable Energy Council Application

This letter is in regard to the cost share to be provided by the Energy & Environmental Research Center (EERC) for the "Renewable Oil Refinery Pilot Plant Construction" proposal submitted to the North Dakota Renewable Energy Council. The EERC will provide $2.25 million toward the $6.5 million project, contingent on award from the 2010 U.S. Department of Energy (DOE)-sponsored Center for Biomass Utilization® (CBU®) Program. CBU funding is expected in early 2010. The likelihood of funding is very strong, as the EERC has been receiving CBU program awards from DOE for nine consecutive years.

If you have any further questions, please contact me by phone at (701) 777-5243 or by e-mail at bfolkedahl@undeerc.org.

Sincerely,

Bruce C. Folkedahl
Senior Research Manager

BCF/jae