R008-H
Renewable Oil Refinery Pilot Plant Construction
Principal Investigators: Chad A. Wocken
Request for $500,000; Total Project Costs $6,500,000

Energy & Environmental Research Center (EERC) Response to Independent Technical Review Comments

Review Criteria 1

Reviewer 4C – "A perfect score was not granted because no plans were developed to take advantage of North Dakota agriculture to provide oleochemical feedstocks to the facility for the near-term.

It is not anticipated that procuring regionally produced crop oils will be problematic. North Dakota grown canola and soybean oil are widely available. Rather than operating continuously, the pilot plant will be operated in campaigns of typically 2 to 4 weeks in duration and, as such, will require about 1 million gallons of feedstock/year.

Regarding crambe oil availability, North Dakota State University (NDSU) Carrington Research Extension Center (CREC) has enough seed from the 2009 growing season to support production up to 200,000 acres within two growing seasons. Availability of crambe oil for the proposed pilot plant will be contingent upon investment in increased crop acreage. It is expected that the construction of the pilot plant will help to promote crambe production as well as other oil seed production in North Dakota.

Review Criteria 2

Reviewer 4A – "Although the main objective is to build a renewable oil refinery pilot plant, the proposal lacked any detail in the timeline or the budget as to the actual construction process (other than to say it will take 1 year)…" "However, the timeline and the proposal did not specify what alternatives would be sought if a compatible general contractor could not be located within the specified timeframe."

An estimated budget and schedule will be completed as part of the ongoing design effort. Once the design is complete, the Energy & Environmental Research Center (EERC) will work with WorleyParsons, Tesoro, and Accelergy Corporation to publish a nationwide bid request to solicit proposals for construction. Bid packages from general contractors will include a construction budget and schedule that will ultimately be incorporated into a contract. If no proposals are received, we will review the bid request, modify if necessary, and resubmit. Initial inquiries to two companies that provide these types of construction services suggest that finding a qualified contractor will not be difficult.

Reviewer 4C – "… the funding to enable this $6.5 Million project is contingent upon the applicants receiving a $2.25 Million DOE "Center for Biomass Utilization" proposal and partner Accelergy raising $3.75 Million cost sharing. The latter adds some uncertainty for the overall project to be successfully completed. Moreover, it is not clear if the DOE grant was (or will be) awarded or not.

The $2.25 million allocation has been awarded by the U.S. Department of Energy. Contract paperwork is being finalized. Accelergy fund-raising efforts are ongoing, and

funding is expected by the second or third quarter of 2010. Additionally, Tesoro has committed unmonetized cost share in the form of plant space and utilities at the Mandan Refinery.

Review Criteria 3

Reviewer 4A - "A major portion of the selection process is determining whether the General Contractor (GC) has the necessary skills and technical responsiveness, yet the method for doing so (i.e., how the technical competency of the GC is to be evaluated was not provided). In addition, the actual process for selecting the GC cannot start until the completion of the FEED project, which is not scheduled to be completed until the 2nd quarter of 2010. The proposal lacks contingency plans if an appropriate general contractor cannot be discovered and does not specify how the project will be advertised and/or whether it will be restricted to local/regional advertisement or be national search."

The EERC has identified and spoken with at least two general contractors who specialize in pilot facilities; both of whom expressed interest in the project. Upon completion of the design, the EERC will put together a bid package soliciting contractors nationwide. This bid package will be developed collaboratively with WorleyParsons, Accelergy, and Tesoro. Bid responses will be evaluated by the team with respect to price and experience relative to this project. Additionally, a statement of qualifications, referrals, and references from bidders will be reviewed by the team. If a satisfactory contractor cannot be found, a second bid request may be issued. If this occurs, the EERC may request an extension to the contract period of performance.

Reviewer 4B – "The methodology in this proposal is fairly well developed and justified… However, the methodology presented does not well validate the specific objective of this proposal. This reviewer would anticipate justifications on why this proposal is important to the overall project, and how the support from NDIC/ERC would further help the successful achievement of the overall project."

EERC personnel are familiar with the refining technologies to be constructed and will provide construction management services to ensure that the system, as built, will perform according to the intent of the design. The EERC will act as a liaison between the design engineers (WorleyParsons), Tesoro, and the selected general contractor.

Reviewer 4C – "I feel the applicants will succeed in preparing the pilot facility. However, the applicants have not demonstrated that their technological approach will work with high-erucic (long, C22, -chain) oleochemical feedstocks such as crambe oil as a sole feedstock source, or as a component thereof, to prepare jet fuels that meet military specifications. The requirements for pre-refining of crambe oil (e.g., degumming, deodorization, etc.) and/or of other feedstocks to accommodate the requirements of the CHI process (e.g., removal of phospholipids and other potentially harmful catalyst "poisons") have not been addressed.

Crambe oil has been successfully processed by the EERC in the laboratory. A gas chromatogram of crambe-derived synthetic paraffinic kerosene is shown in Figure 1.

Weight % n-Paraffins				
	C_7-C_9	C_{10}-C_{13}	C_{14}-C_{16}	C_{17}-C_{19}
5727	4.3	10.8	1.8	0.15
5726	2.1	9.7	2.1	0.29
5725	2.9	6.6	1.2	0.15
5724	2.5	6.7	1.0	0.14
4751	1.7	14.3	2.9	0.12

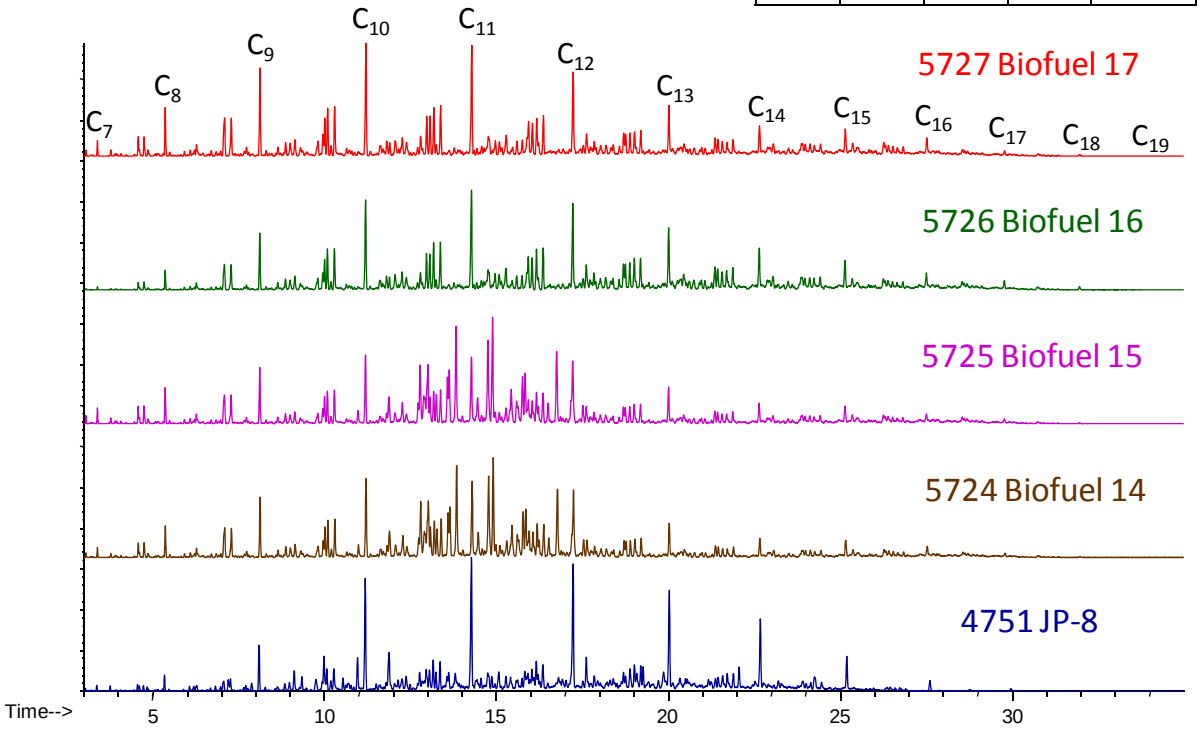

Figure 1. Chromatograms of biofuels and JP-8. Crambe-derived fuel is shown as Biofuel 16.

The EERC recognizes that the crambe oil will need to be refined prior to delivery to the pilot plant, similar to other renewable oil feedstocks. However, feedstock procurement is not contained within the scope of this proposal. Over the course of design and construction, efforts will be made to secure feedstock supply. Once funding to support operation of the pilot plant is available, feedstock supply contracts can be signed. To date, the EERC has identified numerous feedstock suppliers interested in participating in the operation of the pilot facility. Volatility in the feedstock oil market and uncertainty in the pilot plant start-up date have precluded more substantive feedstock supply commitments. The EERC has discussed crude crambe oil processing with several small seed processors and crude oil refiners and is confident that it will be able to purchase refined crambe oil that will suit its needs. Further, 3600 pounds of crambe produced from the 2009 growing season is being processed and the oil refined by U.S. Department of Agriculture currently. We anticipate receiving 80 to 130 gallons of crambe oil for further testing at the EERC to support the ongoing pilot-scale design.

Review Criteria 4

Reviewer 4C – "I believe the scaling up of a novel technology to produce biobased aircraft fuels is meritorious for the benefit of North Dakota and the USA. However, a major concern for the success of this project that has not been addressed is the supply chain of oleochemical feedstock, particularly crambe. Moreover, my concern is that after 18 months the proposed facility will be ready for operation, but will be sitting idle

or will have to operate well below capacity due to an inability to procure a sufficient supply of feedstock. In order for crambe to be cost-effective, co-product development from the feedstock is very important…glucosinylates are incompatible with crambes use as animal feed in many instances. This is an important aspect which needs to be considered for the successful implementation of crambe. In addition, the economic viability of crambe is also contingent upon the degree of pre-processing required to prepare the crude oil for the proposed CHI technological process."

Process objectives would provide scalable demonstration of renewable fuel production and enable further process development while producing quantities of fuel to support ASTM International and U.S. Military fuel qualification activities. Rather than operating continuously, the pilot plant will be operated in campaigns of typically 2 to 4 weeks duration and, as such, will require about 1 million gallons of feedstock/year. These quantities of crambe, soy and canola are expected to be available in the time frame provided. The EERC has spoken with crambe, camelina, cuphea, waste grease, and pennycress producers, all of which are interested in providing feedstock. As a pilot facility, this plant will provide the opportunity to demonstrate feedstock flexibility at a larger scale and thereby encourage investment in increased feedstock oil production, both in North Dakota and nationwide.

The presence of glucosinylates limits crambe meal's use as animal feed but does not eliminate its use as such. According to NDSU, "the Food and Drug Administration has approved use of defatted crambe meal as a beef cattle protein supplement at levels up to 4.2 percent of the total weight of rations."[1] Further studies suggest that higher percentages of crambe meal would be acceptable; however, they have not yet been approved by the Food and Drug Administration.

Review Criteria 5

Reviewer 4A – "A major concern…will be whether sufficient quantities of crambe and other low input industrial seed oils can be grown (ideally, near the refinery). The proposal attempts to address these major factors by expanding the scope of the proposal to include typical yield rates for ND."

Further development of low input industrial oil seeds will be needed to support full-scale operations but are outside the scope of this effort. Parallel activities are ongoing to increase production capacity of crambe. NDSU CREC has enough seed to plant 3000 to 4000 acres this year. This amount would provide enough seed to plant ~200,000 acres of crambe in 2011.

Reviewer 4C - "I believe the core enabling technology…is state-of-the-art. As a minor concern, it is not clear if the applicants are up to date on the overall economics of crambe utilization relating to an oleochemical biorefinery concept."

The EERC does not envision crambe as the only source of feedstock for this pilot plant or subsequent commercial facility. However, it does provide an attractive alternative to traditional biofuel oil seeds, like soy and canola, owing to its lower input costs and attractive rotation with grains in western North Dakota. Feedstock price represents the greatest economic risk to commercial development of biofuels. The priority for the proposed pilot plant is to demonstrate the viability of fungible fuel production from a

[1] www.ag.ndsu.edu/pubs/alt-ag/crambe.htm

variety of renewable oil feedstock with the hope of catalyzing production of lower-cost renewable oil feedstocks. The EERC is working with the NDSU CREC to evaluate the economic viability and scale-up opportunities for crambe in North Dakota and the region.

Review Criteria 6
No response required.

Review Criteria 7
Reviewer 4A – "Communication between the PI's and the GC should be very good…" Communication between the project manager and the two PI's should also be very strong. The financial project management plans seem sufficiently adequate for the scope of the project, while the schedule and milestone chart are too vague and do not address contingency plans and/or additional buffer time should the project experience delays.

The schedule and milestone charts are being completed as part of the ongoing design efforts. A more detailed schedule can be provided to the Council upon conclusion of those efforts and prior to bid requests.

Reviewer 4B – "The project management plan, milestones/schedule, and financial plan are adequate. Plans for communications between the PIs and contractors are not well documented; arrangements of project activities with construction contractors and corresponding milestones are not documented. However, once again, this proposal is a part of the overall project."

The EERC will act as a liaison between the design engineers (WorleyParsons), Tesoro, and the selected general contractor and will provide construction oversight for the project. It is anticipated that once a general contractor is selected, a contract will be developed that includes definition of meetings, progress reviews, and approvals required.

Review Criteria 8
No response required.

Review Criteria 9
No response required.

Review Criteria 10
Reviewer 4A – (Fund) "My main concerns/questions with the proposal are:"

1) "There isn't enough crambe or camelina being grown in the state to support a full scale operation and while NDSU is currently expanding its seed stock it's unclear as the time needed to achieve the 500,000 to 1,000,000 acres needed to support the 100 million gallon/year commercial scale refinery."

Scale-up of both fuel processing capabilities and feedstock are expected to occur in parallel. It is the intent of the EERC to operate the pilot plant facility using readily available oils, such as soy and canola. NDSU CREC has enough seed to plant 3000 to 4000 acres this year. This amount would provide enough seed to plant ~200,000 acres of crambe in 2011. Further, it is expected that successful demonstration of crambe as a feedstock in the pilot-scale refinery will encourage further investment to allow million-acre crambe production in western North Dakota and the surrounding region.

The pilot plant will be a valuable tool to demonstrate the catalytic hydrodeoxygenation and isomerization technology on a variety of North Dakota-grown crops. The crambe oil that is currently available will be used to demonstrate the conversion of this feedstock on a larger scale. Converting crambe oil to valuable fuel products at the pilot plant will aid current efforts to expand crambe oil production in North Dakota. The pilot plant will demonstrate that crambe oil is a valuable feedstock for fuel production, and a subsequent commercial facility would provide a large, local end user of regionally produced crambe oil.

2) "The authors seem to indicate that the refinery cannot currently compete against petroleum based refining methods, but that it may become a financially competitive option in the future. This raises the question as to who will support the plant operations while other facilities are more cost effective."

The EERC, with its commercialization partner Accelergy, will support plant operations as part of ongoing efforts with the U.S. Air Force to establish renewable jet fuel as an alternative to petroleum-derived jet fuel.

3) "The proposal failed to indicate the expected lifetime of the plant and who would take possession of it once construction was finished."

The EERC expects a 3-year life in order to support scale-up and demonstration activities as well as to produce large quantities of fuel for fuel qualification activities. At that time, Tesoro may continue to operate the pilot plant as a research and development pilot or it could be relocated if an alternative demonstration site were identified.

4) "The money requested from NDIC was to be used to secure a general contractor for the actual construction process and ensure that the construction process followed the specified plans. While NDIC's contribution is ~8% of the budget, the amount of money being spent to facilitate the GC selection process seems high.

In addition to the general contractor selection, the requested funding will support EERC oversight of the construction management activities throughout the duration of the project.

5) "What will happen if EERC can't locate a suitable general contractor?"

There are companies that specialize in constructing pilot plant-sized chemical process plants. The EERC has identified at least two qualified general contractors who specialize in pilot facilities.

6-7) "Another aspect was to take pictures of specific installations. Why can't the picture taking process be part of the responsibilities of the GC? The FEED should include detailed schematics for installation. The GC should be able to follow those schematics and verify proper installation with digital pictures."

The EERC is taking responsibility for the operability of this facility and, as such, needs to provide quality control oversight of the general contractor, which will require onsite oversight.

8) "Since the PI's main responsibility seems to focus on technical support during the construction process, the need for two PI's seems inappropriate. This is further justified since the project also has a project manager to handle coordination with the GC and ensure milestones and timelines are adequately followed."

The number of principal investigators can be reduced to one.

Reviewer 4B
No response required.

Reviewer 4C
Comments addressed above.