IV.A.2.a

RESPONSE *(in italics)* TO TECHNICAL REVIEWERS' COMMENTS

LRC-LXXVI(76)-A:
"Investigating the Use of Fly Ash and Nanomaterials for Sustainable Concrete Infrastructure"
Submitted by: University of North Dakota Department of Civil Engineering;
Request for: $14,559; Total Project Costs: $60,642;
Principal Investigator: Daba S. Gedafa, Ph.D., P.E.

1. OBJECTIVES

The objectives or goals of the proposed project with respect to clarity and consistency with Industrial Commission/Lignite Research Council goals are: 1 - very unclear; 2 - unclear; 3 - clear; 4 - very clear; or 5 - exceptionally clear.

Reviewer 13-10 (Rating: 4)

The main objective of this project is to test the hypothesis that ordinary Portland cement can be fully replaced by fly ash and nanomaterials in concrete. In addition, four specific objectives are listed on page 1 of the proposal. The main and specific objectives are consistent with the NDIC/LRC goal to develop and demonstrate the use of marketable lignite byproducts. The objective could be more clearly linked to NDIC/LRC goals by relating the use of ND lignite fly ash to jobs, and economic benefits to the State.
I agree with the reviewer. The objective is to increase the use of fly ash for sustainable concrete infrastructure, which increases the benefits for the fly ash producers, the state, and its people.

Reviewer 13-11 (Rating: 3)

The increased use of lignite-derived fly ash is a benefit to the lignite industry and can be a cost offset rather than a cost burden.
I agree that the increased use of fly ash for sustainable concrete infrastructure is a benefit to the lignite industry, the state, and its people.

Reviewer 13-12 (Rating: 4)

The project is certainly eligible by researching and developing products using ash derived from lignite. If the specific objectives are met, then a conclusion can be made to determine if fly ash and nanomaterials can totally replace cement. The alternative objective of determining the maximum amount of ordinary Portland cement that can be replaced by fly ash and nanomaterials is a valid conclusion as well.
Thank you!

2. ACHIEVABILITY

With the approach suggested and time and budget available, the objectives are: 1 - not achievable; 2 - possibly achievable; 3 - likely achievable; 4 - most likely achievable; or 5 - certainly achievable.

Reviewer 13-10 (Rating: 4)

The standard of success for achievement of the project objectives (see proposal p-14) are fairly modest. The qualifications of the PIs and the proposal are of high quality demonstrating a high project management ability. The objectives measured by the standard of success are most likely achievable.
Thank you!

Reviewer 13-11 (Rating: 3)

The nanomaterial concentration will be increases at 0.5% until properties equivalent... What is the anticipated concentration that will need to be used? If it is too high, numerous tests will need to be conducted that will require a lot of time and budget, which may lead to the project going over budget and not meet the time requirements. The amount of work also seems ambitious with respect to the budget and time frame.
Studies have shown that the optimum nanomaterials content can vary from 0.5-2% depending on the type of nanomaterials when used in combination with ordinary Portland cement. Since fly ash needs more reactive material, the optimum content may be slightly higher than 2%. The PI believes that it is achievable under the proposed budget and time frame.

Reviewer 13-12 (Rating: 5)

The approach is well designed technically.
Thank you!

3. **METHODOLOGY**

The quality of the methodology displayed in the proposal is: 1 - well below average; 2 - below average; 3 - average; 4 - above average; or 5 - well above average.

Reviewer 13-10 (Rating: 5)

Technically, the quality of the methodology displayed in the proposal is well above average.
Thank you!

Reviewer 13-11 (Rating: 3)

Overall, the methodology is sufficient. I would have preferred to see a more detailed test matrix with anticipated maximum and minimum nanomaterial additive ranges instead of "until desired results are obtained." I would like to see some sort of economic analysis to see if the optimum fly ash and nanomaterial blends are cost effective compared to traditional Portland cement or currently used cement/fly ash blends.
The PI anticipates that optimum nanomaterials content may vary from 0.5-3%. The economic benefit due to the increased use of fly ash has been included in the proposal (Table 4 on page 26). Detailed economic analysis will be conducted to determine the cost-effectiveness of fly ash and nanomaterials for sustainable concrete infrastructure.

Reviewer 13-12 (Rating: 5)

The methodology is strong and supported by excellent testing equipment and state-of-the- art laboratory facilities.
Thank you!

4. **CONTRIBUTION**

The scientific and/or technical contribution of the proposed work to specifically address Industrial Commission/LRC goals will likely be: 1 - extremely small; 2 - small; 3 - significant; 4 - very significant; or 5 - extremely significant.

Reviewer 13-10 (Rating: 4)

The technical contribution of the proposed work could be extremely significant. How the scientific and technical contributions specifically address NDIC/LRC goals may or may not be extremely significant.

Reviewer 13-11 (Rating: 2)

This project has the potential to benefit the utilities that sell their fly ash for concrete use. The proposal did not mention which fly ash classes this technology could be applied to and did not mention if this would offer a cheaper alternative to currently used technologies. Also, with respect to current and pending regulations, there are much more pressing needs such as CO2 technologies and the MATS rule that are more pressing funding needs.
Since 2003, Great River Energy has been a Champion of Environmental Protection Agency (EPA's) Coal Combustion Products Partnership (C2P2) to promote the benefits of coal combustion products including fly ash. Class C fly ash that is produced at coal creek station will be used in this study.

Reviewer 13-12 (Rating: 4)

Several of the North Dakota Industrial Commission goals will be met including development and demonstration of marketable lignite byproducts and beneficial impact of reducing landfill wastes.
Thank you!

5. **AWARENESS**

The principal investigator's awareness of current research activity and published literature as evidenced by literature referenced and its interpretation and by the reference to unpublished research related to the proposal is: 1 - very limited; 2 - limited; 3 - adequate; 4 - better than average; or 5 - exceptional.

Reviewer 13-10 (Rating: 5)

This proposal request is for a relatively modest $14,559. The technical, scientific and project management detail is superior to most of the largest NDIS/LRC proposal requests known to this reviewer. The proposal contains extensive use of published and cited literature.
Thank you!

Reviewer 13-11 (Rating: 4)

The PI seems to have a good understanding of fly ash usage in the construction industry.
Thank you!

Reviewer 13-12 (Rating: 5)

The principal investigator has included substantial references of research activity and published literature.
Thank you!

6. **BACKGROUND**

The background of the investigator(s) as related to the proposed work is: 1 - very limited; 2 - limited; 3 - adequate; 4 - better than average; or 5 - exceptional.

Reviewer 13-10 (Rating: 5)

The background if the PIs as related to the proposed work is exceptional. The PI has extensive experience in the laboratory, classroom and in practical application.
Thank you!

Reviewer 13-11 (Rating: 4)

The PI has an extensive background in pavement research and the use of alternative materials research in pavement applications.
Thank you!

Reviewer 13-12 (Rating: 5)

Highly qualified.
Thank you!

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7. PROJECT MANAGEMENT

The project management plan, including a well-defined milestone chart, schedule, financial plan, and plan for communications among the investigators and subcontractors, if any is: 1 - very inadequate; 2 - inadequate; 3 - adequate; 4 very good; or 5 - exceptionally good.

Reviewer 13-10 (Rating: 4)

The project management plan is very good. This reviewer would like to have seen a milestone chart. The timetables and details are provided in the text but visual depiction is helpful. Do the chart and graphs exist?
The text will be supplemented by chart. The chart will be presented to Lignite Research Council.

Reviewer 13-11 (Rating: 1)

No project management plan is presented and there is no discussion of milestones, etc. This must be addressed.
Management plan including milestones will be presented to the council members.

Reviewer 13-12 (Rating: 4)

The team is small in size, the principal investigator and one graduate assistant, the reporting is adequate and the financial plan seems reasonable and affordable.
Thank you!

8. EQUIPMENT PURCHASE

The proposed purchase of equipment is: 1 – extremely poorly justified; 2 – poorly justified; 3 – justified; 4 – well justified; or 5 – extremely well justified. (Circle 5 if no equipment is to be purchased.)

Reviewer 13-10 (Rating: 5)

(NOTE: Reviewer 13-10 provided no comments.)

Reviewer 13-11 (Rating: 5)

No equipment is planned to be purchased with NDIC funds.

Reviewer 13-12 (Rating: 5)

The major equipment purchase will be covered by the UND Civil Engineering Department.

9. **FACILITIES**

The facilities and equipment available and to be purchased for the proposed research are: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – notably good; or 5 – exceptionally good.

Reviewer 13-10 (Rating: 5)

The facilities available through UND and GRE are exceptional.

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Reviewer 13-11 (Rating: 3)

A new freeze-thaw cabinet is proposed to be purchased using UND dollars but no instrument quote is provided with the proposal. The other facilities appear adequate to perform the proposed research.
Quote from Humboldt Manufacturing is attached.

Reviewer 13-12 (Rating: 5)

The project will have access to excellent facilities and equipment.

10. **BUDGET**

The proposed budget "value" [1] relative to the outlined work and the financial commitment from other sources [2] is of: 1 - very low value; 2 - low value; 3 - average value; 4 - high value; or 5 very high value.

Reviewer 13-10 (Rating: 5)

This is a very modest request with support from GRE and UND.

Reviewer 13-11 (Rating: 3)

The proposed budget is requesting a small contribution from NDIC LRC and has support from GRE and UND. It is favorable that the contribution from the LRC is only 24% of the total project. It would be favorable to have additional letters of support from other ND utilities to further strengthen the proposal.

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[1] "Value" – The value of the projected work and technical outcome for the budgeted amount of the project, based on your estimate of what the work might cost in research settings with which you are familiar.
[2] Financial commitment from other sources – A minimum of 50% of the total project must come from other than Industrial Commission sources to meet the program guidelines. Support greater than 50% from Industrial Commission sources should be evaluated as favorable to the application.

Letter of support from Minnkota Power Cooperative is attached. Basic Electric Power Cooperative will send a letter of support directly Lignite Research Council.

Reviewer 13-12 (Rating: 5)

The value of the budget is extremely high because the major facilities and equipment is in place at UND. The principal investigator is highly qualified and the project is well designed.

OVERALL COMMENTS AND RECOMMENDATION:

Please comment in a general way about the merits and flaws of the proposed project and make a recommendation whether or not to fund.

Reviewer 13-10 (Rating: FUND)

The merits of the project include:

- The technical and scientific quality of the proposal
- The proposed management plan
- The merit of the PI and support staff and facilities

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The flaws of the project include:

- A clear and simple explanation of the benefits of the project to ND

Benefits are explained under "VALUE TO NORTH DAKOTA" and it will be presented to Lignite Research Council.

- The omission of a milestone chart

Milestone chart will be presented to Lignite Research Council.

- A discussion of "Why ND lignite"

Project need has been explained in the proposal.

This modest request addresses an additional potential use of ND lignite fly ash. The outstanding nature of this proposal exceeds any of the potential flaws. It was a pleasure to evaluate this well written and documented proposal.

Reviewer 13-11 (Rating: FUNDING MAY BE CONSIDERED)

Funding may be considered.

Project Strengths:
The project may open up new avenues for fly ash use and is requesting a small amount of funding from the NDIC LRC. The overall test process is fairly straightforward and has appropriate statistical analysis of the results.

Project Weaknesses:
A detailed project management plan with milestones must be developed before the project can be funded. The project schedule is also vague and would benefit from a test matrix with planned completion dates. I would also like to see an economic analysis performed on a few of the best fly ash nanomaterial combinations to see if the products are economically feasible for further development and testing. The budget seems insufficient to secure the materials and supplies required for and in-depth test program.

Timetable with milestones and management plan will be presented to Lignite Research Council. Detailed cost-effectiveness analysis of fly ash and nanomaterials will be conducted during the course of the project. The research team believes that the objectives can be achieved within the budget and time proposed.

Reviewer 13-12 (Rating: FUND)

The project is a great example of industry, the state of North Dakota and the University of North Dakota working together to benefit the lignite, transportation and building industries while at the same time reducing waste a landfills, reducing energy consumption and air pollution. It is an excellent project and I would recommend it be funded.
Thank you!

Humboldt Mfg. Co.
3801 North 25th Avenue,
Schiller Park,IL 60176
USA
Tel: 1.708.456.6300
Fax: 1.708.456.0137
www.humboldtmfg.com

Sales Quotation

Quotation Num: 26349
Quotation Date: 11/12/13
Valid Through: 12/12/13
Customer Number: C217390
Customer Ref No Daba S. Gedafa Ph.D.

Bill To:
University of North Dakota
Civil Eng Dept, UPSON 2, Rm 266,243
Centennial Dr
Grand Forks,ND 58202-8115
USA

Ship To:
University of North Dakota
243 Centennial Dr Stop 8115
Upson II Room 260K
Grand Forks, ND 58201

Contact Name: .
Terms: Credit Card
Currency: USD
Customer Tax ID

***Estimated Lead time after receipt of order based on current stock status**

#	Item Code	Description	Harmonized Code	Qty	Unit Price	Total
1	H-3185SD	Rapid Freeze Thaw Cabinet, 115V 60Hz	9027.80.3500	1	21,437.00	21,437.00
2	H-3185SD.3	Thermocouple Assembly		2	90.00	180.00
3	H-3185B.3	Thermocouple Assembly		2	90.00	180.00
4	H-3195	Mold for Freeze Thaw Specimen, 3" X 4" X 16" (76mm X 102mm X 406mm)	8474.31.0000	3	256.00	768.00
5	H-3185T	Tray F/Freeze Thaw Cabinet, SS (F/3 X 4 X 16" Specimens)	9027.90.8950	2	72.00	144.00
6	H-3185TM	Tray for Freeze Thaw Cabinet, Stainless Steel, Metric	9027.80.8950	3	69.00	207.00
7	H-3198M	Mold, 100 X 100 X 400mm		3	260.00	780.00
8	H-3185.1	Seven Day Chrts(100/Bx)-20-80F	9027.90.8950	3	45.00	135.00
9	H-3185.1AC	Charts, 7 Day -30/10C (60/Bx)	9027.90.8950	3	29.00	87.00
10	H-3185.1AF	Charts, 7 Day -20/50F (60/Bx)	8474.31	3	29.00	87.00
11	H-3185SH	Strip Heaters/Freeze Thaw Mach	9027.90.8950	1	180.00	180.00

701-777-3976

Subtotal	**$24,185.00**
Shipping & Handling	$800.00
Total	**$24,985.00**

Ed Hall

Note: To avoid delays, please reference Humboldt's quote number when submitting payment

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Minnkota Power
MPC COOPERATIVE, INC.

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November 13, 2013

Daba S. Gedafa, Ph.D., P.E., M.ASCE
Assistant Professor
Civil Engineering Department
University of North Dakota
Upson II Room 260K
243 Centennial Drive Stop 8115
Grand Forks, ND 58202-8115

Subject: **Lignite Research Council Letter of Support, Flyash replacement for Portland Cement**

Dear Dr. Gedafa:

Minnkota Power Cooperative, Inc. is supportive of research to investigate whether or not fly ash with the addition of nanomaterials can be used to fully replace ordinary Portland cement in concrete. The use of fly ash in conjunction with nanomaterials as a full replacement for ordinary Portland cement in concrete can have environmental and economic benefits. These benefits include the reduction of greenhouse gases from the production of ordinary Portland cement, diversion of fly ash from landfills, reduced use of natural resources used to manufacture ordinary Portland cement, and reduced use of water for concrete production.

Minnkota Power Cooperative, Inc. recommends consideration of this proposal for funding by the Lignite Research Council.

Sincerely,

Luther Kvernen

Luther Kvernen
Vice President – Generation
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