TECHNICAL REVIEWERS’ COMMENTS

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

Reviewer 31-04 (Rating: 4) The goals of this project are clear and consistent with the NDIC stated goals.

Reviewer 31-05 (Rating: 5) No comment

Reviewer 31-06 (Rating: 5) Exceptionally clear. Although it is clear this is only to demonstrate a project at a pilot scale, if commercialized REE production from North Dakota lignite would create a new market for lignite, which will help preserve and create jobs and provide a statewide economic boost.

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 31-04 (Rating: 2) The team has had some challenges as noted in this ask for additional time/funds. The original proposal did not have a site mentioned. Did this lead to some of the delays?

Reviewer 31-05 (Rating: 3) I am somewhat concerned about additional supply and cost changes.

Reviewer 31-06 (Rating: 3) Likely achievable. Obviously due to factors outside of the project’s control, the project as originally envisioned in 2019 did not meet the intended timeline or budget. I think the overall project objectives are likely achievable; however, it does feel like a lot will need to go right in order to meet the 2022-2023 timetable presented in Section 9 of the proposal.

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 31-04 (Rating: 4) The methodology is clear if one reads both proposals.

Reviewer 31-05 (Rating: 4) No comment

Reviewer 31-06 (Rating: 4) Above average. The proposal follows the application requirements in Article 43-03-04 of the North Dakota Administrative Procedures Manual.
4. **CONTRIBUTION**

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

- **Reviewer 31-04 (Rating: 5)** The impact to the coal industry and supply of domestic REEs will be significant.
- **Reviewer 31-05 (Rating: 5)** In addition to the possible positive implications for lignite, America desperately needs reliable sources of rare earth elements. This project may help find a reliable, domestic source, which would greatly enhance economic security.
- **Reviewer 31-06 (Rating: 4)** Very significant. Although this is only a pilot scale project, the technical information gathered from this project will be an important step in assessing the viability of Rare Earth Element production from North Dakota lignite.

5. **AWARENESS**

The principal investigator’s awareness of other 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 31-04 (Rating: 5)** The team is experienced and has been working in this space for several years.
- **Reviewer 31-05 (Rating: 5)** No comment
- **Reviewer 31-06 (Rating: 4)** Better than average. Although the expected retirement of Dr. Mann is difficult to replace, there is an impressive list of Co-PIs involved with this project along with adding Dr. Laudal as project advisor.

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 31-04 (Rating: 3)** The team is very of aware of work in this field. My concern is their experience in operation/construction of a pilot system this size and scope. See my general comments.
- **Reviewer 31-05 (Rating: 5)** No comment
- **Reviewer 31-06 (Rating: 5)** Exceptional. This is an impressive team -- all of the key personnel for this project are exceptionally qualified and their track record speaks for itself.

7. **PROJECT MANAGEMENT**

The project management plan, including a well-defined milestone chart, schedule, financial plan, and plan for communications among the parties involved in the project, is: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – very good; or 5 – exceptionally good.
Reviewer 31-04 (Rating: 3) The project management plan and milestone chart are well defined. The budget displayed is only for the LRP portion of the funding. It would be helpful to see the entire budget plan as this is one project.

Reviewer 31-05 (Rating: 4) The timeline is explained better than in the original application.

Reviewer 31-06 (Rating: 4) Very good. The timeline, although aggressive, is clearly laid out. The project management team will need to use their many years of experience to keep the project on schedule.

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 31-04 (Rating: 2) There is little discussion on the equipment purchases that will be made with extra funding. It is noted that the DOE funding will be used to purchase the equipment, however delays/overruns on those purchases do impact the LRP proposed labor budget as the team has already experienced. I would like to see this addressed adequately if funding is approved.

Reviewer 31-05 (Rating: 4) No comment

Reviewer 31-06 (Rating: 3) Justified. While Appendix 14.1 describes what the NDIC funding will be used for, the original proposal had a better breakdown of the budget categories being funded per participant. It is also notable that the original proposal was asking NDIC to fund 14% of the project ($900k out of $6.5M), and NDIC is now being asked to provide 27% of the additional funding ($175k out of $650k).

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 31-04 (Rating: 3) The facility seems adequate; however, I defer to my comment regarding equipment purchases. I do have some safety concerns that will be noted in my general comments. What is the location of the plant? It is not mentioned in the proposal.

Reviewer 31-05 (Rating: 4) No comment

Reviewer 31-06 (Rating: 5) Exceptionally good. UND has existing analytical, laboratory, and fabrication facilities and personnel that will be leveraged in the proposed work

10. **BUDGET**
*The proposed budget value relative to the outlined work and the financial commitment from other sources is of: 1 – very low value; 2 – low value; 3 – average value; 4 – high value; or 5 – very high value.*
Reviewer 31-04 (Rating: 4) The budget value still remains high, even with cost overruns. These dollars are highly leveraged with DOE and industry partners.

Reviewer 31-05 (Rating: 5) The potential value here is excellent. The possibility of high returns with minimal investment/risk exists.

Reviewer 31-06 (Rating: 3) Average value.

OVERALL COMMENTS AND RECOMMENDATIONS:
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 31-04 (Rating: FUNDING MAY BE CONSIDERED) My recommendation is to consider funding. I have several concerns that warrant attention prior to funding.

- Safety – There seems to be no HAZOP planned prior to operation. A system of this size using concentrated acids/bases MUST have a HAZOP prior to operation. I see two major safety concerns in the photos of the pilot plant, 1) PPE is not being worn by the two people in the photo, and 2) there is no spill containment below the filter press or other vessels. This pilot facility demands that PPE (hardhats and safety glasses) be worn at all times, not just during operation. Vessels containing any liquid (especially acids/bases) must have appropriate spill containment. Further, it looks as though the filter press is sitting directly on open grating or a drain. What is below this area?
- Coal – The coal was procured in 2020 and has been sitting somewhere for nearly two years. Has this coal been stored indoors or at least in weather tight containers? If the coal gets wet, acid can be created from the sulfur in the coal and start leaching components out of the coal. I feel the project team should make certain that the quality of the coal has not been compromised prior to doing the test work.
- Disposition of Waste – There is no discussion of what plans have been made for waste materials. Spent acid/base with potential metals in it cannot be simply put down the drain without analysis and discussing with the local wastewater treatment authorities. The same can be said of the remaining coal residue from the filter press. It simply cannot be landfilled without discussion with a landfill and analytical work to ensure that the material can be placed in the appropriate landfill.
- Processing Engineering Experience – I do not see an experienced process engineer included in fabrication and operation of the system. I highly recommend bringing some experience in this space. This can be done in concert with the HAZOP review.

Reviewer 31-05 (Rating: FUND) The LRC needs clarification on the scale of the processing facility. Page 2 of proposal - 0.5 tonnes per hour of cleaned lignite. Page 4 of proposal - a minimum 0.25 tons/hr feed rate. Page 12 of proposal - a 0.50 ton/hr throughput.

With that clarification, I definitely recommend that the LRC FUND this project.
Reviewer 31-06 (Rating: FUNDING MAY BE CONSIDERED) I recommend that funding be considered for this project. The ultimate project goals are commendable and, if realized, would provide a substantial benefit to the North Dakota lignite industry. However, thought should be given to the prudence of the NDIC picking up a larger percentage of these cost overruns (27%) as compared to the percent contribution from NDIC in the original proposal (14%) and recognize there are still supply chain risks that could impact the project schedule.