Energy & Environmental Research Center

Integrated Fluid-Bed–Asphalt Paving System

EERC Proposal No. 98-0122
Amount Requested: $35,535

Submitted to:

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State of North Dakota
State Capitol
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ABSTRACT

Asphalt paving is a highly energy-intensive process. For example, Northern Improvement, a Bismarck-based, medium-sized paving contractor, uses approximately 109 million Btu/hr of propane in the asphalt plant and enough diesel fuel to operate its 0.8-MW diesel generator set. Northern Improvement has been investigating alternative systems that utilize coal as the primary fuel source in an effort to reduce its high energy costs; however, existing coal-fired equipment does not integrate well with the asphalt paving equipment. Knife River Coal Company, which also owns an asphalt paving business, has expressed needs similar to Northern Improvement.

The Energy & Environmental Research Center (EERC) has been working with King Coal to promote small, modular fluid beds to generate electricity for remote power applications. An extension of that modular fluid-bed concept appears to offer an excellent opportunity to replace diesel fuel and propane with lignite in the asphalt paving industry. The objective of the proposed project is to generate detailed design drawings and specifications of this proposed concept and to determine the cost of producing such a system. This would allow Northern Improvement to assess both the economic and technical viability of integrating the fluid bed into their operation.

The expected results of this feasibility study include the design of a lignite-fired prototype/demonstration fluid-bed system applicable to the asphalt paving industry. It is estimated that each of the 12 contractors in North Dakota could utilize 20,000 to 25,000 tons/yr of lignite each, or up to 300,000 tons/yr total. The new highway bill allocates approximately $1 billion to repair North Dakota roads. This heavy influx of road construction projects coupled with the integrated fluid-bed–asphalt paving system could result in significant increases in sales to the lignite industry. The potential cost savings to a paving contractor and an implementation plan for integrating the fluid bed into paving contractors' current operation will be developed during the project.

The total cost of the proposed project is $106,605. This cost will be shared equally by the North Dakota Industrial Commission, the EERC–U.S. Department of Energy Jointly Sponsored Research Program, and King Coal Furnace Corporation. King Coal will apply for an additional grant to supplement a portion of its contributions to the project. The work will be performed by the EERC and King Coal. Northern Improvement will provide input to the project to ensure that the final product meets its specified needs. Should the results of this project show that the integration of the fluid bed and the asphalt paver is viable, funding options for demonstrating the technology will be investigated.

INTEGRATED FLUID-BED–ASPHALT PAVING SYSTEM

1.0 PROJECT SUMMARY

Northern Improvement, as do all asphalt paving contractors, has a very high energy cost associated with the day-to-day operation of its business. For example, this medium-sized paving contractor uses approximately 109 million Btu/hr of propane in the asphalt plant in addition to enough diesel fuel to operate its 0.8-MW diesel generator set. Northern Improvement has been investigating alternative systems that utilize coal as the primary fuel source in an effort to reduce its high energy costs and has discussed the potential for using products from King Coal Furnace Corporation's existing line of equipment. However, existing coal-fired equipment sold by King Coal and other vendors do not integrate well with the asphalt paving equipment.

The Energy & Environmental Research Center (EERC) has been working with King Coal on a separate project to determine the feasibility of utilizing a small, modular fluid bed to generate electricity for remote power applications. An extension of that modular fluid-bed concept appears to be an excellent fit with the needs of the asphalt paving industry. The objective of the proposed project is to generate detailed design drawings and specifications of this proposed concept and to determine the cost of producing such a system. This would allow Northern Improvement to assess both the economic and technical viability of integrating the fluid bed into their operation. Discussions have also been held with Knife River Coal Company, which sees this process as an excellent means to integrate its coal production and asphalt paving businesses.

The current needs of the asphalt plant are hot flue gases to heat the asphalt and dry the aggregate and energy to drive fans, pumps, and motors. Propane is currently used to provide the hot flue gas, and the diesel engine/generator is used to provide electrical energy for the pumps, fans, and motors. The proposed concept would fire lignite in a fluid bed to generate the hot flue gases. The load currently handled by the diesel engine/generator set would be replaced by hydraulic power provided from a steam engine. An in-bed heat exchanger would be used to heat oil, which would then transfer its heat to generate steam for the steam engine. The steam engine would be coupled with a hydraulic system that would produce the energy to drive the fans, pumps, and motors. No electricity would be generated, eliminating the need for a costly generator set and switchgear. This novel integration of proven and commercially available technologies has several advantages, including the following:

- Eliminates the need for steam generation in the fluid bed, negating the need for pressure parts in the fluid bed.

- Steam generation is done in a small heat exchanger closely coupled with a steam engine.

- Use of hydraulics eliminates the need for electricity generation and the associated switchgear.

- Hydraulic engines are more compact and efficient than their electric counterpart.

- Substantial reduction in fuel costs can be achieved.
- The system is environmentally friendly.
- There is zero solids discharge.
- The technology is applicable to other applications.

Any technology being considered for small modular process heat and power generation must have several attributes if it is to successfully obtain a significant market share. New systems must be affordable, safe, reliable, efficient, self-reliant, and consistent with state and community policies on resource development, demand, distribution, economics, and environmental protection. The set of specific criteria developed to evaluate the integrated fluid-bed–asphalt paving system include 1) the potential for integrated heat and power production as a way to meet multiple demands; 2) a high operational availability; 3) fuel cost significantly lower than current options; 4) a low environmental impact: 5) commercial readiness to guarantee high availability; and 6) safe, simple operation by unskilled labor.

2.0 PROJECT DESCRIPTION

The proposed system will use lignite in a fluid bed to replace the current fuel base as shown in Figure 1. A hydraulic ram system, similar to that used on other King Coal systems, will be used to deliver the lignite to the base of the fluid bed. This will provide a seal to prevent burnback of the

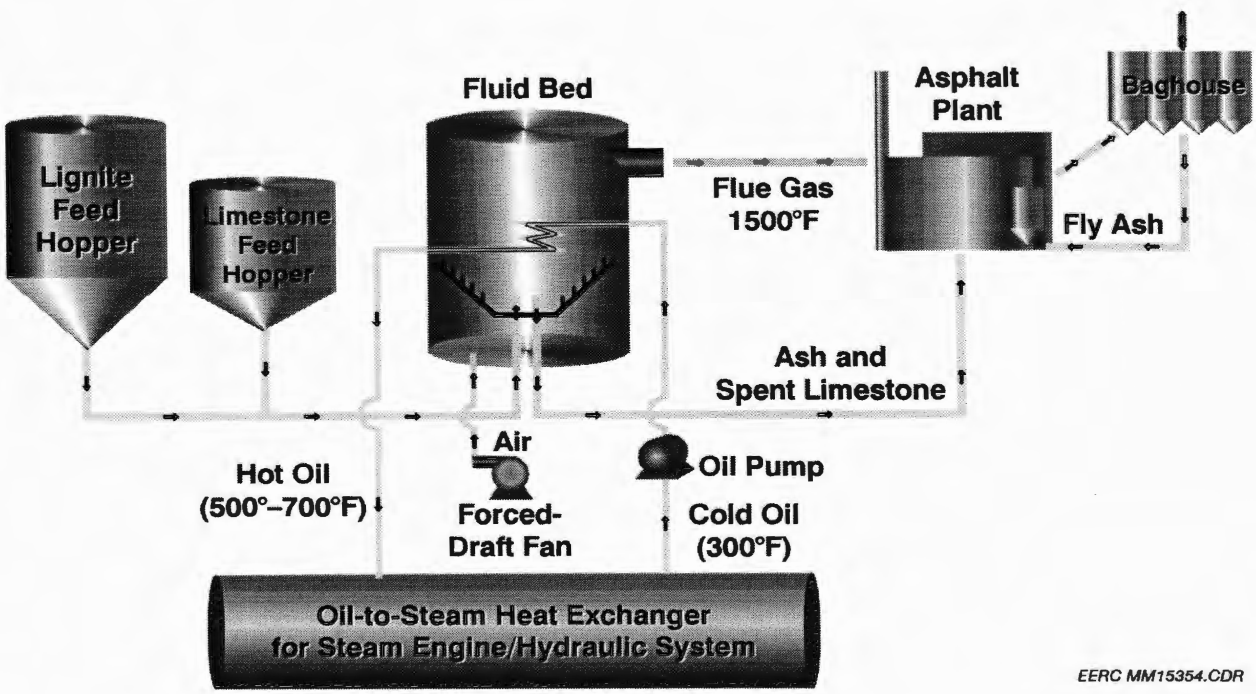

Figure 1. Conceptual drawing of the integrated fluid-bed–asphalt paving system.

lignite. A screw will be used to deliver the coal from the hydraulic delivery system into the bottom of the fluid bed. Limestone will be added for sulfur control and will be premixed and fed into the fluid bed with the lignite.

Fluidizing air will be heated to a design temperature of 1500°F by the combustion of the lignite in the fluid bed. Heat is transferred from the bed to heat a thermal fluid from 300° to 700°F. The oil then transfers its heat external to the boiler in a heat exchanger to generate steam to drive a steam engine. The hot flue gases are directed into the asphalt paving system to replace the hot-gas stream currently supplied by burning propane. Any ash that is carried over in the flue gas is mixed with the asphalt mixture. A baghouse is currently used to collect any particulate matter that is generated during the drying of the aggregate, and this material is mixed with the asphalt. Likewise, any solids drained from the fluid bed would be added to the asphalt mixture. This eliminates the need for any solids disposal. Limestone will be added as needed for control of SO_2.

A hot oil-to-steam heat exchanger will be used to transfer the energy from the oil to a steam engine. The steam engine will be used primarily to drive a hydraulic system. Hydraulic pumps, fans, and motors are more compact and more efficient and reliable than their electric counterparts, and their use eliminates the need to generate electricity from the system. The use of the steam engine also offers advantages over a steam turbine. The steam engine has a history of reliable operation and minimal maintenance. Steam engine technology is simple, and the machinery is ruggedly designed. A skilled auto mechanic using the manufacturer's manual can meet the equipment's maintenance requirements. The operation principles are easily understand and the components' margins and tolerances are not as critical as those found in a steam turbine. A small generator will still be recommended to run lights, the control system, and other incidentals.

The process uses equipment/components that have been proven by themselves and/or with other systems. The key to this concept is the application of a thermal fluid (oil) as an intermediate fluid to transfer the heat of combustion from the combustion gases to the water/steam generation. It is anticipated that this concept will reduce capital costs, since the fluid-bed–oil heat exchange now becomes an atmospheric system, eliminating expensive construction according to American Society for Testing and Materials (ASTM) boiler codes. The heat-transfer area for the steam side will be reduced because of much higher heat-transfer coefficients of the oil as compared to the combustion gases. In addition, the steam side will now be a heat exchanger rather than a fired boiler and fall under less stringent manufacturing codes. The smaller size and reduced codes for the steam side will result in reduced costs. This novel integration will also allow for safer operation and provide additional low-cost flexibility for delivering process heat and/or steam. The use of the steam engine and hydraulic system are also a novel part of the proposed system.

2.1 Technical Approach

The EERC and King Coal will work closely with Northern Improvement and Knife River Coal Company to fully understand their needs and ensure that the proposed system will have direct applicability to the asphalt paving business. The project team will utilize experience gained from similar efforts to help facilitate a quick turnaround and will structure the project format and reporting in a manner that focuses on the implementation of the results of the proposed effort. Although the project will focus primarily on Northern Improvement, a systematic design approach will be used to facilitate transfer of the technology to other paving outfits. Specific tasks proposed are outlined below.

2.1.1 Task 1 – Preliminary Design (King Coal lead)

Status and experience: *Feed prep and fuel feed* systems for lignite, dry sawdust, wood chips, and hog fuel have already been developed and sold on commercial units by King Coal. Three thousand package boilers, mostly firing lignite, have already been developed and sold on commercial and residential units by King Coal. *Fluid-bed combustion (FBC) design* and operation are proven worldwide. The EERC will use its 25 years of experience in FBC to design key components such as feed locations, bed removal, distribution plate design, and in-bed heat-transfer location. *Flue gas-to-oil and oil-to-water/steam heat exchangers* are commercially available. Small steam engines are commercially available.

Approach: The FBC design will be done jointly between King Coal and the EERC. The design will be based on existing prototypes at the EERC and prototypes to be built by King Coal. Several feed systems will be investigated, with a focus on a hydraulic ram combined with a screw feeder to add safety to the system by forming a positive seal that will prevent burn back of the lignite. Burning profiles and heat release patterns will be considered.

The heat exchanger surface area requirements will be calculated based on heat-transfer coefficients and correlations developed at the EERC for fluid-bed applications. The heat-exchange surface for the steam-generating heat exchanger will likewise be calculated. Heat exchangers will then be specified, with input from various vendors offering packaged systems. Several thermal fluids will be evaluated to determine which has the properties most advantageous to the proposed system.

A survey of small steam engine manufacturers will be performed to determine the types and sizes of off-the-shelf engines. A series of engines will then be selected for incorporation into the final design based on a variety of factors, including pressure and temperature requirements, efficiency, and price. The type of steam engine chosen will depend upon load duration, process heating demand, capacity, and other factors.

King Coal currently uses hydraulics extensively in its existing product line to overcome problems associated with other methods of generating mechanical energy. The hydraulic system for the proposed system will be an extension of what is currently used by King Coal.

A preliminary process layout, including preliminary energy and material balances, will be established prior to selection of individual components to serve as a guide to equipment specification. This process layout will be revised once the individual components have been selected and integrated into a complete package. A conceptual design showing the integration of the equipment into a modular package will be drawn, with considerations given for minimizing construction cost, transportability, ease of installation and operation, safety, and room for future expansion.

Deliverables: Upon completion of this task, 1) a process schematic with energy and material balances, along with specifications for capacity, turn-down, and load-following capabilities, fuel consumption, and estimated overall efficiency; 2) a conceptual process layout showing the modularity and transportability of the system; 3) operating and maintenance requirements, including projected labor costs, maintenance schedule and costs, water and utility requirements; and 4) the projected control system will be delivered.

2.1.2 Task 2 – Environmental and Safety Assessment (EERC lead)

Status and experience: King Coal has been designing, manufacturing, and installing steam and hot-water boilers for over 18 years. It is North Dakota ASTM equivalency- and "R" stamp-certified. It has never had a reported accident based on the design of any of its over 3000 systems currently in use. The EERC is a world-recognized leader in all aspects of environmental management and control.

Approach: The EERC will estimate emissions from the system based on existing data burning lignite and projections from that data. Although the systems in this size range are exempt from most state and federal regulations, control systems will be designed as needed to meet or exceed those requirements set forth by the Clean Air Act Amendments (CAAA) of 1990. Permitting requirements for the state of North Dakota will be reviewed to determine the permits required to site this type of system and the federal, state, and local agencies that must be contacted during the permitting process. King Coal will address the safety issues of the system based on its current experience. In addition, a hazardous operations review will be held with the state boiler inspector, Northern Improvement, King Coal, and the EERC to discuss in detail all possible failure scenarios, the potential consequences, and the fail-safes that must be built into the system to limit those consequences. The overall environmental impact of the system will be qualitatively addressed by the EERC, based on experience with similar projects. Particulates, NO_x, SO_2, CO, water, and solid wastes will be specifically addressed.

Deliverables: The expected emissions will be presented and compared to any applicable state regulations and to the CAAA of 1990. A discussion of the expected emissions will also be presented and will include a comparison of emissions from this concept to those from competing technologies. Permitting requirements and applicable agencies will be summarized. Safety features will be presented.

2.1.3 Task 3 – Financial and Cost Assessment (King Coal lead)

Status and experience: King Coal has been in operation for over 18 years selling coal- and biomass-burning stokers and related systems. The integrated fluid-bed–asphalt paving system based on FBC technology is an expansion of their product line. King Coal has the financial resources, manufacturing facilities with state and ASTM certifications, and marketing infrastructure necessary to enter this market. The EERC has put together many conceptual and real systems, including detailed cost estimates with sensitivity analysis. Its assessment of small power systems (Jones, 1995; Hauserman, 1995) indicates that FBC is much more cost-competitive than other alternatives, including gasification and fuel cells.

Approach: The cost for the system will be built up based on the detailed schematic generated in Task 1. Equipment costs will be determined, with the remainder of the cost components calculated as a percentage of equipment costs, based primarily on King Coal's experience in the construction of other similar systems. The need for and type of incentives required to move this product line into the market will be evaluated based on King Coal's experience with the market and interactions with its current customers.

Deliverables: A financial analysis will be presented that includes the system capital and operating costs and cost of electricity (COE). The relative contributions of each cost component will be discussed, along with potential ways to reduce/optimize these costs. Sensitivity analysis will be presented based on number of units sold, delivered fuel costs, including fuel preparation, and labor and operating costs.

2.1.4 Task 4 – Strategic Business Planning and Preliminary Commercialization Strategy (EERC lead)

Status and experience: King Coal has experienced continued growth by making improvements to its product line to expand its market share. Its strategy has included internal investments into product research and improvement, expansion into opportunity markets, and the engineering/packaging of an entire system. The development and addition of the proposed technology fits within King Coal's current business strategy. The EERC also has experience in commercialization, including such ventures as the coal–water slurry diesel demonstration planned for the University of Alaska-Fairbanks, commercialization of the EERC's hydrothermal treatment of refuse-derived wastes by EnerTech, and demonstration of Freeze–Thaw/Evaporation (FTE®) for economically recovering high yields of fresh, potable water from saline or highly contaminated water bodies.

Approach: The EERC will work with King Coal to establish a written business plan and commercialization strategy. This plan will take advantage of King Coal's current business operations and existing infrastructure to allow quick entry into the market. The 12 existing road-paving contractors in North Dakota are an obvious market. Their business is expected to grow substantially with the signing of the new highway bill. The financial cost analysis will be used to further define the market with regard to the size of modular unit(s) to add to King Coal's product line. King Coal and the EERC will apply for a patent on this concept.

Deliverables: The main deliverable is a business/commercialization plan, including a patent application. This plan will define the target market and King Coal's approach as equipment manufacturer and system integrator to enter this market. Special programs to leverage funding, especially during the demonstration phases, will be identified. Short- and long-term objectives will be listed. If the results from this feasibility study and demonstration prove the concept is economically viable, King Coal does not envision requiring outside capital to fund this expansion. However, enough detail will be presented in the business plan to attract investors should the need arise. The market plan will also include details on the target market, including identification of the competition and how its technology compares in cost, flexibility, ease of operation, and other important criteria. King Coal will compare its strengths and weaknesses to those of the competition and present plans to compensate for any perceived weakness to ensure that it can capture a reasonable share of the market.

3.0 STANDARDS OF SUCCESS

The expected results of this feasibility study include the design of lignite-fired prototype/demonstration fluid-bed system applicable to the asphalt paving industry. It is estimated that each of the 12 contractors in North Dakota could utilize 20,000 to 25,000 tons/yr of lignite. This could potentially add up to 300,000 tons/yr total of additional sales to the lignite industry. The implementation of this concept by Northern Improvement would be a major measure of the success of this project. Other criteria developed to evaluate the success of this project include 1) the potential for integrated heat and power production as a way to meet multiple demands; 2) a high operational availability; 3) fuel cost significantly lower than current options; 4) a low environmental impact: 5) commercial readiness to guarantee high availability; and 6) safe, simple operation by unskilled labor.

4.0 BACKGROUND

The EERC has been working with the Alaskan Division of Community and Regional Affairs (DCRA) to evaluate the feasibility of siting small coal-fired systems in the remote villages of Alaska. The results from this ongoing effort have led to some interesting conclusions, many which are directly applicable to this proposal to evaluate the use of a packaged fluid-bed biomass system. A comparison of eight different technologies ranked fluid-bed options the highest because of their ability to produce both heat and electricity, a high operating availability as proven by commercial demonstrations, the ability to burn a variety of fuels while generating low emissions, and the ability to produce a system that is safe and simple to operate. First-generation cost estimates using coal were as low as \$0.17/kWh. Sensitivity analysis showed that fuel costs, operating and maintenance costs, and capital recovery costs all contributed approximately the same amount to the overall COE. For the Alaskan demonstration, creative engineering, packaging, and fuels procurement have resulted in a lower cost for all three components, lowering the projected COE to the point where a demonstration is now feasible and currently in the planning phase. Results from this study are available from the EERC (Jones, 1995).

The EERC and its partner, King Coal, have worked extensively with lignite and recognize the important parameters that must be considered in designing a system for small and/or remote applications. Lignites are low in heating value because of high moisture and have a high volatile content, affecting the combustion/backpass surfacing and design margins for air, gas, and material handling. The noncombustible portion typically generates an ash material that can be conducive to forming low-melting-point compounds. These molten materials can lead to bed agglomeration in fluid beds, formation of clinkers in grate systems, and fouling of the combustor walls and air/fuel penetrations for all combustion systems. Deposits on heat recovery tubes in the backpass can occur as a result of either the carryover of molten or semimolten ash particles or condensation of alkali salts that were vaporized during combustion. Proper design of the fluid bed and judicious selection of operating conditions will allow the fluid bed to operate on the lignites currently available in North Dakota.

5.0 QUALIFICATIONS

The University of North Dakota Energy & Environmental Research Center (EERC) is an internationally recognized contract research organization focusing on energy-related environmental research, with in-depth experience in the areas of advanced, environmentally friendly power systems, emission monitoring and control, and renewable energy. The EERC offers over 40 years of experience in dealing with the many issues related to firing coal and biomass fuels, especially those related to ash, sulfur, alkali, and chlorine. The EERC has had an active FBC program since 1976 and currently operates seven different fluid-bed systems from the bench to pilot scale, both atmospheric and pressurized, and for combustion and gasification. All of these systems have been designed and constructed by EERC personnel. A description of these facilities is included in Appendix A.

King Coal has installed over 3000 small packaged boilers designed for a variety of fuels, including lignite, sawdust, wood chips, and hog fuel. It has continued to upgrade the design of its fuel-handling and feed system, stoker, boiler, dust collection equipment, and fans to produce a product that is price-competitive, easy to operate, and highly reliable. King Coal and the EERC have combined their expertise to develop a concept that meets the criteria required to compete in the small market, that is, a system that is affordable, safe, reliable, efficient, self-reliant, and consistent with state and community policies on resource development demand, distribution, economics, and environmental protection.

6.0 VALUE TO NORTH DAKOTA

Successful development of this concept will provide a low-cost means of utilizing lignite to replace propane and diesel fuel in asphalt paving systems. Direct applications are for facilities such as Northern Improvement's asphalt paving plant. These plants have a very high energy demand. The fluid bed offers an efficient way of using lignite to meet the energy demand while avoiding the use of alternative fuels. Implementation of this concept for Northern Improvement will result in annual coal sales of approximately 25,000 tons. If all 12 of North Dakota paving contractors implemented this process, an additional 300,000 tons/yr of lignite could be sold.

This project will enhance job creation and economic development in a number of ways. The development of a system that provides safe, simple, and cost-effective conversion of lignite to energy in a fashion that can be integrated with asphalt paving plants will greatly increase the viability of enterprises such as Northern Improvement. The development of a new market for power systems will increase King Coal's sales and may provide additional manufacturing jobs to Bismarck. Also, since King Coal uses North Dakota-generated material for its fabrication, increased revenues will be experienced by its suppliers.

The EERC and King Coal would like the opportunity to take the steps required to commercialize their concept for an integrated fluid-bed–asphalt paver. The team has performed some preliminary market assessments and has identified a customer willing to utilize the technology to burn lignite should it prove to be economically viable based on the result of this study. Northern Improvement is seeking alternatives to the current system and would serve as a site for prototype development based on positive results from this project (see letter in Appendix B).

7.0 MANAGEMENT

The EERC will take the overall lead for the project and the technical lead for Tasks 2 and 4. King Coal will take the lead on Tasks 1 and 3. Dr. Michael Mann will be the project manager for the EERC, with Jay Gunderson and John Pavlish providing significant technical input based on their experience with the Alaskan project. Dr. Mann will interact directly with Mike Robb, who will take the lead for King Coal. Although Dr. Mann will act as the primary liaison with the North Dakota Industrial Commission (NDIC) and U.S. Department of Energy (DOE) project managers, attempts will be made to include Mr. Robb in important phone discussions through conference calling. A representative from Northern Improvement will participate in discussions regarding implementation of the concept into its current operations. Resumes of key personnel are included in Appendix C.

8.0 TIMETABLE

The EERC will perform the proposed study within 6 months from the time a contract is put in place. General deliverables for each task have been listed with the scope of work for that task. Specific project deliverables include a midterm review at the EERC and a feasibility report, including chapters summarizing results for each of the four tasks.

9.0 BUDGET

This request is for $35,535 from NDIC to support a program with a total cost of $106,605. The sources of matching funds are discussed in the next section. The NDIC would fund approximately half of the work to be performed at the EERC. The work to be performed by King Coal will be partially funded through its internal funds. King Coal also intends to submit an application to Technology Transfer Inc. to help cover a portion of its cost share. The cost breakdown for this project is shown in Table 1. A more detailed budget breakdown is attached.

TABLE 1

Cost Breakdown, $

	King Coal	NDIC	DOE	Total
Labor	6150	22,083	23,306	51,539
Supplies/other	0	991	1033	2024
Subcontract[1]	18,750	0	0	18,750
Patent Application Costs	6000	0	0	6000
Indirect	4635	12,461	11,196	28,292
Total	35,535	35,535	35,535	106,605

[1] King Coal has a retainer with K.J. Schwartz Engineering, of Bismarck, North Dakota, to perform engineering design services.

10.0 MATCHING FUNDS

King Coal will supply one-third of the cost of the program. A portion of this will be from in-kind services. It will also apply for an additional grant from the Technology Transfer Inc. to supplement the cash requirements for the program. This request is for one-third of the required funding from NDIC, with the remaining one-third to be requested from the EERC–DOE Jointly Sponsored Research Program.

11.0 TAX LIABILITY

None.

12.0 CONFIDENTIAL INFORMATION

None.

13.0 REFERENCES

Jones, M.L. Proceedings of the Alaskan Native, American Indian, and Native Hawaiian Remote-Site Power Generation Workshop: Transferring the Alaskan Experience; Seattle, Washington, Sept. 1995; EERC Publication 96-EERC-02-01, 1995.

Hauserman, W.B. "Electric Power Systems for Small, New, or Incremental-Capacity Addition in Remote or Underdeveloped Areas," topical report; EERC Publication 95-EERC-08-04, Sept. 1995.

Fluid-Bed Po[illegible] System for Asphalt Paving
King Coal/NDIC/DOE
PROPOSED START DATE: 08/01/98
EERC PROPOSAL #98-0122

	01-Jun-98	TOTAL HOURS	TOTAL $ COST	COMMERCIAL SHARE HOURS	COMMERCIAL SHARE $ COST	EERC JSRP SHARE HOURS	EERC JSRP SHARE $ COST
TOTAL DIRECT LABOR		1215	$29,861	588	$14,528	627	$15,333
FRINGE BENEFITS - % OF DIRECT LABOR	52%		$15,528		$7,555		$7,973
TOTAL LABOR			$45,389		$22,083		$23,306
OTHER DIRECT COSTS							
SUPPLIES			$670		$560		$110
COMMUNICATIONS - PHONES & POSTAGE			$150		$40		$110
OFFICE (PROJECT SPECIFIC SUPPLIES)			$250		$40		$210
DATA PROCESSING - SOFTWARE			$200		$67		$133
GENERAL (FREIGHT, FOOD, MEMBERSHIPS, ETC.)			$200		$74		$126
FEES			$554		$210		$344
TOTAL OTHER DIRECT COST			$2,024		$991		$1,033
TOTAL DIRECT COST			$47,413		$23,074		$24,339
INDIRECT COST - % OF MTDC		VAR	$23,657	54%	$12,461	46%	$11,196
EERC ESTIMATED COST			$71,070		$35,535		$35,535
KING COAL COST SHARE			$35,535		$35,535		$0
TOTAL ESTIMATED PROJECT COST			$106,605		$71,070		$35,535

BUDGET NOTES

ENERGY & ENVIRONMENTAL RESEARCH CENTER (EERC)

Background

The EERC is an independently organized multidisciplinary research center within the University of North Dakota. The EERC receives no appropriated funding from the state of North Dakota and is funded through federal and nonfederal grants, contracts, or other agreements. Although the EERC is not affiliated with any one academic department, university academic faculty may participate in a project based on the scope of work and expertise required to perform the project.

The proposed work will be done on a cost-reimbursable basis. The distribution of costs between budget categories (labor, travel, supplies, equipment, subcontracts) is for planning purposes only. The principal investigator may, as dictated by the needs of the work, reallocate the budget among approved items or use the funds for other items directly related to the project, subject only to staying within the total dollars authorized for the overall program. The budget for this proposal has been prepared based on a specific start date; this start date is indicated at the top of the EERC detail budget or identified in the body of the proposal. Please be aware that any delay in the start of this project may result in an increase in the budget. Financial reporting will be at the total project level.

Salaries and Fringe Benefits

As an interdisciplinary, multiprogram, and multiproject research center, the EERC employs an administrative staff to provide required services for various direct and indirect support functions. Direct project salaries are estimated based on the scope of work and prior experience on projects of similar scope. Technical and administrative salaries are charged based on direct hourly effort on the project. Costs for general support services, such as grants and contracts administration, accounting, personnel, purchasing and receiving, as well as clerical support of these functions, are included in the indirect cost of the EERC.

Fringe benefits are estimated based on historical data. The fringe benefits actually charged consist of two components. The first component covers average vacation, holiday, and sick leave (VSL) for the EERC. This component is approved by the UND cognizant audit agency and charged as a percentage of direct labor on permanent staff employees eligible for VSL benefits. The second component covers actual expenses for items such as health, life, and unemployment insurance; social security matching; worker's compensation; and UND retirement contributions.

Travel

Travel is estimated based on UND travel policies, which include estimated GSA daily meal rates. Travel includes scheduled meetings and conference participation as indicated in the scope of work.

Communications (Phones and Postage)

Monthly telephone services and fax telephone lines are included in indirect cost. Direct project cost includes long-distance telephone including fax-related long-distance calls; postage for regular, air, and express mail; and other data or document transportation costs.

Office (Project Specific Supplies)

General purpose office supplies (pencils, pens, paper clips, staples, Post-it notes, etc.) are provided through a central storeroom at no cost to individual projects. Budgeted project office supplies include items specifically related to the project: special research notebooks, binders, and other project organizational materials; duplicating, printing, special covers or paper, and binding of reports; project data forms, transparencies or other presentation materials; literature searches and technical information procurement, including subscriptions; manuals, computer diskettes, memory chips, laser printer paper, and toner cartridges; and other miscellaneous supplies required to complete the project.

Data Processing

Data processing includes items such as site licenses and computer software.

Supplies

Supplies in this category include scientific supply items such as chemicals, gases, and glassware and/or other project items such as: nuts, bolts, and piping necessary for pilot plant operations.

Fees

Laboratory and analytical fees are established and approved at the beginning of each fiscal year and are charged based on a per sample or hourly charge depending on the analytical services performed. Additionally, laboratory analyses may be performed outside the University when necessary.

Engineering support fees are based on an established per hour rate for drafting services related to the production of drawings as part of EERC's quality assurance/quality control program for complying with piping and pressure vessel codes.

Graphic services fees are based on an established per hour rate for overall graphics production such as report figures, poster sessions, standard word or table slides, simple maps, schematic slides, desktop publishing, photographs, and printing or copying.

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

General

Membership fees (if included) 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 as well as by the research team directly involved in project activity.

General expenditures for workshops and conferences may include such items as food (some of which may exceed the institutional established limits), room amenities (e.g., place cards, music, banners, floral arrangements), speaker gifts, security, interpreters, technical tour transportation, and room and equipment rental necessary to conduct workshops and conferences.

Indirect Cost

The indirect cost rate included in this proposal is the rate which became effective July 1, 1995. Indirect cost is calculated on modified total direct costs (MTDC). MTDC is defined as total direct costs less individual items of equipment in excess of $750 and subcontracts/subgrants in excess of the first $25,000 of each award.