LRC-I-8

Energy & Mineral Research Center

Fuels & Process Chemistry Research Institute
ND Mining & Mineral Resources Research Institute
Combustion & Environmental Systems Research Institute

Box 8213, University Station / Grand Forks, North Dakota 58202 / Phone: (701) 777-5000 / Fax: 777-5181

February 29, 1988

Mr. Tim Kingstad, Secretary
North Dakota Lignite Research Council
North Dakota State Land Department
Capitol Building
Bismarck, ND 58505

Dear Mr. Kingstad:

The University of North Dakota Energy and Mineral Research Center is pleased to submit the enclosed proposals to the North Dakota Lignite Research Council for consideration in the first round of project funding. The enclosed proposals focus on a select few lignite research topics which we feel will provide key information and opportunities to the North Dakota lignite industry.

We recognize that the limited funds currently available in this program preclude selection of all these projects during this round of project selection. We do look forward, however, to the Council's selection of some of the projects during this round and to a close, long-term working relationship with the Council.

Sincerely,

Gerald H. Groenewold
Director, Energy & Mineral Research Ctr.
Associate Dean, School of Eng. & Mines

GHG/clh

Enclosures

c: A.G. Fletcher
M.L. Jones
D.V. Mathsen
C.L. Knudson
M.D. Mann
C.R. Schmit

STUDY TO DETERMINE THE TECHNICAL AND ECONOMIC FEASIBILITY OF A LONG-TERM UNDERGROUND COAL GASIFICATION TEST LEADING TO COMMERCIALIZATION OF THE UNDERGROUND COAL GASIFICATION PROCESS IN NORTH DAKOTA

Submitted to:

North Dakota Lignite Research Council
North Dakota State Land Department
Capitol Building
Bismarck, North Dakota 58501

Submitted by:

University of North Dakota
Mining and Mineral Resources Research Institute
Energy and Mineral Research Center
Box 8213, University Station
Grand Forks, North Dakota 58202

Value: $49,898

February 29, 1988

Gerald H. Groenewold
Co-Principal Investigator

Craig R. Schmit 2/29/88
Craig R. Schmit
Co-Principal Investigator

Alex Kotch
Alex Kotch, Director
Office of Research and
Program Development

SUMMARY

Objective: To determine the technical and economic feasibility of a long-term, multi-well underground coal gasification test leading to commercialization of the process in the vicinity of the Great Plains surface gasification facility in Mercer County, North Dakota by:

1. the evaluation of all characteristics of the proposed Great Plains UCG test site that are significant in the design and conduct of a long-term, multi-well UCG test;

2. the evaluation of the economics of a commercial UCG operation in the vicinity of the Great Plains surface gasification facility.

Expected Results: In the area of basic site characterization:

1. the location and collection of all available site-related data that are significant in the design and conduct of a long-term, multi-well UCG test;

2. the identification of the potential relationships between the collected data and the proposed test;

3. the formulation of a supplemental site characterization program to generate key, presently-unavailable, site-related data, though not within the context of this proposal;

4. the formulation of recommendations regarding the design and conduct of the proposed test;

In the area of economic evaluation:

1. the location and assessment of all literature relevant to the siting, design, and conduct of a commerical-scale UCG operation;

2. the development of a process block diagram;

3. the location and collection of all specific data necessary for the generation of the proposed economic model;

4. the generation of the proposed economic model.

The conduct and results from both efforts will be reviewed in a comprehensive final report.

Time Period: Fifteen months beyond the initiation of funding.

Total Project Costs: $49,898

Major Participants: North Dakota Mining and Mineral Resources Research Institute and the Combustion and Environmental Systems Research Institute, both of the UND Energy and Mineral Research Center.

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OBJECTIVES

The overall objective of the proposed research is to determine the technical and economic feasibility of a long-term, multi-well underground coal gasification (UCG) test leading to commercialization of the process in the vicinity of the Great Plains surface gasification facility in Mercer County.

The specific objectives of this project include:

1. the evaluation of all characteristics of the proposed Great Plains UCG test site that are significant in the design and conduct of a long-term, multi-well UCG test. The level of this evaluation will be that allowed by existing and easily-derived data;

2. the evaluation of the economics of a commercial UCG operation in the vicinity of the Great Plains surface gasification facility.

BACKGROUND

Underground coal gasification (UCG), which refers to the controlled burning of coal in place in order to produce natural gas, has been tested since the 1920's as a potential coal-utilization alternative. UCG has continued to receive attention, even during periods of abundant and, thus, cheap natural gas from conventional sources, primarily because it remains the most promising strategy for utilizing coal resources uneconomical to recover by means of conventional technologies. It is particularly attractive to a state such as North Dakota, whose low-grade coal resources are presently only economically recoverable by surface-mining techniques applicable to less than ten percent of the coal known to be present within its boundaries. The successful commercialization of UCG would potentially allow the utilization of much of the remaining 90 percent of North Dakota's coal-resource base, which would serve to broaden the state's energy-related economic base. Coal utilization by UCG would provide active coal companies in the state with a special opportunity, since, by nature of their holdings, they already control large quantities of otherwise unrecoverable coal. Moreover, those companies would have the additional advantage of already employing people with most of the expertise necessary to successfully gasify coal in place.

The recent history of UCG research indicates that there is excellent potential for its commercial application, if on a scale that is yet to be determined. Domestically, this research has largely been done in the context of a series of federally- and industrially-funded field tests involving low-rank coals in Wyoming. This series was initiated in the early 1970's, and is continuing with the ongoing Rocky Mountain 1 (RM1) UCG test in south-central Wyoming. The RM1 test, which is designed to simultaneously evaluate two innovative gasification technologies, is nevertheless typical of the preceding

tests in the series in that: 1) it involves a limited number of process wells, and, therefore is a much smaller operation than commercial development would require, and 2) its scheduled duration is very short relative to the projected life of any commercial UCG operation. The limited scale and duration notwithstanding, it is generally acknowledged that the Wyoming tests to date have collectively demonstrated that the UCG process can be initiated and controlled in such a manner as to produce acceptable quantities of medium-Btu natural gas. At the same time, the UCG research community recognizes that: 1) a long-term test involving substantially more wells is absolutely essential if progress toward establishing the commercial-scale efficiency, economy, and environmental-acceptability of this promising coal-conversion technology is to be maintained, and 2) such a test must be designed and conducted in response to a comprehensive, fundamental understanding of the setting within which it is to take place. This second imperative is a response to the design problems that have often been encountered in past tests, and which can generally be attributed to either: 1) critical inadequacies in pre-test characterization of the geological, geochemical, geotechnical, and hydrogeological aspects of the test setting, or 2) a failure to take existing knowledge of these types into consideration in test design and conduct.

Two major problems have thus far prevented the operation of long-term, multi-well UCG test, namely, the disposition of the large quantities of gas that such a test would produce, and the high costs that such a test would involve. These problems have recently been addressed in a North Dakota Mining and Mineral Resources Research Institute (MMRRI) proposal for a long-term, multi-well UCG test to be conducted near the Great Plains surface gasification facility in Mercer County, North Dakota. According to the tentative project

design, which would allow the utilization of coal not otherwise recoverable, the gas produced could possibly be sold to Great Plains to be used to supplement their normal output, while serving as a backup source of gas should production problems be encountered in the surface facility. In turn, sale of the gas would contribute to the funding of the test, while otherwise reducing test costs, particularly by eliminating the need for specially-constructed gas-processing facilities. In addition to providing an opportunity for disposing of the test product gas, while positively impacting the cost of the test, siting of the test near the Great Plains facility appears to provide a setting that is particularly well-suited, both geologically and hydrogeologically, for a UCG test that must involve many wells over a long period. This combination of factors makes the Great Plains site uniquely desirable as the locale for such a test.

Thus far, the concept of the proposed test has been very favorably received by Great Plains and Department of Energy personnel, as well as other key individuals both within and outside the UCG research community. This response has prompted optimism as a variety of funding options continue to be investigated. Nevertheless, indications are that certain types of information not presently available would enable an even stronger case to be made for this test, which holds such potential significance for the state and its energy-related industries. Two activities, which seem to deserve particular attention as part of this feasibility-assessment process, are the focus of this proposal. The first of these activities is an evaluation of all key site characteristics relative to their potential to affect and be affected by the design and conduct of the proposed test. This evaluation, which will be based on available and easily-derived site-characteristic data, will enable a focused supplementary site-characterization program to be developed, while

contributing information that will be critical to the intelligent design and conduct of a UCG test with a high probability for success. The second activity is the preliminary assessment of the economics of a commercial UCG operation at the proposed Great Plains test site. This assessment is a response to the likelihood that a successful test at the site will lead to serious consideration of commercial UCG development at that location. The MMRRI's conduct of these activities is natural in view of the experience that it is gaining as the result of its wide-ranging, long-term involvement in the ongoing RM1 UCG test, as well as from a variety of successfully completed and ongoing coal-related research projects that it has conducted in North Dakota and elsewhere.

GOALS

This project is designed to achieve a number of goals, each specific to one of the two areas of interest. Collectively, however, these goals will serve to further evaluate the feasibility of both a long-term, multi-well UCG test and a commercial-scale UCG operation near the Great Plains surface gasification facility. The goals include:

1. in the area of basic site characterization --

    a. the location and collection of all available site-related data that are significant in the design and conduct of a long-term, multi-well UCG test;

    b. the identification of the potential relationships between the collected data and the proposed test;

    c. the formulation of a supplemental site-characterization program to generate key, presently-unavailable, site-related data, though not within the context of this proposal;

    d. the formulation of recommendations regarding the design and conduct of the proposed test;

2. in the area of economic evaluation --

    a. the location and assessment of all literature relevant to the siting, design, and conduct of a commerical-scale UCG operation;

    b. the development of a process block diagram;

    c. the location and collection of all specific data necessary for the generation of the proposed economic model;

    d. the generation of the proposed economic model.

A final goal of the project is the production of a comprehensive report summarizing the contracted effort and the results that are forthcoming, with respect to both the basic characterization of the proposed Great Plains UCG test site and the generation of a viable economic model for the development of a commercial UCG operation at that site.

METHODS

The site-characterization activity proposed herein will initially involve the location and collection of all available site-related data that have the potential to affect or be affected by the design and conduct of a long-term, multi-well UCG test near the Great Plains surface gasification facility in Mercer County. Experience gained by others during past UCG tests, as well as by the MMRRI through its extensive involvement in the environmental program of the ongoing RM1 UCG test in Wyoming, indicates that the site characteristics worthy of consideration are numerous, and involve both the surface and subsurface at a potential site such as Great Plains. A list of those characteristics, which is derived from a document entitled "Research Needs Associated With UCG Environmental Assessment" that was prepared by the MMRRI for the Gas Research Institute, includes:

A. Surface

1. topography
2. surface-water distribution
3. surface-water chemistry
4. surface-water utilization
5. recharge and discharge areas
6. faunal and floral distribution
7. land use and ownership
8. accessibility
9. climate

B. Subsurface

1. noncoal sediments (above and immediately below the target coal)

    a. stratigraphy (emphasis on facies distribution and interfacies relationships)
    b. texture
    c. mineralogy
    d. geochemistry
    e. porosity and permeability
    f. attenuation and ion-exchange characteristics and capacities

g. microbial activity
h. structure
i. induration/lithification
j. geotechnical behavior/characteristics under natural and burn conditions

2. target coal

a. depth
b. thickness and thickness variation
c. continuity
d. dip
e. mineralogy
f. chemistry (organic and inorganic)
g. partings
h. permeability (primarily fracture-related)
i. moisture content
j. inorganic combustion products
k. organic combustion products
l. reactivity
m. reaction rates
n. shrink/swell behavior

3. groundwater

a. water table
b. recharge and discharge rates
c. flow (direction, rate, variation)
d. chemistry
e. aquifers
f. utilization

A wide variety of possible sources for these data exist, though the effort necessary to collect the data will vary with the source. A key source for some information concerning most items on the list, and one that is readily accessible, will be the environmental impact statements generated as part of the permitting process for the Great Plains facility, as well as the adjoining Freedom surface coal mine and the Antelope electrical-power-generation facility. However, a host of other potential data sources will also be consulted and utilized, as appropriate, in an effort to supplement useful data contained in those documents, and thus maximize the data-gathering effort. Additional data-gathering activities will include:

1. the assessment of topographic maps and aerial photographs of the area, coupled with field reconnaissance, in an effort to provide additional information on the topography, the location and extent of surface water, accessibility, land use, and the distribution of groundwater discharge and recharge areas;

2. the review of weather records in an effort to provide additional information on climate and accessibility (i.e., its expected seasonal variability);

3. the review of published and unpublished floral and faunal surveys, consultation with acknowledged experts, and field reconnaissance in an effort to provide additional floral and faunal information;

4. the review of land-ownership records in an effort to provide additional ownership information;

5. the review of North Dakota State Water Commission (NDSWC) records and publications, the review of relevant publications from other sources, consultation with NDSWC employees, and the review of any other surface and groundwater monitoring and characterization records to which access might be arranged with Great Plains and Basin Electric, all in an effort to provide additional information on surface and groundwater chemistry, as well as the character of the water table, recharge and discharge rates, groundwater flow characteristics, the location and character of aquifers, and the nature and extent of surface water and groundwater utilization;

6. the review of existing subsurface information for the area, consultation with appropriate people at Great Plains and Basin Electric, as well as the geologist at the Freedom Mine, and the examination of highwalls at the Freedom Mine, again, if access can be arranged, all in an effort to provide additional information on the subsurface distribution and general character of the coal and noncoal sediments in the area, with emphasis on the proposed target coal, its overburden, and its immediate overburden. This effort will include the generation of supplemental detailed cross sections, fence diagrams, coal and overburden thickness maps, etc. The existing subsurface information that will be reviewed is expected to include: a) public drilling information that is on file at the North Dakota Geological Survey b) relevant published reports, map, cross sections, etc., and c) any other subsurface information to which access might be arranged with Great Plains and Basin Electric;

7. the review of coal-related analyses, and combustion test results available in the literature, as well as any that might be made available by Great Plains and Basin Electric, in an effort to provide additional information on the character, combustion characteristics, and combustion products of the proposed target coal in particular.

All data that is collected will be organized and processed in an appropriate fashion, and will be kept on file at the MMRRI offices in Grand Forks.

Upon completion of data-collection activities, the data will be evaluated relative to its potential for affecting or being affected by the design and conduct of the test. In the process, an attempt will be made both to identify the nature of any potential effect and to estimate the impact of those effects. This process will not be based on the application of rigorous risk-identification and risk-assessment methodologies, which have yet to be applied to UCG site characterization efforts, and which, in fact, would not be appropriate at this preliminary site-characterization stage. Rather, this will be an empirical evaluation based on: 1) an in-depth, wide-ranging familiarity with the UCG literature that has been, and will continue to be, developed through the MMRRI's long-term involvement in the environmental program of the ongoing RM1 UCG test, 2) ongoing consultation with many key participants in UCG testing over the past several decades, the contacts with which have also resulted from our RM1-test involvement, and 3) practical experience gained through MMRRI's RM1-related technical assistance and research activities, which include a variety of characterization tasks, including participation in the development of a methodology to determine UCG feasibility. Special attention will be paid to those site characteristics which in past tests have been found to adversely affect the conduct of a UCG test, or, in turn, be adversely affected by the design or conduct of a UCG test.

On the basis of these data-collection and data-evaluation activities, two series of recommendations will be formulated. The first series will focus on the acquisition of critical site-related data that either were found not to be available in the data-collection phase of this project, or were found to require supplementation during the course of data evaluation. Specifically,

we will recommend what additional data should be acquired, as well as the most appropriate methods to acquire those data. In addition, we will attempt to provide reasonable estimates of: 1) the time required for this supplemental data-acquisition activity, and 2) the costs that would be involved. However, this supplementary, focused data-collection program will not be part of this proposed project. The second series of recommendations will focus on the design and conduct of a long-term, multi-well UCG test at the Great Plains site relative to the data-evaluation results. Specifically, we will recommend ways in which such a test can be designed and conducted so as to minimize the environmental impacts, while maximizing the economy and efficiency of the UCG process itself.

The methods to be employed in the evaluation of the economics of a commerical-scale UCG operation at the proposed Great Plains UCG test site will be typical of those applied by chemical and design engineers to similar evaluations of a wide range of facilities. Prior to the application of these methods, however, a substantial effort will necessarily be made to assess the UCG-related literature in order to develop a familiarity with: 1) all of the factors that have the potential to affect the siting, design, and operation, and thus, the economics, of a commerical UCG facility, and 2) the technology available for potential utilization in such a facility. This preliminary evaluation will lead to the development of a block diagram illustrating the process that would most likely characterize a commercial UCG operation at the proposed site. Subsequently, the target-gas production will be defined, which will allow the determination of the quantities of raw materials (in this case, primarily coal) and reactants required to produce the desired quantity and quality of gas. Upon completion of this phase, the nature and cost of the equipment required to produce the desired quantity and quality of gas utiliz-

ing the chosen process will be determined. This will be followed, in turn, by an estimation of the total capital investment required, as well as the total production costs. Finally, profits/losses will be calculated, as will the payback time and the return on investment.

The completion of all of these activities will be followed by the production of a final report that will comprehensively summarize: 1) the suitability of the proposed Great Plains UCG test site for a long-term, multi-well test and 2) the economic feasibility of a commercial-scale UCG operation at the same site.

TIMETABLE

The following timetable, which is broken down by task, is based on a careful consideration of the scope fo the proposed activities in light of the experience gained by the principal participants through their involvement in similar activities in other research projects. Note that the time indicated for each task is not the actual time to be spent on that task, but rather the time necessary to complete that task at the proposed level of funding. Furthermore, note that the time framework of this proposal (15 months) is determined by the site-characterization activities, and that the economic-evaluation activities will be performed over a period of nine months within that framework.

A. Site characterization

Task 1: Location and collection of data -- 5 months

Task 2: Evaluation of data -- 6 months

Task 3: Formulation of recommendations -- 2 months

Task 4: Completion of site-characterization section of final report -- 2 months

B. Economic evaluation

Task 1: Location and assessment of relevant literature -- 2 months

Task 2: Location and collection of data -- 2 months

Task 3: Development of economic model -- 3 months

Task 4: Completion of economic-evaluation section of final report -- 2 months

Quarterly reports summarizing progress during the previous three months will be submitted to the Lignite Research Council within 10 days of the end of each quarter for which funding is granted. The final project report will be submitted to the Lignite Research Council within 30 days of the cessation of funding.

PERSONNEL

Mr. Craig R. Schmit - Mr. Schmit, MMRRI geologist, was trained in geology, and, prior to his employment by the MMRRI five years ago, he gained a wide variety of professional experience in energy-resource exploration and evaluation, as well as in geological characterization. This experience resulted from industry employment, as well as from research in a variety of academic settings. Moreover, he was involved in research to investigate the potential hazard of selected waste streams, as well as in metals-extraction research, at the (US) Bureau of Mines Salt Lake City research facility. Since coming to the MMRRI, Mr. Schmit has been a principal figure in the comprehensive reevaluation of North Dakota's coal resources and in MMRRI research activities related to the geology of the coal-bearing sediments in the northern Great Plains. Furthermore, he has participated in a number of other MMRRI research projects, with much of his involvement focused on geological characterization activities. Presently, Mr. Schmit is also both coordinating and taking an active part in the site-characterization, technical-assistance, and research activities related to the MMRRI's long-term involvement in the ongoing Rocky Mountain 1 underground coal gasification test in south-central Wyoming.

Dr. Gerald Groenewold - Dr. Groenewold is presently the Director of both the North Dakota Mining and Mineral Resources Research Institute (MMRRI) and the University of North Dakota Energy and Mineral Research Center, as well as an Associate Dean in the UND School of Engineering and Mines and an Associate Professor in the UND Department of Geology and Geological Engineering. He is a recognized authority on the geology of the surface and near-surface sediments in the northern Great Plains, as well as on the hydrogeology and

hydrogeochemistry of northern Great Plains shallow-groundwater systems. His research in these areas has focused on sediment mineralogy, geochemistry, trace-element attenuation properties and buffering capacities, in addition to surface-coal-mine reclamation practices, and the impacts of surface coal-mining and the disposal of coal-conversion and oil-and-gas drilling wastes on groundwater. Dr. Groenewold also has ten years of research experience in the characterization and management of wastes, particularly fly ash, from coal-fired power plants and the nation's only commercial, large-scale coal-gasification plant. His extensive experience in designing and managing projects that are typically multi-disciplinary and often multi-institutional is examplified in the MMRRI's long-term involvement in the environmental program of the ongoing Rocky Mountain 1 UCG test in Wyoming. Dr. Groenewold is both project administrator and principal investigator for that project, which consists of a wide range of site-characterization, technical-assistance, and research activities.

Mr. Daniel J. Daly - Mr. Daly, a geologist with the MMRRI, holds a Master of Science degree in geology from the University of North Dakota. Through his involvement in a series of projects concerning the impacts of mining and waste disposal on the environment in the northern Great Plains, Mr. Daly has become familiar with the geology and hydrogeology of the shallow subsurface in the Williston basin, as well as with the siting, installation, and uses of ground-water instrumentation. He also has resource-evaluation experience gained through participation in the MMRRI's long-term program to comprehensively reevaluate North Dakota's coal resources. Finally, Mr. Daly has been involved in several fundamental studies of the geology of the coal-bearing sediments of the northern Great Plains, as well as in the geological characterization

phases of other MMRRI projects, including the long-term project related to the ongoing Rocky Mountain 1 underground coal gasification test in Wyoming.

Dr. Frank W. Beaver - Dr. Beaver is presently MMRRI Research Supervisor of Waste Management, Research Manager of the MMRRI's Coal By-Products Utilization Laboratory (CBUL), and Assistant Professor of Geological Engineering in the UND Department of Geology and Geological Engineering. He has a varied educational background encompassing chemistry, engineering, and geology, and has a wide variety of professional experience utilizing all three disciplines. Specifically, Dr. Beaver developed a working familiarity with all major regulatory and technical aspects of a range of environmental concerns in the northern Great Plains as the North Dakota/South Dakota State Engineer for the US Environmental Protection Agency for nine years. Subsequently, he has been involved in MMRRI research primarily concerned with the characterization of shallow-groundwater systems and the evaluation of impacts on those systems by energy-resource exploration techniques and the disposal of coal-conversion wastes. Dr. Beaver is also active in coal-waste characterization and utilization work through the CBUL. As the result of his recent research efforts, he has developed considerable expertise in the application of computer capabilities and techniques to groundwater-related problems in particular. Dr. Beaver's full range of expertise is presently being applied to the conduct of a variety of site-characterization, technical-assistance, and research activities that are part of the MMRRI's long-term involvement in the ongoing Rocky Mountain 1 UCG test in Wyoming.

Mr. Dennis L. Laudal - Mr. Laudal holds undergraduate degrees in chemistry and biology and a Master of Science degree in chemical engineering. He has been

associated with Energy and Mineral Research Center for over 8 years. His principal areas of expertise are particulate characterization and control, control techniques for SO_x/NO_x, fluidized-bed combustion, and coal preparation and analysis. In addition, Mr. Laudal has been the principle author of economic studies of fly ash-utilization processes, as well as a comparative economic study of particulate-control technology.

Note: Student technicians, under the direction of the principal participants, will be responsible for much of the data collection and certain aspects of data evaluation, a strategy that has proven successful over the past several years. An attempt will be made to employ students with training and/or experience in geology or related disciplines, supplemented, if possible, by computer-related experience, for the characterization-related work. A student with chemical engineering training and/or experience will be sought for work related to the economic evaluation.

APPLICANT QUALIFICATIONS

The following summary, recently prepared at the request of our GRI project manager: 1) reviews the activities that the MMRRI will be involved in during the course of our long-term participation in the RM 1 UCG test program in Wyoming, and 2) provides a rationale for the design and conduct of those activities. This summary serves to illustrate many of our qualifications for performing the work proposed herein, and, at the same time, it gives a clear indication of the philosophy that will guide our effort.

The underground gasification of coal both affects and is affected by the geological, geochemical, geotechnical, and hydrogeological character of the setting within which it takes place. Without a fundamental understanding of the complete range of those site characteristics and their relationship to the UCG process, the design and conduct of efficient, economical, and environmentally-acceptable UCG tests is not possible. In essence, UCG-related environmental research activity must not only address regulatory issues and mandates, but also must generate key fundamental test-site information which will allow theoretical, rather than empirical, UCG process design, as well as generic transferability of that design to potential UCG sites. In turn, without UCG tests which focus on a fundamental understanding of both process and environmental issues, the timely development of UCG as an acceptable energy-production alternative cannot continue. The overall RM1 environmental program, funded largely by GRI, is the most comprehensive effort to date to: 1) characterize a UCG site, 2) evaluate how and to what extent key site characteristics affect and are affected by the test burn, and 3) evaluate strategies for dealing with potential environmental impacts.

The long-term involvement of the MMRRI in the RM1 environmental program complements and supports the RM1 process-design and environmental activities

of the other major participants, Stearns-Roger (S-I) and the Western Research Institute (WRI), by providing critical site-characterization data, project overview technical assistance to the GRI project officer, and important research activities not provided for in the original program.

The MMRRI technical assistance activities are designed to aid the project manager in maintaining the quality and scope of all of the program's tasks at a level necessary to meet the overall objectives in a timely fashion. These tasks include:

1. the monitoring and evaluation of S-I/WRI activities;
2. the subcontracting of a longwall-mining expert for input regarding cavity development and overburden stability;
3. the preparation and submittal of information on topics relevant to, but not provided for in, the original program at the request of the project officer;
4. the evaluation of the UCG-related documents in the GRI Coal Gasification EH&S Information System, and the review of additional related documents for entry into that system;
5. the review of four recently-generated computer models with respect to their application to UCG, and, in particular, to the RM1 UCG test;
6. the completion, in cooperation with WRI, of a key document entitled "Environmental Site Characterization Methodology to Determine UCG Feasibility;" and
7. the coordination of the synthesis of the information generated by all RM1 environmental program activities. This synthesis will be the basis for a major final report. This report will be critical to the adaption of GRI's RM1 environmental program to future UCG tests, as well as to the development of siting and process-design strategies for future tests.

The MMRRI research activities, the inclusion of which were a critical factor in the approval of environmental-related test permits by the Wyoming Department of Environmental Quality, include:

1. chemical characterization of water in the unsaturated zone, which is vital to the identification of key chemical processes that control groundwater quality at the RM1 site;

2. determination of temperature profiles in the overburden before, during, and after the test burn, which is important in evaluating and modeling cavity growth and overburden stability, as well as post-burn groundwater movement and quality;

3. mineralogical chemical, and, in some cases, organic characterization of: (a) unaltered sediments typical of those surrounding the RM1 target coal, (b) sediments typical of those surrounding the RM1 target coal, as well as the inorganic fraction of the target coal, all thermally-altered in the laboratory under simulated UCG conditions, and (c) solid residues from the Tono, Washington, UCG test, WRI reactor tests, and the RM1 test itself. These characterization activities are important in evaluating and modeling cavity growth and overburden stability, burn-related thermal transformations, and post-burn groundwater movement and quality;

4. leaching characterization of RM1 solid test-residues, which will contribute to an understanding of post-burn groundwater quality, as well as to the design and evaluation of UCG-related groundwater protection and restoration strategies; and

5. characterization of the attenuation capacity of sediments surrounding the RM1 target coal, which is critical in evaluating and modeling the intrinsic ability of those sediments to mitigate potential test-related inorganic contaminants. This, in turn, is essential to the design and evaluation of UCG-related groundwater-protection and groundwater-restoration strategies.

The RM1-related MMRRI site characterization, technical assistance, and research activities are carefully designed to maximize GRI's RM1 environmental-assessment effort utilizing an integrated, multidisciplinary approach focused on questions that will lead to: 1) a fundamental and generic understanding of the nature, degree, extent, and duration of potential UCG-related environmental impacts, and 2) insights into ways in which those impacts may be avoided or managed in the future. In turn, those data will be critical to evaluating the results of the RM1 test and process designs, and will provide the information essential to the determination of the generic applicability of those process designs to other potential UCG sites. It is the view of a wide range of informed researchers, regulators, and industry

representatives, that without this comprehensive approach focused on both process and environmental issues, the continued development of UCG as a safe, efficient means of producing natural gas is in considerable jeopardy.

UNDERGROUND COAL GASIFICATION FEASIBILITY PROGRAM
PROPOSAL BUDGET

LABOR	LABOR CATEGORY	HOURLY RATE	HOURS	$ COST
C. SCHMIT	GEOLOGIST III	$15.26	375	$5,723
G. GROENEWOLD	PRINCIPAL SCIENTIST	$28.85	80	$2,308
D. DALY	GEOLOGIST II	$13.23	100	$1,323
F. BEAVER	RES. SCIENTIST III	$23.08	130	$3,000
D. LAUDAL	RES. SCIENTIST II	$15.70	380	$5,966
----------	WORD PROC/GRAPHICS	$7.25	180	$1,305
----------	STUDENT ASSISTANT	$4.00	650	$2,600
DIRECT LABOR			1895	$22,225
FRINGE BENEFITS AS % OF DIRECT LABOR		24%		$5,334
RES. SUPPORT AS % OF DIRECT LABOR *		69%		$15,335
TOTAL LABOR BASED CHARGES				$42,894
OTHER DIRECT COSTS				
TRAVEL				$1,280
OPERATING SUPPLIES INCLD. RAW MATERIALS				$800
TOTAL OTHER DIRECT COST				$2,080
TOTAL DIRECT COST = LABOR BASED + OTHER DIRECT				$44,974
INDIRECT COST - % OF MTDC*			21.9%	$9,849
TOTAL PROJECT COST				$54,823
INDIRECT COST WAIVED BY UND				($4,925)
TOTAL REQUESTED FROM ND LIGNITE COUNCIL				$49,898

*SEE BUDGET NOTES IN THE PROPOSAL

BUDGET NOTES-ENERGY & MINERAL RESEARCH CENTER

The proposed work would be done on a time and materials 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. Financial reporting will be at the total project level.

Engineering Overhead

1) Research Support

Administrative and facility support expenses directly related to the operations of the University of North Dakota Energy & Mineral Research Center are allocated on the pro rata basis to each contract. The distribution of these direct costs is reflected under research support, which is applied against salaries and wages. The pro rata allocation is adjusted annually as of July 1st for the upcoming fiscal year. The rate of 69% which became effective July 1, 1987 was used in this proposal.

2) Fringe Benefits

Fringe benefits are estimated at 24% of direct labor. This rate is based on historical data. Actual fringe benefit costs will be charged. Non-productive time (vacation, sick leave, and holidays) are not included in the fringe benefits, but they are included in research support.

COMPLIMENTARY FUNDING

The requested funding total of $49,898 is complimented by in-place UCG-related funding to the MMRRI from the Gas Research Institute (GRI) totaling $1,175,677 for the period 10/15/86 - 12/31/92. This GRI funding is applicable to a wide variety of site-characterization, technical-assistance, and research activities related to the Rocky Mountain 1 (RM1) UCG test program in Wyoming. The GRI funding of MMRRI research at the RM1 UCG site provides an appropriate and more than adequate match for the funding requested here because of the MMRRI's long-term and wide-ranging involvement in that test. In addition, because of the MMRRI's extensive research experience in various topical areas related to coal-bearing strata in the northern Great Plains, the MMRRI has been able to design their Wyoming research program such that the RM1 test data will have direct applicability to the proposed Great Plains test site. The RM1 test allows the MMRRI to:

1. participate in the development of, and have access to, UCG site-characterization and technology data bases, both of which are, in large part, generically transferable to the proposed Great Plain test site;

2. develop a substantial UCG-related experience base, which will, in large part, be directly applicable to the conduct of the activities proposed herein;

3. develop UCG-related contacts and a familiarity with the UCG-related literature that will be invaluable in meeting the objectives of this proposal.

In essence, without the experience and data that the MMRRI brings to the proposed project as the result of its involvement in the RM1 program, the proposed objectives could not be met for less than 10 times the requested level of funding, and certainly not in as timely as manner.

In addition to the GRI complimentary funding, the University of North Dakota has agreed to waive 50 percent of the indirect cost of this project. The waiver amounts to $4,925.