Jointly Sponsored Research Program

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EXECUTIVE SUMMARY

EERC Jointly Sponsored Research Program Continuation Application

I. Introduction

The Jointly Sponsored Research Program (JSRP) is a U.S. Department of Energy (DOE) program funded through the Office of Fossil Energy and administered at the Morgantown Energy Technology Center. Under this program, which has been in place since Fiscal Year 1990, DOE makes approximately \$2.5 million available each year to the Energy & Environmental Research Center (EERC) to fund projects that are of current interest to industry but which still involve significant risk, thus requiring some government contribution to offset the risk if the research is to move forward. The program guidelines require that at least 50% of the project funds originate from nonfederal sources. Projects funded under the JSRP often originate under a complementary base program, which funds higher-risk projects.

II. 1996 Accomplishments

In Fiscal Year 1996, \$2,030,000 was available to the EERC for funding projects under the JSRP. In addition, two projects totaling \$260,000 were canceled, which brought total available funding to \$2,290,000. The EERC submitted proposals to utilize this funding for 21 projects, 12 of which were new activities and nine of which continued projects initiated in earlier years. The DOE share of the 21 projects totaled \$2,272,108 (40%), while the nonfederal share of the projects totaled \$3,361,655 (60%). EERC's internal goal of 60% nonfederal funding of the JSRP has been achieved each of the last two fiscal years.

Projects funded under the JSRP must address issues of interest to DOE's Office of Fossil Energy. The projects funded in Fiscal Year 1996 addressed a wide range of Fossil Energy interests, including hot-gas filters for advanced power systems; development of cleaner, more efficient processing technologies; development of environmental control technologies; development of environmental remediation and reuse technologies; development of improved analytical techniques; and development of a beneficiation technique to broaden the use of high-sulfur coal. Descriptions and status for each of the projects funded during the past fiscal year are included in Section A of this document, Statement of Technical Progress.

III. 1997 Plan

For Fiscal Year 1997, the EERC has identified ten current projects and 22 new projects as candidates for funding. The total estimated DOE share of these projects is approximately \$3,225,000, while the estimated nonfederal share is approximately \$4,800,000. These projects are described in Section B of this document. In addition to the projects already included in Section B, it has been the EERC's experience that new JSRP opportunities develop very rapidly and that several projects not included in Section B will be considered for funding before the year is finished. Since the DOE share

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Fiscal Year 1997 and more projects are expected to develop and compete for funding before the end of the year, the EERC will have to select the projects that appear to offer the best opportunities for commercial success. The range of Fossil Energy interests and technologies being developed in Fiscal Year 1997 projects is expected to cover the same broad range as the Fiscal Year 1996 projects.

IV. Carryover

Section C of this document includes required application forms, certifications, and budget information. Also included in this section is a table of estimated project balances at the end of the current budget period. This information is supplied for each task previously funded under the JSRP. The estimated total is \$1,027,862. This estimate will be corrected to actual carryover when the budget period ends and final figures are available.

TABLE A-1

SUMMARY OF ALL PROJECTS APPROVED FOR FUNDING
UNDER COOPERATIVE AGREEMENT DE-FC21-93MC30098

Task No.	Title	DOE Share	Cosponsor Share	Total
Task 1	Multiple-Use Marketing of Lignite	\$ 20,000	\$ 20,000	\$ 40,000
Task 2	Seventeenth Biennial Low-Rank Fuels Symposium	\$ 35,000	\$ 35,000	\$ 70,000
Task 3	Slagging and Fouling Assessment of Coal and Coal Chars	\$ 15,175	\$ 15,175	\$ 30,350
Task 4	Chlorine Analysis and Removal from Products of Thermally Recycled Plastics	\$ 131,101	\$ 131,113	\$ 262,214
Task 5	Sorbent Regeneration from Circulating Fluidized-Bed Combustors (FBCs)	\$ 44,956	\$ 44,966	\$ 89,922
Task 7	Development of Methods to Predict Agglomeration and Deposition in Fluidized-Bed Combustors	\$ 440,000	\$ 440,000	\$ 880,000
Task 8	Development of a Fireside Performance Index: Convective Pass Fouling and Fly Ash Collectibility	\$ 370,000	\$ 370,000	\$ 740,000
Task 10	Timing of the Deposition of Uppermost Cretaceous and Paleocene Coal-Bearing Deposits in the Greater Glendive Area, Montana and North Dakota	\$ 33,980	\$ 33,980	\$ 67,960
Task 11	Coal Agglomeration Consortium	\$ 0	\$ 0	\$ 0
Task 13	Phenol Purification Studies	\$ 22,000	\$ 22,000	\$ 44,000
Task 14	Effect of Ethanol Denaturant on Gasoline Reid Vapor Pressure	\$ 49,978	\$ 49,981	\$ 99,959
Task 15	Process Development Unit Test Program for Thermally Recycled Plastics	\$ 630,000	\$ 809,120	\$ 1,439,120
Task 16	Bench-Scale Preparation and Combustion Testing of Refuse-Derived Fuel-Coal Slurry Fuels	\$ 95,000	\$ 135,000	\$ 230,000
Task 17	Enhanced Air Toxics Control	\$ 712,047	\$ 767,403	\$ 1,479,450
Task 18	Coal Ash Resources Research Consortium	\$ 270,240	\$ 377,294	\$ 647,534
Task 19	The Application of Fluidized-Bed Combustion Residues for High-Volume Utilization Options	\$ 0	\$ 0	\$ 0
Task 20	FT-IR Spectroscopic Investigation of Fireside Deposits in a Pilot Plant Combustor	\$ 45,000	\$ 45,000	\$ 90,000
Task 21	Sour Gas Plant Subsurface Remediation Technology Research and Demonstration Project	\$ 380,250	\$ 502,250	\$ 882,500
Task 22	Evaluation of Supercritical Fluid Extraction for Analysis of Petroleum Industry Wastes	\$ 100,000	\$ 100,000	\$ 200,000
Task 23	Gas Industry Groundwater Research Program	\$ 1,299,754	\$ 1,300,000	\$ 2,599,754

Continued . . .

TABLE A-1 (continued)

Task No.	Title	DOE Share	Cosponsor Share	Total
Task 24	Utilization of Western Coals in Bituminous Boilers - Pilot Plant Assessment of Blend Properties and Their Impact on Critical Utility Power Plant Components	\$ 15,881	\$ 195,000	\$ 210,881
Task 25	Physical Cleaning of Lignite	\$ 30,000	\$ 30,000	\$ 60,000
Task 26	Remote-Site Power Generation Opportunities for Alaska	\$ 250,000	\$ 271,400	\$ 521,400
Task 27	Alaskan Low-Rank Coal-Water Fuel Environmental Attributes and Combustion Test Marketing	\$ 50,000	\$ 62,000	\$ 112,000
Task 28	An Assessment of the Subsurface Fate of Monoethanolamine at Sour Gas Processing Plant Sites	\$ 165,130	\$ 247,032	\$ 412,162
Task 29	Mitigation of Air Toxics from Lignite Generation Facilities	\$ 100,000	\$ 100,000	\$ 200,000
Task 30	Hot-Gas Filter Ash Characterization Project	\$ 825,000	\$ 1,005,000	\$ 1,830,000
Task 31	Formal Evaluation of Flue Gas Chemical Measurement Methods Phase I - Verification of Mercury Speciation by EPA (Draft) Method 29	\$ 1,032,155	\$ 1,658,980	\$ 2,691,135
Task 32	Organic Sulfur Removal from Coal with Super- and Subcritical Water	\$ 160,218	\$ 198,527	\$ 358,745
Task 33	Upgraded North Dakota Lignite - Production of Test Quantities	\$ 25,000	\$ 40,000	\$ 65,000
Task 34	Coal Quality Expert Fouling and Slagging Algorithm Development	\$ 40,000	\$ 60,000	\$ 100,000
Task 35	Evaluation of Field Analytical Techniques for Mercury in Soil	\$ 40,000	\$ 89,500	\$ 129,500
Task 36	Combustion Characterization of Carbonized RDF from Temperature Optimization Tests	\$ 200,000	\$ 304,096	\$ 504,096
Task 37	Recent Advances in Research on Ash Deposition in Utility Boilers: Practical Applications for the Electric Power and Coal Industries	\$ 60,331	\$ 90,502	\$ 150,833
Task 38	Mercury Remediation Technology Research and Demonstration	\$ 40,000	\$ 60,500	\$ 100,500
Task 39	Preparation and Gasification of Thailand Coal-Water Fuels	\$ 49,771	\$ 75,000	\$ 124,771
Task 40	Mercury Sorbent Evaluation	\$ 124,350	\$ 185,650	\$ 310,000
Task 41	Lignite Resource Characterization and Evaluation for Mitigation of Ash Deposition	\$ 152,000	\$ 228,000	\$ 380,000
Task 42	Holocene Cyclicity in Western North Dakota—Climate Change Interpreted from Fluctuations in Alluvial Sedimentation	\$ 64,972	\$ 99,964	\$ 164,936

Continued . . .

TABLE A-1 (continued)

Task No.	Title	DOE Share	Cosponsor Share	Total
Task 43	Oxidation of North Dakota Scrubber Sludge for Soil Amendment and Production of Gypsum	\$ 40,000	\$ 80,000	\$ 120,000
Task 44	Pilot Plant Assessment of Fly Ash Agglomeration	\$ 209,993	\$ 318,007	\$ 528,000
Task 45	Small-Scale Demonstration of the Freeze-Thaw Evaporation Process to Treat Oil and Gas Produced Waters	\$ 200,000	\$ 600,000	\$ 800,000
Task 46	Training and Support for Hot-Gas Filter Testing	\$ 20,539	\$ 20,539	\$ 41,078
Task 47	Development of a Coal Combustion By-Products (CCBs) Database System	\$ 19,800	\$ 29,700	\$ 49,500
Task 48	Coal Ash Behavior in Reducing Environments (CABRE) II	\$ 118,000	\$ 242,000	\$ 360,000
Task 49	Validation of Fireside Performance Indices	\$ 100,000	\$ 150,000	\$ 250,000
Task 50	Deposition of Lignites in the Fort Union Group and Related Strata of the Northern Great Plains	\$ 25,000	\$ 25,000	\$ 50,000
Task 51	Oxygen Plasma Unit for Soil Decontamination: Demonstration of a Field-Scale Unit	\$ 199,703	\$ 499,000	\$ 698,703
Task 52	Evaluation of a Zirconium Additive for the Mitigation of Molten Ash Formation During Combustion of Residual Fuel Oil	\$ 25,373	\$ 38,060	\$ 63,433
Task 53	Construction, Demonstration, and Evaluation of an Economic and Environmentally Safe Evaporation and Holding Pond Design	\$ 70,000	\$ 130,000	\$ 200,000
Task 54	Activated Carbon for Environmental Applications	\$ 26,668	\$ 40,000	\$ 66,668
Task 55	Binderless Agglomeration of K-Fuel® Product - Preliminary Evaluation	\$ 139,253	\$ 207,420	\$ 346,673
Task 56	Preliminary Economic Evaluation of UCG at Saba Yoi, Thailand	\$ 60,000	\$ 90,000	\$ 150,000
Task 57	Preparation and Combustion of Coal-Water Fuel from a Lignite from Southern Thailand	\$ 27,490	\$ 41,240	\$ 68,730
Total		\$ 9,401,108	\$ 12,710,399	\$ 22,111,507

SECTION A
STATEMENT OF
TECHNICAL PROGRESS

PROJECT DESCRIPTIONS AND STATUS

Task 1	Multiple-Use Marketing of Lignite	Status: Complete	
Cosponsors	Knife River Coal Mining Company; J.R. Simplot Company; North Dakota Industrial Commission		
Summary <p>The objective of this program was to provide a market feasibility study for the multiple uses of lignite in the city of Grand Forks, North Dakota. Lignite and sulfur-capture additives were used to clean agriculture wastewater. Lignite was also used after wastewater cleanup to generate steam and produce lignite briquettes.</p> <p>Various combinations of lignite, waste lime sludge, lime, and an additive have been used to produce clear, essentially odor-free water from potato wastewater. Collected residue containing starch material and lignite has been successfully briquetted. A major expense in the upgrading of lignite (drying) is the capital and operating cost of dust-handling equipment. Preliminary tests indicate these costs may be reduced by proper pretreatment of the coal. Information has been collected on the economics of the multiple-use marketing of lignite used in cogeneration or steam generation, wastewater cleaning, and/or briquettes, including possible waste solids disposal costs in Grand Forks. The most environmentally acceptable coal-to-steam process is fluidized-bed combustion. No multiple-use scheme was found that would make North Dakota lignites more economically acceptable than subbituminous coals. The final report was issued in September 1993.</p>			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$20,000	\$20,000	\$40,000

Task 2	Seventeenth Biennial Low-Rank Fuels Symposium	Status: Complete	
Cosponsors	BNI Coal, Ltd.; Northern States Power Company; Minnesota Power; American Coal Ash Association; N-R-G Energy, Inc.; Knife River Coal Mining Company; MDU Resources Group, Inc.; Minnkota Power Cooperative, Inc.; North American Coal Corporation; Otter Tail Power Company; Utility Fuels, Inc.		
Summary The goal of the Low-Rank Fuels Symposium is to provide a forum for industry, government, and academia to allow the exchange of information that can be used to develop efficient technologies to utilize low-rank fuels in an environmentally acceptable manner. The last symposium, held May 10-13, 1993, in St. Louis, Missouri, was organized in a manner to provide for the discussion, communication, and dissemination of recent information on low-rank fuel utilization. Participants in the symposium consisted of a multidisciplinary blend of representatives from industry, research organizations, government agencies, and universities. The conference proceedings were issued in May 1994.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$35,000	\$35,000	\$70,000

PROJECT DESCRIPTIONS AND STATUS

Task 3	Slagging and Fouling Assessment of Coal and Coal Chars	Status: Complete	
Cosponsor	Illinois State Geological Survey		
Summary Eastern utility boilers now firing high-sulfur, high-volatile bituminous Illinois coal must consider alternatives to meet the 1995 emission guidelines of 2.5 lb of SO ₂ /MMBtu. Alternatives include coal switching, blending coals, or retrofitting with costly scrubbers. Another alternative is to use a low-sulfur char produced from the mild gasification of Illinois coal and subsequent low-temperature oxidation of the char. This char could be burned exclusively or blended with the parent coal to reduce emissions. An Illinois Basin coal and two coal-char blends were submitted by the Illinois State Geological Survey for evaluation of their fouling and slagging propensity. Laboratory tests and calculations indicated that one blend, prepared from char produced under high-temperature conditions with the addition of hydrated lime, would cause severe slagging, high-temperature fouling, and, possibly, low-temperature fouling problems. The second blend, prepared from char produced under low-temperature conditions, exhibited slagging and fouling behavior similar to that of the Illinois coal itself and is seen as an attractive feedstock because of a lower sulfur content and higher Btu content than the parent coal. All laboratory testing, analysis, and interpretation of the results have been completed. The final report for the project was submitted to the Illinois State Geological Survey and to the U.S. Department of Energy in September 1993.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$15,175	\$15,175	\$30,350

PROJECT DESCRIPTIONS AND STATUS

Task 4	Chlorine Analysis and Removal from Products of Thermally Recycled Plastics	Status: Complete	
Cosponsor	American Plastics Council and 3M Company		
Summary Plastics account for nearly 20% by volume of the material entering a landfill. Public pressures to recycle products and, correspondingly, to reduce the amount of material landfilled have prompted investigation of practicable means of plastics recycling. Some plastics (e.g., high-density polyethylene) are easily isolated and recycled by existing mechanical methods. Other types are difficult to recycle by traditional methods for a variety of reasons. Thermal depolymerization, or thermal cracking, breaks down plastics to liquids and gaseous products similar to the petroleum-based starting materials used in plastics manufacturing. These products are then reintroduced to a petroleum refinery, where they will be used for new plastics production and for the production of other petroleum products. A key aspect of any plastics recycling process is the removal of chlorine, present primarily from polyvinyl chloride (PVC). All currently envisioned end uses for recycled plastics have tolerance levels for chlorine. Earlier work at the Energy & Environmental Research Center (EERC) using sorbents for chlorine capture in the process was very successful. This program examined the potential for using a postreactor fixed sorbent bed for chlorine removal from postconsumer plastics. Variables investigated included fixed-bed temperature, sorbent particle size, and chlorine loading. In addition to the fixed-bed study, an analytical development effort was completed that examined the detection limits and accuracy of the gas chromatograph-atomic emission detector technique used at the EERC to quantitate organic chlorine content of the product liquids. Analysis of the liquids indicated total organic chlorine could be reduced to 20 ppm with a feed stream of 2%-5% PVC, which was the goal of the program. The final report was submitted in December 1994.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$131,101	\$131,113	\$262,214

PROJECT DESCRIPTIONS AND STATUS

Task 5	Sorbent Regeneration from Circulating Fluidized-Bed Combustors (FBCs)	Status: Complete
Cosponsor	Community Energy Alternatives Inc.	

Summary

Circulating fluidized-bed combustion is an efficient method for burning high-sulfur fuels to meet stringent SO₂ emission level requirements. One concern when high-sulfur coal is burned is the high usage of limestone and, consequently, the relatively large amounts of solid waste for disposal. The large amount of limestone is a result of utilizing only 30%–50% of the available calcium in a once-through system. In this project, a sorbent regenerator was coupled with the Energy & Environmental Research Center (EERC) circulating fluidized-bed combustor (CFBC) pilot plant system to study the regeneration and recycling of the spent sorbent.

The first series of combustion tests was completed on the EERC pilot-scale CFBC. During this testing, the performance of pelletized fly ash from the baghouse of a full-scale CFBC was compared to that of fresh limestone. Based on these results, the limestone feed and subsequent solid waste disposal could be reduced by approximately 25% with pelletization and recycle of the fly ash alone.

Further testing coupling the fly ash pelletization with the regeneration of the bottom ash resulted in limestone usage being reduced by a maximum of 84.5%. There appears to be significant potential for better optimizing and integrating the operations of the fly ash pelletization and the bottom ash regeneration processes with the CFBC operation to meet the original goal of greater than 90% reduction in limestone usage. This would likely require some detailed bench-scale studies of the pelletization and regeneration processes before proceeding with further pilot-scale testing.

The final report for the project was submitted to sponsors in May 1994.

Funding Profile	DOE Share	Nonfederal Share	Total
	\$44,956	\$44,966	\$89,922

PROJECT DESCRIPTIONS AND STATUS

Task 7	Development of Methods to Predict Agglomeration and Deposition in Fluidized-Bed Combustors (FBCs)	Status: Complete	
Cosponsors	Ahlstrom Pyropower, Inc.; Riley Stoker Corporation; Northern States Power Company; Electric Power Research Institute; North Dakota Industrial Commission		
Summary The focus of this project is to develop a method to predict agglomeration and deposition in fluidized-bed combustors (FBCs). The basic mechanisms of agglomeration and deposition have been developed from the detailed analysis performed on samples from the Montana-Dakota Utilities' Heskett Station, Northern States Power's Black Dog Station and the 1-MW Energy & Environmental Research Center pilot-scale circulating FBC. A simple model based on ash chemistry has been developed that may be able to predict agglomerating tendencies. The bench-scale test matrix, in which operating conditions, sorbent type, and additives were varied, has been completed. The data from these tests were incorporated into the agglomeration mechanisms. The testing has identified a number of bed material/sorbents that greatly reduce the agglomeration tendency. A computer model designed to predict deposition in pulverized coal-fired units was adapted to predict deposition in FBCs. Using the information generated from the full-scale and bench-scale systems, combined with work on the fundamental chemistry and physics of the deposited materials, we developed methods for predicting the onset of deposition and agglomeration and possible mitigating measures. A final report for this 3-year project was completed February 1996.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$440,000	\$440,000	\$880,000

PROJECT DESCRIPTIONS AND STATUS

Task 8	Development of a Fireside Performance Index: Convective Pass Fouling and Fly Ash Collectibility	Status: Complete	
Cosponsors	Northern States Power Company; Minnesota Power; Electric Power Research Institute; Union Electric, Inc.; Kansas City Power & Light		
Summary A performance index to provide utilities and coal companies with a quick method to assess coal performance has been developed. Work began on the project in October 1992 and was completed by July 31, 1995. Work has been completed using a drop-tube furnace for the purpose of carrying out bench-scale fouling and slagging combustion tests to refine existing fouling and slagging indices that are based on computer-controlled scanning electron microscopy. Four field tests were conducted at Union Electric's Labadie Station, Minnesota Power's Clay Boswell Station, Northern States Power Company's Sherburne County Station, and Kansas City Power & Light's Iatan and Hawthorn Stations to verify the performance indices. Mineralogical data and other pertinent information obtained for over 50 different coals were used to develop the performance indices. Final algorithms were developed and packaged as a software product for predicting low-temperature fouling, high-temperature fouling, slagging, slag tapping, grindability, ash erosion, ash collectibility-opacity, and sootblowing indices using the coal database and the empirical combustion performance information from the laboratory and the field. Beta versions of the software were sent out in February 1995, and a final version of the software was distributed, along with a training seminar, in June 1995. A report summarizing the first phase of the work was submitted to the sponsor in July 1993. A final report was issued in November 1995 detailing the work performed during the second phase of the project.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$370,000	\$370,000	\$740,000

PROJECT DESCRIPTIONS AND STATUS

Task 10	Timing of the Deposition of Uppermost Cretaceous and Paleocene Coal-Bearing Deposits in the Greater Glendive Area, Montana and North Dakota	Status: Complete	
Cosponsor	The Research Foundation of the State University of New York at Stony Brook; National Geographic Society		
Summary This research concerns determination of the timing of coal deposition in the Fort Union Coal Region, as developed in the Glendive and adjacent areas in Montana and North Dakota. The project objective is to develop a time framework that allows for the temporal comparison of coal deposits and thus coal-forming conditions through the transition from non-coal-bearing to coal-bearing deposits in the Fort Union Coal Region. Such a regional coal chronostratigraphic (time-rock) framework permits local and regional interpretations of environments of coal deposition controlling coal quality and thickness, contributing significantly to effective resource evaluation and utilization. This research is part of a larger program designed to provide information on the timing of deposition of coal beds in the Fort Union Coal Region. Temporal characterization of coal-bearing strata is especially critical in considerations specific to nonstrippable coal, which represents the bulk of North Dakota coal resources, in which there will be increasing interest as more accessible resources are depleted. Thus this study provides information of value to secure future energy supplies by expanding the recoverable coal resource through an understanding of when and how the peat forming the coal deposit accumulated. Final paleontologic field studies were conducted during the summer of 1995. The results of this and previous field and laboratory studies have been compiled, and final reports were completed in February 1996 for the National Geographic Society (State University of New York-Stony Brook and the Energy & Environmental Research Center) and the U.S. Department of Energy (Energy & Environmental Research Center).			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$33,980	\$33,980	\$67,960

PROJECT DESCRIPTIONS AND STATUS

Task 11	Coal Agglomeration Consortium	Status: Canceled	
Cosponsor	Bennett Industries of Alabama, Inc.; Custom Coals Corporation: North American Coal: BNI Coal		
Summary The Energy & Environmental Research Center has developed a prospectus for a Coal Agglomeration Consortium in order to advance briquetting and other agglomeration technologies. It aims to provide cost-effective methods to produce strong, stable, and high-performance compacts, having an increased value from high-rank coal fines or low-rank coal. Binders, other additives including organic waste (e.g., biomass) materials, and key aggregating machines will be examined. The consortium direction and work plan will each have major contributions from the sponsors of the consortium. The overall objective is to develop new briquetting technologies to produce coal briquettes that will achieve environmental compliance. The specific aims are to 1) conduct briquette formulation tests on a minimum of four coals per year selected by consortium members; 2) evaluate the strength, stability, and combustion/gasification reactivity of the briquettes; 3) begin developing correlations between fundamental coal properties and briquetting parameters; and 4) perform an economic assessment of briquetting processes. A work plan will be determined at the first and subsequent meetings of the sponsors.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$0	\$0	\$0

Task 13	Phenol Purification Studies	Status: Complete	
Cosponsor	Dakota Gasification Company		
Summary Phenolics are major liquid products obtained during the gasification of coals. Unfortunately, they are not recovered as pure compounds, but contain a wide range of contaminants, including neutral oils and basic nitrogen compounds. On the open market, the cost and purity of the phenol dictate the marketability of the product. Dakota Gasification Company has a strong interest in reducing the cost of upgrading to produce purer phenol that can be more readily marketed. The Energy & Environmental Research Center performed tests on a number of possible purification methods and parametric studies on methods that showed promise. Selected catalysts would destroy certain reactive impurities but at the expense of producing higher-molecular-weight polymers. The project was completed, and the final report was submitted in October 1994.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$22,000	\$22,000	\$44,000

PROJECT DESCRIPTIONS AND STATUS

Task 14	Effect of Ethanol Denaturant on Gasoline Reid Vapor Pressure	Status: Complete	
Cosponsor	National Corn Growers Association		
Summary <p>The mainstay of current ethanol utilization is as an oxygen additive and octane enhancer for gasoline. The significant reduction in carbon monoxide emissions by the use of oxygenated fuels has won wide support for the practice of oxygen addition to gasoline. As attention is brought to bear on other air pollutants, particularly oxides of nitrogen (NO_x), the benefits of ethanol have been questioned.</p> <p>It is commonly accepted that when ethanol is added to a gasoline, the Reid vapor pressure (RVP) of the feedstock fuel is increased. For a 10% ethanol-blended fuel (E10), this increase is usually reported as 1 pound per square inch. The tendency of ethanol to increase RVP has caused it to be labeled by some as a polluting fuel. The U.S. Environmental Protection Agency has proposed to control NO_x emissions by reducing RVP and capping oxygen levels.</p> <p>Following established laboratory protocols, in all nine cases where water was added to an E10 blend, RVP increased. Additionally, the four ethanol denaturants studied produced significantly different final RVPs. It can be concluded that the RVP increase currently attributed to ethanol may be an ethanol-denaturant-water effect. This possibility increases the strategies to reduce the RVP of E10 blends. A final report has been completed, issued, and approved by sponsors.</p>			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$49,978	\$49,981	\$99,959

PROJECT DESCRIPTIONS AND STATUS

Task 15	Process Development Unit Test Program for Thermally Recycled Plastics	Status: Complete
Cosponsor	The American Plastics Council	

Summary

Plastics account for nearly 20% by volume of the material entering a landfill. Public pressures to recycle products and, correspondingly, to reduce the amount of material landfilled, have prompted investigation of practicable means of plastics recycling. Some plastics (e.g., high-density polyethylene) are easily isolated and recycled by existing mechanical methods. Other types are difficult to recycle by traditional methods for various reasons. Thermal depolymerization, or thermal cracking, breaks down plastics to liquid and gaseous products similar to the petroleum-based starting materials used in plastics manufacturing. These products are then reintroduced to a petroleum refinery, where they will be used for new plastics production and for the production of other petroleum products.

A yearlong scoping study of the thermal depolymerization characteristics of several plastics typically found in postconsumer streams was completed at the Energy & Environmental Research Center (EERC). Because of the success of this program, a scaleup program was funded, whose purpose was to evaluate the viability of a commercial-scale thermal depolymerization process. This evaluation was based upon a series of tests using the EERC's 100-lb/hr fluid-bed process development unit. Goals of the program included the generation of liquid and gaseous products for end-user evaluation and familiarity with and the collection of product yield data and of scalable engineering data. The data can be used to perform an economic assessment of the process. Tests conducted in the process development unit indicated liquid yields from postconsumer plastics similar to those seen in bench-scale tests. Bench-scale tests were also conducted to determine olefin versus liquid yields. Testing has been completed.

Liquid products have been characterized and were determined to be an acceptable refinery feedstock. All process streams have been analyzed and found to be nonhazardous. Results from the product characterizations were presented in a workshop involving officials from U.S. Environmental Protection Agency headquarters, the state of North Dakota, local municipalities, and industries. Results from the bench-scale testing indicate that olefin yields coupled with olefin prices appear to make a more attractive option over liquid production in locations where an olefin plant is located.

Other results indicated that the most important process conditions, in order of importance, are temperature, gas residence time, bed material, and solids residence time. Sufficient data have been produced to perform a detailed commercial economic and process design.

A final report on the process development unit test program was issued in January 1996. A comprehensive summary of the work, including a summary of liquid production, olefin production, terephthalic and benzoic acid production, and chlorine capture, has been completed.

Funding Profile	DOE Share	Nonfederal Share	Total
	\$630,000	\$809,120	\$1,439,120

PROJECT DESCRIPTIONS AND STATUS

Task 16	Bench-Scale Preparation and Combustion Testing of Refuse-Derived Fuel-Coal Slurry Fuels	Status: Complete	
Cosponsor	EnerTech Environmental, Inc.		
Summary As public concern grows and government regulations become increasingly strict, numerous municipalities and industries face exorbitant costs for solid waste disposal that run head-on into bottom-line profits. Concurrently, markets for lignite coal have been limited primarily because of its high moisture content, which results in a low heating value per unit weight and high transportation costs per unit energy. In addition, most of the North Dakota lignite reserves have sulfur contents that exceed the Clean Air Act Amendments Phase II emission limits for power plants of 1.2 lb of SO ₂ per MMBtu. EnerTech Environmental, Inc., and the Energy & Environmental Research Center have developed a slurry carbonization technology that efficiently converts low-sulfur solid waste materials such as municipal solid waste, municipal sludge, and pulp and paper sludge into clean, homogeneous, high-energy slurry fuels. The goal of blending the solid waste with lignite was to reduce the SO ₂ emissions from combustion of the carbonized slurry fuel and also to provide a much better means of utilizing the potential energy from the solid waste. The objective of this research program was to assess the feasibility of blending refuse-derived fuel (RDF) with a lignite coal and thermally treating the mixture in an aqueous phase (slurry carbonization). Batch slurry carbonization experiments were conducted with three different slurries: a RDF slurry, a North Dakota lignite slurry, and a blend of North Dakota lignite and RDF. After the slurry carbonization treatment, all three slurries were concentrated and combusted in a bench-scale pressurized fluidized-bed combustion unit. Slurry performance tests conducted on the feed and carbonized RDF slurry indicated an increase in solids loading, from 10 to over 45 wt% solids. In addition, chloride concentrations were reduced by over 80 wt% in the carbonized RDF slurry. Slurry carbonization studies for lignite indicated that the slurry heating value was increased by over 60%, with an achievable solids concentration over 55 wt%. Also, sulfur concentrations were reduced from 1.8 to 1.3 wt% (moisture-free) for the carbonized lignite slurry. Results from the blended carbonized RDF and lignite slurry indicated a compliance fuel that could be slurried to approximately 57 wt%, a 220% increase in energy density. Pressurized fluidized-bed combustion results indicated that all three fuels obtained excellent combustion efficiencies, exceeding 99.0%. Sulfur dioxide emissions were significantly lower for the carbonized RDF slurry (0.10 lb/MMBtu) than for the carbonized lignite slurry (0.62 lb/MMBtu). A final report was issued in November 1994.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$95,000	\$135,000	\$230,000

PROJECT DESCRIPTIONS AND STATUS

Task 17	Enhanced Air Toxics Control	Status: Ongoing
Cosponsor	Electric Power Research Institute	

Summary

The primary goal of this project is to determine the potential to control air toxic emissions in conventional particulate control devices. Since many of the toxic heavy metals are more concentrated in fine fly ash particles, a method of superior control of these air toxic emissions is simply to collect them in a particulate control device. For elements that are entirely in the solid state, effective control is dependent on achieving a high collection efficiency for the particle sizes where air toxic metals are primarily concentrated. In the case of volatile elements, such as mercury, effective control may depend on the surface adsorption properties of the fly ash or added sorbents. Introduction of small amounts of a high-surface-area material, such as activated carbon, ahead of a particulate control device may provide effective mercury control. Parametric pilot tests were conducted, evaluating independent variables such as sorbent type, sorbent concentration, temperature, and coal type.

Preliminary conclusions from the pilot-scale test program include the following:

- Inlet mercury concentration was dependent on coal type and Method 29 sampling filter temperature.
- The natural mercury capture of the fly ash is highly temperature dependent (Absaloka showed the highest level of natural mercury capture).
- Lignite-based activated carbon provided good mercury control at temperatures of 250°F and lower for all three coals.
- Iodine-impregnated activated carbon provided effective mercury control at 300° and 400°F with the Absaloka subbituminous coal but was ineffective for the Comanche subbituminous coal.
- Iodine-impregnated activated carbon was highly effective at reducing the outlet elemental mercury concentration for all three coals (in some cases it appeared to convert elemental mercury to oxidized mercury).

Tasks 7 and 8 were added to the project in April 1996, extending the project duration by 7 months. The new completion date is January 31, 1997. The scope of work for 1996 has switched from pilot-scale to bench-scale activities. One of the main purposes of the bench-scale work is to develop a protocol to screen sorbents under simulated conditions that predict the mercury control capability in full-scale applications. Separate tests are being conducted with elemental mercury and mercuric chloride.

Funding Profile	DOE Share	Nonfederal Share	Total
	\$712,047	\$767,403	\$1,479,450

PROJECT DESCRIPTIONS AND STATUS

Task 18	Coal Ash Resources Research Consortium (CARRC)	Status: Ongoing
Cosponsors	Otter Tail Power Company; Cooperative Power; Contech-J.W. Brett, Inc.; Northern States Power Company; National Minerals Corporation	

Summary

The Coal Ash Resources Research Consortium (CARRC, pronounced "cars") performs research on coal combustion by-products, with emphasis on the scientific understanding of the behavior of these materials in utilization applications and various disposal conditions.

The primary goal of CARRC is to work with industry to solve ash-related problems and promote the environmentally safe, economical utilization and disposal of these highly complex materials. Secondary goals include the generation of scientific and engineering information regarding regulations and specifications for coal combustion fly ash, the development of improved characterization methods for coal combustion by-products, the demonstration of new or improved coal combustion by-product use applications, and technology transfer.

Past CARRC tasks have been broadly based and include the development of the Coal Ash Properties Database (CAPD); the use of CAPD information to study fly ash and its use as a mineral admixture in concrete; comparison of by-products in controlled low-strength materials; development of a predictive leaching procedure for coal by-products; comparative leaching study of coal fly ash and cements; demonstration of high-volume fly ash concrete; comparison of U.S. Department of Transportation specifications for coal ash utilization; and development of advanced characterization techniques for coal combustion by-products. The research tasks are designed to provide useful and complementary information for CARRC members and to promote general coal combustion by-product utilization in engineering, construction, and manufacturing applications. Many research tasks continue annually or are modified as results are collected and interpreted. The CARRC multidisciplinary research team coordinates all tasks and incorporates information from other Energy & Environmental Research Center research, as well as collaborating with other research groups, CARRC members, and other industry partners. Research progress is reported at regular intervals to CARRC members at annual meetings and through topical and annual reports.

In 1997, the proposed CARRC research tasks are focused in three key areas: 1) educational and promotional activities, 2) determination of coal combustion by-product (CCB) reactivity, and 3) behavior of CCBs in products. These focus areas emphasize research and information transfer, addressing issues identified by CARRC members, the general coal combustion by-product industry, and the U.S. Department of Energy. Education and promotion of coal combustion by-product utilization has become increasingly important in the coal combustion by-product industry, and the emphasis on those activities is addressed through the tasks in the 1997 work plan. Development of characterization procedures will continue and will focus on reasonable evaluations of coal combustion by-products and better classification of coal combustion by-products for utilization. The continued development of characterization procedures will facilitate the evaluation of several engineering tasks performed in previous years as well as some continuing tasks.

Funding Profile	DOE Share	Nonfederal Share	Total
	\$270,240	\$377,294	\$647,534

PROJECT DESCRIPTIONS AND STATUS

Task 19	The Application of Fluidized-Bed Combustion Residues for High-Volume Utilization Options	Status: Canceled	
Cosponsors			
<p>Summary</p> <p>Large volumes of residual bed material and fly ash are barriers to commercialization of advanced fluidized-bed combustion (FBC) technologies and contribute to the nation's growing solid waste problems. Utilization options can be identified and demonstrated to make these FBC residues commercially marketable. Since a wide range of FBC residues and related end-use products can be produced from different fuels under various processing conditions, it will be advantageous to investigate a variety of these materials for physical, chemical, mineralogical, and environmental characteristics. By employing a combined materials science and engineering approach, the University of North Dakota Energy & Environmental Research Center (EERC) was to move the investigation beyond the largely empirical approach used in most past projects to enhance utilization options for FBC residuals. We believe that a greatly increased understanding of the materials and processes involved is vital to identifying and demonstrating realistic utilization options that are technically, economically, and environmentally feasible under institutional and regulatory constraints applying in the real world.</p> <p>Unfortunately, after submitting this project to the U.S. Department of Energy (DOE), the EERC was unable to attract sufficient nonfederal funding to match DOE funds. As a result, this project was canceled and the DOE funds used to fund an alternate project.</p>			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$0	\$0	\$0

PROJECT DESCRIPTIONS AND STATUS

Task 20	FT-IR Spectroscopic Investigation of Fireside Deposits in a Pilot Plant Combustor	Status: Complete	
Cosponsor	Electric Power Research Institute		
Summary <p>Successful operation of current, as well as advanced, coal combustion systems depends on controlling and minimizing the development of ash fouling and slagging, i.e., fireside deposits. The development of these deposits depends not only on the combustion design and operating conditions, but also on the composition and quantity of the inorganic species in the coal. The increasing demand for control and mitigation of ash deposition in combustion boilers necessitates refined and advanced technologies. To optimize control strategies, a distinct need exists to obtain improved and faster identification of imminent ash deposition. New advanced spectroscopic techniques offer the potential to achieve this goal.</p> <p>An infrared emission sampling probe (IESP) was designed as an accessory to a Fourier transform infrared (FT-IR) spectrometer to monitor deposit formation in the convective pass of a pilot-scale combustor. The IESP provides a means to monitor infrared emissions produced inside the furnace duct and is designed to fit into a standard optical access while still providing operator viewing through the port.</p> <p>Tests involving the collection of emission spectra of ash deposits on the furnace duct and deposition probes under coal-fired operating conditions of the combustor were conducted on two coals using the IESP. The infrared monitoring of ash deposits was evaluated using Antelope subbituminous and Illinois No. 6 bituminous coals.</p> <p>Data collected using the IESP indicate that the current instrument configuration offers promise in application as a deposit thickness monitor. No information was obtainable on deposit chemistry during formation using this configuration of the IESP; however, several improvements in the instrument can be made that will make it more effective in the measurement of deposit chemistry.</p> <p>The capability of FT-IR spectrometry for remotely monitoring deposit thickness has been demonstrated. After some refinement of the optical interface and development of turnkey software, further investigation of the infrared emissions of ash deposits can be done. The development of the FT-IR spectrometry technique coupled with the IESP can be continued to advance capabilities for the determination of deposit chemistries in situ.</p> <p>In addition, for the application of remote infrared measurements to deposit thickness, a simple optical instrument can be developed using the concept of a two-wavelength measurement. The new instrument will be much less complicated to construct and operate than a FT-IR spectrometer. A unit could be built as a handheld device similar to an optical pyrometer.</p> <p>This project is complete, and the final report was submitted in December 1995.</p>			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$45,000	\$45,000	\$90,000

PROJECT DESCRIPTIONS AND STATUS

Task 21	Sour Gas Plant Subsurface Remediation Technology Research and Demonstration Project	Status: Ongoing	
Cosponsor	Canadian Association of Petroleum Producers		
Summary This project involves a number of interdependent research components related to the development and/or demonstration of remediation technologies to address soil and groundwater contamination at natural gas processing facilities. Continuing research activities include a field evaluations of bioventing, air sparging, ex situ bioremediation of groundwater, and prototype development and demonstration of freeze crystallization. Ex situ bioremediation and freeze crystallization of contaminated groundwater have recently been completed. Final technical task reports on these activities will be submitted in January, 1997. Bioventing using air injection and air sparging trials will be continued throughout the winter months, with confirmatory sampling and analysis to assess cleanup scheduled for early March, 1997. Final technical task reports on these activities will be submitted in March, 1997.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$380,250	\$502,250	\$882,500

PROJECT DESCRIPTIONS AND STATUS

Task 22	Evaluation of Supercritical Fluid Extraction for Analysis of Petroleum Industry Wastes	Status: Complete	
Cosponsor	American Petroleum Institute		
Summary A previous joint venture project with the American Petroleum Institute was completed in March 1993. The first project investigated used supercritical fluid extraction (SFE) to extract gasoline and diesel-range hydrocarbons from soils and included a successful field demonstration of the technique. Extraction of pollutants from waste petroleum sludges and preliminary investigations to define "quantitative" extractions for complex samples were performed. The results of these studies were sufficiently encouraging that a second project with the American Petroleum Institute was started in March 1993 to develop on-line methods for benzene, toluene, ethylbenzene, and xylene (BTEX) determinations as well as to extend SFE methods to heavier hydrocarbons. A number of publications were produced to summarize the methods developed and analytical results from the project. General categories of activities and advances include total petroleum hydrocarbons and BTEX determinations in the gasoline and diesel range; total petroleum hydrocarbon determinations for heavy hydrocarbons and polycyclic aromatic hydrocarbons, including fuel evaluations; and theoretical factors controlling "quantitative" aspects of SFE. Methods developed include SFE coupled with gas chromatography, SFE-infrared spectrometry, SFE with carbon dioxide and oxyanionic modifiers, quantitative SFE methods, and use of drying agents. The project final report was submitted in August 1994.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$100,000	\$100,000	\$200,000

PROJECT DESCRIPTIONS AND STATUS

Task 23	Gas Industry Groundwater Research Program	Status: Ongoing	
Cosponsor	Gas Research Institute		
Summary The objectives of this research program are to develop a comprehensive study to evaluate soil and groundwater contamination at natural gas industry sites and to assess cleanup options. Years 1 and 2 of the program focused on the collection and assessment of background information and data necessary to conduct long-term laboratory and field studies. Year 3 activities included the instrumentation of four gas industry field study sites in New Mexico and Pennsylvania and associated laboratory studies. Contamination from elemental mercury has been the focus of these initial field and laboratory studies. During Year 4, two additional mercury field sites were instrumented in Louisiana. Four quarters of groundwater sampling were completed during Year 5. A total of fourteen GRI topical reports have been published, including eight related to mercury. In addition, a risk-based screening model (HgSCREEN™) was developed for prioritizing sites for mercury remediation. During Year 6, a workshop focused on mercury contamination at oil and gas industry sites was held in New Orleans, Pittsburgh, and San Diego. A total of 145 attendees included representatives from the energy industry, regulatory agencies, environmental consulting firms, and universities. The focus of the program has shifted from mercury to other contaminants at gas industry facilities, such as glycols and amines. Amines are commonly used for the removal of acid gases from the natural gas streams in which they occur. At gas processing plants that use amines for acid gas removal, spills and the on-site management of wastes containing alkanolamines and their thermal reaction products have commonly resulted in subsurface contamination that is the focus of some environmental concern. A comprehensive research program to evaluate the environmental transport and fate of two of the most commonly used amines, diethanolamine (DEA) and methyldiethanolamine (MDEA), in soil and groundwater has been initiated. This research program includes determination of the interactions of these amines with soils and water; an examination of the biodegradability of DEA and MDEA; and thorough organic and inorganic characterization of sludges generated by gas industry use of DEA and MDEA. It is anticipated that this effort will continue for several years and will include a major effort addressing the remediation of sites contaminated from past practices.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$1,299,754	\$1,300,000	\$2,599,754

PROJECT DESCRIPTIONS AND STATUS

Task 24	Utilization of Western Coals in Bituminous Boilers – Pilot Plant Assessment of Blend Properties and Their Impact on Critical Utility Power Plant Components	Status: Complete	
Cosponsors	Electric Power Research Institute; Consol; Empire State Electric Energy Research Corporation; Ziegler Coal Company		
Summary The objective of this program was to assess the impact on boiler performance of blending eastern and western coals. Flame stability testing, high-temperature (2000° and 2200°F) fouling tests, and low-temperature (1500°F) fouling tests were completed for two subbituminous coals and one bituminous coal. Mill performance tests, performed by Consol, Inc., were also completed. The final project report was submitted in December 1994. Results indicate that blending of Powder River Basin (PRB) coals with bituminous coals is an effective strategy for reducing SO ₂ emissions from pulverized coal-fired boilers. The presence of the subbituminous coal will result in a number of operational impacts to a bituminous-design boiler. Mill testing indicated thermal load derates between 25% and 55% of the maximum input of bituminous coal when the higher-moisture subbituminous coals are ground. High-temperature and low-temperature fouling of boiler heat-transfer surfaces can also be expected to increase as the percentage of PRB coal in the blend is increased; conversely, levels of unburned carbon may be expected to decrease. This was confirmed during flame stability testing, which indicated as good or better flame stability as the percentage of PRB in the blend was increased.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$15,881	\$195,000	\$210,881

Task 25	Physical Cleaning of Lignite	Status: Complete	
Cosponsors	Knife River Coal Mining Company; North Dakota Industrial Commission		
Summary The purpose of this study was to elucidate the feasibility of producing from select North Dakota lignites a stable lump fuel with reduced sulfur, moisture, and sodium oxide contents. For this study, a single North Dakota lignite was crushed, sized, and then treated by bench-scale washability testing. The reduction of sulfur and inorganic contents as a function of coal size was estimated for commercial physical cleaning methods. The sized coal was also subjected to a novel water classification process to separate clean coal from inorganic-laden coal fines. Ion exchange using carbonated water (carbonic acid) was investigated as a method for reducing the coal sodium content to improve fouling characteristics. Commercial dry coal-cleaning methods, such as a high-gradient magnetic separation, were investigated for sulfur reduction using various coal size fractions. An Energy & Environmental Research Center-developed oil agglomeration process was investigated for selective rejection of minerals from fine lignite coal (- 100 mesh) and as a method to aggregate fine coal produced during water classification experiments. Pellets were prepared using conventional binders or novel binders, e.g., coal gasification-derived tar oil. A recommendation was prepared concerning the processing methodology required to produce larger quantities of lump fuel. This study demonstrated that lignite could be physically cleaned to reduce ash content from 9 to 6 wt% moisture-free and sulfur emissions from 2.0 to 0.9 lb SO ₂ /MMBtu. Low-moisture briquettes with heating values near 10,000 Btu/lb were successfully produced using low-cost waste wheat and newspaper binders. A final report was submitted to the sponsors in September 1994.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$30,000	\$30,000	\$60,000

PROJECT DESCRIPTIONS AND STATUS

Task 26	Remote-Site Power Generation Opportunities for Alaska	Status: Complete
Cosponsors	Alaska Science & Technology Foundation; Usibeli Coal Mine, Inc.; Placer Dome U.S. Inc.; ENPAC Energy Pacific Company; Major International; Power Engineers; International Coal Preparation Consultants Limited; University of Alaska-Fairbanks	

Summary

The U.S. Department of Energy (DOE) together with the Alaska Division of Energy and a number of the native corporations has undertaken a project to develop alternative small-scale power generation technology options for application in remote villages of Alaska. The Energy & Environmental Research Center is working with the DOE Morgantown Energy Technology Center to assess options for using the tremendous reserves of fossil fuels found in Alaska for small-scale power units.

Typically, remote villages in Alaska use diesel generators fueled with expensive fuel oil for electricity production. The high cost of diesel power in Alaska is heavily subsidized by the state through the Power Cost Equalization program, which amounts to about \$20 million annually. Fuel oil is used extensively for residential and public building heating. The goal of this activity will be to reduce the use of fuel oil in Alaskan villages by developing small, low-cost power generation applications.

A Small Alternative Power Generation Workshop was held in Anchorage, Alaska, in May 1994 as a first step in the development of safe, reliable, and efficient energy systems throughout the state. The workshop was a success: it established good three-way communication among government policy makers, suppliers of technology, and end users, the rural Alaskans. As a result of the interactive presentations and breakout discussion groups during the workshop, the needs of the Alaskans were heard, and a number of technology options were offered that could meet their needs.

A second workshop was held in Seattle, Washington, in September 1995 to share the results of activities undertaken to meet the energy needs of remote villages in Alaska. Additionally, this workshop was used to explore the opportunity to commercialize the technologies and transfer the information to other indigenous communities. The proceedings for this workshop has been issued as the final deliverable for this activity. With this report, this work has been completed.

Funding Profile	DOE Share	Nonfederal Share	Total
	\$250,000	\$271,400	\$521,400

PROJECT DESCRIPTIONS AND STATUS

Task 27	Alaskan Low-Rank Coal-Water Fuel Environmental Attributes and Combustion Test Marketing	Status: Complete	
Cosponsor	Alaska Division of Energy		
Summary This work was proposed as a means to expedite a project to demonstrate at a commercial scale the production and utilization of coal-water fuel (CWF) made from hot-water-dried Alaskan subbituminous coal. Its objectives included developing low-rank CWF combustion test programs with selected potential end users, defining the environmental benefits of replacing heavy oil with CWF, and updating the marketing video prepared with the Alaska Energy Authority, now the Division of Energy. The work plan was completed and approved in October 1995. A final report and other deliverables were submitted to the U.S. Department of Energy in December 1995.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$50,000	\$62,000	\$112,000

PROJECT DESCRIPTIONS AND STATUS

Task 28	An Assessment of the Subsurface Fate of Monoethanolamine at Sour Gas Processing Plant Sites	Status: Ongoing
Cosponsor	Canadian Association of Petroleum Producers; Canadian Occidental Petroleum Ltd.; Environment Canada; National Energy Board (Canada) (other cosponsors are being sought)	

Summary

Monoethanolamine (MEA) is one of the most commonly used chemicals for the removal of hydrogen sulfide, carbon dioxide, and other acid gases from the natural gas in which they occur. At gas processing plants that use alkanolamines for acid gas removal, spills and the on-site management of wastes containing alkanolamines and their thermal reaction products have commonly resulted in subsurface contamination that is the focus of some environmental concern. This project is investigating the natural attenuation processes that control the fate of MEA.

Project activities have thus far accomplished the following:

- A series of samples for project activities has been obtained from a presently inactive sour gas processing plant site in Alberta.
- Experiments designed to determine the effects of temperature and concentration of MEA on the rate of MEA biodegradation in soil/sediment have been completed.
- Experiments designed to estimate the biodegradability of organic compounds in soil/sediment exposed to MEA-containing "sweetening" wastes have been completed.
- Experiments designed to determine whether high concentrations of MEA are toxic or inhibitory to microorganisms in soil/sediment have been completed.
- Experiments designed to estimate the biodegradability of MEA under anaerobic conditions have been completed.
- Experiments designed to assess the role of interactions between MEA and soil/sediment by the determination of distribution coefficients (K_d values) have been completed.
- Available ion chromatography (IC) capabilities have been adapted for the quantitation of MEA in liquids at levels down to 10 ppb. Some work has also been done on adapting these capabilities for the quantitation of MEA thermal reaction products in liquids at ppm levels.
- An effective method for the extraction of MEA from soil, sediment, and solid experimental residues for IC analysis has been developed.
- A joint effort with the National Hydrology Research Institute to examine the use of IC and liquid chromatography/mass spectrometry methods for the detailed analysis of MEA and MEA-related compounds in selected liquid samples has been completed.
- The final report on the experimental activities completed in 1995 has been submitted.
- Selected analytical support has been provided to other investigators that are more comprehensively evaluating the toxic effects of subsurface contaminants at the noted sour gas processing plant site.
- The results of experimental activities designed to examine the biodegradation of MEA sludge in soil indicate that a period of rapid biodegradation of MEA sludge occurred after a short acclimation period, typically resulting in a fixed amount of organic nitrogen removal of about 44%.
- Experimental activities to examine the nature, toxicity, and biological recalcitrance of the remaining organic nitrogen fraction have been completed. Experimental activities designed to assess the biodegradability of selected MEA-related thermal reaction products and to evaluate the effectiveness of landfarming as a remediation technique for soils with MEA-related contamination have also been recently completed.
- The results of the 1996 experimental activities are currently being evaluated and will be presented in a report that will be finalized in early 1997.

Funding Profile	DOE Share	Nonfederal Share	Total
	\$165,130	\$247,032	\$412,162

PROJECT DESCRIPTIONS AND STATUS

Task 29	Mitigation of Air Toxics from Lignite Generation Facilities	Status: Complete
Cosponsor	Lignite Research Council; Electric Power Research Institute; Montana-Dakota Utilities Company; Minnesota Power; Basin Electric Power Cooperative; Cooperative Power Association	

Summary

Concerns over emissions of trace metals, considered air toxics, from coal-fired power plants are increasing. The Amendments to the Clean Air Act of 1990 list 189 substances as potential hazardous air pollutants. Further, the Amendments established a schedule under which the U.S. Environmental Protection Agency (EPA) is required to establish maximum achievable control technology standards for existing major sources of hazardous pollutants. A major source is any source that emits (or has the potential to emit) more than 10 tons per year of any one listed pollutant or 25 tons per year or more of any combination of listed pollutants. Coal combustion is thought to be a significant source for eleven metals on the list of 189 substances (antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, mercury, nickel, and selenium).

The purpose of this project was to determine the applicability of using sorbents to control the emissions of trace elements during the combustion of lignite and Powder River Basin (PRB) coals. Research activities performed under this project supplemented and complemented other research projects under way at the Energy & Environmental Research Center.

The Big Sky PRB coal was analyzed using atomic absorption and inductively coupled argon plasma spectroscopy to determine the concentrations of antimony, arsenic, beryllium, cadmium, chromium, cobalt, lead, manganese, mercury, nickel, and selenium. Along with the trace element analysis, standard bulk chemistry analyses were performed.

Lime and activated carbon-based sorbents were selected for testing based on results from a complementary project currently funded by EPA, the North Dakota Industrial Commission, and industry. The selected precombustion (lime) and postcombustion (activated carbon) sorbents were tested separately in a pilot-scale 550,000-Btu/hr particulate test combustor (PTC) equipped with an electrostatic precipitator and baghouse. Both particulate and gas samples were obtained during the tests to determine their trace element contents. Particulate and gas samples were collected and analyzed using currently accepted EPA methods. Results from the PTC testing were compiled to determine the reduction in trace element emissions as a result of the mitigation technologies tested. Most of the trace elements, with the exception of mercury and selenium, were in the solid phase and collected in the baghouse. Precombustion and postcombustion sorbents do not appear to be effective for capturing mercury or selenium. The ashes from the tests were tested for their leachability, which may impact their potential disposal. The pre- and postcombustion sorbents tested do not appear to have any detrimental effect on ash utilization and disposal.

A final report was completed and submitted to the U.S. Department of Energy in October 1995.

Funding Profile	DOE Share	Nonfederal Share	Total
	\$100,000	\$100,000	\$200,000

PROJECT DESCRIPTIONS AND STATUS

Task 30	Hot-Gas Filter Ash Characterization Project	Status: Ongoing
Cosponsors	Electric Power Research Institute; Westinghouse; Lurgi Lentjes Babcock (Germany); PowerGen; Schumacher Filters America; Electricité de France, ECN/NOVEM (Netherlands); Electric Power Development Corporation (Japan); ABB-Carbon (Sweden)	

Summary

The Electric Power Research Institute has organized a consortium to fund research to be performed at the Energy & Environmental Research Center (EERC) to determine the coal- and system-related factors that lead to the formation of ash that blinds and bridges hot-gas cleanup filters. The objectives are threefold: 1) to determine the mechanisms by which difficult-to-clean ash is formed and how it blinds or bridges hot-gas filters; 2) to develop a method to determine the rate of blinding or bridging based on analyses of the feed coal and sorbent and on the operating conditions; and 3) to provide suggestions for preventing blinding and bridging. The work will encompass field sampling and laboratory-, bench-, and pilot-scale testing. The main deliverable will be a computer model and database that could be used to optimize energy system operating conditions, choose coals and sorbents, or design the cleanup system.

To date, over a dozen sets of samples, including coal, sorbent, bed material, and ashes, have been received from the American Electric Power Tidd plant and are being analyzed by advanced scanning electron microscope and surface science techniques. Samples have also been received and analyzed from the Grimethorpe pressurized fluidized-bed combustor (PFBC), the British Coal Filter Development Rig, and the British Coal Gas Utilization Facility filter, the Demkolee integrated gas combined cycle (IGCC), the Foster Wheeler pilot plant in Karhula, Finland, the U.S. Department of Energy Morgantown Energy Technology Center gasifier, and the EERC transport reactor. In addition, a high-temperature powder tensile strength tester has been built and used to test three filter ashes at temperatures to 800°C. Thermochemical equilibrium modeling is being performed with the University of Montreal FACT code to determine possible upon-deposition reactions in the Tidd and Piñon Pine filter vessels. Five 500-hour cake sintering tests have been performed, and bench-scale testing simulating Tidd operating conditions has begun to determine factors affecting the final size and composition distribution of filter ash particles. Sixteen ash formation tests and a 100-hour test of residual cake formation have been completed with a bench-scale PFBC.

Funding Profile	DOE Share	Nonfederal Share	Total
	\$825,000	\$1,005,000	\$1,830,000

PROJECT DESCRIPTIONS AND STATUS

Task 31	Formal Evaluation of Flue Gas Chemical Measurement Methods Phase I – Verification of Mercury Speciation by EPA (Draft) Method 29	Status: Ongoing	
Cosponsor	Electric Power Research Institute		
Summary The objective of the work is to determine whether the U.S. Environmental Protection Agency (EPA) Method 29 or other mercury-sampling methods can reliably quantify and speciate mercury in flue gas from coal-fired boilers. Work has been completed on both pilot- and bench-scale testing. Sampling methods that have been tested to date include the EPA Method 29, an acetate buffer method, a tris-buffer method, the Mercury Speciation Adsorption Method (MESA), and the Ontario Hydro method. All of these methods, with the exception of the MESA, are modifications of EPA Method 29. Bench- and pilot-scale results show that for a medium-sulfur bituminous coal, EPA Method 29 overestimates the oxidized fraction of the mercury by up to 30%. At the bench-scale level, the MESA method also overestimates oxidized mercury when 1500 ppm SO ₂ and 600 ppm NO are present in the simulated flue gas. Bench-scale results showed that the Ontario Hydro and tris-buffer had promise for speciating mercury correctly in coal-fired systems. This observation was supported by the most recent pilot-scale tests. In these pilot tests at the outlet of a high-efficiency pulse-jet baghouse, both of these methods correctly speciated the flue gas mercury based on known spiked concentrations of either elemental mercury or mercury(II) chloride. Additional bench- and pilot-scale tests will be completed to verify these results, and if the results from these tests continue to show promise then formal validation pilot-scale tests will follow.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$1,032,155	\$1,658,980	\$2,691,135

PROJECT DESCRIPTIONS AND STATUS

Task 32	Organic Sulfur Removal from Coal with Super- and Subcritical Water	Status: Ongoing	
Cosponsor	Illinois Clean Coal Institute		
Summary <p>The main objective of this investigation is to develop an economically feasible method for the removal of organic sulfur and selected hazardous air pollutants (HAPs) from Illinois Basin high-sulfur coals for clean coal and niche market applications. During this project super- and subcritical water were used as extraction fluids rather than the traditional organic liquid solvents. This work took advantage of the properties of subcritical water (temperature <374°C, pressure <218 atm) for the removal of organic sulfur and selected HAPs by simply controlling the extraction temperature and pressure.</p> <p>Initial efforts were to focus on using a bench-scale system to evaluate the water's extractive properties on selected coal samples. Results indicated that a compliance coal could be produced from a coal with nearly 3.0 wt% sulfur using subcritical water extraction. Remaining solid residual was blended with a desulfurized aromatic mixture which was produced during the process. Data on the fuel indicated a sulfur content of 0.7 wt%, with recoveries nearly 70 wt%. In addition, mercury concentration were reduced by nearly 90 wt% in the coal using the extraction procedures.</p> <p>Recent efforts were to scale up the technology using EERC's hydrothermal pilot-scale system, capable of treating 100-lb/hr. Year 3 will involve optimization of a continuous process for desulfurization of coal and on-line tar desulfurization. In addition to organic sulfur removal, the third year of the current research program will include the investigation of selected HAP (e.g., mercury) removal from coal with subcritical water at the pilot scale. Combustion tests will be carried out with the deep-cleaned product to determine burn characteristics as well as investigate selected HAPs (e.g., mercury) and other emissions.</p> <p>The scheduled completion date of the third-year investigation is August 31, 1997.</p>			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$160,218	\$198,527	\$358,745

PROJECT DESCRIPTIONS AND STATUS

Task 33	Upgraded North Dakota Lignite – Production of Test Quantities	Status: Complete	
Cosponsor	North Dakota Industrial Commission		
Summary The objective of this project was to produce two 1-ton quantities of upgraded North Dakota lignite that would subsequently be subjected to test burns (in a separate project) as a potential blend stock for pulverized coal combustion. Two selected North Dakota lignites were subjected to size reduction and classification and then treatment by wet dense-media (magnetite) physical cleaning to reduce the inorganic (mineral) and pyrite contents. One cleaned lignite was treated by the Energy & Environmental Research Center hot-water-drying technology. This technology effectively reduced the moisture content of the coal, precluding reabsorption, and also diminished the alkali content. The treated coals were aggregated via briquetting. Thermal treatment with superheated nitrogen was used to reduce the moisture content and increase the heating value of one briquetted lignite. The products met target specifications for theoretical sulfur emissions, moisture level, heat content, sodium content, size, and ash content. The final technical report was submitted in November 1994.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$25,000	\$40,000	\$65,000

Task 34	Coal Quality Expert Fouling and Slagging Algorithm Development	Status: Ongoing	
Cosponsor	Black & Veatch		
Summary Task 1 - Code Completion. This task concentrated on completing and enhancing the previously developed codes so that no programming or concept errors remained. The work is completed for both the fouling and the slagging codes. Specific work to be completed was development of slagging deposit removal mechanisms, integration of all algorithms into a time-and-temperature history algorithm, and output of all data into the Coal Quality Expert (CQE) main program. This work included completing all of the coding aspects as required by Black & Veatch for complete integration into the CQE code. Task 2 - Testing and Validation. This task will entail cooperation between the Energy & Environmental Research Center and Black & Veatch in "tuning" the fouling and slagging codes for optimum performance. Although these codes are state of the art, they do contain a significant number of parameters for which experimental data are lacking. The codes will need to be designed to run under expected situations and conditions. Only a limited amount of validation will be performed with currently existing experimental results because of the lack of available quantitative data. The final version of both the fouling and slagging codes have been provided to Black & Veatch. Validation of the codes is being performed with Black & Veatch. A final report will be submitted during the first quarter 1997.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$40,000	\$60,000	\$100,000

PROJECT DESCRIPTIONS AND STATUS

Task 35	Evaluation of Field Analytical Techniques for Mercury in Soil	Status: Ongoing	
Cosponsor	Gas Research Institute; NOVA Corporation of Alberta; General Electric; BioNebraska; Spectrace		
Summary Within the natural gas industry there exists a need for fast, reliable analytical techniques for the quantitation of mercury in soils. These techniques could potentially be used in initial investigations at mercury spill sites, as guidance in site remediation activities, and for confirmation in postclosure monitoring. Within the last 2 years, several techniques have been developed and refined that may be able to provide this capability. However, no detailed comparison of these techniques to one another and to standard methods of analysis has been undertaken. The objective of this project is to compare the accuracy and precision of four analytical techniques for the quantitation of mercury in various soil types. Two of the techniques are commercially available, and the other two are under development, including one being developed at Oak Ridge National Laboratory. Preliminary results indicate that several of the field-transportable analytical techniques have significant potential to provide fast, reliable data for the quantitation of mercury in soil. One of the project cosponsors, NOVA Corporation, has slightly modified one of the techniques and has been using the modified technique for field analysis with promising results. Reviewers' comments have been incorporated into the final report and a final review will be completed in December 1996. The report will be issued first quarter 1997.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$40,000	\$89,500	\$129,500

Task 36	Combustion Characterization of Carbonized Refuse-Derived Fuel from Temperature Optimization Tests	Status: Ongoing	
Cosponsor	EnerTech Environmental Inc.; City of Grand Forks		
Summary A refuse-derived fuel obtained locally was converted through the Energy & Environmental Research Center (EERC)-EnerTech carbonization process to a pumpable slurry fuel for use in a pilot-scale combustion test. The fuel was fired at a rate sufficient to maintain a furnace exit gas temperature of 2000°F at an excess air rate near 25 %. Results indicated excellent combustion efficiency, as more than 99.5% of the carbon was converted to carbon dioxide and water. The fuel exhibited a very low ash-fouling potential, and fly ash resistivity measurements indicated that adequate collection could be achieved using an electrostatic precipitator. The fly ash was also tested to determine the degree to which toxic trace elements would be leached from the ash in a disposal or reuse scenario. Analyses indicated that toxic trace elements would not be leached from the fly ash above current standards. The EERC is currently negotiating a development program that will include demonstration of an alternate method of dealing with municipal solid waste involving presorting municipal solid waste followed by slurry carbonization to produce an energy-rich slurry fuel. This fuel will then be fired in the EERC's test furnaces to demonstrate its technical and environmental viability. A preliminary engineering assessment of a full-scale facility to meet the future needs of the city of Grand Forks will also be included.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$200,000	\$304,096	\$504,096

PROJECT DESCRIPTIONS AND STATUS

Task 37	Recent Advances in Research on Ash Deposition in Utility Boilers: Practical Applications for the Electric Power and Coal Industries	Status: Ongoing	
Cosponsors	Multiclients		
Summary Over the course of the past several years, significant advances have been made at the Energy & Environmental Research Center in the understanding of ash behavior. These advances in understanding are leading to the development of new methods to predict and mitigate ash-related problems. The advanced methods are much more complex than those based on American Society for Testing and Materials analyses. The approach to the problem involves a more quantitative understanding of the inorganic composition of the coal and the processes involved in the formation of ash and ash deposits. The complexity of the problem creates a natural void between the researcher and the practical engineer, operator, and designer. One of the most important issues is the need to develop better communication among the researcher, coal company, boiler manufacturer, and utility. Common ground between each of these members of the coal community must be established to facilitate the transfer of information essential for solving ash-related problems. The objective of this program is to transfer technical information concerning ash formation and ash deposition in utility boilers through the use of a short course. To date, short courses have been presented in Orlando, Florida; Chicago, Illinois; Bismarck, North Dakota and Minneapolis, Minnesota. Additional short courses are scheduled to be held in Petten (The Netherlands); Madison, Wisconsin, and Clearwater, Florida.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$60,331	\$90,502	\$150,833

Task 38	Mercury Remediation Technology Research and Demonstrations	Status: Complete	
Cosponsor	Gas Research Institute		
Summary This project involves research and demonstration of commercial mercury remediation technologies for treating gas industry-contaminated soils. This work was done at two sites where commercial soil remediation activities were currently ongoing. Two companies recently began offering mercury remediation technologies specifically designed to treat gas industry mercury-contaminated soils. The two companies are Earth Treatment Technologies (ETT), operating in Ohio, and Mercury Recovery Services (MRS), operating in New Mexico. ETT used a combination of physical separation and chemical leaching (soil washing) to remove mercury from gas industry soils that were shipped to this facility (a Resource Conservation Recovery Act Part B treatment, storage, and disposal facility). MRS used thermal retorting and processed over 6000 tons of mercury-contaminated soil at their client's site. One ton of elemental mercury has been recovered for recycling. Both operations have been witnessed and sampled by Energy & Environmental Research Center personnel. The final report will be issued in December 1996.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$40,000	\$60,500	\$100,500

PROJECT DESCRIPTIONS AND STATUS

Task 39	Preparation and Gasification of Thailand Coal-Water Fuels	Status: Complete	
Cosponsor	Department of Mineral Resources, Thailand		
Summary The project objective was to evaluate the technical feasibility of employing coal beneficiation techniques to upgrade Thai lignite to generate a coal-water fuel (CWF). This fuel was gasified in an existing system at the Energy & Environmental Research Center (EERC). The gasification efficiency and heat energy content of the gas was determined from various measurements on the product gas and residual solids. Approximately 600 kg of 6 in. × 0 lignite was received in mid-October. The coal was sized and processed using bench-scale cleaning and hydrothermal equipment. Cleaning resulted in a 70% reduction in ash but only a moderate reduction in sulfur content. Hydrothermal tests were conducted at three temperatures using raw coal ground to two different particle-size distributions, producing CWF with over 50 wt% solids. Over 500 pounds of CWF was produced using EERC's pilot-scale hydrothermal treatment system for subsequent gasification testing. Three tests were conducted using Thailand raw and treated coal samples. All three tests were conducted under mild gasification systems. Gasification results will assist personnel select future testing conditions and potential commercial systems. Also, in February 1996, personnel from the Thailand Department of Mineral Resources completed interactive training by observing bench- and pilot-scale demonstrations in coal cleaning, briquetting, hot-water drying, CWF preparation and evaluation, and CWF gasification. A final report was issued July 1996.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$49,771	\$75,000	\$124,771

Task 40	Mercury Sorbent Evaluation	Status: Ongoing	
Cosponsor	Electric Power Research Institute		
Summary The purpose of the project is to evaluate the mercury control capabilities of new sorbents that have been selected after discussion among the U.S. Department of Energy, Electric Power Research Institute, and the Energy & Environmental Research Center. The focus of the program has been switched from pilot- to bench-scale tests to evaluate sorbents for mercury control. It was originally set up as a separate task at the request of the industrial sponsor. However, the current scope of work for Tasks 17 and 40 is similar, and the two tasks are being conducted in parallel. A fixed-bed configuration is being used along with an on-line mercury analyzer to evaluate sorbents. Results to date include:			
<ul style="list-style-type: none">• Design and construction of a fixed-bed bench-scale unit to evaluate sorbents for capture of elemental mercury and mercuric chloride.• Development of a test protocol for evaluating potential mercury sorbents.• Establishment of repeatable results and system blanks with the fixed-bed system.• Development of a thermal conversion system to convert oxidized forms of mercury to elemental mercury, which can be measured by the on-line mercury analyzer.• Evaluation of several activated carbons for elemental mercury control.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$124,350	\$185,650	\$310,000

PROJECT DESCRIPTIONS AND STATUS

Task 41	Lignite Resource Characterization and Evaluation for Mitigation of Ash Deposition	Status: Complete	
Cosponsor	Montana-Dakota Utilities; Knife River Coal Mining Company; North Dakota Industrial Commission		
Summary The Energy & Environmental Research Center has nearly completed a coordinated research program to evaluate and optimize both mine coal quality and utility boiler operation at the Knife River Coal Mining Company Beulah mine and the minemouth plant at Montana-Dakota Utilities Coyote Station, respectively. The Coyote Station has experienced severe ash fouling and slagging in the past, which decreases power production efficiency and threatens the continued economical utilization of a vast lignite resource. A detailed mineral and chemical characterization of the lignite currently being mined was performed, as well as a concurrent examination of the plant's operating characteristics. Methods were devised to blend different mine reserves in a way that minimizes ash fouling and slagging. In conjunction with the coal quality assessment, methods were devised to minimize ash fouling and slagging in the boiler by optimizing boiler operating procedures. A computer program that will drive the predictive capabilities for mine planning was developed. Technologies and methods developed through this project have the potential to be implemented by similar mine and power plant operations, with the end result of stabilizing use of low-rank coals.			
The final report for this task will be completed by the end of December 1996.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$152,000	\$228,000	\$380,000

Task 42	Holocene Cyclicity in Western North Dakota—Climate Change Interpreted from Fluctuations in Alluvial Sedimentation	Status: Ongoing	
Cosponsor	Electric Power Research Institute		
Summary <p>This project will interpret a portion of the postglacial climatic history of the northern plains by examining the alluvial record in badlands terrain. Examination of this record for short-term cycles has not been previously attempted. Knowing, however, the close connection between cycles of erosion and deposition and climate in semiarid landscapes suggests this approach may prove very useful in interpreting paleoclimates and, hopefully, the cycles of change in the recent past. Such interpretations would provide a new approach to examining climatic variability in the past, reflecting periods of extended dry and moist conditions, and result in the development of a more rigorous context for interpreting human interactions with both their physical and biotic surroundings.</p> <p>Sediment samples collected in June and September are being analyzed for standard physical characteristics (e.g., grain size, loss on ignition) by Ms. Deborah Beck (University of North Dakota), stable carbon isotopes by Drs. Thomas Boutton and David Kuehn (Texas A&M University), palynomorphs by Dr. Timothy J. Kroeger (Bemidji State University), phytoliths by Dr. Greg Fredlund (University of Wisconsin-Milwaukee), and radiometric dating at the AMS Facility at Woods Hole Oceanographic Institute.</p>			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$64,972	\$99,964	\$164,936

PROJECT DESCRIPTIONS AND STATUS

Task 43	Oxidation of North Dakota Scrubber Sludge for Soil Amendment and Production of Gypsum	Status: Ongoing	
Cosponsor	Cooperative Power Associates; North Dakota Industrial Commission		
Summary Oxidation of North Dakota scrubber sludge is a two-phase project focusing on the potential for utilization of this material. Phase I is focused on optimization of the oxidation of sulfite in the scrubber sludge to sulfate for agricultural utilization. Phase II of the project will expand on Phase I, utilizing oxidized scrubber sludge for other markets, such as the manufacture of gypsum wallboard. Laboratory studies of the oxidation process are nearly completed, and a pilot-scale oxidation of 500 gallons of scrubber sludge has been completed. Material produced in this pilot-scale run has been pelletized using a variety of binders. The results of pelletization are being evaluated. Material produced in the pilot-scale run is being characterized to determine partitioning of trace elements between the liquid and solid phase as well as particle-size distribution, bulk chemistry, and morphology. Preliminary results indicate that an extremely pure material was produced, similar to that generated in laboratory-scale experiments.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$40,000	\$80,000	\$120,000

Task 44	Pilot Plant Assessment of Fly Ash Agglomeration	Status: Ongoing	
Cosponsor	Thermal Energy Systems, Inc.		
Summary The project objective is to demonstrate the potential for two novel ionization systems for agglomerating fly ash to improve electrostatic precipitator (ESP) performance. One system places the ionizer in the combustion zone, while the other would be installed in the ductwork ahead of the ESP. To accomodate the in-furnace ionizer, the EERC's combustion test facility was redesigned, extending the overall height of the test furnace and modifying the flue gas piping and surrounding support structure. System modifications required to install the ionizer systems have been completed. Thermal Energy Systems, Inc., will provide the ionization systems after design and construction has been completed. Project activities have been postponed to allow the commercial sponsor to secure funding for completion of the project.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$209,993	\$318,007	\$528,000

PROJECT DESCRIPTIONS AND STATUS

Task 45	Small-Scale Demonstration of the Freeze-Thaw/ Evaporation Process to Treat Oil and Gas Produced Waters	Status: Ongoing	
Cosponsor	Gas Research Institute; Amoco Production Company		
Summary The freeze-thaw/evaporation demonstration project is being conducted to evaluate the economical coupling of the freeze crystallization water purification process with evaporation in order to reduce the volumes of oil- and gas-related produced waters that ultimately require disposal in Class II injection wells, as well as to evaluate the freeze crystallization process to produce a reusable quality of purified water. Project activities completed to date have included the acquisition of regulatory approval from the state of New Mexico's Oil Conservation Division and the construction and installation of equipment at the technology demonstration facility. Hydrostatic testing of the piping, pumps, tanks, and related instrumentation has also been conducted. Operations over the winter of 1995-1996 confirmed the potential for economical production of water suitable for various beneficial uses. Preparations were completed in the fall of 1996 such that operation of the process can resume over the winter of 1996-1997. This will be followed by an observation at the evaporation process during the spring and summer of 1997, followed by an evaluation of the data collected for the coupled freeze-thaw/evaporation process and final report preparation.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$200,000	\$600,000	\$800,000

Task 46	Training and Support for Hot-Gas Filter Testing	Status: Complete	
Cosponsor	3M, Industrial Filter & Pump, and Pall Advanced Filters		
Summary The University of North Dakota Energy & Environmental Research Center has completed a program called "Training and Support for Hot-Gas Filter Testing" as part of the Jointly Sponsored Research Program. The goal of this program was to maximize the exchange of information during a 200-hour filter test on the transport reactor demonstration unit. Photos, samples, and operations data were distributed to Southern Company Services, Inc. (SCS), Morgantown Energy Technology Center (METC), M.W. Kellogg, and Brigham Young University on the transport reactor demonstration unit. SCS, METC, M.W. Kellogg, 3M, Westinghouse, Industrial Filter & Pump, and Pall Advanced Filters have received data and samples from the filter test program. The program has been completed, and the information will be reported with the final transport reactor demonstration unit/hot-gas filter test report.			
The final report was completed in September 1996.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$20,539	\$20,539	\$41,078

PROJECT DESCRIPTIONS AND STATUS

Task 47	Development of a Coal Combustion By-Product (CCB) Database System	Status: Ongoing	
Cosponsor	American Coal Ash Association		
Summary This task involves developing a computer database and application program to contain analytical and engineering information on coal combustion by-products. Data will be collected from American Coal Ash Association (ACAA) members and input to the database. A complete database application, manual, and final report will be delivered to ACAA and the U.S. Department of Energy. This project was initiated in October 1995 with funding from the ACAA. Since October, the collection forms for data have been designed. A prototype of the database application was developed and sent to the ACAA for review. The ACAA approved the prototype at the end of May 1996. The application (user front-end) is in the process of being developed from data that the Coal Ash Resources Research Consortium (CARRC) has input to the database. The database has been designed.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$19,800	\$29,700	\$49,500

Task 48	Coal Ash Behavior in Reducing Environments (CABRE) II	Status: Ongoing	
Cosponsor	KEMA; ELCOGAS; Babcock-Hitachi K.K.; Krupp-Koppers; Electric Power Research Institute; NOVEM		
Summary The Coal Ash Behavior in Reducing Environments (CABRE) II program is a 3-year multiclient program set in four tasks. The overall purpose of Task 1 is to advance the current fundamental understanding of ash formation by correlating ash characteristics in large-scale systems with their operational parameters. Ash formation and decomposition will be assessed on the effects of an H ₂ S atmosphere, short-residence-time transformations, and the formation of submicron or aerosol particles, largely through the use of a pressurized entrained-flow gasification simulator. Task 2 will focus on the incorporation of engineering and systems applications designed to best mimic the deposition attributes of large-scale systems. This will involve field discussions and sample collection at large-scale sites, laboratory testing of strength and growth rates in bench-scale units, and viscosity modeling of ash and deposits. Task 3 will use the information gained from CABRE I and CABRE II to develop a series of deposition indices that will aid designers and operators in the mitigation of ash-related problems. Demonstrations of the models on sponsor systems will be performed. Task 4 is the management and reporting function of the program. A kickoff meeting was held in Petten, Netherlands, in April 1996, and another meeting in Grand Forks in October 1996. Laboratory work is in progress.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$118,000	\$242,000	\$360,000

PROJECT DESCRIPTIONS AND STATUS

Task 49	Validation of PCQUEST	Status: Ongoing	
Cosponsor	Duke Power; Foster Wheeler; Entergy/Arkansas Power & Light; Wisconsin Power & Light; Mountain Inc.; Electric Power Research Institute		
Summary Since the development of the fireside performance indices for coal combustion called PCQUEST, many utilities and coal companies have used PCQUEST for selecting coals and boiler operating parameters. A joint venture project between commercial industry clients and the U.S. Department of Energy has been established, which continues to provide modifications, validation, and customization of PCQUEST as applied to the variety of new fuels and systems that are being used by the coal and power industries. The work includes expansion of the fuel database by performing advanced and conventional coal analyses; further refining the accuracy of predictive algorithms for slagging, high-temperature fouling, low-temperature fouling, slag-tapping ability, opacity, tube erosion, coal grindability, and sootblower effectiveness; performing drop-tube furnace experiments to verify combustion ash characteristics; and evaluating full-scale conditions for correlation to the predictive indices. To date this program has engaged in the following projects: 1) participation from Mountain, Inc., in the evaluation of fireside performance of a Fort Union Formation Montana subbituminous coal, 2) a project with Foster Wheeler for determining the fireside performance impacts of two bituminous coals in a boiler that has had slag screens removed, 3) work performed to assess low-temperature deposit formation in the finish superheat assembly of the Entergy/Arkansas Power & Light White Bluff Unit 2, 4) an evaluation of five different fuels and one coal-soil blend at a Duke Power coal-fired boiler, and 5) the investigation of reheater high-temperature ash deposition at the Wisconsin Power & Light Columbia Energy Center.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$100,000	\$150,000	\$250,000

PROJECT DESCRIPTIONS AND STATUS

Task 50	Deposition of Lignites in the Fort Union Group and Related Strata of the Northern Great Plains	Status: Ongoing	
Cosponsor	The Philip McKenna Foundation		
Summary <p>This research concerns determination of the timing of coal deposition in the Fort Union Coal Region, as occurring in the northern Great Plains areas, particularly in North Dakota and Montana. The project objective is to develop a time framework that allows for the temporal comparison of coal deposits and, thus, coal-forming conditions, through the sequence of intercalated freshwater and marine deposits occurring from the uppermost Cretaceous through the Paleocene and into the Early Eocene in the Paleocene in the Fort Union Coal Region. The objective of this project is to better delimit the timing of coal formation in the Fort Union Coal Region to make possible more rigorous interpretations of the paleoenvironmental conditions under which lignite formed in this region. Such knowledge potentially permits more precise prediction of coal quality and thickness and thus contributes significantly to effective resource evaluation and utilization.</p> <p>Research conducted to date has resulted in a means to better interpret the timing of the deposition of sediments and formation of peat deposits leading to the formation of coal in the Paleocene strata of North Dakota and adjacent areas. Through the use of paleomagnetic reversal stratigraphy, radiometric dates, nonmarine mollusks and mammals, marine microfossils, and subsurface lithostratigraphic correlations, a chronostratigraphic (temporal) framework has been constructed for the uppermost Cretaceous, Paleocene, and lower Eocene strata of North Dakota.</p>			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$25,000	\$25,000	\$50,000

Task 51	Oxygen Plasma Unit for Soil Decontamination: Demonstration of a Field-Scale Unit	Status: Ongoing	
Cosponsor	AGSCO, Inc.		
Summary The Energy & Environmental Research Center (EERC) organized a project to demonstrate a field-scale unit for the cleanup of soils contaminated from pesticides, petrochemicals, and other organic toxins. Previous projects at the EERC have demonstrated the use of a low-temperature plasma to break down harmful organics into the basic constituents of carbon dioxide and water. Results from the work within this project showed the potential for cleanup at larger scales; however, areas requiring additional understanding, which are critical to its operation at larger scales, were also identified. As a result, the research portions of the project were terminated until additional research is performed through other means that satisfy the project need for effective scale-up. A compilation of this research and identification of the areas needing additional research will be identified in the final report, which will be completed in the first quarter of 1997.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$199,703	\$499,000	\$698,703

PROJECT DESCRIPTIONS AND STATUS

Task 52	Evaluation of a Zirconium Additive for the Mitigation of Molten Ash Formation During Combustion of Residual Fuel Oil	Status: Ongoing	
Cosponsor	Florida Power & Light		
Summary The project objective is to verify the formation of a molten black glass deposit during combustion of residual fuel oil at pilot scale. Once established, subsequent testing will determine the effectiveness of using an additive to modify the deposition mechanism. To date, testing has been unsuccessful in establishing the baseline deposit. Two days of testing in the Energy & Environmental Research Center's combustion test facility (CTF) indicated that the deposition rate was too low to permit the formation of the black glass deposit. Microscopic examination of the deposits generated indicated the onset of the molten ash phase. In a smaller-scale combustor, deposits were collected over 2 days of operation with similar results. Based on the microscopic examination, it was determined that additional time would be required to form the baseline deposit. With limited resources, an alternative solution was sought. At the direction of Florida Power & Light, fly ash taken from one of their oil-fired units will be added to the oil at a level sufficient to increase the ash content of the oil from 0.1% to 1.0%. It is expected that the increased ash content will increase the deposition rate such that the expected baseline deposit may be formed in a much shorter time period.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$25,373	\$38,060	\$63,433

PROJECT DESCRIPTIONS AND STATUS

Task 53	Construction, Demonstration, and Evaluation of an Economic and Environmentally Safe Evaporation and Holding Pond Design	Status: Negotiating with commercial sponsors
Cosponsor	Electric Power Research Institute; Amoco Production Company	

Summary

The economic and environmentally safe pond design to be demonstrated calls for the construction of the pond above ground surface on a gravel/sand pack that incorporates a well screen seepage recovery header for leachate collection. This seepage collection layer overlies compacted native materials. The net effect created by these two layers is a horizontal-to-vertical permeability ratio of greater than 1000, reducing the potential for subsurface seepage to effectively zero. A containment trench, seepage return pump, and piping are automatically controlled by trench fluid level to return seepage to the pond. A moisture sensor grid is installed underneath the well screen header to confirm no leakage to the subsurface. In addition, a berm for temporary fluid containment is in place in case of a catastrophic event. The project will be conducted over an 18-month period, as follows:

- Task 1 - Acquisition of the required regulatory approval for the construction and demonstration of the pond.
- Task 2 - Construction of the pond and installation of piping, pumps, and instrumentation required to perform the demonstration.
- Task 3 - Operation of the pond with the objectives of collecting sufficient data to evaluate the efficiency of the design.
- Task 4 - Evaluation of the pond. The objectives of this task are as follows:
 1. Confirm the technical and economic feasibility of the pond.
 2. Gain regulatory approval for further uses of the pond design.

Contractual negotiations are ongoing with the Electric Power Research Institute. It is anticipated that funding will be in place by late December 1996, and the project will begin shortly thereafter.

Funding Profile	DOE Share	Nonfederal Share	Total
	\$70,000	\$130,000	\$200,000

Task 54	Activated Carbon for Environmental Applications	Status: Ongoing
Cosponsor	Environmental Energy Systems Incorporated	

Summary

The Energy & Environmental Research Center at the University of North Dakota and Environmental Energy Systems Incorporated through a collaborative effort propose to develop and test a hydrothermal process involving principles of sub- and supercritical water processing for producing and regenerating specialized sorbents for environmental pollutant cleanup applications.

Initial efforts were focused on completing a fundamental review of lignite char properties and their applicability to utilization as activated carbons. Various blends of lignite and other biomass/waste material are also being considered as potential feedstock. New efforts are aimed at using the hydrothermal process to stabilize mercury once it has been captured by sorbents.

Funding Profile	DOE Share	Nonfederal Share	Total
	\$26,668	\$40,000	\$66,668

PROJECT DESCRIPTIONS AND STATUS

Task 55	Binderless Agglomeration of K-Fuel® Product – Preliminary Evaluation	Status: Ongoing	
Cosponsor	Kennecott Corporation		
Summary The goal of this project is to evaluate the technical and economic potential for using binderless agglomeration to reconstitute K-Fuel®-treated low-rank coal to produce a premium fuel for industrial stokers, utility boilers, and domestic heating furnaces. Success of the process will yield a strong lump product that is stable toward water reabsorption, friability, and spontaneous, or self-, heating and that retains the desired properties of the K-Fuel®-treated coal. Based on the individual merits of the K-Fuel® and binderless agglomeration processes, it is contended that a combined process represents a feasible, practical approach to upgrade low-rank coal to a commercially viable premium product. Furthermore, the combined process provides a technology with significant export potential to East Central Europe and the Asia-Pacific region, where there are reserves of billions of tons of lignite and brown coal. Results indicate that a relatively strong briquette can be produced using roll briquetting after the K-Fuel® process. Fundamental review of physical and chemical properties of K-Fuel® both before and after agglomeration has identified the importance of process temperature. Efforts continue to characterize the handling properties of the briquettes and review the commercial applicability of the selected agglomeration technology.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$139,253	\$207,420	\$346,673

Task 56	Preliminary Economic Evaluation of UCG at Saba Yoi, Thailand	Status: Ongoing	
Cosponsor	Department of Mineral Resources, Thailand		
Summary The project goals consist of technical and economic evaluation of the use of underground coal gasification (UCG) technology at the Saba Yoi coalfield in southern Thailand to provide a feedstock for petrochemical production and commercial on-site electric power generation. The project was initiated in October 1996. The ongoing feasibility study focuses on 1) the evaluation of the available site technical and economic data, 2) design and interpretation of supplementary site characterization data, and 3) preliminary economic analyses and evaluation of the UCG feasibility at the site.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$60,000	\$90,000	\$150,000

PROJECT DESCRIPTIONS AND STATUS

Task 57	Preparation and Combustion of Coal-Water Fuel from a Lignite from Southern Thailand	Status: Ongoing	
Cosponsor	Department of Mineral Resources, Thailand		
Summary The project involves the investigation of the application of an Energy & Environmental Research Center-developed nonevaporative hydrothermal, or hot-water drying (HWD), process to a lignite from southern Thailand and to evaluate the combustion performance of the coal-water fuel slurry product from the HWD process. It includes three major tasks: 1) bench-scale HWD tests, 2) pilot-scale HWD testing, and 3) combustion and emission testing of the coal-water fuel. Approximately 500 kg of lignite from Southern Thailand was received in November. Autoclave testing and pilot-scale hydrothermal processing runs are scheduled for December, 1996 and January, 1997. Combustion tests will be completed in March or April, 1997.			
Funding Profile	DOE Share	Nonfederal Share	Total
	\$27,490	\$41,240	\$68,730