"Providing solutions to energy and environmental problems"

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QUARTERLY TECHNICAL PROGRESS REPORT

JOINTLY SPONSORED RESEARCH

July-September 1997

*Prepared for
U.S. Department of Energy
Federal Energy Technology Center*

WRI-97-R030

PROVIDING SOLUTIONS
TO
ENERGY AND ENVIRONMENTAL
PROBLEMS

QUARTERLY
TECHNICAL PROGRESS
REPORT

FOR
JULY 1, 1997 THROUGH SEPTEMBER 30, 1997

ON

COOPERATIVE AGREEMENT DE-FC21-93MC30127--19
JOINTLY SPONSORED RESEARCH PROGRAM

FOR THE

U.S. DEPARTMENT OF ENERGY
OFFICE OF FOSSIL ENERGY
FEDERAL ENERGY TECHNOLOGY CENTER
MORGANTOWN, WEST VIRGINIA

BY

WESTERN RESEARCH INSTITUTE
LARAMIE, WYOMING

OCTOBER 1997

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Cumulative JSRP Funding Summarized by Technology Area

More than \$18 million for energy programs emphasizing enhanced oil recovery, coal beneficiation and upgrading, coalbed methane recovery and renewable energy resources

\$4.1 million for technology enhancement activities encompassing resource characterization studies, improved environmental monitors and sensors, and improved dispersion modeling techniques

\$8.9 million for technology to clean underground oily wastes, mitigate acid mine drainage, and demonstrate uses for CCT and PFBC waste solids

Cooperative Agreement DE-FC21-93MC30127
Status of Total Approved Projects on July 1, 1997

***WRI's JSR Program is Focused on Technology Development
to Meet National and Regional Needs***

Goals of WRI's Jointly Sponsored Research Program

Increase the production of U.S. and western energy resources: low-sulfur coal, natural gas, oil, and renewable energy resources

Enhance the competitiveness of U.S. and western energy technologies in international markets and assist in technology transfer

Reduce the nation's dependence upon foreign energy supplies and strengthen the U.S. and regional economies

Minimize the impact of energy production and utilization on the environment

SUMMARY
OF
APPROPRIATIONS,
OBLIGATIONS
&
EXPENDITURES
BY
TASK

Executive Summary

Jointly Sponsored Research Program

The Jointly Sponsored Research Program emphasizes technology commercialization and continues to be highly successful and supported strongly and enthusiastically by WRI's industrial clientele. All of the available Department of Energy (USDOE) funding for each of the first seven years has been committed to projects. All available FY 97 funding was obligated in June 1997. The demand for funds continues to outstrip available monies and an additional \$3 million per year in USDOE funding could easily be accommodated. As summarized in Table 1, since the program's inception in 1990, \$19,140,754 in USDOE funds have been obligated and committed against an industrial match of \$25,446,281.

Table 1
Summary of JSRP Funding for FY 1990-97

Fiscal Year	Funds Available	Funds Committed	No. of Projects	New Starts
1997	2,050,754	2,096,213	22	2
1996	2,220,000	2,174,541	20	2
1995	2,800,000	2,800,000	18	1
1994	2,411,000	2,411,000	17	3
1993	2,437,000	2,437,000	14	9
1992	2,442,000	2,442,000	17	10
1991	2,489,000	2,489,000	11	5
1990	2,291,000	2,291,000	14	14
Total	\$19,140,754	\$19,140,754		

Since entering into a new JSRP cooperative agreement with the Department of Energy on March 26, 1993 (Cooperative Agreement DE-FC21-93MC30127), WRI has put into place projects utilizing a total of \$13,082,477 in USDOE funds. These funds have been matched against \$18,342,205 in industrial funds to produce a program valued at \$31,424,682. Letters of commitment have already been obtained which envision utilizing more than \$5 million in FY 98 funds. As a result of this strong demand for program participation, unless additional funding is available, WRI may not be able to work in a significant fashion with any new JSRP participants until FY 98 or beyond. In fact, we estimate that \$6.5 million would be needed in FY 98 to adequately meet present demand. As Table 1 clearly indicates, new program participants can only be added in those instances where existing money can be reobligated.

Table 2
Tasks Approved for Funding Through Fiscal Year 1997

Task	Project	Previous Commitments			FY 97 Commitment			Total Commitment		
		USDOE	Sponsor	Total	USDOE	Sponsor	Total	USDOE	Sponsor	Total
Energy Programs										
1	Electric Downhole Steam Generator	1,282,785	1,315,200	2,745,985				1,282,785	1,315,200	2,745,985
2	Wetting Behavior of Crude Oil/Brine/Rock Systems	1,132,356	1,220,793	2,353,149				1,132,356	1,220,793	2,353,149
3	Kerr Coal Product Market Study	57,039	60,000	117,039				57,039	60,000	117,039
7	Optimization of FMC Carbonizer	48,418	45,000	93,418				48,418	45,000	93,418
9	Demonstration of the "Series C" Process	2,456,205	2,588,800	5,045,005	548,527	932,500	1,481,027	3,004,732	3,521,300	6,526,032
14	"Series B" Pilot Plant Tests	8,668	10,092	18,760				8,668	10,092	18,760
6	Enhanced Recovery of Coalbed Methane	1,135,900	1,716,270	2,852,170				1,135,900	1,716,270	2,852,170
16	Demonstration of a Wood-Fired Gas Turbine System	1,416,234	2,303,984	3,720,218				1,416,234	2,303,984	3,720,218
Subtotal Energy Programs		7,537,605	9,260,139	16,797,744	548,527	932,500	1,481,027	8,086,132	10,192,639	18,278,771

Table 2 (Continued)
Tasks Approved for Funding Through Fiscal Year 1997

Task	Project	Previous Commitments			FY 97 Commitment			Total Commitment		
		USDOE	Sponsor	Total	USDOE	Sponsor	Total	USDOE	Sponsor	Total
Technology Enhancement Programs										
8	Chemical Sensor and Field Screening Technology	749,900	749,900	1,499,800				749,900	749,900	1,499,800
10	Remote Chemical Sensor Development	355,000	232,081	587,081				355,000	232,081	587,081
12	NMR Analysis of Matured Kerogens	30,192	15,000	45,192				30,192	15,000	45,192
17	NMR Analysis of Mowry Formation Shales	60,064	60,000	120,064	20,000	20,000	40,000	80,064	80,000	160,064
19	PERF Phase II Demonstration	502,124	945,330	1,447,454				502,124	945,330	1,447,454
21	Validation of a New VOC Sampler	50,541	62,500	113,041	149,762	187,500	337,262	200,303	250,000	450,303
Subtotal Technology Enhancement		1,747,821	2,064,811	3,812,632	169,762	207,500	377,262	1,917,583	2,272,311	4,189,894

Table 2 (Continued)
Tasks Approved for Funding Through Fiscal Year 1997

		Previous Commitments			FY 97 Commitment			Total Commitment		
Task	Project	USDOE	Sponsor	Total	USDOE	Sponsor	Total	USDOE	Sponsor	Total
Environmental Programs										
4	Impact of CCT Waste Leachate on the Stability of Clay Liners	231,043	259,580	490,623				231,043	259,580	490,623
11	Market Assessment Study of PFBC Ash Use	447,638	603,500	1,051,138				447,638	603,500	1,051,138
13	CROW Field Demonstration Bell Lumber and Pole	120,800	541,396	662,196	23,000	36,000	59,000	143,800	577,396	721,196
15	In Situ Treatment of MPG Contaminated Soils	405,289	1,360,523	1,765,812				405,289	1,360,523	1,765,812
18	Acid-Mine Drainage Prevention and Control	211,068	210,845	421,913				211,068	210,845	421,913
20	Field Testing of the TaBoRR Process	285,000	285,415	570,415	1,282,287	2,500,000	3,782,287	1,567,287	2,785,415	4,352,702
22	Market Assessment Study of PFBC Ash Use from Lignite				72,637	79,996	152,633	72,637	79,996	152,633
Subtotal, Environ. Programs		1,700,838	3,261,259	4,962,097	1,377,924	2,615,996	3,993,920	3,078,762	5,877,255	8,956,017
Total, All Programs		10,986,264	14,586,209	25,572,473	2,096,213	3,755,996	5,852,209	13,082,477	18,342,205	31,424,682

Current Expenditures

Table 3
Expenditures on Contract DE-FC21-93MC30127

<i>Task</i>	<i>Budget</i>	<i>Expended Prior Periods</i>	<i>July 1997</i>	<i>August 1997</i>	<i>September 1997</i>	<i>Total</i>
1	\$1,282,785	\$1,297,451		Completed		\$1,304,835
2	1,132,356	1,161,421		Completed		1,161,421
3	57,039	56,989		Completed		56,989
4	231,043	232,574		Completed		232,574
5				Withdrawn		
6	1,135,900	985,766	10,770	10,668	11,339	1,018,543
7	48,418	36,974		Completed		36,974
8	749,900	740,941		Completed		745,899
9	3,004,732	2,223,960	15,268	118,383	30,570	2,388,181
10	355,000	354,182		Completed		354,182
11	447,638	452,627	7,217	(10,587)	(10,054)	439,203
12	30,192	30,780		Completed		30,780
13	143,800	121,403	1,752	1,900	801	125,855
14	8,668	8,668		Completed		8,668
15	405,289	396,235		Completed		398,000
16	1,416,234	1,282,013		Completed		1,282,013
17	80,064	59,160	758	438	1,338	61,694
18	211,068	186,122	3,255	2,485	5,679	197,540
19	502,124	328,755	4,032	12,052	23,262	368,101
20	1,567,287	1,270,863	56,121	38,903	29,904	1,395,791
21	200,303	57,903	4,205	8,818	8,003	78,930
22	72,637		8,581	4,593	10,384	23,558
Total	\$13,082,477	\$11,284,787	\$118,657	\$195,044	\$111,242	\$11,709,730

Technical Highlights

Shakedown activities for the KFx 500,000 tpy commercial plant (Task 009) are progressing steadily. Modifications are being made to correct mechanical problems with components.

On Task 011, WRI presented a paper on the geotechnical properties of PFBC ash as related to ash use in construction and soil amendment applications at the **Advanced Coal-Based Power and Environmental Systems '97 Conference** held in July 22-24, 1997. The presentation focused on the geotechnical properties of the PFBC ash as related to construction and soil amendment applications and addressed the high and low sulfur derived circulating PFBC ash from the Foster Wheeler Energia Oy pilot facility in Karhula Finland, as well as the AEP Tidd bubbling bed PFBC ash from Brilliant, Ohio.

On Task 013, the phase-one, full-scale remediation at the Bell Lumber and Pole Site in New Brighton, Minnesota is operating with over 42,000 gallons of organics recovered. The project is operating continuously with the injection/production rates and the injection temperature being continuously increased to meet design values. The organic production rate is exceeding anticipated values.

On Task 021 Susan Sorini attended the ASTM/EPA accelerated standards meeting in Alexandria, VA in August. She is working closely with the committee to update ASTM D-4547, "Standard Guide for Sampling Waste and Soils for Volatile Organic Compounds".

Testing has confirmed the acceptable geotechnical properties of the MDU flowable fill material. (Task 022). The environmental testing has shown some elevated pH, sodium, SAR, and sulfate levels in the permeate of the MDU flowable fill. However, the trend appears to indicate a decrease in concentration of these parameters with increasing solids water contact.

**SUMMARY
OF
OBJECTIVES
&
ACCOMPLISHMENTS
BY
TASK**

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Task 2	Wetting Behavior of Selected Crude Oil/Brine/Rock Systems	Status Completed
<p align="center">Sponsors</p> <p><i>ARCO, British Petroleum, Chevron, Conoco, Dagang (China), ELF (France), Exxon, Marathon, Mobil, NorskHydro (Norway), Phillips, Shell (The Netherlands), Statoil (Norway), and the University of Wyoming</i></p>		
<p align="center">Reporting Period: July 1 through September 30, 1997</p>		
<p align="center">Background</p> <p><i>Fluid distribution and the displacement of oil by water or other fluids in an oil reservoir are governed by the fluid-solid interactions (wettability) of that system. Wettability governs interface shapes, which determine the mechanisms and efficiency of oil displacement from reservoir rocks. Because water flooding accounts for more than half of the oil production in the United States, understanding the effect of wettability on oil recovery is of great importance. To this end, WRI has undertaken a study of crude oil/brine/rock interactions for several selected crude oils, including oil from Prudhoe Bay. Special attention is being given to the possibility of increasing the efficiency of waterfloods through selection or adjustment of the composition of the injected brine.</i></p>		
<p align="center">Status</p> <p><i>The project has been completed.</i></p>		

**Task
3**

**Coal Gasification, Power Generation,
and Product Market Study**

**Status
Completed**

**Sponsor
Kerr Coal Company**

Reporting Period: July 1 through September 30, 1997

Background

The primary use of western low-sulfur coal is for power generation. Other potential uses of this coal need to be evaluated. This study is to perform a market survey of potential products and alternate technologies that may produce high-value products from coal obtained from the Kerr Company coal mine in Walden, Colorado.

Status

The project has been completed.

Task 4	The Impact of Leachate from Clean Coal Technology Waste on the Stability of Clay Liners	Status Completed
<p align="center">Sponsor Public Service Company of Colorado</p>		
<p align="center">Reporting Period: July 1 through September 30, 1997</p>		
<p align="center">Background</p> <p>Wastes generated from clean coal technologies have much different physical and chemical characteristics than the wastes generated from conventional power plants. These wastes can have significantly different impacts on the permeability of a clay liner, which can affect the active lifetime of the liner. This study is evaluating the influence that clean coal technology waste materials will have on the stability of clay liners. Specifically, an understanding of the chemical and physical interactions will be determined between clay liners and waste leachates. The findings of the study will provide industry with valuable information for the management of wastes generated by the implementation of clean coal technology programs.</p> <p align="center">Status</p> <p align="center">The project has been completed.</p>		

**Task
5**

**Investigation of Coprocessing Heavy Oil,
Automobile Shredder Residue, and Coal**

**Status
Withdrawn**

**Sponsor
Environmental Recovery Systems, Inc.**

Reporting Period: July 1 through September 30, 1997

Background

A major environmental problem today is the disposal of automobile shredder residue (ASR). This residue is composed of plastic, rubber, foam rubber, wood, glass, dirt, oil, and other fluids. WRI is developing a low-temperature coprocessing concept for conversion of ASR, heavy oils, and coal into gasoline and diesel fuel distillates. This concept is being explored to alleviate the problems associated with ASR disposal and to generate useful product streams.

Status

This project was withdrawn due to the sponsor's inability to provide matching funds.

Task 6	Injection into Coal Seams for Simultaneous CO₂ Mitigation and Enhanced Recovery of Coalbed Methane	Status Ongoing
<p align="center">Sponsors Amoco, Conoco, Resource Enterprises Inc., and New Mexico Petroleum Recovery Research Center</p>		
<p align="center">Reporting Period: July 1 through September 30, 1997</p>		
<p align="center">Background</p> <p><i>This study is evaluating the technical feasibility of injecting CO₂, a byproduct of methane recovery from some coalbeds, into the coalbeds as both a technique of mitigating the level of CO₂ emissions from the production of methane from the coalbeds and as a technique for enhancing the recovery of methane from the coalbeds. The evaluation will be based on the operation and results of a two-well field pilot test in northwestern New Mexico.</i></p>		

Task Objectives

The overall objective of this task is to test the technical viability of injecting CO₂ into the Fruitland Coal to displace methane from the coal and to mitigate CO₂ emissions which are a consequence of primary coalbed methane production from surrounding wells in the area. To evaluate this technical viability, a field test was conducted and the test is being interpreted using data measured in WRI's laboratory, as well as using Amoco's state-of-the art coalbed methane simulator. Also, a second pilot of the process is being evaluated using the simulator. Ultimately, the technology developed will be applied to a Wyoming coal. The task is divided into five subtasks:

- Subtask 6.1: Two-Well Pilot Test of CO₂ Injection
- Subtask 6.2: CO₂/N₂ Laboratory Tests in the Fruitland Coal
- Subtask 6.3: Modeling of Two-Well Pilot Test
- Subtask 6.4: Allison Unit CO₂ Pilot Study and
- Subtask 6.5: CO₂/N₂ Laboratory Tests in Wyoming Coals.

Quarter Objectives

- Complete the revised draft of the final document on Subtask 1 and submit it to Amoco in July for review.
- Bind the documents on subtasks 2 and 3.
- Complete the draft of the final report on the modeling study for Subtask 4 and submit it to Amoco for review.
- Contact Wyoming coalbed methane operators, obtain coal samples from these operators and begin laboratory testing of the samples.

Accomplishments

Subtask 6.1-Two-Well Pilot Test of CO₂ Injection

The revised draft final report was completed and sent to Amoco for review in early August.

Subtask 6.2-CO₂/N₂ Laboratory Tests in the Fruitland Coal

The final report was bound and sent to Amoco.

Subtask 6.3-Modeling of Two-Well Pilot Test

The final report was bound and sent to Amoco.

Subtask 6.4-Design of Phase II CO₂ Injection

The pilot data was updated and the actual pilot performance since the prediction was made was compared to the prediction. A draft final report was written and will be sent to Amoco in early October.

Subtask 6.5 CO₂/N₂ Laboratory Tests in Wyoming Coals

No significant work was accomplished on this subtask.

Activities for Next Quarter

- Send the final document on Subtasks 1 and 4 to WRI's Publication Coordinator when Amoco completes its review.
- Contact Wyoming coalbed methane operators, obtain coal samples from these operators and begin laboratory testing of the samples.

Program/Project Identification No. DE-FC21-93MC30127	Program/Project Title TASK 006 INJECTION INTO COAL SEAMS FOR SIMULTANEOUS CO₂ MITIGATION AND ENHANCED RECOVERY OF COALBED METHANE	Reporting Period 7/1/97 through 9/30/97
Name and Address WESTERN RESEARCH INSTITUTE 365 NORTH NINTH STREET LARAMIE, WYOMING 82070		Program/Project Start Date MARCH 26, 1993
		Completion Date JUNE 30, 1998

	USDOE	SPONSOR(S)
FY 1993 FUNDING	812,639	1,701,789
FY 1994 FUNDING		
FY 1995 FUNDING	323,261	14,481
FY 1996 FUNDING		
FY 1997 FUNDING		
PROJECT FUNDING TO DATE	1,135,900	1,716,270
TOTAL PROJECT VALUE \$2,852,170

COSPONSOR FUNDING IN FY 95 CONSISTED OF \$14,481 CASH
COSPONSOR FUNDING IN FY 93 CONSISTED OF \$41,389 CASH AND \$1,660,400 IN-KIND

Signature of Recipient and Date Lee E. Bradley 10/27/97	Signature of USDOE Reviewing Representative and Date
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Task 7	Optimization of Carbonizer Operations in the FMC Coke Process	Status Completed
Sponsor University of Wyoming Western Coal Consortium		
Reporting Period: July 1 through September 30, 1997		
Background <i>Operation of the FMC coking process to date has resulted in insufficient production of heavy tar materials that serve as the binder in the coke production. Laboratory tests were conducted by WRI, in conjunction with the University of Wyoming, to develop the optimum operating conditions for the carbonizer to maximize the amount of tar produced for binder and to investigate the applicability of the process to other western coals.</i>		
Status <i>The project has been completed.</i>		

Task 8	Chemical Sensor and Field Screening Technology Development	Status Completed
Sponsor In-Situ Incorporated		
Reporting Period: July 1 through September 30, 1997		
<p>Background</p> <p><i>The determination or screening of environmental contaminants in the field using portable analytical methodologies or down-hole real time in-situ measurements is an area of great interest in the environmental industry. WRI is expanding its efforts into new technology areas for the development and commercialization of these technologies.</i></p> <p>Status</p> <p><i>The project has been completed.</i></p>		

Task 9	Demonstration of the Koppelman "Series C" Process Using a Batch Test Unit with Powder River Basin Coal as Feed	Status Ongoing
Sponsor K-Fuel Incorporated		
Reporting Period: July 1 through September 30, 1997		
<p align="center">Background</p> <p><i>Although having the desirable characteristic of being low in sulfur, most western coals are comparatively low in heating value. Bench-scale tests have been successfully conducted using the Koppelman "Series C" process in which subbituminous Powder River Basin coal has been converted to a higher value product having the characteristics of a low-sulfur bituminous coal. WRI is working with K-Fuel Inc. to construct and operate a large-scale batch unit that will provide the design basis for a commercial plant and to evaluate the product samples and process emissions from the unit.</i></p>		

Task Objectives

- (Phase I) Demonstrate the feasibility of the Koppelman Series C process by constructing a 1,000 lb. batch test unit; conducting tests to further develop the design basis for a commercial plant; and producing samples of the product for testing and evaluation.
- (Phase II) Improve the process economics by designing, constructing and testing a low-cost, high-efficiency version of the processor.
- Characterize the gaseous and water emissions from the process by determining the quantity and composition of those respective emissions.
- (Phase III) Support the design and operation of the 500,000 ton per year commercial plant now being constructed by KFx and Thermo Ecotek.
- Expand the market for the products by testing high sulfur U.S. coals and foreign coals.
- Increase the product density by developing an extrusion system, and

- Reduce the costs of future plants using the Koppelman Series C process by developing a feed-coal preheater along with an inverted processor.

Quarter Objectives

Continue to support the startup activities of the commercial plant and conducting bench-scale tests and tests using the Series C pilot plant. Prepare an annual technical report describing activities during the first year of Phase III.

Accomplishments

During this quarter we conducted extensive activities to help diagnose and correct problems in the commercial plant. We also continued bench-scale testing of foreign and domestic coal and participated in several tests using the Series C pilot plant. We are continuing preparation of a technical report describing WRI activities during this phase of the project.

Activities for Next Quarter

Continue to support the startup activities of the commercial plant and continue bench-scale testing and testing using the Series C pilot plant. Continue preparation of a technical report describing activities during Phase III.

Program/Project Identification No. DE-FC21-93MC30127	Program/Project Title TASK 009 DEMONSTRATION OF THE KOPPELMAN "SERIES C" PROCESS USING A BATCH TEST UNIT WITH POWDER RIVER BASIN COAL AS FEED	Reporting Period 7/1/97 through 9/30/97
Name and Address WESTERN RESEARCH INSTITUTE 365 NORTH NINTH STREET LARAMIE, WYOMING 82070		Program/Project Start Date MARCH 26, 1993
		Completion Date JUNE 30, 1998

PROJECT FUNDING HISTORY		
	USDOE	SPONSOR(S)
FY 1993 FUNDING	604,999	634,200
FY 1994 FUNDING	851,206	954,600
FY 1995 FUNDING		
FY 1996 FUNDING	1,000,000	1,000,000
FY 1997 FUNDING	548,527	932,500
PROJECT FUNDING TO DATE	3,004,732	3,521,300
TOTAL PROJECT VALUE \$6,526,032

COSPONSOR FUNDING IN FY 97 CONSISTED OF \$932,500 IN-KIND
 COSPONSOR FUNDING IN FY 96 CONSISTED OF \$250,000 CASH AND \$750,000 IN-KIND
 COSPONSOR FUNDING IN FY 94 CONSISTED OF \$175,000 CASH AND \$779,600 IN-KIND
 COSPONSOR FUNDING IN FY 93 CONSISTED OF \$634,200 IN-KIND

Signature of Recipient and Date <i>Lee E Breda</i> 10/21/97	Signature of USDOE Reviewing Representative and Date
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**Task
10
(Old
5.25)**

Remote Chemical Sensor Development

**Status
Completed**

**Sponsor
In-Situ Incorporated**

Reporting Period: July 1 through September 30, 1997

Background

The detection and monitoring of groundwater and soil contaminants is essential to environmental mitigation efforts. WRI is continuing work begun under the earlier cooperative agreement on the development of needed instruments for accurate measurements of chemical materials with easy-to-use, portable equipment and for in-situ, real-time monitoring. This includes development of a new field test kit for measurement of diesel and other fuels in soils and a downhole monitoring device for volatile organic compounds. The work involves optimizing soil extraction chemistry, exploring optimal design and configuration of the fuel test kit photometer, and constructing prototype instruments for downhole VOC monitoring.

Status

The project has been completed.

Footnote

This task completed work begun as Task 5.25 under the previous cooperative agreement. Total USDOE and cosponsor funding was \$575,000 each for a project total of \$1,150,000.

Task 11	Market Assessment and Technical Feasibility Study of PFBC Ash Use	Status Ongoing
<p align="center">Sponsor Electric Power Research Institute</p>		
<p align="center">Reporting Period: July 1 through September 30, 1997</p>		
<p align="center">Background</p> <p><i>The chemical characteristics of pressurized fluidized bed combustion (PFBC) ash are quite different from other Clean Coal Technology (CCT) ashes. These characteristics may make the PFBC ash more amenable to options for its use than other CCT ashes. This study is to make a market assessment of potential uses of PFBC ash, evaluate the technical feasibility of these uses, and develop plans for full-scale demonstrations of the most promising options.</i></p>		

Task Objective

The objective of this task is to determine the market and technical use options for PFBC ash.

Quarter Objectives

- Conduct soil amendment testing via greenhouse studies.
- Present paper on the geotechnical properties of PFBC ash as related to ash use in construction and soil amendment applications to the Advanced Coal-Based Power and Environmental Systems '97 Conference.
- Continue preparation of the final report.

Accomplishments

- Hydration phase analysis composition determination as a function of curing conditions continued. Germination studies were completed and plant production studies were via greenhouse testing were completed. The soil amendment greenhouse study used each of the PFBC ashes and both Meadow Foxtail Grass and Common Bermuda Grass and an acid soil. The PFBC ashes showed potential for amending an acid soil supporting the establishment of both

grass species. Second cutting production was lower than expected. The cause for this behavior as presented in the detailed results of the greenhouse testing are being evaluated.

- WRI prepared a manuscript and presentation on the geotechnical properties of PFBC ash as related to ash use in construction and soil amendment applications for presentation at the **Advanced Coal-Based Power and Environmental Systems '97 Conference** held in July 22-24, 1997. The presentation focused on the geotechnical properties of the PFBC ash as related to construction and soil amendment applications and addressed the high and low sulfur derived circulating PFBC ash from the Foster Wheeler Energia Oy pilot facility in Karhula Finland, as well as the AEP Tidd bubbling bed PFBC ash from Brilliant, Ohio.
- Preparation of the final report continued. The topical report is being modified to include the results of the Karhula high sulfur coal tests.

Activities for Next Quarter

- Continue preparation of the final report.

Program/Project Identification No. DE-FC21-93MC30127	Program/Project Title TASK 011 MARKET ASSESSMENT AND TECHNICAL FEASIBILITY STUDY OF PFBC ASH USE	Reporting Period 7/1/97 through 9/30/97
Name and Address WESTERN RESEARCH INSTITUTE 365 NORTH NINTH STREET LARAMIE, WYOMING 82070		Program/Project Start Date MARCH 26, 1993
		Completion Date JUNE 30, 1998

	USDOE	SPONSOR(S)
FY 1993 FUNDING	99,998	100,000
FY 1994 FUNDING		
FY 1995 FUNDING	147,640	303,500
FY 1996 FUNDING	200,000	200,000
FY 1997 FUNDING		
PROJECT FUNDING TO DATE	447,638	603,500
TOTAL PROJECT VALUE \$1,051,138

COSPONSOR FUNDING IN FY 96 CONSISTED OF \$200.000 IN-KIND
 COSPONSOR FUNDING IN FY 95 CONSISTED OF \$303.500 IN-KIND
 COSPONSOR FUNDING IN FY 93 CONSISTED OF \$100.000 IN-KIND

Signature of Recipient and Date Lee E Brechev 10/27/97	Signature of USDOE Reviewing Representative and Date
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Task 12	Solid State Nuclear Magnetic Resonance (NMR) Analysis of Naturally and Artificially Matured Kerogens	Status Completed
Sponsor University of Wyoming--EPSCoR		
Reporting Period: July 1 through September 30, 1997		
Background <i>As part of the University of Wyoming research project to develop new approaches and supporting technology for oil and gas exploration in the United States, pressure compartmentalization is being modeled. To do so, fundamental data are required on the natural and artificial maturation of petroleum source rocks. WRI is performing solid-state NMR measurements to provide a significant part of the required data.</i>		
Status <i>The project has been completed.</i>		

Task 13 (Old 5.6)	Contained Recovery of Oily Wastes (CROW™) Field Demonstration with Bell Lumber and Pole	Status Ongoing
Sponsor Bell Lumber and Pole		
Reporting Period: July 1 through September 30, 1997		
<p align="center">Background</p> <p><i>Operation of a pole and tie treatment plant in New Brighton, Minnesota for a number of years resulted in contamination of soils at the site with organic materials. WRI is using the CROW process to demonstrate remediation of the site. The process displaces and recovers part of the contaminating materials. This is followed by in-situ bioremediation of the residual oily substances.</i></p> <p align="center">Footnote</p> <p><i>This task completes work begun as Task 5.6 under the previous cooperative agreement. Total USDOE funding is \$587,644 and total cosponsor funding is \$2,024,955 for a project total of \$2,612,599.</i></p>		

Task Objectives

The objective of this task is to design, construct, and operate a field demonstration of the CROW™ process technology to treat a site contaminated with organic wastes from the wood treatment process.

Quarter Objective

Continue the phase-one, full-scale field demonstration.

Accomplishments

As of September 1997, the CROW system has been operating continuously for 180 days. To

date, approximately 7.7 million gallons of water have been injected and over 42,000 gallons of oil recovered. Bell Lumber and Pole continues to use a portion of the recovered product in their pole treatment operation. Continuous hot-water injection has only averaged 175°F. A new heat exchanger to produce the heated injection fluid was installed in April 1997. Efforts are underway to increase temperatures and flowrates. The water treatment system has been improved and optimized.

Activities for Next Quarter

Operation of the phase-one, full-scale remediation will continue next quarter.

Program/Project Identification No. DE-FC2 I-93MC30 I 27	Program/Project Title TASK 013 CONTAINED RECOVERY OF OILY WASTES (CROW™) FIELD DEMONSTRATION WITH BELL LUMBER AND POLE	Reporting Period 7/1/97 through 9/30/97
Name and Address WESTERN RESEARCH INSTITUTE 365 NORTH NINTH STREET LARAMIE, WYOMING 82070		Program/Project Start Date MARCH 26, 1993
		Completion Date JUNE 30, 1998

PROJECT FUNDING HISTORY		
	USDOE	SPONSOR(S)
FY 1993 FUNDING	90,800	
FY 1994 FUNDING		207,396
FY 1995 FUNDING		250,000
FY 1996 FUNDING	30,000	84,000
FY 1997 FUNDING	23,000	36,000
PROJECT FUNDING TO DATE	143,800	577,396
TOTAL PROJECT VALUE \$721,196

THE PROJECT COSPONSOR HAS ADDED AN ADDITIONAL \$541,396 CASH TO THE PROJECT RAISING THEIR TOTAL CONTRIBUTION FROM \$1,940,955 TO \$2,482,351
COSPONSOR FUNDING IN FY 97 CONSISTED OF \$36,000 CASH

Signature of Recipient and Date Lee E. Bradley 10/27/97	Signature of USDOE Reviewing Representative and Date
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Task 14	"B Series" Pilot Plant Tests	Status Completed
Sponsor Heartland Fuels Corporation		
Reporting Period: July 1 through September 30, 1997		
<p>Background</p> <p><i>In a previous JSRP task, WRI participated with Heartland Fuels Corporation in conducting pilot-scale tests of the "B" series process using three different coals. The present study determined the characteristics of the process condensate when operated at lower temperatures than previously tested. Seven tests were conducted in the pilot plant and samples of the condensate were collected and analyzed.</i></p> <p>Status</p> <p><i>The project has been completed.</i></p>		

**Task
15**
(Old 5.26)

**In Situ Treatment
of Manufactured Gas Plant Contaminated Soils
Demonstration Program**

**Status
Complete**

Sponsors

**Pennsylvania Power and Light, US Environmental Protection Agency, Gas Research Institute,
and Electric Power Research Institute**

Reporting Period: July 1 through September 30, 1997

Background

The process of manufacturing gas from coal years ago resulted in the contamination of soils with carcinogenic materials. One such site that is presently being cleaned is the Brodhead Creek Site in Stroudsburg, Pennsylvania. WRI is using its CROW process in conjunction with in-situ biotreatment to demonstrate remediation of the site. The overall steps in the study are to design the application of the CROW process to the site, obtain permits, construct and operate the field demonstration test and evaluate the results.

Footnote

This task completes work begun as Task 5.26 under the previous cooperative agreement. Total USDOE funding is \$518,689 and total cosponsor funding is \$1,360,523 for a project total of \$1,879,212.

Status

The project has been completed and awaits EPA approval for site closure.

**Task
16**

**Development and Demonstration
of a Wood-Fired Gas Turbine System**

**Status
Completed**

Sponsors
Power Generating Inc. and Office of Conservation and Renewable Energy,
US Department of Energy

Reporting Period: July 1 through September 30, 1997

Background

Development of a means to use inexpensive solid fuels for electrical power generation and thermal energy has the double benefit of providing low-cost energy and utilization of an otherwise possibly unused resource. Power Generating Inc. has patented a unique, direct-fired gas turbine power system that could be operated on such fuels. The system is expected to operate at thermal efficiencies in excess of 70% through full utilization of the electrical and thermal energy generated. Problems generally inherent in such systems are overcome by the unique design of this system and by close control of fuel specifications and operating procedures. WRI is working on the detailed design of a demonstration unit. When designed, a 425 kilowatt power system will be constructed and tested on a clean wood fuel. Immediately following the wood testing, the system will be reconfigured and operated on a low-ash coal.

Status

The project has been completed.

**Task
17**

**Solid State NMR Analysis of Mowry Formation Shale
from Different Sedimentary Basins**

**Status
Ongoing**

Sponsors

University of Wyoming and Gas Research Institute

Reporting Period: July 1 through September 30, 1997

Background

New approaches and supporting technology are needed to reverse the diminishing returns from oil and gas exploration in the United States. The discovery of subsurface fluid or pressure chambers has the potential to delineate a new class of hydrocarbon traps, thereby revitalizing interest in domestic exploration. The University of Wyoming has a research project to develop a conceptual model of the formation, distribution, and destruction of pressure chambers and seals in sedimentary basins. A key to understanding the diagenetic and maturational behavior is knowledge of the organic carbon structure of the kerogen in petroleum source rocks and how the kerogen structure changed during petroleum generation. As a part of this project, WRI is performing solid-state NMR measurements to provide information on the diagenesis and maturation of petroleum source rocks. The material being studied in this task is Mowry Formation shale from sedimentary basins.

Task Objective

The objectives of this JSR project are to use solid-state nuclear magnetic resonance (NMR) methods to study the maturation of source rocks from different sedimentary basins brought about naturally by depth of burial and artificially by hydrous pyrolysis experiments.

Quarter Objective

Continue analyses on samples as required..

Accomplishments

An extended abstract of a paper, Use of Solid-State ^{13}C NMR to Help Delineate Pressure Compartments in Sedimentary Basins, was submitted for presentation at the International Gas Research Conference (IGRC98) to be held in San Diego, CA in November 1998. The paper will describe the use of solid-state ^{13}C NMR

measurements to help delineate zones of abnormal pressures in shales and coals taken from different Laramide basins and from different burial depths in order to ascertain their capacity to generate hydrocarbons.

Toward the end of the quarter, samples of Cretaceous shales and coals from different formations in Wyoming and from different burial depths were acquired for NMR analysis. Formations include the Lance, Mesaverde, Fort Union, Meeteetse, and Phosphoria. Depths of burial ranged from 0 ft (out crop and mine samples) to 19,850 ft. NMR and other measurements are in progress and will be reported on in the next quarterly report.

Activities for Next Quarter

Perform NMR analyses on Cretaceous shales and coals from different basins in support of research at the Institute For Energy Research.

Program/Project Identification No.

DE-FC21-93MC30127

Program/Project Title

TASK 017
ANALYSIS OF MOWRY FORMATION SHALE
FROM DIFFERENT SEDIMENTARY BASINS

Reporting Period

7/1/97 through 9/30/97

Name and Address

WESTERN RESEARCH INSTITUTE
365 NORTH NINTH STREET
LARAMIE, WYOMING 82070

Program/Project Start Date

MARCH 26, 1993

Completion Date

JUNE 30, 1998

PROJECT FUNDING HISTORY

	USDOE	SPONSOR(S)
FY 1993 FUNDING		
FY 1994 FUNDING	30,064	30,000
FY 1995 FUNDING	30,000	30,000
FY 1996 FUNDING		
FY 1997 FUNDING	20,000	20,000
PROJECT FUNDING TO DATE	80,064	80,000

TOTAL PROJECT VALUE \$160,064

PROJECT EXPENDITURES

FRAN MIKNIS, PROJECT MANAGER

MAJOR MILESTONE STATUS

COSPONSOR FUNDING IN FY 97 CONSISTED OF \$20,000 CASH
COSPONSOR FUNDING IN FY 95 CONSISTED OF \$30,000 CASH
COSPONSOR FUNDING IN FY 94 CONSISTED OF \$30,000 CASH

Signature of Recipient and Date

Lee E Brecher 10/27/97

Signature of USDOE Reviewing Representative and Date

Task 18	<i>Acid-Mine Drainage Prevention, Control, and Treatment Development for the Stockett/Sand Coulee Area</i>	<i>Status Ongoing</i>
<p align="center">Sponsor Montana Bureau of Mines and Geology</p>		
<p align="center">Reporting Period: July 1 through September 30, 1997</p>		
<p align="center">Background</p> <p><i>Extremely acidic water is continually discharging from abandoned coal mines in the Stockett/Sand Coulee area in Montana. The water is unusable and contaminates other waters in the area. Considerable money has been spent trying to remediate the acid-mine drainage that is occurring and in replacing other water supplies that have been contaminated by the drainage water. Techniques applied to the problem so far have focused on managing and containing the mine waters, with little success. This study is identifying the geologic, hydrologic, and chemical factors that control the production of the acid-mine drainage. Once the mechanisms are identified, potential treatment techniques will be evaluated. The most promising techniques will be modeled using a series of laboratory studies. Results of the study will be used to design a field demonstration project for the amelioration of drainage water at a specific site in the problem area.</i></p>		

Task Objective

The task objective is to evaluate the methods available and to develop methods to control or eliminate the production of acid in the Stockett/Sand Coulee mine area.

Quarter Objectives

Column studies evaluating the impact of acid neutralizing materials on acid mine drainage will continue. Selected treatments dealing with acid neutralization in underground mine situations using alkaline and phosphate materials will be simulated in the laboratory. A selected number of the core samples will be analyzed to determine the extent of the acid-forming reaction zone in the Number 6 mine. The monitoring program will continue at the mine site.

Accomplishments

On-site water monitoring is on-going. A column study showing the impact of underground placement of acid-neutralizing materials on acid mine drainage is ongoing.

Activities for Next Quarter

Core samples will continue to be analyzed to determine the extent of the acid-forming reaction zone in the Number 6 mine. A set of columns evaluating a combination of acid neutralizing materials in various sequences on acid mine drainage will be initiated. The monitoring program will continue at the mine site.

Program/Project Identification No.

DE-FC21-93MC30127

Program/Project Title

TASK 018
**ACID-MINE DRAINAGE PREVENTION,
 CONTROL, AND TREATMENT DEVELOPMENT
 FOR THE STOCKETT/SAND COULEE AREA**

Reporting Period

7/1/97 through 9/30/97

Name and Address

WESTERN RESEARCH INSTITUTE
365 NORTH NINTH STREET
LARAMIE, WYOMING 82070

Program/Project Start Date

MARCH 26, 1993

Completion Date

JUNE 30, 1998

PROJECT FUNDING HISTORY

	USDOE	SPONSOR(s)
FY 1993 FUNDING		
FY 1994 FUNDING	119,665	120,000
FY 1995 FUNDING	91,403	90,845
FY 1996 FUNDING		
FY 1997 FUNDING		
PROJECT FUNDING TO DATE	211,068	210,845

TOTAL PROJECT VALUE \$421,913

PROJECT EXPENDITURES

TERRY BROWN, PROJECT MANAGER

MAJOR MILESTONE STATUS

COSPONSOR FUNDING IN FY 95 CONSISTED OF \$90,845 IN-KIND
 COSPONSOR FUNDING IN FY 94 CONSISTED OF \$120,000 IN-KIND

Signature of Recipient and Date

Lee E. Breckner 10/27/97

Signature of USDOE Reviewing Representative and Date

Task 19	PERF Dispersion Modeling Project Phase 2 Major Field Demonstration	Status Ongoing
<p align="center">Sponsor Petroleum Environmental Research Forum <i>(Allied Signal Corporation, Amoco Corporation, Chevron Research and Technology Co., CITGO Petroleum Corporation, Clark Oil and Refining Co., Exxon Research and Engineering Co., Marathon Corporation, Mobil Research and Development Co., Phillips Petroleum Co., and Shell Research and Development Company)</i></p>		
<p align="center">Reporting Period: July 1 through September 30, 1997</p>		
<p align="center">Background</p> <p><i>WRI and Petroleum Environmental Research Forum (93-16) are assessing the application of newly developed mathematical models for predicting dense gas dispersion by testing the models against the experimental results of large scale field simulations of chemical spills. The PERF and WRI are conducting field scale tests of dense gas dispersion in order to validate the models and to provide the hydrocarbon and chemical industries with information needed to conduct risk management assessments. Major components of the tests are; source emissions release system, meteorology data analyses and meteorology instrumentation, and the array configuration. The WRI 1993 HAZMAT spill test results, wind tunnel tests, and model results were used to aid in the design of the dispersion grid dimensions, sensor location, and test operation.</i></p>		

Task Objective

Implement and conduct the PERF 93-16 tests to the design specification and collect data for gas releases in the simulated petroleum refinery/tank farm under neutral and stable atmospheric conditions

Quarter Objectives

Develop the data reduction and validation procedures to be used for both the WRI-PERF sponsored enhanced roughness tests and EPA sponsored smooth tests that compose the entire "Kit Fox" field tests.

Accomplishments

WRI has drafted a calibration and validation procedure and sent it to PERF. Calibration and validation procedure activity, independent of EPA, have also been conducted this quarter. A statement of work was drafted and sent to all

PERF participants to identify how Kit Fox data will be analyzed over the next five months to complete the Kit Fox data processing phase of the project.

The Kit Fox dispersion data will test application of newly developed/modified mathematical models for predicting dense gas dispersion. The models were developed through the concurrent two and three dimensional wind tunnel studies conducted by WRI, EPA and the PERF. Studies conducted at the EPA, RTP wind tunnel, University of Arkansas, and the University of Surrey (Great Britain) are also a part of the analyses phase of the Kit Fox project.

Activities for Next Quarter

Complete the calibration and processing of dense gas dispersion tests and complete the quality assurance for the final design specifying the calibration with traceable standards and procedures for test operations. The final report will be prepared in February of 1998.

Program/Project Identification No. DE-FC21-93MC30127	Program/Project Title TASK 019 PERF DISPERSION MODELING PROJECT PHASE 2 MAJOR FIELD DEMONSTRATION	Reporting Period 7/1/97 through 9/30/97
Name and Address WESTERN RESEARCH INSTITUTE 365 NORTH NINTH STREET LARAMIE, WYOMING 82070		Program/Project Start Date MARCH 26, 1993
		Completion Date JUNE 30, 1998

	USDOE	SPONSOR(S)
FY 1993 FUNDING		
FY 1994 FUNDING		
FY 1995 FUNDING	502,124	945,330
FY 1996 FUNDING		
FY 1997 FUNDING		
PROJECT FUNDING TO DATE	502,124	945,330
TOTAL PROJECT VALUE \$1,447,454

COSPONSOR FUNDING IN FY 95 CONSISTED OF \$315,000 CASH AND \$630,330 IN-KIND

Signature of Recipient and Date Lee E. Brecht 10/27/97	Signature of USDOE Reviewing Representative and Date
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Task 20	Field Testing of the TaBoRR Process Using the Asphalt and Dry Bottoms Configurations	Status Ongoing
<p align="center">Sponsors Naval Petroleum Reserve -3, Pease Oil Field Equipment, Wallace Energy, Inc., the Rocky Mountain Oilfield Testing Center and Canadian Earth and Environmental Engineering, Inc.</p>		
<p align="center">Reporting Period: July 1 through September 30, 1997</p>		
<p align="center">Background</p> <p><i>Tank bottom wastes are emulsions composed of crude oil, water and solids that are produced from various depths. The crude oil composition is dependent on the source rock and reservoir maturation and consists of a wide range of hydrocarbons that include alkanes, naphthenes and aromatic compounds. These compounds have a wide range of emulsion characteristics that prevent the effective use of any current technology. Although the TaBoRR process was conceptually designed to handle this wide range of emulsified material, further testing is required to verify this experimentally. This project addresses the issues of processing a variety of different feed materials from many sources as well as modifying the process to handle a wider range of oil, water and solid concentrations.</i></p>		

Task Objectives

The task objectives are to:

- Perform modifications to the process to allow for handling larger water concentrations and larger solid sizes present in the feed material;
- Test and operate the unit using a variety of feed materials;
- Determine the feasibility of using the bottoms material as a road material;
- Perform modifications to the process to convert the bottoms into solid material and use the gaseous hydrocarbons as a fuel source for the process; and
- Test and operate the unit to ensure environmental compliance and verify process economics

Quarter Objectives

Inspect, explore and evaluate options for cleaning the stripper. Perform cause and effect analysis to prevent future plugging. Shakedown the pyrolyzer with stripper bottoms. Process the NPR-3 feed material and characterize the product created.

Accomplishments

Samples of the material deposited in the stripper were shown to be composed of petroleum coke and mineral matter. Four techniques were used in an attempt to remove the material deposited in the stripper. These techniques were product oil rinsing, pressurized water wash, nitric acid soak and rinse, and burn-water wash cycles. Each technique removed small amounts of the material, but the burn-wash technique was found to be the most successful in removing the material from volumes between the tubes in the bundle. A cause and effect analysis determined that this deposition could be reduced and possibility eliminated by recirculating the material in the stripper, thereby keeping solids in suspension.

This can be achieved by installing a high temperature circulation pump in the stripper. This modification will be performed during the next quarter.

Shakedown tests of the pyrolyzer subsystems were performed. Analysis of these tests indicated that channeling was occurring in the fluid bed reactor at a location near the air inlet in the plenum. The distributor plate being used was a Johnson screen, which because of its large open area did not impart enough back pressure for adequate air distribution. A header type distributor was designed and installed to eliminate these problems. Other issues identified during shakedown were the development of hot spots on the outside shell of the reactor and ejection of hot sand through the stack. Inspections showed that hot gases and sand were bypassing a pre-installed liner and contacting the outer shell, and hence the hot spots. The sand ejection problem was caused by leaks in the bed-confining screen in the freeboard. Attempts to seal the liner were unsuccessful because of the small thickness of the sheet metal used. The problem was remedied by installing a thicker liner and then seal welding all exposed seams. The sand ejection problem has been remedied by installing a screen at the outlet of the reactor. Some leaks were also identified in the shell of the reactor. These will be patched during the next quarter.

Shakedown tests also identified a need for additional instrumentation. Required hardware is being procured and upgrades will be implemented during the next quarter.

Tests were performed using the material received from NPR-3. Analyses indicated that this material contained approximately 70 percent water. Flashing of the water was completed during this quarter and stripping operations will be completed next quarter.

A paper was presented at the 4th International Petroleum Environmental Conference held in San Antonio, TX, on September 8 – 12, 1997.

Activities for Next Quarter

Install the circulation pump on the stripper and test operations. Finish processing the NPR-3 material and determine product quality. Complete the pyrolyzer modifications and determine the processing capacity of the pyrolyzer by processing stripper bottoms currently being stored in tanks at the WRI/ATC. A short-term test using an inertial separation device will be conducted to evaluate this alternative for de-watering TaBoRR feedstocks. If successful, this modification can lead to considerable energy savings in processing difficult, high-water feedstocks such as Wallace material and NPR-3 feedstock.

Program/Project Identification No. DE-FC21-93MC30127	Program/Project Title TASK 020 FIELD TESTING OF THE TABORR PROCESS USING THE ASPHALT AND DRY BOTTOMS CONFIGURATIONS	Reporting Period 7/1/97 through 9/30/97
Name and Address WESTERN RESEARCH INSTITUTE 365 NORTH NINTH STREET LARAMIE, WYOMING 82070		Program/Project Start Date MARCH 26, 1993
		Completion Date JUNE 30, 1998

PROJECT FUNDING HISTORY		
	USDOE	SPONSOR(S)
FY 1993 FUNDING		
FY 1994 FUNDING		
FY 1995 FUNDING		
FY 1996 FUNDING	285,000	285,415
FY 1997 FUNDING	1,282,287	2,500,000
PROJECT FUNDING TO DATE	1,567,287	2,785,287
TOTAL PROJECT VALUE \$4,352,702

COSPONSOR FUNDING IN FY 97 CONSISTED OF \$750,000 CASH AND \$1,750,000 IN-KIND
COSPONSOR FUNDING IN FY 96 CONSISTED OF \$285,415 IN-KIND

Signature of Recipient and Date <i>Lee E. Bradley 10/27/97</i>	Signature of USDOE Reviewing Representative and Date
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Task 21	Validation of a New Soil VOC Sampler	Status Ongoing
Sponsor En Chem Incorporated		
Reporting Period: July 1 through September 30, 1997		
<p align="center">Background</p> <p><i>WRI is providing technical support directed at achieving national acceptance for the EnCore sampling device to enhance its market acceptance by both the regulatory community and environmental contract firms that are responsible for the evaluation of VOC contamination at sites throughout the country. One version of the EnCore sampler is accepted for use by the state of Wisconsin. It is a stainless steel device that requires cleaning after use. En Chem is developing a disposable version of the sampler which will lower the cost of use and enhance its acceptance. WRI is evaluating the operation of the stainless steel device. Following successful evaluation, WRI will approach the American Society for Testing and Materials (ASTM) to initiate a process for method preparation and approval in ASTM format. The ASTM approval process will be initiated with the goal of providing national acceptance of the EnCore samplers. WRI will also provide technical support to En Chem in the development of a disposable plastic version of the EnCore sampler.</i></p>		

Task Objective

Western Research Institute is facilitating national acceptance of the EnCore™ soil volatile organic compound (VOC) sampling device by conducting product tests, method development, and method validation activities.

Quarter Objectives

- Attend the meeting of ASTM committee D-34 on Waste management in St Louis in April and discuss the new draft practice and revision of ASTM D-4547.
- Work with the corporate co-sponsor to perform experiments to verify the performance of the disposable prototype EnCore sampling devices. Incorporate the results into the new draft practice.

Accomplishments

- Susan Sorini attended the ASTM/EPA accelerated standards meeting in Alexandria, VA in August. The draft

revision of D-4547, "Standard Guide for Sampling Waste and Soils for Volatile Organic Compounds", was discussed. WRI voted negative on the draft. Several changes to the draft guide were recommended this quarter and several drafts were reviewed. Changes were recommended.

- Responses to the ASTM publicity announcement describing the development and validation of the new draft practice that appeared in the June issue of ASTM's Standardization News and other trade journals were fielded. Several companies are interested in participating in the validation process.
- The status of upcoming tests required for the development of the new ASTM practice were discussed with En Chem, Inc. personnel. Final versions of the disposable 5-gram soil sampling device are nearly ready, and systematic testing is expected to begin next quarter, assuming

the devices perform well in initial shakedown tests.

- Based on discussions at the ASTM/EPA accelerated standards meeting in August, the draft practice for using a coring tube for sampling and storing soil for volatile organic analysis was revised. The most significant revision involves changing the storage time requirement to 48 hours or longer, if tests show no loss occurs.

Activities for Next Quarter

- Once the final version of the disposable prototype EnCore sampling devices are ready, work with the corporate co-sponsor to perform experiments to verify their performance.
- Attend the ASTM D-34 committee meeting in San Diego in October.

Program/Project Identification No. DE-FC21-93MC30127	Program/Project Title TASK 021 VALIDATION OF A NEW SOIL VOC SAMPLER	Reporting Period 7/1/97 through 9/30/97
Name and Address WESTERN RESEARCH INSTITUTE 365 NORTH NINTH STREET LARAMIE, WYOMING 82070		Program/Project Start Date MARCH 26, 1993
		Completion Date JUNE 30, 1998

PROJECT FUNDING HISTORY		
	USDOE	SPONSOR(S)
FY 1993 FUNDING		
FY 1994 FUNDING		
FY 1995 FUNDING		
FY 1996 FUNDING	50,541	62,500
FY 1997 FUNDING	149,762	187,500
PROJECT FUNDING TO DATE	200,303	250,000
TOTAL PROJECT VALUE \$450,303

COSPONSOR FUNDING IN FY 97 CONSISTED OF \$37,500 CASH AND \$150,000 IN-KIND
COSPONSOR FUNDING IN FY 96 CONSISTED OF \$12,500 CASH AND \$50,000 IN-KIND

Signature of Recipient and Date Lee E Brecher 10/27/97	Signature of USDOE Reviewing Representative and Date
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Task 22	Market Assessment and Demonstration of Lignite FBC Ash Flowable Fill Applications	Status Ongoing
<p align="center">Sponsor North Dakota Industrial Commission and Montana-Dakota Utilities</p>		
<p align="center">Reporting Period: July 1 through September 30, 1997</p>		
<p align="center">Background</p> <p><i>Controlled low strength flowable fill materials have found acceptance in the construction industry as a viable low cost option for excavatable and structural fill applications. Use of the FBC ash derived from the burning of North Dakota lignite at the Montana-Dakota Utilities (MDU) Heskett plant in flowable fill construction materials represents a potential new market for the ash providing revenue and avoiding the costs and environmental consequences associated with its disposal. This study is to (1) establish the engineering and environmental properties of MDU ash based flowable fill materials; (2) make an assessment of the market for MDU flowable fill; and (3) demonstrate the viability of MDU flowable fill materials through full scale demonstrations.</i></p>		

Task Objective

Determine through laboratory testing and field demonstration the technical and environmental potential of using FBC ash from the Montana-Dakota Utilities (MDU) Heskett fluidized bed combustion (FBC) plant in the production of 'excavatable' and structural' grade flowable fill materials for construction applications.

Quarter Objectives

- Complete the laboratory scale MDU CLSFFM testing
- Initiate market assessments and potential field demonstration sites

Accomplishments

Market assessment of the Bismarck-Mandan region for the MDU flowable fill material has been initiated. Several potential demonstration sites and activities have been identified for the Fall '97 construction period that could be used for the demonstration portion of this project. Due to a number of project delays including delays in environmental assessment tests has in turn

delayed NDDH approval as well. Unfortunately, it does not seem feasible to conduct the demonstration activities this year and will likely be postponed until Spring of '98.

Task II laboratory testing of the MDU flowable fill, which addressed the following areas, continued during the quarter..

Expansion-Shrinkage Pressures and Settlement - Standard consolidation tests were performed according to ASTM D-2435. The results of the testing are presently being evaluated. Preliminary analysis suggests that the MDU 'structural grade' flowable fill material shows very little consolidation with loads up to 18.6 tsf. Testing was also conducted to ascertain the pressures associated with the swelling and shrinkage observed during wet/dry cycle durability testing. The preliminary results indicate no swelling with loads as low as 0.3 tsf. This suggests that swelling is not a problem if overburden loads of 0.5 feet are present.

Freeze/Thaw Cycle Performance - Freeze/thaw and wet/dry cycle durability testing has been completed. The testing followed the ASTM D-560 procedure using the MDU 'structural' grade

flowable fill with and without air entrainment. The issue of freeze/thaw durability is not an issue for the 'excavatable' grade of MDU CLSFFM. The results of the testing indicate that AEA are not needed for freeze/thaw durability. However, AEA can be used to reduce the strength for excavatable fill materials.

Environmental Testing - The North Dakota Department of Health had suggested that WRI conduct environmental testing to include more detailed characterization of the raw ash and leaching according to the ASTM D-3987. Samples of both the MDU raw fly ash and MDU flowable fill mix have been subjected to ASTM leachate D-3987 testing and bulk chemical analysis. The characterization of these materials is extensive, including trace metals and radionuclides. The list covers the relevant chemical species included in the Primary and Secondary Drinking Water Standards. The results have been tabulated and were reviewed by ND Department of Health. In summary, with the exception of the pH the D-3987 extract meets the specifications of both the domestic and agriculture water standards. However, the ND Department of Health analysis concluded that the data were inconclusive for pH, sodium and sulfates. They wish to reserve their opinion of the environmental character of the flowable fill materials until they could review the results of the permeate analyses described below.

Permeate Characteristics - The permeate characteristics are being tested according to the experimental plan and methodology developed in conjunction with the North Dakota Department of Health. Based on the results of the ASTM D-3987 leachate and bulk analysis tests, WRI has developed a list of chemical parameters to be analyzed for on the permeates from the 'field simulator'.

Environmental 'field simulator' testing is underway using a series of flex-wall permeameters at WRI. To date, WRI has set up or is initiating tests using the following materials.

- Test 1 - MDU flowable fill core surrounded by a local ND soil;
- Test 2 - MDU fill only;
- Test 4 - Rubblized MDU fill with soil mixture at 50:50 proportions.

- Test 5 - MDU flowable fill core surrounded by a local ND soil - soil attenuation test;
- Test 6 - Soil only;
- Test 7 - NDRM excavatable fill only;
- Test 8 - NDRM excavatable fill core surrounded by a local ND soil (comparative test);

Permeates are being collected for analysis from all tests except Test 5. The permeate sampling intervals are to approximate water/solids contacting ratios from 0.5 to 5. The Test 1 results indicate relatively high SAR values in the initial waters permeating through the field simulator. However, the concentrations of key components appear to decrease with successive permeate samples.

The Mix 6 rubblized MDU flowable fill and ND soil mixture, designed to simulate the impact of excavated fill on the soil, also shows elevated levels of sodium and sulfates and even nitrates/nitrites in the initial permeate samples. It is expected that these constituents will decrease in concentration in later permeate samples. The presence and origin of the nitrates/nitrites is curious since neither the ash nor the soil showed any significant concentrations. The data are being evaluated as they are generated.

The hydraulic conductivity of the soil and the flowable fill materials is very low, in the range of 10^{-8} to 10^{-9} cm./sec. As a result the testing is taking a long time in generating permeates for analysis. The possibility of conducting permeate samples from the flowable fill materials under a high pressure permeameter is being evaluated. This apparatus could improve the permeate generation by a factor of approximately 50.

Embed Compatibility - The embed testing continues. Test coupons of copper, rebar, galvanized conduit, Portland cement and Portland cement with fly ash have been implanted in MDU flowable fill mix and are being cycled under wet/dry conditions for up to 1 year. Multiple sets of mixes and coupons have been fabricated to allow the coupons to be examined after varying ages. The first set of coupons were evaluated at the end of July (6 months). There was no evidence of corrosion with any of the materials examined to date. At the request of MDU, WRI fabricated a set of black pipe coupons and initiated testing of these

coupons during this quarter as well. The black pipe testing was in support of a possible natural gas pipeline trench filling demonstration application.

Activities for Next Quarter

- Continue the laboratory scale MDU CLSFFM testing with emphasis on the results of the permeate analyses, and
- Continue market assessments and assess potential field demonstration sites for the Spring construction period.

Program/Project Identification No. DE-FC21-93MC30127	Program/Project Title TASK 022 MARKET ASSESSMENT AND DEMONSTRATION OF LIGNITE FBC ASH FLOWABLE FILL APPLICATIONS	Reporting Period 7/1/97 through 9/30/97
Name and Address WESTERN RESEARCH INSTITUTE 365 NORTH NINTH STREET LARAMIE, WYOMING 82070		Program/Project Start Date MARCH 26, 1993
		Completion Date JUNE 30, 1998

	USDOE	SPONSOR(S)
FY 1993 FUNDING		
FY 1994 FUNDING		
FY 1995 FUNDING		
FY 1996 FUNDING		
FY 1997 FUNDING	72,637	79,996
PROJECT FUNDING TO DATE	72,637	79,996
TOTAL PROJECT VALUE \$152,633

COSPONSOR FUNDING IN FY 97 CONSISTED OF \$50,996 CASH AND \$29,000 IN-KIND

Signature of Recipient and Date Lee E Bredy 10/27/97	Signature of USDOE Reviewing Representative and Date
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