WRI-94-R028

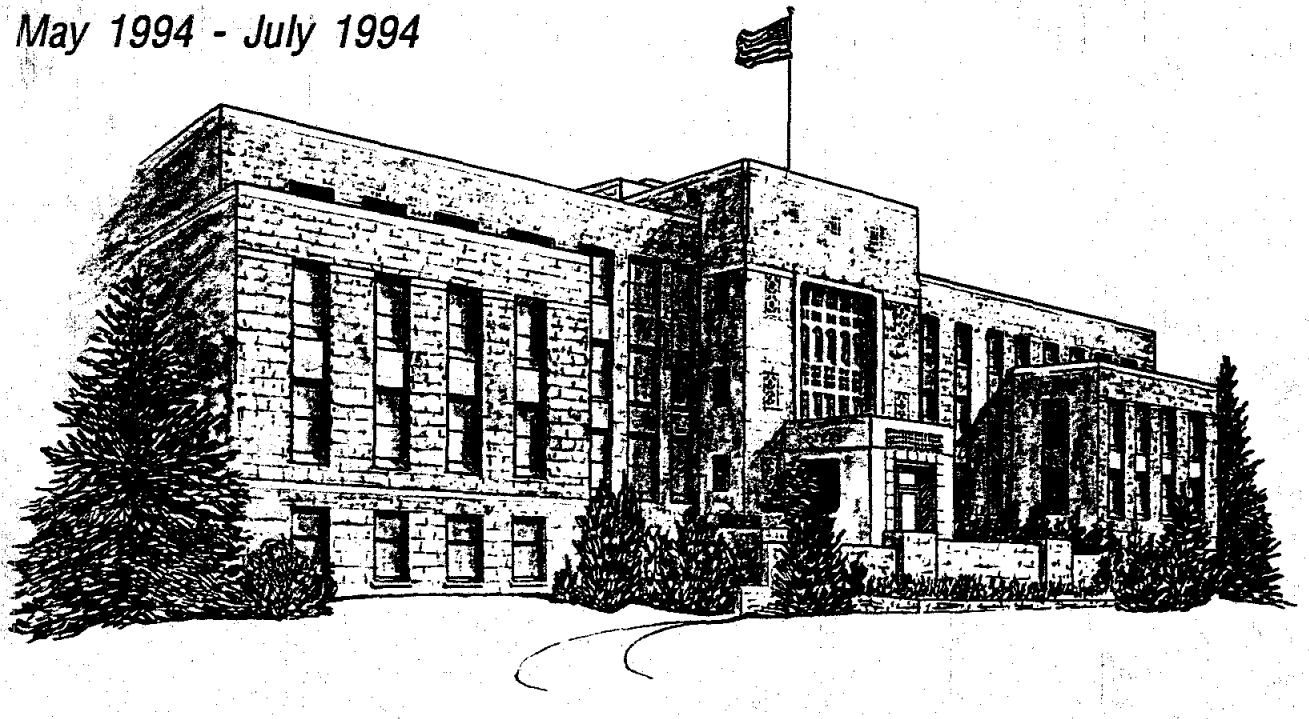
WESTERN RESEARCH INSTITUTE
"Providing solutions to energy and environmental problems"

QUARTERLY TECHNICAL PROGRESS REPORT

BASE PROGRAM ON ENERGY RELATED RESEARCH

Prepared for
U.S. Department of Energy
Morgantown Energy Technology Center

May 1994 - July 1994



WRI-94-R028

QUARTERLY TECHNICAL PROGRESS REPORT

BASE PROGRAM ON

ENERGY RELATED RESEARCH

For the

U.S. DEPARTMENT OF ENERGY

MORGANTOWN ENERGY TECHNOLOGY CENTER

By

WESTERN RESEARCH INSTITUTE

Under Cooperative Agreement DE-FC21-93MC30126

May 1994 - July 1994

ACKNOWLEDGMENT

This report was prepared with the support of the U.S. Department of Energy (DOE), Morgantown Energy Technology Center, under Cooperative Agreement Number DE-FC21-93MC30126. However, any opinions, findings, conclusions, or recommendations expressed herein are those of the author(s) and do not necessarily reflect the views of the DOE.

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1.0 OIL AND GAS

TASK 1.1

CROW™ Process Modeling

Reporting Period: May - July 1994

Principal Investigators: Lyle A. Johnson and Francis M. Carlson

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Task Objectives: This task is to incorporate new physical relationships peculiar to the CROW™ process into the existing thermal simulator and to validate the simulator based on controlled laboratory simulations.

Quarter Objectives: The objectives for this quarter were to compile the data from the two-dimensional tests and the relative permeability testing and to continue model verification using the results from the test simulations.

Accomplishments: Tests using nonaqueous phase liquid (NAPL) and dense nonaqueous phase liquid (DNAPL) were completed. At higher flushing temperatures there were problems with failure of the Plexiglas sides of the reactor. The problem was mitigated by replacement of the sides with thin aluminum sheets. All of the two-dimensional testing was completed.

Model modification was continued using the data from the two-dimensional tests for history matching and verification.

Procedures: The primary steps being taken in this task are (1) model development, (2) physical simulations, and (3) model verification. Step 1 will be used initially to identify the parameters for step 2 and will also include the incorporation of new physical relationships determined during the conduct of step 2. Upon completion of step 1, the data from step 2 will be used to validate the model in step 3.

Three scenarios of organic contamination in an aquifer are being investigated: LNAPL contamination floating on groundwater at the top of an aquifer, DNAPL contamination at the bottom of an aquifer, and NAPL contamination that has a density nearly identical to water, resulting in a suspended phase within an aquifer.

To conduct the two-dimensional tests, a vessel was constructed out of 0.25-inch Plexiglas. The vessel is 3-ft long, 2-ft high and 2-inches thick. Slotted and screened pipes of varying lengths are installed at one end of the vessel from the top to simulate the injection well. Similar slotted and screened pipes are installed on the other end of the vessel from the bottom to simulate the extraction well. A throttle valve controls the extracted fluid flow rate. Testing of the NAPL and DNAPL conditions could not be completed because of failures with the Plexiglas sides of the reactor. This has been resolved by replacement of the sides with aluminum sheets.

For each test, the vessel is filled with both organic material and water saturated, fine-grained, uniform 20-40 frac sand. This type of material has been chosen because it is similar to material found at a large number of contaminated sites. After the vessel is completely filled with sand and liquids, the vessel is sealed to establish a no-flow boundary condition, as used by the simulator.

The apparatus for measuring relative permeability consists of a test cell, an injection system, and a production collection system. The test cell consists of a cylindrical, stainless steel vessel that contains the packed, unconsolidated sand. The test cell is surrounded by guard heaters and insulated to produce isothermal conditions during the elevated temperature tests.

The fluid injection system consists of three positive displacement pumps for fluid or chemical injection, and an injected fluid heater. The positive displacement pumps are precalibrated to deliver the specified injection rates of organic material and water. The fluid heater has sufficient capacity to heat the injected fluids to the temperatures necessary for the experiments.

The collection system for the produced fluids includes a regulating valve to maintain back pressure on the system and a series of graduated collection vessels. The series of collection vessels permits the determination of individual component production rates versus time.

The entire reactor system is equipped with pressure gauges, pressure transmitters, and thermocouples to monitor the pressure and temperature of the system. All pressure transmitter and thermocouple signals are collected, analyzed, and stored by a data acquisition and control system. The guard heaters for the test cell are also controlled by this system. The problem of measuring the small differential pressures across the cell has been resolved by adding an inclined manometer to the system.

Organic samples to be used in the physical simulations have been combined with the mineral material to ensure that any interactions between the two have stabilized before the testing occurs. The minimum contact time before use of the material in a test is 1000 hours.

Activities Scheduled for Next Quarter: The relative permeability testing with the DNAPL organic contaminants will be completed. Model verification using the results from the two-dimensional test simulations and the relative permeability tests will continue.

For Form EIA-459E

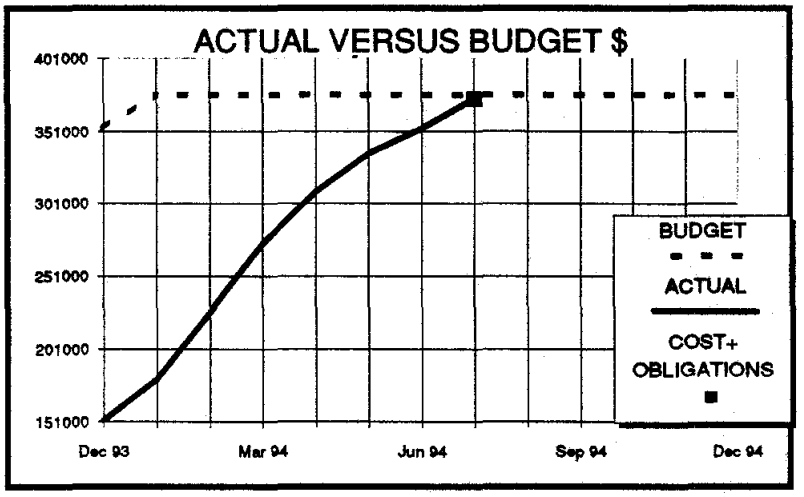
ACCOUNT STATUS REPORT

Month/Year
JULY 1994

Title	Base Program
Contract No	DE-FC21-93MC30126
Client	DOE
Contract Type	Cooperative Agreement
Account Value	
Proposal No	
Account No	

Description: Task 1.1
CROW Process Modeling

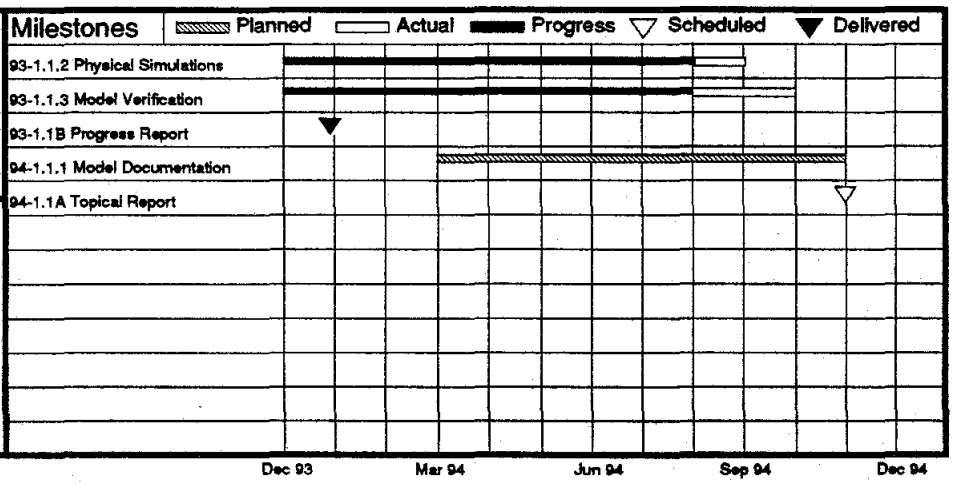
Essential Elements of Information	Yes	No	Customer Notfid'	Customer Appvd'
I. Meeting Performance Requirements				
II. On Schedule				
III. Within Contractual Cost				
A. Overrun $				
B. Scope Change $				
1. Funds Authorized				
2. Work Started				
IV. Adequate Funding				



Key Personnel

Proj Mgr: Smith, Verne
Task Mgr: Johnson Jr, Lyle
Sub Task Mgr:
Proj Admin:

	Date
Contract Start	02/02/93
Contract Complete	02/01/98
Plan Approved	02/02/93
Last Review	
Next Review	



PROGRAM HIGHLIGHTS

Budget vs Actual Table

	May 94	Jun 94	Jul 94
Budget	375983.66	375983.66	375983.66
Cost	335195.75	352764.86	373090.13
Variance	40787.91	23218.80	2893.53

F-Formal
I-Informal

Approved

Project Manager

Vice President

TASK 1.3

Development of a Portable Data Acquisition System and Coalbed Methane Simulator

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Reporting Period: May - July 1994

Principal Investigators: Francis M. Carlson and Charles G. Mones

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Task Objectives: The objectives of this task are to develop a self-contained, portable data acquisition system, to develop an in-house coalbed methane simulator, and to improve model physics to develop competitive advantage. Therefore, this task is divided into three relevant subtasks: 1.3.1 Development of Data Acquisition System, 1.3.2 Development of Coalbed Methane Simulator, and 1.3.3 Laboratory Work to Improve Model Physics and to Gain Competitive Advantage.

Quarter Objectives: The objective for the quarter for subtask 1.3.1 was to compare results for helium concentrations obtained from the portable coalbed methane data acquisition system with those obtained from an independent laboratory. Under 1.3.2, if time permitted, the objective was to add single-component sorption to one of the models for which we have the source code. There was no objective planned for subtask 1.3.3.

Accomplishments: The helium trace-component data obtained by the portable data acquisition system compared favorably with those taken by an independent laboratory. Under subtask 1.3.2, single-component sorption was not added to the model as planned this quarter because of other demands from other projects.

Procedures: Comparisons were made between the helium concentrations obtained by the data acquisition system whose primary component is a small dual-column gas chromatograph manufactured by MTI Analytical Instruments and those obtained by an independent laboratory using a mass spectrometer. Periodic grab samples were taken during the period when maximum helium response was indicated by the data acquisition system. These grab samples were then later analyzed by an independent laboratory.

Although sorption was not added to any of the models available to Western Research Institute (WRI) during the period, consideration is being given to altering the data input of the model to simulate coal desorption either through pressure reduction or displacement. The general approach would be to use equilibrium relationships between liquid and vapor to describe the adsorption-desorption process where the coal is treated as a nonmobile liquid phase and the K-values (y/x) are selected in such a way as to represent the sorption processes. The advantage of using such methodology is that coding changes would not have to be made to a standard compositional model.

Results: Concerning the comparison of the helium concentrations obtained from the data acquisition system and the helium concentrations obtained from another laboratory's mass spectrometer, favorable results were obtained. Although the concentrations determined by the MTI gas chromatograph were slightly higher than the concentrations determined by the mass spectrometer, the signatures of the responses were very similar from both sources.

Activities Scheduled for Next Quarter: During the next quarter, an attempt will be made to alter the input data of a model to get the effect of sorption processes in coal. If time permits and appears necessary, single-component sorption will be added either to UTCOMP or WRI's implicit model to test the stability of the model under sorption conditions.

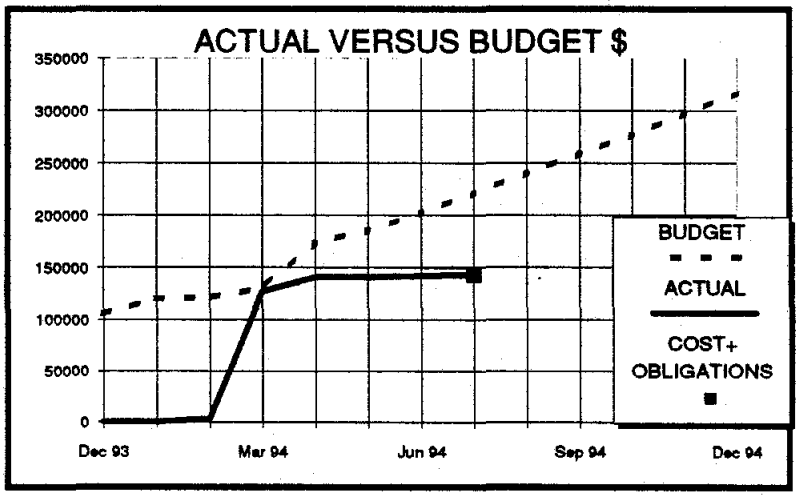
Form EIA-459E

ACCOUNT STATUS REPORT

Month/Year
JULY 1994

Title	: Base Program	**Description: Task 1.3** Portable Data Acquisition System and Coalbed Methane Simulator
Contract No	: DE-FC21-93MC30126	
Client	: DOE	
Contract Type	: Cooperative Agreement	
Account Value	:	
Proposal No	:	
Account No	:	

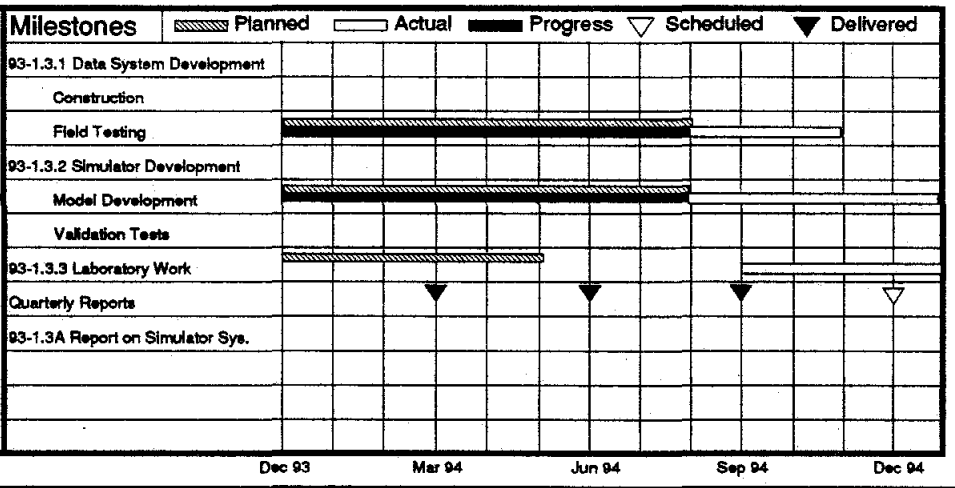
Essential Elements of Information	Yes	No	Customer Notfid'	Customer Appvd'
I. Meeting Performance Requirements				
II. On Schedule				
III. Within Contractual Cost				
A. Overrun $				
B. Scope Change $				
1. Funds Authorized				
2. Work Started				
IV. Adequate Funding				



Key Personnel

Proj Mgr: Smith, Verne
Task Mgr: Carlson, Frank
Sub Task Mgr:
Proj Admin:

	Date
Contract Start	02/02/93
Contract Complete	02/01/98
Plan Approved	11/24/93
Last Review	
Next Review	



PROGRAM HIGHLIGHTS

Budget vs Actual Table

	May 94	Jun 94	Jul 94
Budget	184937.45	202340.01	220785.46
Cost	140423.21	141965.75	143014.54
Variance	44514.24	60374.26	77770.92

F-Formal
I-Informal

Approved _____ Project Manager

_____ Vice President

TASK 1.4

Tank Bottom Waste Processing Using the TaBoRR™ Process

Reporting Period: May - July 1994

Principal Investigators: Lyle Johnson, Robert Satchwell, and Vijay Sethi

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Task Objectives: This task is to develop information relevant to the successful deployment of WRI's patented TaBoRR™ technology. Four subtasks have been identified, with the specific objectives to: (1) gather emission and effluent related information from a pilot-scale unit and perform nondestructive testing of process equipment for durability, (2) design, construct, and operate a process development unit (PDU) capable of processing 1 to 2 barrels/day of wastes, (3) perform numerical modeling and economic analysis for the prediction of process performance based on feedstock analysis, and (4) report all efforts.

Quarter Objectives: The objectives for this quarter were to complete preparation of the facilities for the PDU, initiate construction of the PDU, complete the experimental plan for the task, and continue monitoring the development and construction of the pilot-scale unit.

Accomplishments: Preparation of the test facilities was completed. Design and specification of the PDU components were initiated and are nearly completed. Several components have been specified and purchase requests issued. All components for the PDU should be received and installed during the next quarter.

Monitoring of the pilot-scale TaBoRR unit that is being developed under the JSR program has continued. When the unit is in operation, environmental and materials data will be collected.

Procedures: The primary subtasks being undertaken in this task are (1) collection of data from a pilot-scale unit, (2) construction and operation of a PDU unit, (3) numerical modeling and economic evaluation of the process, and (4) reporting. Subtask 1 is the collection of environmental and materials data from a pilot-scale unit being developed under a JSR program. These data will provide information critical to the permitting of the process and in construction of future TaBoRR units.

Subtask 2 will provide a PDU system in which the fate of some of the contaminants, such as sulfur, chlorides, and asphaltenes, can be determined. The fate of the contaminants directly impact the process performance and economics. The PDU will also provide a system to evaluate and develop the operating parameters for individual feedstocks and to evaluate materials of construction for the individual system components.

The development of numerical modeling in subtask 3 will provide the ability to predict the performance of the process based on feedstock analysis. Also, this effort will include the economic evaluation of the process based on data gathered from the first two subtasks and the numerical modeling. Reporting will be done under subtask 4.

Activities Scheduled for Next Quarter: The experimental plan for the task will be completed and submitted for approval. Construction of the PDU system will continue, with completion of the system to follow approval of the experimental plan. Monitoring of the development and operation of the pilot-scale unit will continue.

For Form EIA-459E

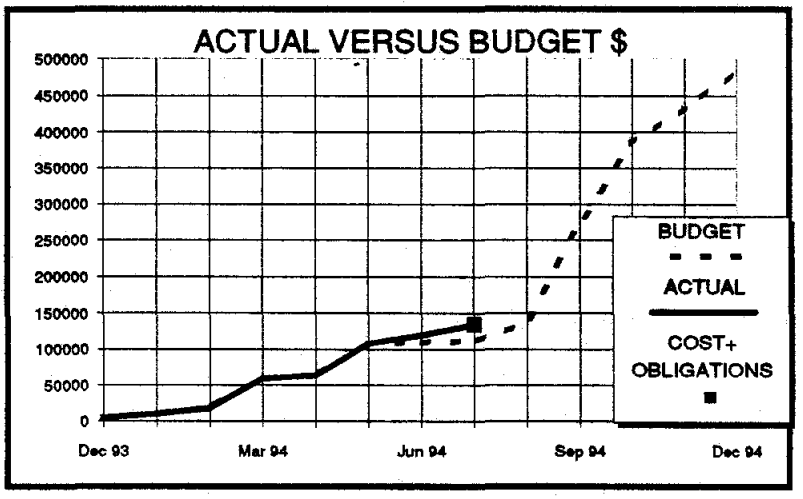
ACCOUNT STATUS REPORT

Month/Year
JULY 1994

Title	:	Base Program
Contract No	:	DE-FC21-93MC30126
Client	:	DOE
Contract Type	:	Cooperative Agreement
Account Value	:	
Proposal No	:	
Account No	:	

Description: Task 1.4
Investigation of Tank Bottom Waste Processing Using the TaBoRR Process

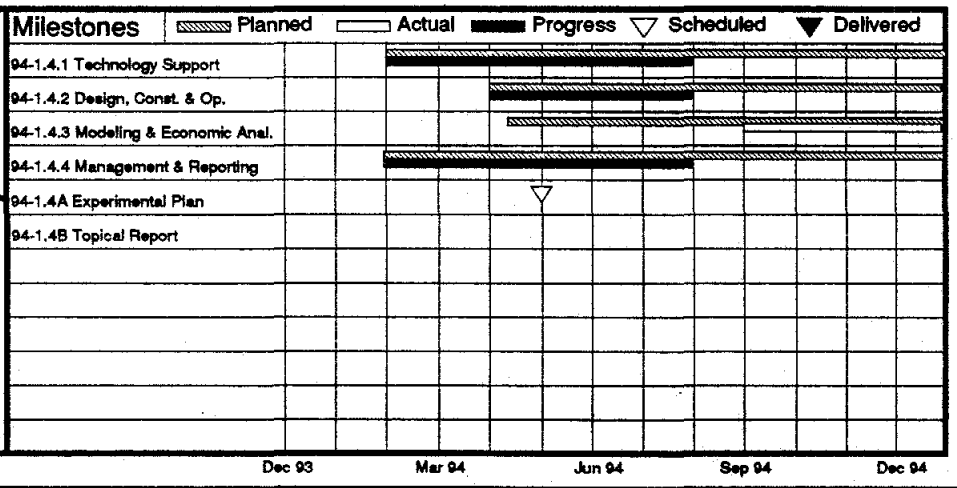
Essential Elements of Information	Yes	No	Customer Notfid'	Customer Appvd'
I. Meeting Performance Requirements				
II. On Schedule				
III. Within Contractual Cost				
A. Overrun $				
B. Scope Change $				
1. Funds Authorized				
2. Work Started				
IV. Adequate Funding				



Key Personnel

Proj Mgr:	Smith, Verne
Task Mgr:	Johnson Jr, Lyle
Sub Task Mgr:	
Proj Admin:	

	Date
Contract Start	02/02/93
Contract Complete	02/01/98
Plan Approved	03/29/94
Last Review	
Next Review	



PROGRAM HIGHLIGHTS

Budget vs Actual Table

	May 94	Jun 94	Jul 94
Budget	108021.00	109657.00	111084.00
Cost	108021.23	119657.45	133931.84
Variance	-0.23	-10000.45	-22847.84

F-Formal
I-Informal

Approved _____ Project Manager

_____ Vice President

2.0 ADVANCED SYSTEMS APPLICATIONS

TASK 2.1

Development and Optimization of a Process for the Production of a Premium Solid Fuel from Western U. S. Coals

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Reporting Period: May - July 1994

Principal Investigator: Norm Merriam

Task Objectives: The long-term objective of this task is to develop a technically and economically feasible process for producing a low-sulfur, high-Btu, fuel from western coals. The objectives for 1993 were (1) to develop an economical method to control spontaneous combustion in pyrolyzed coal and (2) to demonstrate the removal of mercury from the coal by thermal treatment. The objective for the work in 1994 is to test the process using a continuous, bench-scale system that integrates the drying and pyrolysis reactors.

Quarter Objectives: Objectives for the first year of work on this task were achieved and reported in previous quarters. Most of the work for the second year is scheduled for later in the year.

Accomplishments: The topical reports describing the test results (Merriam 1993; Merriam and Turner 1993) were approved by DOE in a previous quarter. A poster session presentation, describing the process, was given at the METC Contractors Meeting in June 1994.

References:

Merriam, N.W., 1993, Removal of Mercury for Powder River Basin Coal by Low-Temperature Thermal Treatment. Laramie, WY, WRI Report to DOE, WRI-93-R021.

Merriam, N.W., and T.F. Turner, 1993, COMPCOAL™: A Profitable Process for Production of a Stable High-Btu Fuel from Powder Basin Coal. Laramie, WY, WRI Report to DOE, WRI-93-R008.

For Form EIA-459E

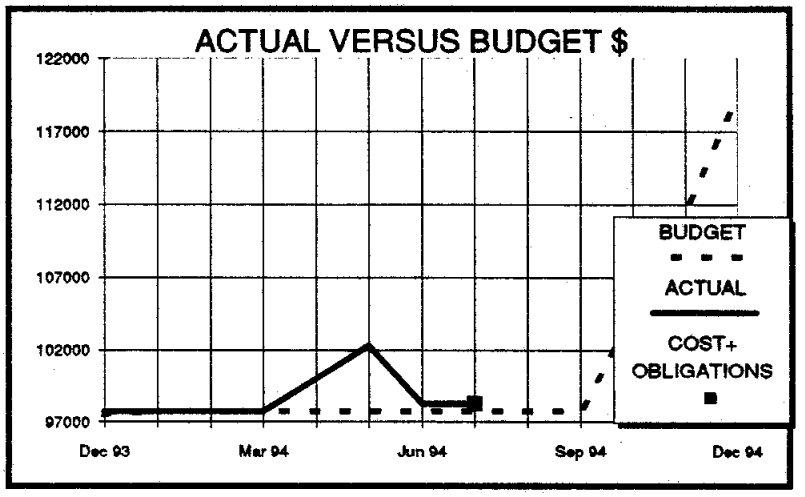
ACCOUNT STATUS REPORT

Month/Year
JULY 1994

Title	:	Base Program
Contract No	:	DE-FC21-93MC30126
Client	:	DOE
Contract Type	:	Cooperative Agreement
Account Value	:	
Proposal No	:	
Account No	:	

Description: Task 2.1
Development and Optimization of a Process for the Production of a Premium Solid Fuel from Western U.S. Coals

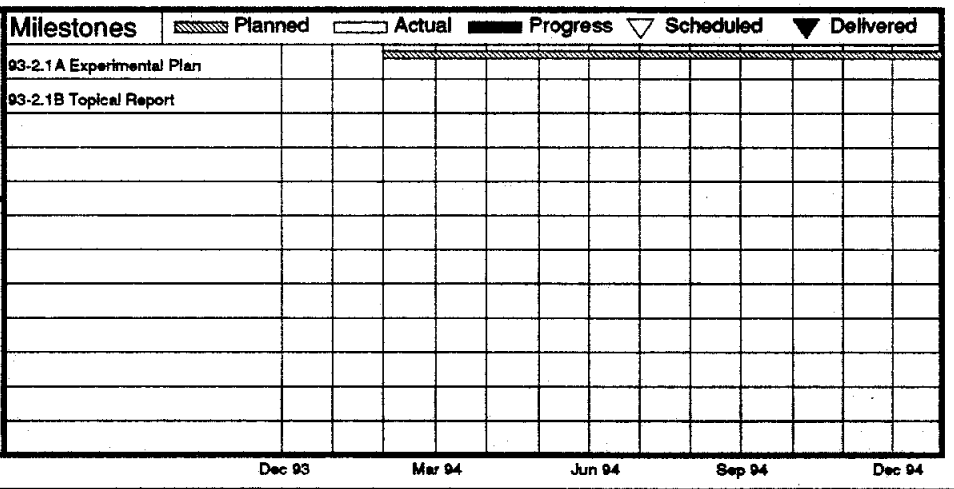
Essential Elements of Information	Yes	No	Customer Notfid'	Customer Appvd'
I. Meeting Performance Requirements				
II. On Schedule				
III. Within Contractual Cost				
A. Overrun $				
B. Scope Change $				
1. Funds Authorized				
2. Work Started				
IV. Adequate Funding				



Key Personnel

Proj Mgr: Smith, Verne
Task Mgr: Merriam, Norman
Sub Task Mgr:
Proj Admin:

	Date
Contract Start	02/02/93
Contract Complete	02/01/98
Plan Approved	02/02/93
Last Review	
Next Review	



PROGRAM HIGHLIGHTS

Budget vs Actual Table

	May 94	Jun 94	Jul 94
Budget	97715.19	97715.19	97715.19
Cost	102268.83	98227.74	98237.34
Variance	-4553.64	-512.55	-522.15

F-Formal
I-Informal

Approved _____ Project Manager

_____ Vice President

TASK 2.4

Process Support and Development

Reporting Period: May - July 1994

Principal Investigator: David Sheesley

Task Objective: The objective of this task is to obtain support leading to development of a COMPCOAL™ pilot plant.

Quarter Objective: The objective for this quarter was to prepare the topical report of the results of this study.

Accomplishments: Work continued on the preparation of the topical report.

Procedures: The COMPCOAL process consists of four steps:

- Initial Drying
- Partial Decarboxylation
- Mild Pyrolysis
- Stabilization

Results: The process reduces the weight of coal by about 40%, thus reducing transportation costs and improving coal marketability. Companion projects with this process have produced stabilized coal particles resistant to oxidation and readsorption of moisture.

Activities Scheduled for Next Quarter: The topical report, including the presentation materials will be completed.

For Form EIA-459E

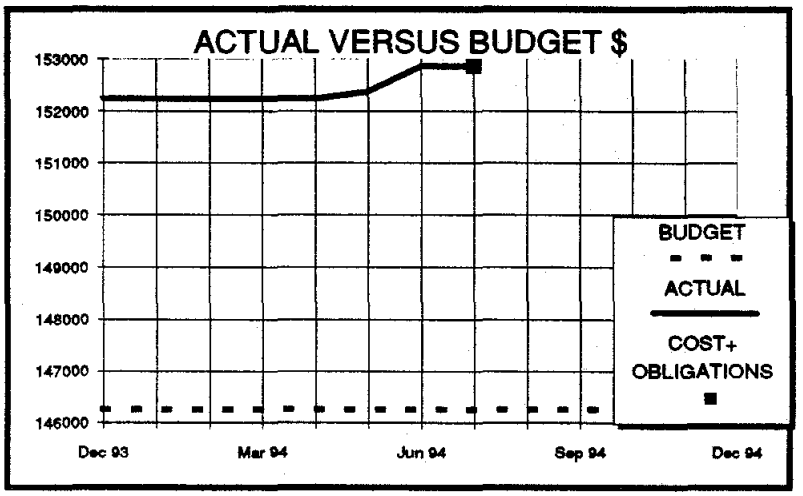
ACCOUNT STATUS REPORT

Month/Year
JULY 1994

Title	Base Program
Contract No	DE-FC21-93MC30126
Client	DOE
Contract Type	Cooperative Agreement
Account Value	
Proposal No	
Account No	

Description: Task 2.4
Process Support and Development

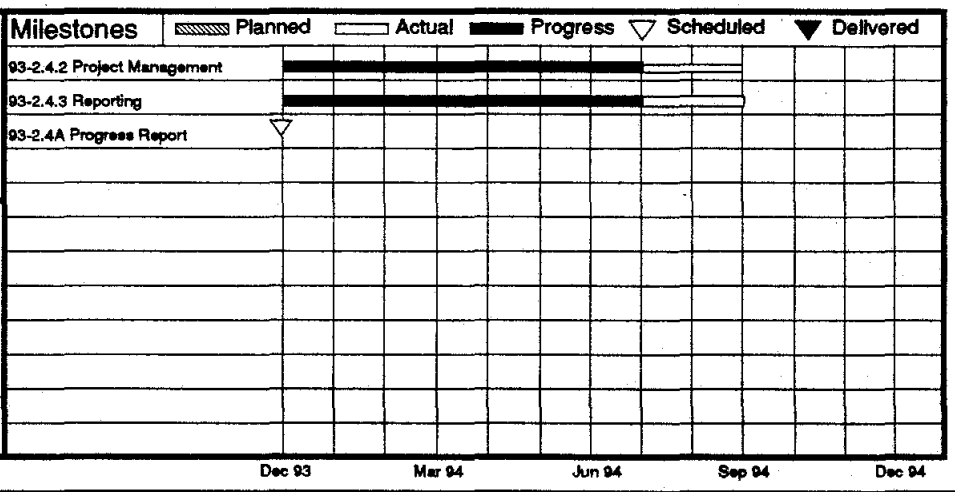
Essential Elements of Information	Yes	No	Customer Notfid	Customer Appvd
I. Meeting Performance Requirements				
II. On Schedule				
III. Within Contractual Cost				
A. Overrun $				
B. Scope Change $				
1. Funds Authorized				
2. Work Started				
IV. Adequate Funding				



Key Personnel

Proj Mgr:	Smith, Verne
Task Mgr:	Sheesley, David
Sub Task Mgr:	
Proj Admin:	

	Date
Contract Start	02/02/93
Contract Complete	02/01/98
Plan Approved	02/02/93
Last Review	
Next Review	



PROGRAM HIGHLIGHTS

Budget vs Actual Table

	May 94	Jun 94	Jul 94
Budget	146249.97	146249.97	146249.97
Cost	152375.17	152852.57	152852.57
Variance	-6125.20	-6602.60	-6602.60

F-Formal
I-Informal

Approved _____ Project Manager

_____ Vice President

TASK 2.5

Eastern Shale Oil Residue as an Asphalt Additive

Reporting Period: May - July 1994

Principal Investigator: Kenneth Thomas

Task Objectives: The objectives of this task are to determine whether an asphalt modifier produced from eastern shale is or is not beneficial to reduce age hardening and moisture damage susceptibility in asphalt concrete used in public roads.

Quarter Objectives: The objectives for this quarter were to complete and submit the detailed work plan, to receive a stabilized eastern shale oil product produced by the University of Kentucky Center for Applied Energy Research (CAER), and to evaluate the stability of the product.

Accomplishments: The detailed experimental plan was completed and submitted. Material was received from CAER and its stability was evaluated.

Procedures: The ASTM procedures used included D 92 (flash point open cup) and D 4402 (Brookfield viscosity).

Results: Approximately 2 liters of oil product was received from CAER on July 22, 1994. An aliquot of the oil was submitted for analysis to determine appropriate properties and its stability. The flash point of the material is 191.5°C (377°F) and its viscosity is 1290 cP at 60°C (140°F). Approximately 1 month later the viscosity of the oil was determined to be 1300 cP at 60°C (140°F). Thus, it is concluded that the oil is stabile, and it is appropriate to continue the testing sequence.

Activities Scheduled for Next Quarter: The primary activities planned for next quarter are to vacuum distill the oil product to produce a residue that is more appropriate for blending (i.e., something comparable to an AC 5 or an AC 10 asphalt), to initiate the testing sequence by preparing blends of the eastern shale oil residue with selected SHRP asphalts, and to begin the evaluation of aging and moisture susceptibility of the blends and neat asphalts.

Form EIA-459E

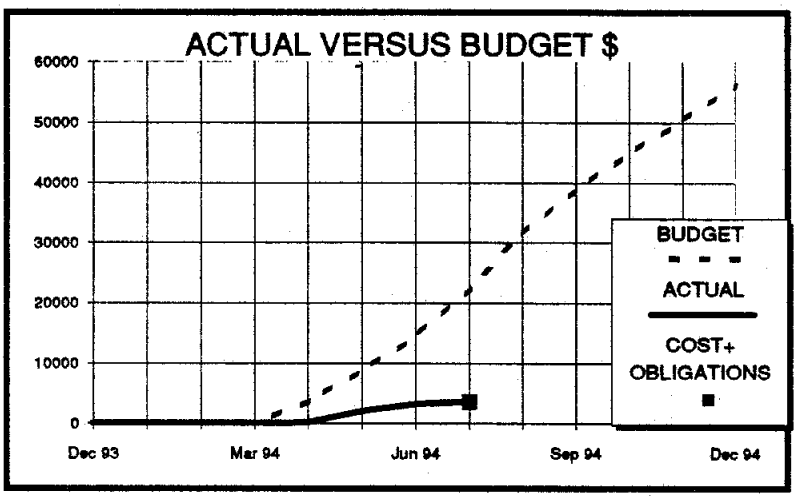
ACCOUNT STATUS REPORT

Month/Year
JULY 1994

Title	:	Base Program
Contract No	:	DE-FC21-93MC30126
Client	:	DOE
Contract Type	:	Cooperative Agreement
Account Value	:	
Proposal No	:	
Account No	:	

Description: Task 2.5
Development of an Eastern Shale Oil Residue as an Asphalt Additive

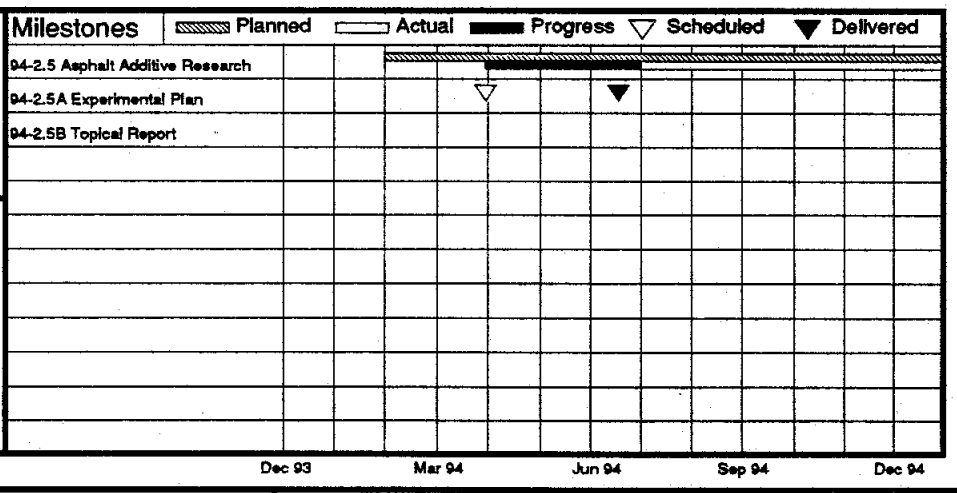
Essential Elements of Information	Yes	No	Customer Notfid'	Customer Appvd'
I. Meeting Performance Requirements				
II. On Schedule				
III. Within Contractual Cost				
A. Overrun $				
B. Scope Change $				
1. Funds Authorized				
2. Work Started				
IV. Adequate Funding				



Key Personnel

Proj Mgr: Smith, Verne
Task Mgr: Thomas, Kenneth
Sub Task Mgr:
Proj Admin:

	Date
Contract Start	02/02/93
Contract Complete	02/01/98
Plan Approved	03/29/94
Last Review	
Next Review	



PROGRAM HIGHLIGHTS

Budget vs Actual Table

	May 94	Jun 94	Jul 94
Budget	8758.73	14309.56	22360.89
Cost	2006.10	3199.78	3574.48
Variance	6752.63	11109.78	18786.41

F-Formal
I-Informal

Approved _____ Project Manager

_____ Vice President

3.0 ENVIRONMENTAL TECHNOLOGIES

TASK 3.1

Solid Waste Management

Reporting Period: May - July 1994

Principal Investigator: Alan Bland

Task Objectives: The objectives of this task are to develop options and technologies, specifically designed to enhance the conditioning, handling, storage, disposal, and use of solid waste from emerging, as well as conventional fossil fuel technologies.

Quarter Objectives: The objectives for the quarter were: (1) to receive ashes from CFBC facilities and begin initial characterization and (2) to continue the analytical methods development and the synthesis of ettringite and thaumasite minerals.

Accomplishments: Ashes representing selected ages from three energy mixes were prepared and are being tested by XRD, TGA and DTGA, and SEM.

Ettringite of variable composition has been synthesized and analyzed by a number of analytical techniques. These techniques include XRD, TGA and DTGA, SEM, and DSC. The results of the analytical methods development appear promising for quantifying the reaction products.

A number of FBC facilities have been contacted and have agreed to supply ash for the geotechnical, conditioning and chemical hydration reaction testing. These include: (1) AES Barbers Point (low-sulfur and ash bituminous coal-fired); (2) NISCO (petroleum coke-fired); (3) Tri-State Nucla (low-sulfur subbituminous); (4) TVA (high-sulfur coal and petroleum coke-fired); and (5) AEP Tidd (high-sulfur coal-fired PFBC).

Procedures: Standard ASTM procedures for geotechnical testing were used, including ASTM D 698 and 1557 for moisture-density relationships, ASTM C 109 (modified) for unconfined compressive strength, and ASTM C 157 for dimensional stability (expansion/shrinkage) testing. Chemical characterization used ASTM wet chemical methods, and standard ICAP, XRF, TGA, DSC, SEM, and XRD techniques.

Results: A number of FBC facilities have been contacted and they have agreed to supply ash for the geotechnical, conditioning, and hydration reaction testing. These include: (1) AES Barbers Point (low-sulfur and ash bituminous coal-fired), (2) NISCO (petroleum coke-fired), (3) Tri-State Nucla (low-sulfur subbituminous coal-fired), (4) TVA (high-sulfur coal and petroleum coke-fired), and (5) AEP Tidd (high-sulfur coal-fired PFBC). Ashes have been received from the AEP Tidd plant and TVA facilities. Initial chemical and physical characterizations of the ashes are presented in Tables 1 and 2.

Table 1. Summary of the Chemical Composition of FBC Fly Ashes

	AEP Tidd Fly Ash	AEP Tidd Bed Ash	AEP Tidd Fly Ash (1)	AEP Tidd Bed Ash (2)	AEP Tidd Fly Ash (3)	AEP Tidd Bed Ash (4)
Ca/S Ratio	1.3	1.3	1.86	1.86	2.5	2.5
Moisture	0.11	0.00	na	na	na	na
Carbon (org.)	na	na	na	na	na	na
LOI	11.08	4.76	na	na	na	na
SiO_2	25.65	8.35	14.33	4.49	74.88	5.78
TiO_2	0.49	0.13	na	na	na	na
Al_2O_3	11.23	3.18	12.47	10.58	21.92	4.16
Fe_2O_3	12.51	1.58	14.22	5.69	14.51	5.12
CaO	16.94	31.33	23.37	33.72	21.41	34.56
MgO	9.39	18.45	16.23	26.89	15.54	26.46
K_2O	1.24	0.14	1.20	0.31	2.36	0.24
Na_2O	0.58	0.35	na	na	na	na
P_2O_5	0.25	0.34	0.08	0.04	0.08	0.03
SO_3	10.55	31.31	12.98	21.22	13.23	25.72
CO_2	na	na	4.70	3.24	3.77	2.04
Total	88.94	95.14	98.97	105.82	167.44	105.85

(1 - 4) Data from Dravo (Phase I Report)
(1) Tidd 3; (2) Tidd 4; (3) Tidd 6; (4) Tidd 7

Table 2. Summary of the Bulk Density and Moisture-Density Relationships of FBC Ashes

	Bulk Density		ASTM D 698	
FBC Ash Sources	Poured (pcf)	Packed (pcf)	Optimum Moisture (%)	Max. Dry Density (pcf)
TVA Shawnee, USA				
High-S Coal/Pet-Coke Fly Ash	51.3	71.0		
High-S Coal/Pet-Coke Ash Blend	83.4	100.5	26.43	87.99
AEP Tidd, USA				
Ohio #8 Ca/S=1.3 6/94 Fly Ash	52.7	71.0	24.32	102.10
Ohio #8 Ca/S=1.3 6/94 Ash Blend		80.9	89.5	
Ohio #8 Ca/S=2.5 (Tidd 6)*	na	na	25	98.8
Ohio #8 Ca/S=2.5 (Tidd 3/4)*	na	na	18	114.3

na - not analyzed
Ash Blend - 30% bed ash and 70% fly ash. Bed ash prehydrated at 18% moisture.
* Data from Phase I Report (Dravo).

For the stability range and methods of control of hydration reactions portion of the study, ettringite of variable composition has been synthesized and analyzed by a number of techniques. The results of the analytical methods development are promising and techniques for quantifying the reaction products appear possible. Figure 1 shows the results of high resolution TGA of synthetic ettringite.

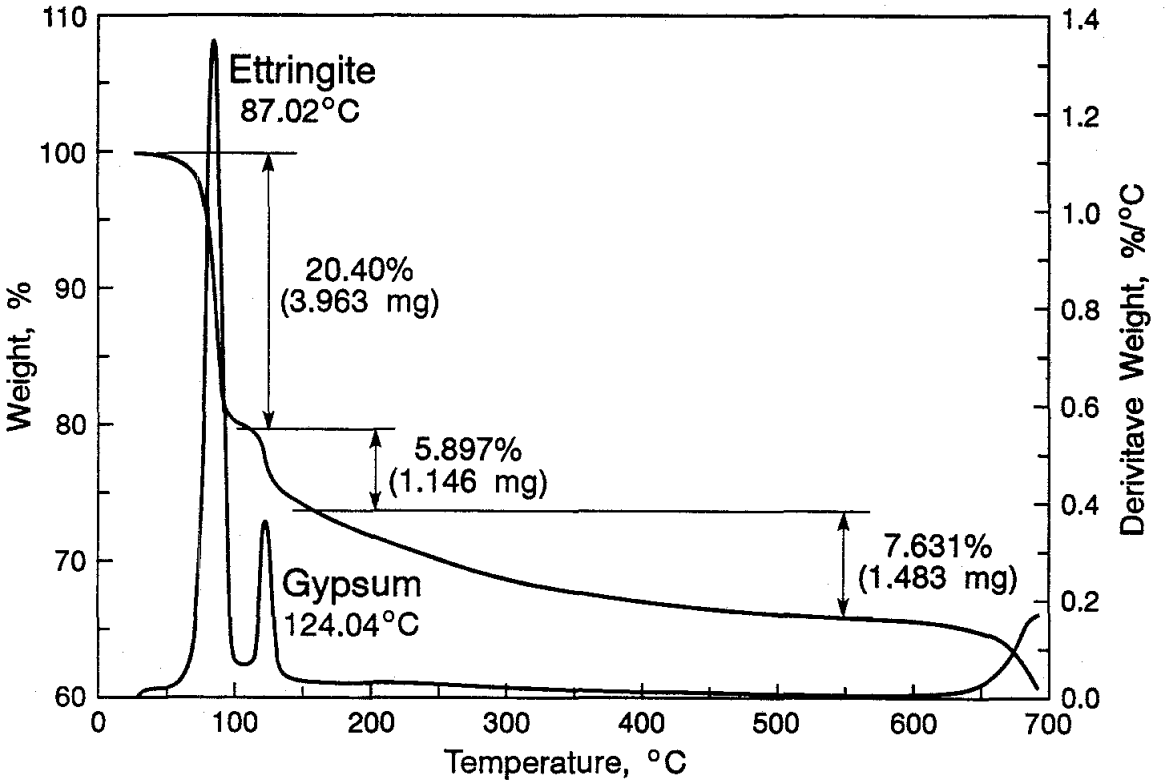


Figure 1. High Resolution Thermogravimetric Analysis of Ettringite Synthesized at Western Research Institute

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Activities Scheduled for Next Quarter: Activities planned for next quarter include receiving ashes from the CFBC facilities and starting their characterization, and continuing the analytical methods development and the synthesis of ettringite and thaumasite minerals.

For Form EIA-459E

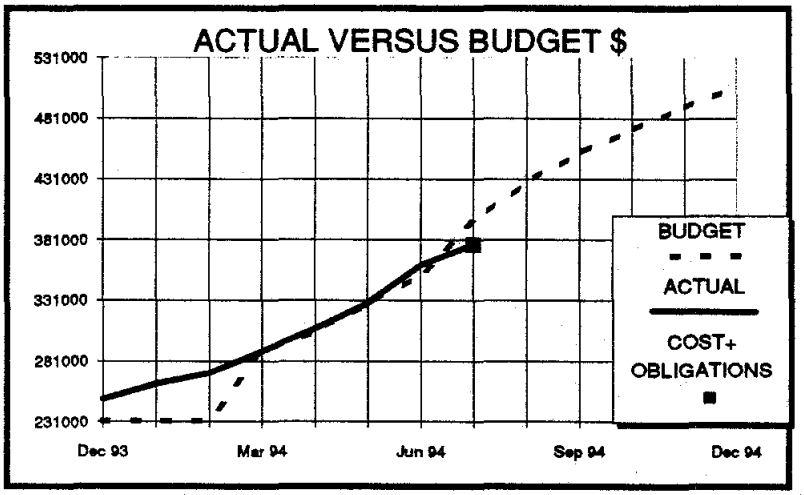
SUB-TASK STATUS REPORT

Month/Year
JULY 1994

Title	:	Base Program
Contract No	:	DE-FC21-93MC30126
Client	:	DOE
Contract Type	:	Cooperative Agreement
Sub-Task Value	:	
Proposal No	:	
Sub-Task No	:	

Description: Task 3.1
Solid Waste Management

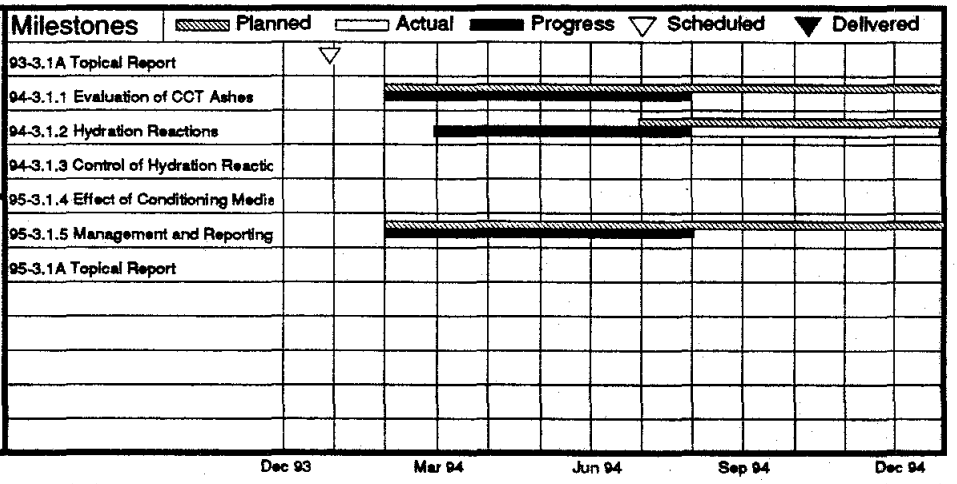
Essential Elements of Information	Yes	No	Customer Notfid	Customer Appvd
I. Meeting Performance Requirements				
II. On Schedule				
III. Within Contractual Cost				
A. Overrun $				
B. Scope Change $				
1. Funds Authorized				
2. Work Started				
IV. Adequate Funding				



Key Personnel

Proj Mgr: Smith, Verne
Task Mgr: Bland, Alan
Sub Task Mgr:
Proj Admin:

	Date
Contract Start	02/02/93
Contract Complete	02/01/98
Plan Approved	02/02/93
Last Review	
Next Review	



PROGRAM HIGHLIGHTS

Budget vs Actual Table

	May 94	Jun 94	Jul 94
Budget	327756.65	351625.83	395317.47
Cost	328281.71	359601.91	376915.20
Variance	-525.06	-7976.08	18402.27

F-Formal
I-Informal

Approved _____ Project Manager

_____ Vice President

TASK 3.2

Remediation of Contaminated Soils

Reporting Period: May - July 1994

Principal Investigators: Alan Bland and Terry Brown

Task Objective: The objective of this task is to develop physical, chemical, and thermal treatments to remediate inorganic and organic toxics from contaminated materials.

Quarter Objectives: The objectives for the quarter were to: (1) find a chemical composition of collectors and frothers that can separate and suspend in the liquid phase hydrocarbon contaminants from a soil sample containing a high percentage of clays, (2) demonstrate that column flotation can be used to concentrate the hydrocarbon contaminant from the liquid phase into a collapsed froth, and (3) obtain materials and carbon balances for the scrubber system.

Accomplishments: The petroleum and mercury contaminated soils were acquired as "feedstock" for the remediation testing. The initial portion of the work relating to the petroleum contaminated soil has been completed. The chemistry of the collection and frothing system has not been optimized; however, preliminary results show that the flotation process separates hydrocarbons from the very fine soil fraction.

Procedures: The scrubber chemical optimization tests were conducted using 1-liter beakers. A high-speed laboratory mixer with an impact bar was used to simulate the action of an attrition scrubber. A typical test was conducted with 15 g of contaminated soil sample and 500 mL of solution containing the chemicals being evaluated. The solids settling from solution were dried and the carbon content was determined. The materials remaining in solution were flocculated using $CaCl_2$. The resulting material was dried and carbon content determined. The carbon content of the settled solids and the dried flocculated materials were compared and the changes were used to evaluate the chemicals used in the process.

Results: Numerous tests were conducted using surfactant combinations. The results show that the larger particle size fraction (+325 mesh and -325 mesh that settles in a 24-hour period) can be cleaned quite effectively. All tests show a higher carbon content for the collapsed foam indicating that the carbon can be concentrated by flotation. However, limited success was experienced cleaning the fine fraction (-325 mesh suspended). The most efficient conditions for the cleaning the fine fraction were using TIDE detergent with the column in the stripping mode. Using these conditions, about 58% of the carbon was removed from the soil material.

These results seem to indicate that hydrocarbon removal from soil materials using the column flotation procedure will work. However, considerable effort will need to be made to develop more effective combinations of surfactants that will efficiently remove hydrocarbons from the contaminated materials.

Activities Scheduled for Next Quarter: The mercury contaminated soil will be characterized and preliminary testing will be conducted using various combinations of reagents that will be effective in remediating the soil. Efforts will continue in an effort to reduce turbulence in the column. A trip is planned to visit a pilot-scale column flotation unit that is operated by Dr. Glen Dobby, MinnovEX Technologies (Montreal, Canada).

For Form EIA-459E

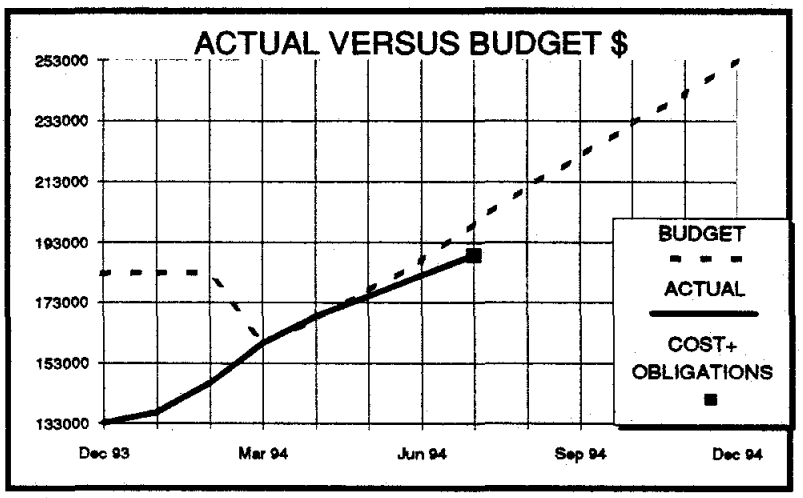
ACCOUNT STATUS REPORT

Month/Year: JULY 1994

Title	Base Program
Contract No	DE-FC21-93MC30126
Client	DOE
Contract Type	Cooperative Agreement
Account Value	
Proposal No	
Account No	

Description: Task 3.2
Remediation of Contaminated Soils

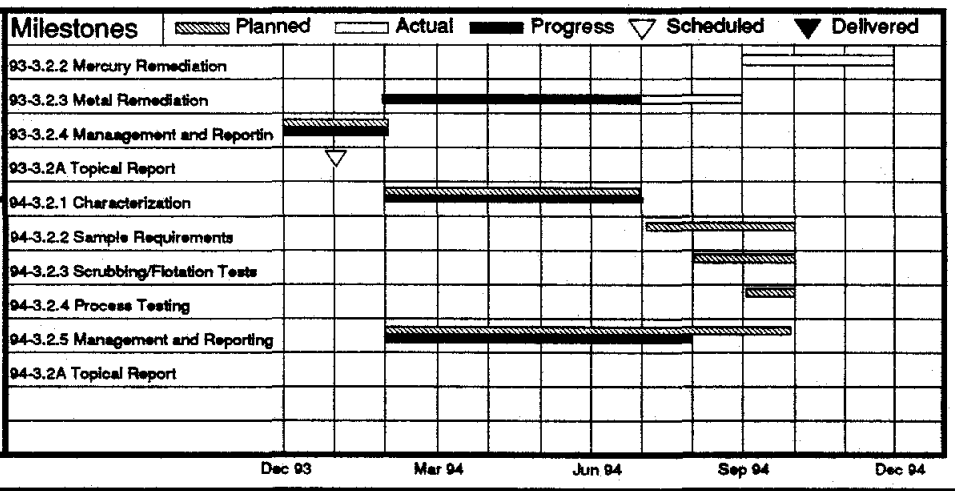
Essential Elements of Information	Yes	No	Customer Notfid	Customer Appvd
I. Meeting Performance Requirements				
II. On Schedule				
III. Within Contractual Cost				
A. Overrun $				
B. Scope Change $				
1. Funds Authorized				
2. Work Started				
IV. Adequate Funding				



Key Personnel

Proj Mgr: Smith, Verne
Task Mgr: Bland, Alan
Sub Task Mgr:
Proj Admin:

	Date
Contract Start	02/02/93
Contract Complete	02/01/98
Plan Approved	02/02/93
Last Review	
Next Review	



PROGRAM HIGHLIGHTS

Budget vs Actual Table

	May 94	Jun 94	Jul 94
Budget	176934.39	186548.55	199362.71
Cost	174957.68	182081.99	188709.55
Variance	1976.71	4466.56	10653.16

F-Formal
I-Informal

Approved _____ Project Manager

_____ Vice President

TASK 3.3

The Syn-Ag™ Process: Coal Combustion Ash Management Option

Reporting Period: May - July 1994

Principal Investigator: Alan Bland

Task Objectives: The overall objectives of this task are to develop and demonstrate the technical process feasibility and economic viability of the Syn-Ag™ process for power plant ashes, including "off-spec" ashes. Objectives for the first year of this task are to: (1) develop and document the use of additives for a range of conventional coal combustion ashes, (2) determine the optimum curing conditions for the Syn-Ag process, (3) verify the properties of the aggregate produced from the Syn-Ag process, and (4) determine the process costs.

Quarter Objectives: The objectives for the quarter were to obtain additional samples of the Laramie River and Craig ashes and to assess the effect of pre-pelletization aging of the two ashes on the strength development behavior of the pelletized products.

Accomplishments: Disclosures have been written and patent applications are being considered. **As a result, information about the Syn-Ag process remains confidential to WRI and protected therein.**

Additional ash material has been obtained from the Craig facility and additional material has been requested from the Laramie River Station.

The assessment of the effect of pre-pelletization aging of the ashes from the Craig and Laramie River plants has been postponed due to complications with logistics at the facilities.

Additional curing tests with heat and steam at various temperatures with an FBC ash were conducted, illustrating the value of heat on strength development rate.

Procedures: Standard ASTM procedures for the geotechnical testing were used, including ASTM D 698 and D 1557 for moisture-density relationships, ASTM C 109 (modified) for unconfined compressive strength, and ASTM C 157 for dimensional stability (expansion/shrinkage) testing. Chemical characterization used ASTM wet chemical methods, as well as standard ICAP, XRF, and XRD techniques.

Results: A set of experiments were conducted to evaluate the effect of curing temperature under sealed conditions. Results are shown in Table 3 for an ash from an FBC facility.

Table 3. Summary of Testing of Effect of Curing Temperature on the Strength Development of FBC Ash Synthetic Aggregate

Mix Proportions (g/mix)	FA/HBA (A)	FA/HBA (A-2)	FA/HBA (B)	FA/HBA (D)	FA/HBA (E)	FA/HBA (C)
Fly Ash	1300	1300	1300	1300	1300	1300
Hydrated Bed Ash	700	700	700	700	700	700
Water	700	600	700	700	700	700
Total Weight - Mix	2700	2600	2700	2700	2700	2700
W/S Ratio	0.35	0.30	0.35	0.35	0.35	0.35
Density (pcf)	100.65	93.95	97.07	99.74	101.28	97.03
Unconfined Compressive Strength (psi)						
1 hour	na	43	nd	na	na	nd
2 hours	nd	23	78	75	70	nd
3 hours	170	123	120	95	88	75
4 hours	315	465	315	185	178	198
5 hours	628	655	760	343	nd	473
6 hours	1028	845	1125	575	565	690
7 hours	na	nd	nd	nd	nd	nd
8 hours	nd	1145	1325	913	948	1313
10 hours	nd	nd		1093	1183	nd
22 hours	1778	1393	1550	nd	nd	1545
24 hours	1845	nd	nd	1878	1730	1888
26 hours	nd	1340	1748	1948	nd	1968

na - not able to test (too soft); nd - not determined.
Hydrated bed ash hydrated at 13%
(A) - room temperature conditioning water added to hot ash (185°F) and mixture compacted and sealed cured at 185°F
(B) - conditioning water (185°F) added to hot ash (185°F) and mixture compacted and sealed cured at 185°F
(C) - room temperature (R.T.) conditioning water added to (R. T.) ash and compacted and sealed cured at room temperature.
(D) - hot conditioning water (150°F) added to hot ash (150°F) and mixture compacted and sealed cured at 150°F
(E) - room temperature conditioning water (R. T.) added to hot ash (150°F) and mixture compacted and sealed cured at 150°F

Activities Scheduled for Next Quarter: An evaluation of the strength development of the spray dryer ashes immediately after collection compared to 6 weeks will be determined. Additional pelletizing trials are planned for the third quarter.

For Form EIA-459E

ACCOUNT STATUS REPORT

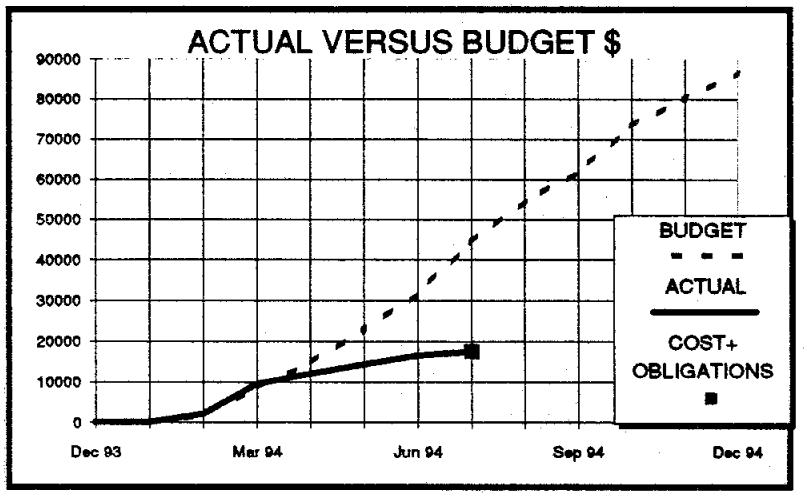
Month/Year: JULY 1994

Title	Base Program
Contract No	DE-FC21-93MC30126
Client	DOE
Contract Type	Cooperative Agreement
Account Value	
Proposal No	
Account No	

Description: Task 3.3

Syn-Ag Process: Coal Combustion Ash Management Option

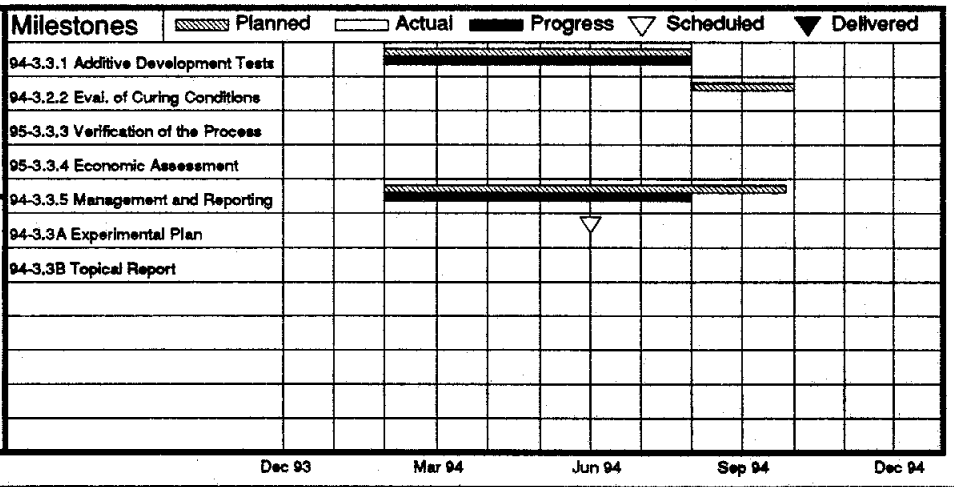
Essential Elements of Information	Yes	No	Customer Notfid	Customer Appvd
I. Meeting Performance Requirements				
II. On Schedule				
III. Within Contractual Cost				
A. Overrun $				
B. Scope Change $				
1. Funds Authorized				
2. Work Started				
IV. Adequate Funding				



Key Personnel

Proj Mgr: Smith, Verne
Task Mgr: Bland, Alan
Sub Task Mgr:
Proj Admin:

	Date
Contract Start	02/02/93
Contract Complete	02/01/98
Plan Approved	03/29/94
Last Review	
Next Review	



PROGRAM HIGHLIGHTS

Budget vs Actual Table

	May 94	Jun 94	Jul 94
Budget	22831.73	31645.21	44258.68
Cost	14336.23	16538.63	17399.52
Variance	8495.50	15106.58	26859.16

F-Formal
I-Informal

Approved _____ Project Manager

_____ Vice President

TASK 3.4

The Maxi-Acid™ Process: In Situ Amelioration of Acid Mine Drainage

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Reporting Period: May - July 1994

Principal Investigators: Terry Brown and Alan Bland

Task Objective: The objective of this task is to develop a method for the in situ amelioration of acid mine drainage problems.

Quarter Objectives: The objectives for the quarter were to acquire and set up laboratory equipment, complete the development of the experimental plan, and to begin pyrite oxidation studies using humidity cell testing and column studies.

Accomplishments: The detailed experimental plan is nearly completed. Preliminary data currently being collected will be used as input so that a more definitive plan can be developed.

Activities Scheduled for Next Quarter: The work plan will be finalized and the laboratory investigations will be initiated.

For Form EIA-459E

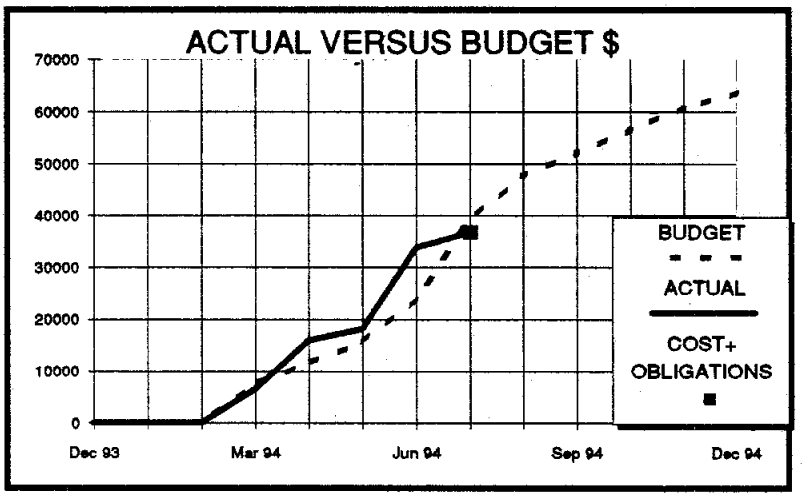
SUB-TASK STATUS REPORT

Month/Year
JULY 1994

Title	:	Base Program
Contract No	:	DE-FC21-93MC30126
Client	:	DOE
Contract Type	:	Cooperative Agreement
Sub-Task Value	:	
Proposal No	:	
Sub-Task No	:	

Description: Task 3.4
Maxi-Acid Process: In Situ Amelioration of Acid Mine Drainage Problems

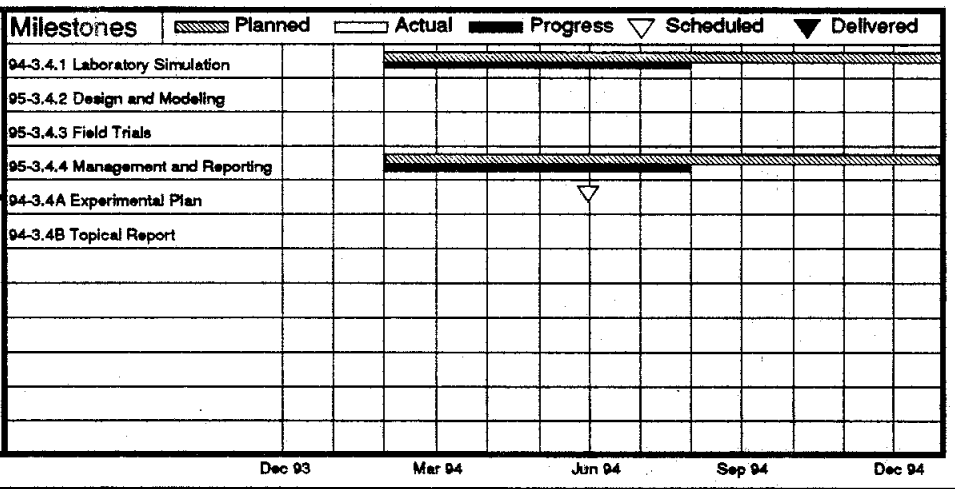
Essential Elements of Information	Yes	No	Customer Notfid	Customer Appvd
I. Meeting Performance Requirements				
II. On Schedule				
III. Within Contractual Cost				
A. Overrun $				
B. Scope Change $				
1. Funds Authorized				
2. Work Started				
IV. Adequate Funding				



Key Personnel

Proj Mgr:	Smith, Verne
Task Mgr:	Brown, Terry
Sub Task Mgr:	
Proj Admin:	

	Date
Contract Start	02/02/93
Contract Complete	02/01/98
Plan Approved	03/29/94
Last Review	
Next Review	



PROGRAM HIGHLIGHTS

Budget vs Actual Table

	May 94	Jun 94	Jul 94
Budget	15520.54	23913.00	39102.45
Cost	18077.67	33810.09	36757.36
Variance	-2557.13	-9897.09	2345.09

F-Formal
I-Informal

Approved _____ Project Manager

_____ Vice President

TASK 3.5

Spill Test Facility Data Base

Reporting Period: May - July 1994

Principal Investigator: David Sheesley

Task Objectives: The overall objective of this task is to develop a data base for the Liquefied Gaseous Fuels Spill Test Facility (LGFSTF) Program that will provide information to the government and industry related to releases of fuels and chemicals. Specific objectives are to: (1) archive spill test results from the facility, (2) complete the data base on spill control technology documents and data, (3) archive and monitor literature references to selected real-world significant hazardous spill incidents, and (4) transfer this information to Clean Air Act Amendment participants of the U.S. Environmental Protection Agency (EPA) Research Program for the Development of Emergency Response Technologies and to others.

Quarter Objectives: The objectives for this quarter were to expand the bibliography, to make it consistent with the format of the previous bibliography, and move LGFSTF spill test results to a format allowing data checking.

Accomplishments: Over 2,000 entries were added to the bibliography. The current bibliography is being made consistent with the previous bibliography. The process of making the bibliography uniform and merging of the two bibliographies is progressing.

Procedures: All post-1986 spill test results have been stored in spreadsheets. One pre-1986 spill test has been stored in a spreadsheet. The previous and present bibliographies will be merged into one uniform bibliography. Data from the LGFSTF database archived prior to 1988 will be moved from individual ASCII files into a cohesive format.

Results: An inventory of post-1986 spill test information in the system are is follows:

ANSUL Generated Checklists - April 1990
- Summary of 1988 National Foam Tests
- Checklists for Tests 1 - 9

ANSUL Test Series - April 1990
- Test Schedule
- Test Data Description
- Data Plots

- TCS Database
- Checklists for Tests 1 - 9
- Floppy Disks
  - FDAS Weather Data
  - TCS Test Data

CCPS Test Series - August/September 1990
- Checklists for Tests 1 - 60

CCPS Test Series - August/September 1990
- Alarm Typer Data (separated by test number)
  - Tests 1 - 22 (Cl)
  - Tests 23 - 40 (MMA)
  - Tests 41 - 60 (CYC)
- FDAS Weather Plots (separated by test number)
  - Tests 1 - 22 (Cl)
  - Tests 23 - 40 (MMA)
  - Tests 41 - 60 (CYC)

DOW Test Series - June 1990
- TCS Graphic Screens
- Humidity Calculations
- TCS Database
- Checklists for Dry Run #1 and Tests 1 - 6
- FDAS Weather Plots (separated by test number) for Tests 1 - 6
- Alarm Typer Data (separated by test number) for Tests 1 - 6
- Floppy Disks
  - FDAS Weather Data for Tests 1 - 6

SHC Test Series - May 1990
- Alarm Typer Data for Tests 1 - 13
- TCS Database
- TCS Plot Generation Information
- TCS Data Plots
- FDAS Gas Plots

SHC Test Series - May 1990
- Heat Flux Transducer Locations
- Test Data Description
- Checklists for Tests 1 - 13

LLNL Test Series (HF) - May 1991
- Checklists for Tests 1 - 8

LLNL Test Series (Phase I). Test #1 - Test #8 - May 1991
- Checklists for Tests 1 - 8
- FDAS Weather Plots (separated by test number) for Tests 1 - 8
- Alarm Typer Data (separated by test number) for Tests 1 - 8
- TCS Raw Data
- TCS Graphics Screens
- TCS Database

LLNL Test Series (Phase II). Test #9 - Test #17 - July 1991
- Checklists for Tests 9 - 17
- FDAS Weather Plots (separated by test number) for Tests 9 - 17
- Alarm Typer Data (separated by test number) for Tests 9 - 17
- TCS Raw Data

- TCS Graphics Screens
- TCS Database

LLNL Test Series (Cl_2) Test #1 - Test #10 - June 1992
- Checklists for Tests 1 - 10
- EG&G Mechanical Startup Lists for Tests 1 - 10
- Alarm Typer Data (separated by test number) for Tests 1 - 10
- FDAS Weather Plots (separated by test number) for Tests 1 - 10
- TCS Plot (separated by test number) for Tests 1 - 10
- TCS Selected Tabular Data (separated by test number) for Tests 1 - 10
- Floppy Disks
  - TCS Raw Data
  - TCS Graphics Screen
  - TCS Test Data
  - TCS Database

LLNL Test Series (NH_3) Test #11 - Test #24 - July 1992
- Checklists for Tests 11 - 24
- EG&G Mechanical Startup List (separated by test number) for Tests 11 - 24
- Alarms Typer Data (separated by test number) for Tests 11 - 24
- FDAS Weather Plots (separated by test number) for Tests 11 - 24
- TCS Plot (separated by test number) for Tests 11 - 24
- TCS Selected Tabular Data (separated by test number) for Tests 11 - 24
- Floppy Disks
  - TCS Raw Data
  - TCS Test Data

DuPONT Mitigation Workshop (Session 1) Test #1 - Test #10 - April 1992
- DuPont Tag Name Description
- Control Room Checklists for Tests 1 - 10
- EG&G/EM Mechanical Startup List (separated by test number) for Tests 1 - 10
- Alarm Typer Data (separated by test number) for Tests 1 - 10
- FDAS Weather Plots (separated by test number) for Tests 1 - 10
- Floppy Disks
  - TCS Raw Data
  - TCS Graphics Screen
  - TCS Test Data
  - TCS Data Plots

DuPONT Mitigation Workshop (Session 2) Test #11 - Test #20 - May 1992
- DuPont Tag Name Description
- Control Room Checklists for Tests 11 - 20
- EG&G/EM Mechanical Startup List (separated by test number) for Tests 11 - 20
- Alarm Typer Data (separated by test number) for Tests 11 - 20
- FDAS Weather Plots (separated by test number) for Tests 11 - 20
- Floppy Disks
  - TCS Raw Data
  - TCS Graphics Screen
  - TCS Test Data
  - TCS Data Plots

DuPONT Mitigation Workshop (Session 3) Test #21 - Test #31 - May 1992

- DuPont Tag Name Description
- Control Room Checklists for Tests 21 - 31
- EG&G/EM Mechanical Startup List (separated by test number) for Tests 21 - 31
- Alarm Typer Data (separated by test number) for Tests 21 - 31
- FDAS Weather Plots (separated by test number) for Tests 21 - 31
- Floppy Disks
  - TCS Raw Data
  - TCS Graphics Screen
  - TCS Test Data
  - TCS Data Plots

Activities Scheduled for Next Quarter: The previous and present bibliographies will be merged into one uniform bibliography. Data from the LGFSTF database archived prior to 1988 will be moved from individual ASCII files into a common format.

For Form EIA-459E

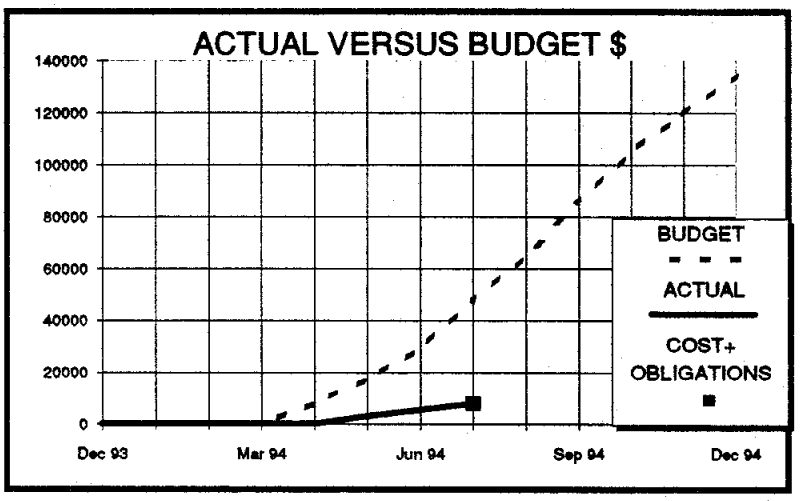
ACCOUNT STATUS REPORT

Month/Year
JULY 1994

Title	:	Base Program
Contract No	:	DE-FC21-93MC30126
Client	:	DOE
Contract Type	:	Cooperative Agreement
Account Value	:	
Proposal No	:	
Account No	:	

Description: Task 3.5
Spill Test Facility Data Base

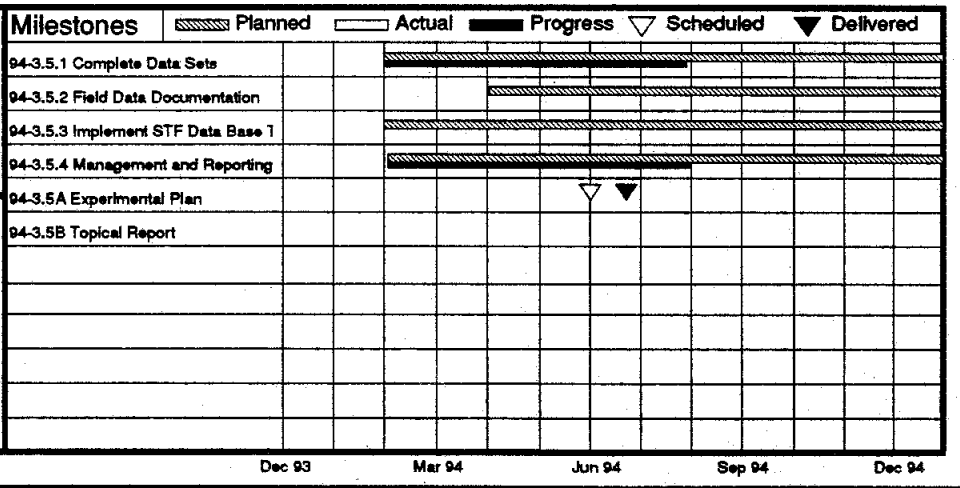
Essential Elements of Information	Yes	No	Customer Notfid	Customer Appvd
I. Meeting Performance Requirements				
II. On Schedule				
III. Within Contractual Cost				
A. Overrun $				
B. Scope Change $				
1. Funds Authorized				
2. Work Started				
IV. Adequate Funding				



Key Personnel

Proj Mgr:	Smith, Verne
Task Mgr:	Sheesley, David
Sub Task Mgr:	
Proj Admin:	

	Date
Contract Start	02/02/93
Contract Complete	02/01/98
Plan Approved	03/29/94
Last Review	
Next Review	



PROGRAM HIGHLIGHTS

Budget vs Actual Table

	May 94	Jun 94	Jul 94
Budget	17200.13	29194.34	47620.20
Cost	3026.54	5403.12	7966.19
Variance	14173.59	23791.22	39654.01

F-Formal
I-Informal

Approved _____ Project Manager

_____ Vice President

4.0 APPLIED ENERGY SCIENCE

TASK 4.1

Heavy Oil/Plastics Co-Processing

Reporting Period: May - July 1994

Principal Investigator: Frank D. Guffey

Task Objective: The objective of this research is to evaluate the catalytic activity responsible for the decrease in thermal decomposition temperature observed when a mixture of plastic resin types are co-processed with heavy oil.

Quarter Objectives: The objectives for this quarter were to address the GC/MS evaluation of the produced distillate samples and to begin preparation of the topical report.

Accomplishments: The GC/MS data has been collected and the majority of the interpretation has been completed. A draft of the final report has been initiated.

Procedures: The GC/MS data were collected on a Hewlett Packard 5985B GC/MS system. The identity of each compound eluting from the gas chromatograph was made with a library search, comparison of unknown spectra with spectra available in the literature, and by interpretation of the unknown spectra.

Results: The results of the GC/MS analysis of the distillate produced at 380°C (716°F) are listed in Table 4 as an example of the composition of the distillate. The distillate is composed primarily of aromatic, paraffinic, and cycloparaffinic hydrocarbons, and alkenes. The distillate covers both the gasoline and diesel fuel boiling ranges and there has been no evidence of chlorine-containing hydrocarbons. Based on these data, the distillate can undergo mild hydrotreating and be suited for use as a blending stock for the production of gasoline and diesel fuel.

Table 4. Results GC/MS Analysis of the Distillate Produced at 380°C

Retention Time	Compound or Compound Type Identified	Area Percent
3.2	2-Butene	0.7
3.4	2-Methyl-2-Butene	1.4
3.5	2-Pentene	1.8
3.8	3-Methyl-2-Pentene	0.5
3.9	Cyclohexane	0.5
4.0	Hexane	0.4
4.1	4-Methyl-2-Pentene	0.1
4.2	2,4-Dimethyl-Pentane	0.6
4.4	2-Dimethylcyclopentane	0.2
4.5	2,4-Dimethyl-2-Pentene	1.2
4.7	Benzene	1.2
4.8	3-Ethylpentane	0.3
5.0	1,2-Dimethylcyclopentane	1.1
5.2	Heptane	0.7
5.3	3-Methyl-2-Ethyl-1-Butene	0.8
5.5	2,4,4-Trimethyl-1-Pentene	0.7
5.8	2,4,4-Trimethyl-2-Pentene	1.4
5.9	Trimethylcyclopentane	0.2
6.1	Trimehylcyclopenane	0.3
6.3	1,2-Dimethylcyclohexene	0.2
6.4	2,4-Dimethyl-1,3-Pentadiene	1.0
6.6	2-Methyl-Heptane	1.2
6.8	Toluene	3.3
7.1	1,3-Dimethylcyclohexane	0.3
7.2	Dimmethylcyclohexane	0.2
7.4	1-Methyl-2-Ethylcyclopentane	1.1
7.5	2,3-Dimethyl-2-Hexene	1.3
7.6	3-Ethylhexane	0.6
7.9	C3-Substituted Cyclopentane	0.5
8.0	2,5-Dimethyl-2,4-Hexadiene	
8.6	Dimethyl Substituted Cyclohexane	0.4
8.8	Propylcyclohexane	1.4
9.0	1,1,3-Trimethylcyclohexane	0.4
9.1	C4 Substituted Cyclopentane	0.6
9.6	1,2,4-trimethylcyclohexane	0.4
9.8	o-Methoxyphenol	0.5
10.0	Xylene or Ethyl Benzene	3.2
10.2	3,4-Dimethyl-2,4-Hexadiene	1.3
10.3	Xylene or Ethyl Benzene	1.4
10.9	1-Nonene	0.2
11.1	C3 Substituted Cyclohexane	0.6

Table 4. Results GC/MS Analysis of the Distillate Produced at 380°C (continued)

Retention Time	Compound or Compound Type Identified	Area Percent
11.2	Styrene	4.1
11.5	2-Methyl-3-Ethylhexane	1.4
11.7	1,2,3-Trimethylcyclohexane	0.3
11.8	1-Methyl-1-Ethylcyclohexane	0.4
11.9	C3-Substituted Cyclohexene	0.2
12.6	C3-Substituted Benzene	1.1
12.9	Propylcyclohexane	0.2
13.0	Branched C10 Alkane	0.7
13.3	Propylheptane	0.5
13.7	C2 Substituted Tetralin plus Branched C10 Alkene	1.2
14.0	C3 Substituted Benzene plus Branched C10 Alkene	0.4
14.2	4-n-Propylheptane	0.5
14.4	C3 Substituted Benzene plus Butylthiophene	0.6
14.6	Branched C10 Alkene	0.4
14.7	C3 Substituted Benzene	0.2
15.3	C3 Substituted Benzene	0.5
15.4	m-Methylstyrene	2.0
15.8	Branched C10 Alkene	0.9
16.0	2,3,4,5-Tetramethyl-1,4-Hexadiene	0.7
16.1	C3 Substituted Benzene	1.2
16.2	Branched C10 Alkane	
16.7	Branched C11 Alkane	0.4
17.0	Branched C10 Alkene	1.0
17.4	4-Methyldecane	0.5
17.6	C3 Substituted Benzene	0.6
17.7	Branched C11 Alkene	0.5
17.8	o-Methylstyrene	0.1
18.0	Pentylthiophene	2.3
18.1	Branched C11 Alkene	0.1
18.2	Branched C11 Alkane	0.3
18.4	Branched C11 Alkene	0.1
18.8	Branched C11 and C12 Alkenes	0.2
19.0	C4 Substituted Benzene	0.3
19.3	Branched C11 Alkane	1.6
19.4	C4 Substituted Benzene	0.6
19.6	Branched C11 Alkane	0.2
19.9	C4 Substituted Benzene	0.5

Table 4. Results GC/MS Analysis of the Distillate Produced at 380°C (continued)

Retention Time	Compound or Compound Type Identified	Area Percent
20.4	C4 Substituted Benzene	0.3
20.5	C4 Substituted Benzene	0.3
20.7	Branched C11 Alkene	0.2
20.9	C4 Substituted Benzene	0.5
21.0	1-Undecene	1.1
21.3	Branched C11 Alkene	0.3
21.5	Undecane	1.7
21.7	4-Propyloctene	0.7
22.0	C4 Substituted Benzene	0.2
22.2	C1 Substituted Decalin	0.3
22.5	C4 Substituted Benzene	0.6
22.7	C4 Substituted Benzene	0.5
22.9	Branched C12 Alkane	0.3
23.4	Branched C11 Alkene	0.2
24.0	Branched C12 Alkene	0.3
24.3	C2 Substituted Styrene	0.8
24.4	C4 Substituted Benzene	
24.6	C5 Substituted Benzene	0.6
24.7	Methylindene	0.3
24.8	C5 Substituted Benzene	0.3
26.2	Dodecene	1.9
26.5	Branched C12 Alkene	0.4
26.7	Dodecane	1.6
26.8	C1 Substituted Tetralin	0.3
26.9	Branched C12 Alkene plus C5 Substituted Benzene	0.2
27.3	Branched C13 Alkane	1.2
27.8	Hexylthiophene	0.2
28.7	Branched C12 Alkene plus C5 Substituted Benzene	0.2
29.4	Ethyl-Methylstyrene	
30.4	Branched C15 Alkene	
30.5	Octylthiophene	1.9
30.9	Branched C15 Alkane	0.4
31.2	Branched C14 Alkene	1.6
31.6	Branched C13 Alkane	2.0
31.9	Branched C14 Alkene	1.0
32.4	Branched 15 Alkene	0.7
34.1	Nonylthiophene	2.9
35.8	Branched C14 Alkane	1.6

Table 4. Results GC/MS Analysis of the Distillate Produced at 380°C (continued)

Retention Time	Compound or Compound Type Identified	Area Percent
35.9	Tetradecene	1.3
36.2	Tetradecane	2.9
36.7	Branched C15 Alkene	0.5
36.9	Branched C15 Alkane	0.4
37.3	Dimethyl Phenanthrene	0.3
38.4	Branched C16 Alkene	0.3
38.7	Branched C16 Alkane	0.4
38.8	Branched C16 Alkane	0.6
40.2	Pentadecene	0.8
40.6	Pentadecane	0.7
41.2	Branched C16 Alkene	0.4
44.7	Hexadecane	2.6

Activities Scheduled for Next Quarter: The topical report will be prepared.

For Form EIA-459E

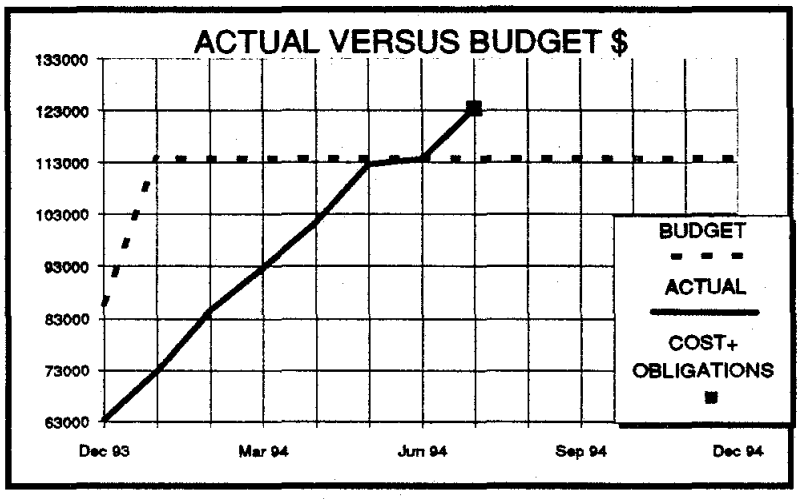
ACCOUNT STATUS REPORT

Month/Year: JULY 1994

Title	:	Base Program
Contract No	:	DE-FC21-93MC30126
Client	:	DOE
Contract Type	:	Cooperative Agreement
Account Value	:	
Proposal No	:	
Account No	:	

Description: Task 4.1
Heavy Oil/Plastics Co-Processing

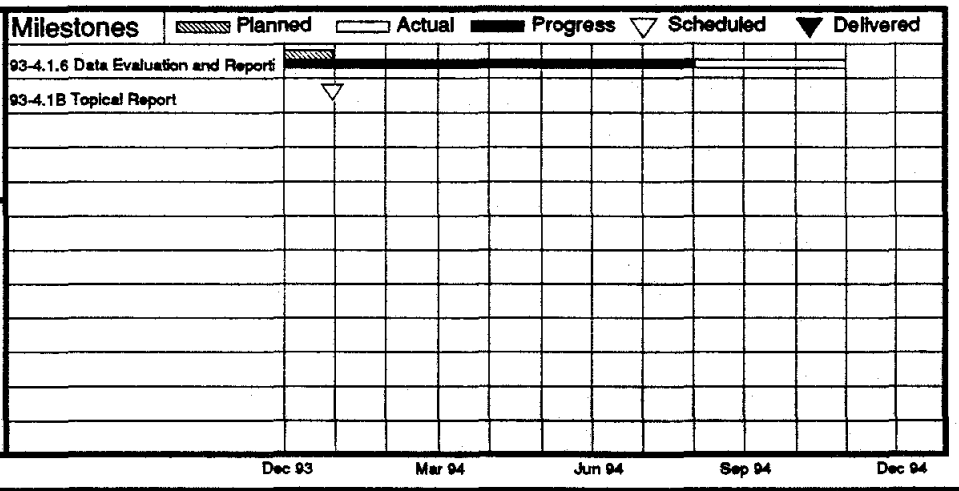
Essential Elements of Information	Yes	No	Customer Notfid	Customer Appvd
I. Meeting Performance Requirements				
II. On Schedule				
III. Within Contractual Cost				
A. Overrun $				
B. Scope Change $				
1. Funds Authorized				
2. Work Started				
IV. Adequate Funding				



Key Personnel

Proj Mgr: Smith, Verne
Task Mgr: Thomas, Kenneth
Sub Task Mgr:
Proj Admin:

	Date
Contract Start	02/02/93
Contract Complete	02/01/98
Plan Approved	02/02/93
Last Review	
Next Review	



PROGRAM HIGHLIGHTS

Budget vs Actual Table

	May 94	Jun 94	Jul 94
Budget	113781.58	113781.58	113781.58
Cost	112488.24	113681.37	123423.08
Variance	1293.34	100.21	-9641.50

F-Formal
I-Informal

Approved _____ Project Manager

_____ Vice President

TASK 4.2

Fossil Fuel and Hydrocarbon Conversion Using Hydrogen-Rich Plasmas

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Reporting Period: May - July 1994

Principal Investigator: Francis Miknis

Task Objective: The objective of this task is to develop a novel and innovative, noncatalytic method for directly converting fossil fuel materials to hydrogen-rich fuels, while simultaneously reducing the heteroatom contents.

Quarter Objectives: The objectives for the quarter were to prepare and submit an experimental plan, to design and construct a microwave plasma reactor system, and to begin preliminary plasma experiments.

Accomplishments: The experimental plan has been submitted and approved. A microwave reactor system has been assembled, and preliminary experiments have begun.

Procedures: Fossil fuel hydrocarbon materials will be irradiated in microwave-generated plasmas to produce improved hydrogen-rich liquid fuels. Initial experiments will be conducted with plasmas generated from hydrogen and methane. Solid, liquid, and gaseous products will be analyzed to determine the degrees of conversion and hydrogenation that have taken place. The starting hydrocarbon material will also be extracted with a suitable solvent to determine the amount of soluble, nonvolatile material that may be produced. Liquid products from selected experiments will be analyzed to determine the extent of hydrogenation and heteroatom removal that results from exposure to different plasmas under various conditions.

Results: Exploratory experiments were conducted on the use of microwave-induced hydrogen plasmas for converting scrap tires to useful products. Two experimental arrangements were employed. In one arrangement, a small glass thimble containing ~0.5 g of -40 +80 mesh Granular Products scrap tire was placed inside a 19 mm (o.d.) Vycor tube. This assembly was then placed in the wave guide of a Cober Electronics model S6F industrial microwave generator. The contents were evacuated to ~20 torr pressure and a flow of hydrogen maintained at this pressure. A hydrogen plasma was induced by discharging a Tesla coil onto a thin metal rod which extended into the plasma region. The rod was removed after plasma initiation.

The scrap tire was irradiated for about 15 minutes under these conditions, which produced about an 8% weight loss. For this preliminary experiment, gases and liquids were not trapped. However, there was a noticeable change in the color of the residue from black to brown. Solid state ^{13}C NMR measurements were made on the residue material (Figure 2b). The spectrum clearly shows the loss of natural rubber (133, 124, 22 ppm), styrene-butadiene (128, 25 ppm), and butyl rubber (128, and 32 ppm) components as a result of chemical reactions in the plasma. The residual component at ~110 ppm has not been identified. Typically, carbon resonances in this spectral region are due to various protonated aromatic carbons, alkenes, vinyl, and substituted vinyl structures. The carbon at 28 ppm in the residue does not appear in the spectrum of the original scrap tire. This carbon could be due to a methyl group β to an aromatic ring, which would form as a result of cleavage of the styrene butadiene copolymer. No attempts were made to positively identify the residue carbons in these exploratory experiments. However, it is interesting to note that the most prominent carbon type in the residue is a minor component of the starting material. The origin of the broadening of the resonances was not determined.

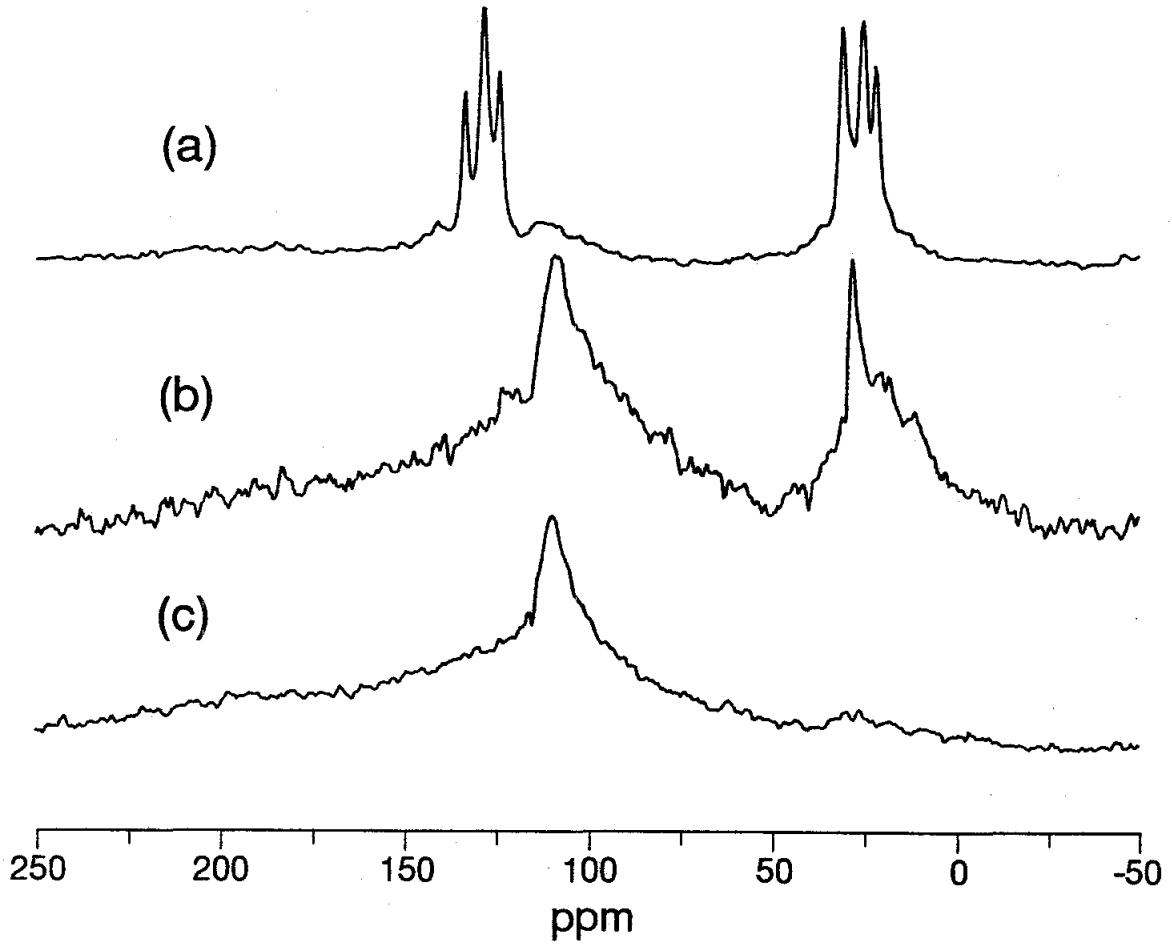


Figure 2. Single Pulse Solid-State ^{13}C NMR Spectra of: (a) Scrap Tire, (b) Tire Residue after Hydrogen Plasma Reaction in Cober Unit, (c) Tire Residue after Hydrogen Plasma Reaction in Kenmore Oven

Another scrap tire/hydrogen plasma experiment was conducted using a Kenmore microwave oven. In this experiment ~3 g of scrap tire were placed in a round bottom flask which was configured to maintain a flow of hydrogen at ~20 torr. The scrap tire was irradiated for ~9 minutes in the hydrogen plasma during which there was a 53% conversion to gas and liquid products. Most of the conversion occurred during the first few minutes. Liquids accounted for 37.5% of the amount converted.

The residue from this experiment was examined by solid-state ^{13}C NMR (Figure 2c). This residue resembled the starting material in terms of color. However, the residue severely detuned the NMR probe, presumably because of increased electrical conductivity of the residue carbon. Comparison of the NMR spectra of both residues show removal of most of the carbons in the polyisoprene (natural rubber) and polystyrene-butadiene components.

Produced liquids were trapped in a dry ice/methanol bath. A simulated distillation was performed on the liquid product to assess its quality (Figure 3). The distillation curve was bimodal with almost one third (31.5%) of the material boiling in the gasoline and diesel boiling ranges. Residue accounted for about 10% of the material.

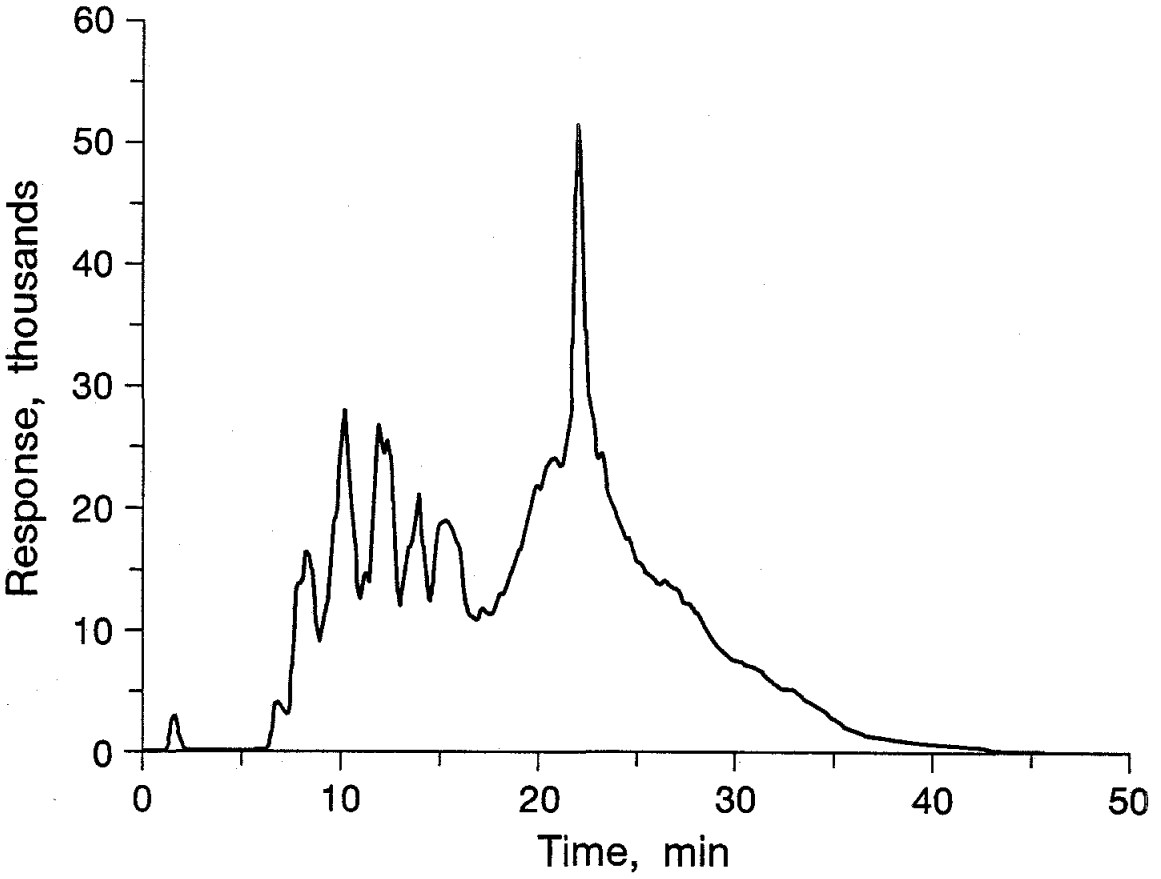


Figure 3. Distillation Curve of Pyrolysis Liquids Resulting from Microwave-Plasma Induced Decomposition of Scrap Tire Material

A "blank" experiment was run on the scrap tire in the hydrogen gas with the microwave turned on, but without generating a plasma. In this experiment there was no noticeable weight loss for the same reaction time of about 9 minutes.

Although these experiments were exploratory, they do illustrate that microwave-induced plasmas can be used to decompose waste tires into potentially useful liquid products. In the exploratory experiments the rubber tire was placed in the region where the plasma was generated. However, this arrangement tends to produce more gases than liquids. Additional studies are necessary to more completely determine the feasibility of the process. Such studies include inter alia varying the geometry of the sample/plasma arrangement, the use of magnetic fields to concentrate the reactive species, and the use of other gases (e.g. methane) to alter the reaction chemistry and final value-added product distribution.

Activities Scheduled for Next Quarter: Microwave-plasma experiments using methane will continue.

For Form EIA-459E

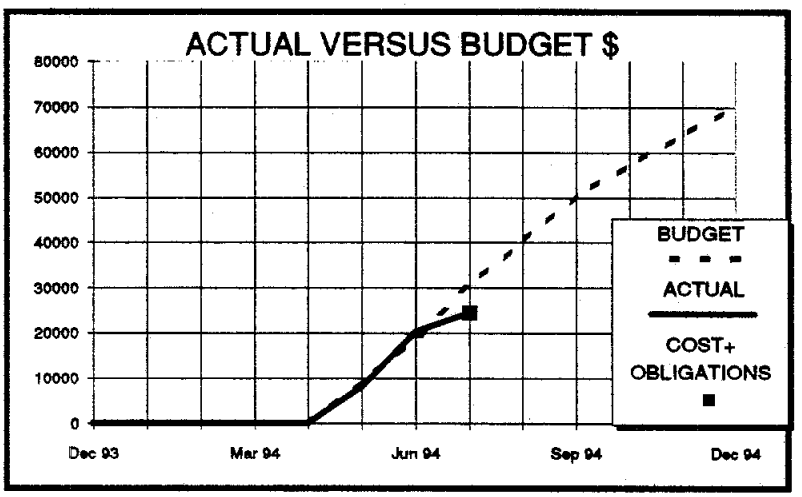
ACCOUNT STATUS REPORT

Month/Year
JULY 1994

Title	Base Program
Contract No	DE-FC21-93MC30126
Client	DOE
Contract Type	Cooperative Agreement
Account Value	
Proposal No	
Account No	

Description: Task 4.2
Fossil Fuel and Hydrocarbon Conversion Using Hydrogen-Rich Plasmas

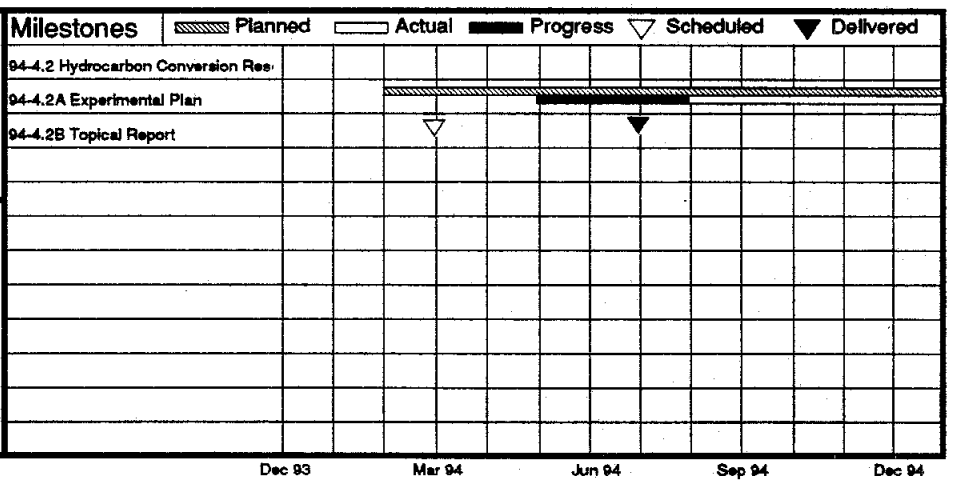
Essential Elements of Information	Yes	No	Customer Notfid'	Customer Appvd'
I. Meeting Performance Requirements				
II. On Schedule				
III. Within Contractual Cost				
A. Overrun $				
B. Scope Change $				
1. Funds Authorized				
2. Work Started				
IV. Adequate Funding				



Key Personnel

Proj Mgr:	Smith, Verne
Task Mgr:	Miknis, Francis
Sub Task Mgr:	
Proj Admin:	

	Date
Contract Start	02/02/93
Contract Complete	02/01/98
Plan Approved	03/29/94
Last Review	
Next Review	



PROGRAM HIGHLIGHTS

Budget vs Actual Table

	May 94	Jun 94	Jul 94
Budget	9283.75	18611.40	30439.05
Cost	8154.97	20207.00	24387.03
Variance	1128.78	-1595.60	6052.02

F-Formal
I-Informal

Approved _____ Project Manager

_____ Vice President

6.0 REMEDIATION

TASK 6.1

North Site Remediation

Reporting Period: May - July 1994

Principal Investigator: Norm Merriam

Task Objectives: The objectives of this task are to evaluate and properly dispose of hazardous and nonhazardous materials and to decontaminate and remove nonfunctional equipment at the North Site. These objectives are defined in five phases:

I Definition of Waste Streams
II Disposal of Hazardous Wastes
III Disposal of Nonhazardous Wastes
IV Sampling and Disposal of Buried Wastes
V Removal of Nonfunctional Equipment

Quarter Objectives: Objectives for the quarter were to continue work on disposal of hazardous and nonhazardous North Site materials (phases II and III); begin phase IV activities, which involve soil sampling and removal and disposal of buried wastes; and submit the plan for phase V of the remediation project, which involves removal of oil storage tanks and oil shale retorts.

Accomplishments: Phase II: Disposal of the hazardous North Site materials is about 85% completed. Preparing the materials for shipment, which involved profiling, packaging, and labeling, was completed. Hazardous waste disposal during this quarter included shipment of 74 drums of tar sand heavy oil, heavy oil and coal, heavy fuel oil, and tank bottom heavy oil; 5,000 gallons of shale oil from the storage tank; five drums of chemicals; five drums of smelter dust and mining waste; 85 drums of coal tars, shale oil, water treatment chemicals, acid gas scrubbing chemicals, and oils mixed with nonchlorinated solvents; 32 drums of eastern oil shale; and three drums of high pH salt water. In addition, nine drums of water containing radium 226 at a concentration of about 115 picocuries per liter were returned to their original source. There are only 18 drums of western shale oil and the shale oil and water in the storage tanks remaining on site for disposal. Air stripping of the trichloroethylene (TCE) from the water in the storage tank has reduced the TCE concentration to 0.055 ppm, which is suitable for disposal in an industrial injection well. Used stainless steel drums, from which shale oils were transferred, were cleaned for reuse.

Phase III: Disposal of the nonhazardous North Site materials is about 80% completed. Little activity was conducted under phase III during this quarter so that phase II activities could be performed. As part of phase III, 14 drums of sand, which passed the Toxicity Characteristic Leaching Procedure (TCLP) (U.S. EPA 1990), were transferred for use as road fill. In addition, cleaning and disposition of tanks that have been used for shale oil storage were discussed with Tom Rinehart of the Wyoming Department of Environmental Quality (DEQ). According to the Wyoming DEQ, no permit is needed to clean and dispose of these shale oil storage tanks. The tanks are to be steam cleaned and sold or given away. Soil that is presently under the shale oil storage tanks and in the berm around the tanks will be sampled and analyzed to determine if removal of this material is necessary.

Phase IV: This phase of the remediation project is about 80% completed. The gas cylinders, which had been buried at the North Site, were emptied and given to a metal salvage company; the empty drum that had been buried and filled with dirt was emptied and transported to the local landfill; and metal plates, which had also been buried at the North Site, were given to a metal salvage company. Soil sampling of the burial areas and storage/spill areas and analyses of the soil samples were completed. Evaluation of the resulting data was performed, and a summary of these results was prepared and discussed with DOE. An outline for the final report for phase IV was prepared and approved by DOE. Photographs were taken to document the various phase IV activities.

Phase V: The plan for Phase V was prepared and submitted.

Procedures: Phase II: Profiling, packaging, and labeling of the hazardous North Site materials were performed under the direction of and with assistance from Special Resource Management (SRM). SRM was also responsible for transportation, treatment, and disposal of the hazardous materials. These activities were performed in accordance with all local, state, and federal regulations and requirements.

Phase IV: The buried gas cylinders, which were dug up as described in the previous quarterly report, contained either hydrogen or nitrogen gas. The cylinders were chained to the south fence of the North Site, and their caps were removed so any gas remaining in them could be released. The empty cylinders were then given to a local salvage company. The soil that had been removed from the burial site so the cylinders could be located was put back in place so soil sampling could be performed.

A power auger was used to collect the soil samples from the burial areas and storage/spill areas. Samples were collected down to the bedrock, which for most locations at the North Site, is no more than 2 ft below the soil surface. In addition to the burial areas and storage/spill areas, samples from the eastern border of the North Site, within the fence boundary, and samples from the eastern border, outside of the fence boundary, were collected and analyzed to provide data on the background concentrations that can be expected in uncontaminated North Site soil. Table 5 shows the phase IV sampling locations and the analytes for which the composite sample(s) from each location was analyzed.

Table 5. Sampling Locations and Analytes for Evaluation of the Soil Samples Collected in Phase IV of the North Site Cleanup Project

Sampling Locations	Analytes
Southeast Burial Site (SBS)	RCRA metals[a]
Northeast Burial Site (NBS)	RCRA metals; semivolatile organic compounds and volatile organic compounds, including those regulated by the toxicity characteristic
Soil In and Surrounding the Buried Drum	RCRA metals; semivolatile organic compounds and volatile organic compounds, including those regulated by the toxicity characteristic
Areas Under & Surrounding the Spent Oil Shale Pile (SO)	RCRA metals; semivolatile organic compounds, including toxicity characteristic regulated compounds
Old Septic Tank Leach Field (SL-1)	RCRA metals
New Septic Tank Leach Field (SL-2)	RCRA metals
Septic Tank Leach Field (Retort) (SL-3)	RCRA metals
Storm Water Outfall (South) (SW-1)	RCRA metals; semivolatile organic compounds and volatile organic compounds, including those regulated by the toxicity characteristic
Storm Water Outfall (North) (SW-2)	RCRA metals; semivolatile organic compounds and volatile organic compounds, including those regulated by the toxicity characteristic

Table 5. Sampling Locations and Analytes for Evaluation of the Soil Samples Collected in Phase IV of the North Site Cleanup Project (continued)

Sampling Locations	Analytes
Automotive Shop Area (B-836)	RCRA metals; semivolatile organic compounds and volatile organic compounds, including those regulated by the toxicity characteristic
Tar Sand Berm Area (TS)	RCRA metals[a]; semivolatile organic compounds and volatile organic compounds, including those regulated by the toxicity characteristic
Drum Storage Area (DS)	RCRA metals; semivolatile organic compounds and volatile organic compounds, including those regulated by the toxicity characteristic
Hazardous Waste Storage Area (HW)	RCRA metals; semivolatile organic compounds and volatile organic compounds, including those regulated by the toxicity characteristic
Old Pond (P)	RCRA metals; semivolatile organic compounds and volatile organic compounds, including those regulated by the toxicity characteristic
Flammable Storage Area (B-899)	RCRA metals; semivolatile organic compounds and volatile organic compounds, including those regulated by the toxicity characteristic

Table 5. Sampling Locations and Analytes for Evaluation of the Soil Samples Collected in Phase IV of the North Site Cleanup Project

Sampling Locations	Analytes
Area Around the In Situ Processing Lab (B-852)	RCRA metals; semivolatile organic compounds and volatile organic compounds, including those regulated by the toxicity characteristic
Area Around the Storage Tanks (ST)	RCRA metals; semivolatile organic compounds and volatile organic compounds, including those regulated by the toxicity characteristic
Storage Building & Surrounding Area (B-850)	RCRA metals[a]; semivolatile organic compounds and volatile organic compounds, including those regulated by the toxicity characteristic
North Fence Area	RCRA metals
Eastern Border of the North Site (B-1) (Inside Fence)	RCRA metals; semivolatile organic compounds and volatile organic compounds, including those regulated by the toxicity characteristic
Eastern Border of the North Site (B-2) (Outside Fence)	RCRA metals; semivolatile organic compounds and volatile organic compounds, including those regulated by the toxicity characteristic

[a] Metals regulated under the Resource Conservation and Recovery Act - arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver

Analytes were selected based on knowledge of materials that were buried, stored, or had possibly leaked or spilled during storage or transfer at the various locations. At each burial site, 20 samples were collected, and two samples were composited to give a total of 10 composite samples for analysis. At the other sampling locations, four samples were collected and composited together to give one composite sample for analysis.

Soil samples from areas suspected of containing metal contamination were characterized for their total concentrations of the eight metals regulated under the Resource Conservation and Recovery Act (RCRA) (1984). The concentrations of the RCRA metals in the soil are being evaluated based on their toxicity characteristic regulatory levels (U.S. EPA 1990). The RCRA metals and their action levels are listed in Table 6.

The soil samples were prepared for analysis of the RCRA metals by digesting them using SW846 Method 3050, Acid Digestion of Sediments, Sludges, and Soils (U.S. EPA 1986). After digestion, the following methods were used to analyze the digestates, depending on the specific analyte: SW846 Method 6010 for determination of barium cadmium, chromium, lead, and silver; SW846 Method 7060 for determination of arsenic; SW846 Method 7471 for determination of mercury; and SW846 Method 7740 for determination of selenium (U.S. EPA 1986).

Soil samples from areas suspected of containing contamination from semivolatile and volatile organic compounds were characterized for the U.S. EPA Contract Laboratory Program (CLP) target list semivolatile and volatile organic compounds (Tables 7 and 8) in addition to those compounds regulated under the toxicity characteristic (Table 6). Analytical methods specified in the U.S. EPA CLP Statement of Work of Organic Analysis (U.S. EPA 1991) were used to characterize the soil samples.

Results: Phase IV: To determine if the soil at the North Site is contaminated, concentrations of metals and semivolatile and volatile organic compounds in the composite soil samples from the burial sites and storage/spill areas were compared to their concentrations in the background composite soil samples. In addition, to evaluate the degree of contamination, concentrations of the analytes detected in the composite soil samples were adjusted for TCLP dilution and compared to the toxicity characteristic regulatory levels.

Phase IV Semivolatile Organic Analysis: The composite soil samples from the northeast burial site and the storage/spill areas were analyzed for the 65 semivolatile organic compounds that are listed in Table 7. None of these compounds were detected in the background composite samples at concentrations above the analytical detection limits. In the background samples, 56 of the semivolatile organic compounds were reported to be present at concentrations less than 0.36 μg/g, and the other nine compounds were reported to be present at concentrations less than 0.90 μg/g. These values are the minimum attainable detection limits for the compounds in the background soil matrix.

Table 6. Toxicity Characteristic Constituents[a], Regulatory Levels, and Hazardous Waste Numbers

EPA HW No.[b]	Constituent	Regulatory Level, mg/L
D004	Arsenic	5.0
D005	Barium	100.0
D018	Benzene	0.5
D006	Cadmium	1.0
D019	Carbon Tetrachloride	0.5
D021	Chlorobenzene	100.0
D022	Chloroform	6.0
D007	Chromium	5.0
D023	o-Cresol	200.0[c]
D024	m-Cresol	200.0[c]
D025	p-Cresol	200.0[c]
D026	Cresol	200.0[c]
D027	1,4-Dichlorobenzene	7.5
D028	1,2-Dichloroethane	0.5
D029	1,1-Dichloroehtylene	0.7
D030	2,4-Dinitrotoluene	0.13
D032	Hexachlorobenzene	0.13
D033	Hexachloro-1,3,butadiene	0.5
D034	Hexachloroethane	3.0
D008	Lead	5.0
D009	Mercury	0.2
D035	Methyl ethyl ketone	200.0
D036	Nitrobenzene	2.0
D037	Pentachlorophenol	100.0
D038	Pyridine	5.0
D010	Selenium	1.0
D011	Silver	5.0
D039	Tetrachloroethylene	0.7
D040	Trichloroethene	0.5
D041	2,4,5-Trichlorophenol	400.0
D042	2,4,6-Trichlorophenol	2.0
D043	Vinyl chloride	0.2

[a] Regulated pesticides and herbicides are not listed.
[b] EPA hazardous waste number
[c] If o-, m-, and p-cresol concentrations can not be differentiated, the total cresol (D026) concentration is used. The regulatory level for total cresol is 200 mg/L.

Table 7. Semivolatile Organic Compounds Analyzed for in Phase IV of the North Site Cleanup Project

Semivolatile Compounds
Phenol (200)[a]
bis(2-Chloroethyl) ether
2-Chlorophenol
1,3-Dichlorobenzene
1,4-Dichlorobenzene (7.5)
1,2-Dichlorobenzene
2-Methylphenol (200)
2,2'-oxybis (1-Chloropropane)
3/4-Methylphenol (200)
N-Nitroso-di-n-propylamine
Hexachloroethane (3.0)
Nitrobenzene (2.0)
Isophorone
2-Nitrophenol
2,4-Dimethylphenol
bis(2-Chloroethoxy)methane
2,4-Dichlorophenol
1,2,4-Trichlorobenzene
Naphthalene
4-Chloroaniline
Hexachlorobutadiene (0.5)
4-Chloro-3-methylphenol
2-Methylnaphthalene
Hexachlorocyclopentadiene
2,4,5-Trichlorophenol (400)
2,4,6-Trichlorophenol (2.0)
2-Chloronaphthalene
2-Nitroaniline
Dimethylphthalate
Acenaphthylene
2,6-Dinitrotoluene
3-Nitroaniline
Acenaphthene

[a] The value given in parentheses is the TCLP regulatory level in ppm.

Table 7. Semivolatile Organic Compounds Analyzed for in Phase IV of the North Site Cleanup Project (continued)

Semivolatile Compounds
2,4-Dinitrophenol
4-Nitrophenol
Dibenzofuran
2,4-Dinitrotoluene (0.13)[a]
Diethylphthalate
4-Chlorophenyl-phenylether
Fluorene
4-Nitroaniline
4,6-Dinitro-2-methylphenol
N-nitrosodiphenylamine
4-Bromophenyl-phenylether
Hexachlorobenzene (0.13)
Pentachlorophenol (100)
Phenanthrene
Anthracene
Carbazole
Di-n-butylphthalate
Fluoranthene
Pyrene
Butylbenzylphthalate
3,3'-Dichlorobenzidine
Benzo(a)anthracene
Chrysene
bis(2-Ethylhexyl)phthalate
Di-n-octylphthalate
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Benzo(a)pyrene
Indeno(1,2,3-cd)pyrene
Dibenz(a,h)anthracene
Benzo(g,h,i)perylene
Pyridine (5.0)

[a] The value given in parentheses is the TCLP regulatory level in ppm.

Table 8. Volatile Organic Compounds Analyzed for in Phase IV of the North Site Cleanup Project

Volatile Compounds
Chloromethane
Bromomethane
Vinyl Chloride (0.2)[a]
Chloroethane
Methylene Chloride
Acetone
Carbon Disulfide
1,1-Dichloroethene (0.7)
1,1-Dichloroethane
1,2-Dichloroethene (total)
Chloroform (6.0)
1,2-Dichloroethane (0.5)
2-Butanone (200)
1,1,1-Trichloroethane
Carbon Tetrachloride (0.5)
Bromodichloromethane
1,2-Dichloropropane
cis-1,3-Dichloropropene
Trichloroethene (0.5)
Dibromochloromethane
1,1,2-trichloroethane
Benzene (0.5)
trans-1,3-Dichloropropene
Bromoform
4-Methyl-2-pentanone
2-Hexanone
Tetrachloroethene (0.7)
Toluene
1,1,2,2-Tetrachloroethane
Chlorobenzene (100)
Ethyl Benzene
Styrene
Xylenes (Total)

[a] The value given in parentheses is the TCLP regulatory level in ppm.

For semivolatile organic analysis of the composite soil samples from the northeast burial site, none of the compounds were reported at concentrations above the analytical detection limits. For composite samples 1-9, 56 of the semivolatile organic compounds were reported at concentrations less than 0.39 μg/g, and the other nine semivolatile organic compounds were reported at concentrations less than 0.98 μg/g. Once again, these values are the minimum attainable detection limits for the compounds in the matrices of the composite soil samples. Because of analytical interferences in the sample matrix, the minimum attainable detection limit for 56 of the compounds in composite sample 10 from the northeast burial site was 1.5 μg/g, and for the other 9 compounds, it was 3.7 μg/g. As a result, the concentrations of the 56 compounds in composite sample 10 were reported at less than 1.5 μg/g, and the concentrations of the other nine compounds were reported at less than 3.7 μg/g.

Concentrations of 56 of the semivolatile organic compounds in the composite of the soil from within and surrounding the buried drum in the northeast burial site were reported at less than 0.38 μg/g, and the other nine compounds were reported at less than 0.95 μg/g.

With the exception of 2,4-dinitrotoluene and hexachlorobenzene, the minimum attainable detection limits for all of the semivolatile organic compounds in the matrices of the northeast burial site composite soil samples fall below the TCLP regulatory limits. However, dividing the detection limits for 2,4-dinitrotoluene and hexachlorobenzene by 20, which is the TCLP dilution factor assuming 100% extraction, also gives values that are less than the regulatory limits for these compounds.

Concentrations of 56 of the semivolatile organic compounds in all of the composite soil samples from the storage/spill areas, except the composite representing the area around the storage tanks, were reported at less than 0.41 μg/g, and concentrations of the other nine semivolatile organic compounds in these same composites were reported at less than 1.0 μg/g. Phenanthrene was detected in the composite sample from the area around the storage tanks at a concentration of 4.6 μg/g, and the following compounds were estimated to be present in the concentrations that are listed.

Acenaphthene:	0.81 μg/g
Fluorene:	0.99 μg/g
Anthracene:	1.4 μg/g
Fluoranthene:	1.3 μg/g
Pyrene:	3.5 μg/g
Benzo(a)anthracene:	0.73 μg/g
Chrysene:	0.50 μg/g

These are estimates because the compounds were detected, but at concentrations at or below the analytical detection limit of 3.5 μg/g. Phenanthrene and the compounds that are listed above are not regulated under the toxicity characteristic. Forty-seven of the remaining semivolatile organic compounds were reported at concentrations less than 3.5 μg/g, and the other nine semivolatile organic compounds were reported at concentrations less than 8.8 μg/g. These minimum attainable detection limits are very high due to analytical interferences in the sample matrix. TCLP dilution adjustment of the minimum attainable detection limits for all of the semivolatile organic compounds gives values that are less than the regulatory limits.

Phase IV Volatile Organic Analysis: The composite soil samples from the northeast burial site and the storage/spill areas were analyzed for 33 volatile organic compounds (Table 8). None of these compounds were detected in the background composite samples at concentrations above the analytical detection limits. In the background samples, 32 of the volatile organic compounds were reported to be present at concentrations less than 0.01 μg/g, and carbon disulfide was reported to be present at a concentration less than 0.02 μg/g. These values are the minimum attainable detection limits for the compounds in the background soil matrix.

For volatile organic analysis of the composite soil samples from the northeast burial site, none of the compounds were reported at concentrations above the analytical detection limits. In composite samples 1-10, the concentrations of the 33 volatile organic compounds were reported at less than 0.01 μg/g.

Concentrations of the 33 volatile organic compounds in the composite of the soil from within and surrounding the buried drum in the northeast burial site were also reported at less than 0.01 μg/g.

Concentrations of 31 of the volatile organic compounds in all of the composite soil samples from the storage/spill areas were reported at less than 0.01 μg/g, and the concentrations of acetone and carbon disulfide in these composite samples were reported at less than 0.02 μg/g.

The data described above show that the North Site soil does not contain any of the volatile organic compounds that were analyzed in concentrations above the analytical detection limits (0.01 and 0.02 μg/g). In addition, the minimum attainable detection limits for these volatile organic compounds are all well below the TCLP regulatory limits.

Phase IV Metals Analysis: For evaluation of the North Site soil metals data, metal concentrations in the North Site soils were compared with background values determined for the composite soil sample that was prepared from samples collected outside the southeast fence boundary of the North Site. These comparisons are presented in Tables 9-12.

The data presented in these tables show that the composite soil samples from the North Site burial sites and storage/spill areas do contain levels of some of the RCRA metals that are greater than those determined to be present in the background composite sample. However, none of the composite soil samples would fail TCLP extraction. If the composite soil samples that are listed in Tables 9-12 were tested by TCLP, and the total amounts of the RCRA metals that are in the samples were extracted into the TCLP extract, the concentrations of the metals would be diluted by the extraction fluid. For solid materials, such as soil, the dilution factor is 20. If the metal concentrations listed in Tables 9-12 are divided by 20, the resulting metal concentrations for all of the composite samples, as shown in Tables 13-15, are well below the TCLP regulatory limits. This means that the RCRA metal concentrations in the soils do not make them hazardous based on toxicity, do not require special disposal practices, and should not pose a threat to the quality of the groundwater in the area.

Table 9. Concentrations of the RCRA Metals in Composite Soil Samples from the Northeast Burial Site Compared with Concentrations Present in a Background Composite Soil Sample, mg/Kg

Soil Sample	As	Ba	Cd	Cr	Pb	Hg	Se	Ag
Background Sample	**<2.5**	**25.9**	**<0.5**	**9.88**	**<2.5**	**<0.02**	**<5.0**	**<0.5**
Soil Sample 1	<2.5	33.8	<0.5	10.5	3.48	<0.02	<2.5	<0.5
Soil Sample 2	<2.5	42.3	<0.5	11.0	9.01	0.053	<2.5	<0.5
Soil Sample 3	<2.5	28.0	<0.5	10.7	2.43	<0.02	<2.5	<0.5
Soil Sample 4	<2.5	33.4	<0.5	9.81	6.59	0.11	<2.5	<0.5
Soil Sample 5	<2.5	29.5	<0.5	9.63	5.66	0.03	<2.5	<0.5
Soil Sample 6	<2.5	35.3	<0.5	10.8	3.37	<0.02	<2.5	<0.5
Soil Sample 7	<2.5	24.3	<0.5	14.2	5.36	<0.02	<2.5	<0.5
Soil Sample 8	<2.5	21.5	<0.5	8.74	4.61	<0.02	<2.5	<0.5
Soil Sample 9	<2.5	20.2	<0.5	10.3	4.67	<0.02	<2.5	<0.5
Soil Sample 10	<2.5	30.3	0.62	9.21	6.06	<0.02	<2.5	<0.5
Avg. Conc. in 10 Samples	<2.5	29.9	9/<0.5	10.5	5.12	---	<2.5	<0.5
Standard Dev.	0	6.7	---	1.5	1.9	---	0	0

Table 10. Concentrations of the RCRA Metals in a Composite Sample of Soil from Within and Surrounding a Buried Drum in the Northeast Burial Site Compared with Concentrations Present in a Background Composite Soil Sample, mg/Kg

Soil Sample	As	Ba	Cd	Cr	Pb	Hg	Se	Ag
Background Sample	**<2.5**	**25.9**	**<0.5**	**9.88**	**<2.5**	**<0.02**	**<5.0**	**<0.5**
Soil in and surrounding the Buried Drum	14.2	139	<0.5	12.3	8.35	<0.02	<2.5	<0.5

Table 11. Concentrations of the RCRA Metals in Composite Soil Samples from the Southeast Burial Site Compared with Concentrations Present in a Background Composite Soil Sample, mg/Kg

Soil Sample	As	Ba	Cd	Cr	Pb	Hg	Se	Ag
Background Sample	**<2.5**	**25.9**	**<0.5**	**9.88**	**<2.5**	**<0.02**	**<5.0**	**<0.5**
Soil Sample 1	<2.5	19.6	<0.5	2.99	8.03	<0.02	<2.5	<0.5
Soil Sample 2	<2.5	24.4	<0.5	8.79	4.34	0.02	<2.5	<0.5
Soil Sample 3	<2.5	24.0	<0.5	9.91	5.08	<0.02	<2.5	0.54
Soil Sample 4	<2.5	23.8	<0.5	8.54	2.99	0.03	<2.5	<0.5
Soil Sample 5	<2.5	23.5	<0.5	8.01	2.97	<0.02	<2.5	<0.5
Soil Sample 6	6.5	28.1	<0.5	7.95	3.05	<0.02	<2.5	<0.5
Soil Sample 7	<2.5	32.8	<0.5	11.3	<2.5	<0.02	<2.5	<0.5
Soil Sample 8	<2.5	33.2	<0.5	22.2	<2.5	<0.02	<2.5	<0.5
Soil Sample 9	<2.5	118	<0.5	17.8	3.72	<0.02	<2.5	0.77
Soil Sample 10	<2.5	146	<0.5	20.4	3.62	<0.02	<2.5	<0.5
Avg. Conc. in 10 Samples	9/<2.5	47.3	<0.5	11.6	8/4.2	8/<0.02	<2.5	8/<0.5
Standard Dev.	---	45.3	0	6.6	---	---	0	---

Table 12. Concentrations of the RCRA Metals in Composite Soil Samples from the Storage/Spill Areas Compared with Concentrations Present in a Background Composite Soil Sample, mg/Kg

Soil Sample	As	Ba	Cd	Cr	Pb	Hg	Se	Ag
Background Sample	**<2.5**	**25.9**	**<0.5**	**9.88**	**<2.5**	**<0.02**	**<5.0**	**<0.5**
Area Under & Surrounding the Spent Oil Shale Pile	<2.5	64.7	<0.5	9.40	<2.5	<0.01	<2.5	<0.5
Hazardous Waste Storage Area	<2.5	75.4	<0.5	8.70	<2.5	<0.01	<2.5	<0.5
Spilt of Hazardous Waste Storage Area	<2.5	71.6	<0.5	8.49	<2.5	<0.01	<2.5	<0.5
Drum Storage Area	<2.5	55.9	<0.5	11.1	11.5	0.022	<2.5	<0.5
Old Pond Area	<2.5	37.6	<0.5	10.2	3.90	0.098	<2.5	<0.5
Split of Old Pond Area	4.00	36.5	<0.5	10.3	3.80	0.091	<2.5	<0.5
Storage Building & Surrounding Area	<2.5	72.4	<0.5	22.3	<2.5	0.829	<2.5	<0.5
Septic Tank Leach Field (Retort)	<2.5	219	<0.5	16.0	<2.5	0.057	<2.5	<0.5
Area Around Storage Tanks	<2.5	28.9	0.69	9.24	<2.5	0.051	<2.5	1.0
Automotive Shop Area	<2.5	150	<0.5	16.3	7.48	0.016	<2.5	<0.5

Table 12. Concentrations of the RCRA Metals in Composite Soil Samples from the Storage/Spill Areas Compared with Concentrations Present in a Background Composite Soil Sample (continued), mg/Kg

Soil Composite	As	Ba	Cd	Cr	Pb	Hg	Se	Ag
Background Sample	**<2.5**	**25.9**	**<0.5**	**9.88**	**<2.5**	**<0.02**	**<5.0**	**<0.5**
Storm Water Outfall Area (South)	<2.5	80.2	0.79	42.6	7.00	0.016	<2.5	<0.5
Storm Water Outfall Area (North)	<2.5	64.6	<0.5	17.9	<2.5	0.036	5.1	<0.5
North Fence Area	4.29	74.7	<0.5	24.5	7.69	0.012	<2.5	<0.5
Area Around the In Situ Processing Lab	3.82	68.7	<0.5	13.4	13.6	0.015	<2.5	<0.5
Split of the Area Around the In Situ Processing Lab	<2.5	63.0	<0.5	16.3	11.6	0.015	<2.5	<0.5
Flammable Storage Area	3.42	96.5	<0.5	19.6	6.06	<0.01	<2.5	<0.5
Tar Sand Berm Area	5.51	37.5	<0.5	12.1	6.27	<0.02	<5.0	<0.5
Old Septic Tank Leach Field	<2.5	72.9	<0.5	14.3	7.28	0.035	<2.5	<0.5
New Septic Tank Leach Field	2.60	82.7	<0.5	22.9	9.64	<0.01	<2.5	<0.5

Table 13. Concentrations of the RCRA Metals in Composite Soil Samples from the Northeast Burial Site Adjusted for TCLP Dilution, ppm

Soil Sample	As (5.0)[a]	Ba (100)	Cd (1.0)	Cr (5.0)	Pb (5.0)	Hg (0.2)	Se (1.0)	Ag (5.0)
Soil Sample 1	<0.125	1.69	<0.025	0.525	0.174	<0.001	<0.125	<0.025
Soil Sample 2	<0.125	2.11	<0.025	0.550	0.450	0.003	<0.125	<0.025
Soil Sample 3	<0.125	1.40	<0.025	0.535	0.121	<0.001	<0.125	<0.025
Soil Sample 4	<0.125	1.67	<0.025	0.490	0.329	0.005	<0.125	<0.025
Soil Sample 5	<0.125	1.47	<0.025	0.481	0.283	0.001	<0.125	<0.025
Soil Sample 6	<0.125	1.76	<0.025	0.540	0.168	<0.001	<0.125	<0.025
Soil Sample 7	<0.125	1.21	<0.025	0.710	0.268	<0.001	<0.125	<0.025
Soil Sample 8	<0.125	1.07	<0.025	0.437	0.230	<0.001	<0.125	<0.025
Soil Sample 9	<0.125	1.01	<0.025	0.515	0.233	<0.001	<0.125	<0.025
Soil Sample 10	<0.125	1.51	0.031	0.460	0.303	<0.001	<0.125	<0.025
Soil in and around Buried Drum	0.710	6.95	<0.025	0.615	0.417	<0.001	<0.125	<0.025

[a] The value in parentheses is the TCLP regulatory level in mg/L for each analyte.

Table 14. Concentrations of the RCRA Metals in Composite Soil Samples from the Southeast Burial Site Adjusted for TCLP Dilution, ppm

Soil Sample	As (5.0)[a]	Ba (100)	Cd (1.0)	Cr (5.0)	Pb (5.0)	Hg (0.2)	Se (1.0)	Ag (5.0)
Soil Sample 1	<0.125	0.980	<0.025	0.149	0.401	<0.001	<0.125	<0.025
Soil Sample 2	<0.125	1.22	<0.025	0.439	0.217	0.001	<0.125	<0.025
Soil Sample 3	<0.125	1.20	<0.025	0.495	0.254	<0.001	<0.125	0.027
Soil Sample 4	<0.125	1.19	<0.025	0.427	0.149	0.001	<0.125	<0.025
Soil Sample 5	<0.125	1.17	<0.025	0.400	0.148	<0.001	<0.125	<0.025
Soil Sample 6	0.325	1.40	<0.025	0.397	0.152	<0.001	<0.125	<0.025
Soil Sample 7	<0.125	1.64	<0.025	0.565	<0.125	<0.001	<0.125	<0.025
Soil Sample 8	<0.125	1.66	<0.025	1.11	<0.125	<0.001	<0.125	<0.025
Soil Sample 9	<0.125	5.90	<0.025	0.890	0.186	<0.001	<0.125	0.038
Soil Sample 10	<0.125	7.30	<0.025	1.02	0.181	<0.001	<0.125	<0.025

[a] The value in parentheses is the TCLP regulatory level in mg/L for each analyte.

Table 15. Concentrations of the RCRA Metals in Composite Soil Samples from the North Site Storage/Spill Areas Adjusted for TCLP Dilution, ppm

Soil Composite	As (5.0)[a]	Ba (100)	Cd (1.0)	Cr (5.0)	Pb (5.0)	Hg (0.2)	Se (1.0)	Ag (5.0)
Area Under & Surrounding the Spent Oil Shale Pile	<0.125	3.23	<0.025	0.470	<0.125	<0.0005	<0.125	<0.025
Hazardous Waste Storage Area	<0.125	3.77	<0.025	0.435	<0.125	<0.0005	<0.125	<0.025
Spilt of Hazardous Waste Storage Area	<0.125	3.58	<0.025	0.424	<0.125	<0.0005	<0.125	<0.025
Drum Storage Area	<0.125	2.79	<0.025	0.555	0.575	0.001	<0.125	<0.025
Old Pond Area	<0.125	1.88	<0.025	0.510	0.195	0.005	<0.125	<0.025
Split of Old Pond Area	0.200	1.82	<0.025	0.515	0.190	0.005	<0.125	<0.025
Storage Building & Surrounding Area	<0.125	3.62	<0.025	1.11	<0.125	0.041	<0.125	<0.025
Septic Tank Leach Field (Retort)	<0.125	10.9	<0.025	0.800	<0.125	0.003	<0.125	<0.025
Area Around Storage Tanks	<0.125	1.44	0.034	0.462	<0.125	0.003	<0.125	0.050
Automotive Shop Area	<0.125	7.50	<0.025	0.815	0.374	0.0008	<0.125	<0.025

[a] The value in parentheses is the TCLP regulatory level in mg/L for each analyte.

Table 15. Concentrations of the RCRA Metals in Composite Soil Samples from the North Site Storage/Spill Areas Adjusted for TCLP Dilution (continued), ppm

Soil Composite	As (5.0)[a]	Ba (100)	Cd (1.0)	Cr (5.0)	Pb (5.0)	Hg (0.2)	Se (1.0)	Ag (5.0)
Storm Water Outfall Area (South)	<0.125	4.01	0.039	2.13	0.350	0.0008	<0.125	<0.025
Storm Water Outfall Area (North)	<0.125	3.23	<0.025	0.895	<0.125	0.002	0.255	<0.025
North Fence Area	0.214	3.73	<0.025	1.22	0.384	0.0006	<0.125	<0.025
Area Around the In Situ Processing Lab	0.191	3.43	<0.025	0.670	0.680	0.0008	<0.125	<0.025
Split of the Area Around the In Situ Processing Lab	<0.125	3.15	<0.025	0.815	0.580	0.0008	<0.125	<0.025
Flammable Storage Area	0.171	4.82	<0.025	0.980	0.303	<0.0005	<0.125	<0.025
Tar Sand Berm Area	0.276	1.88	<0.025	0.605	0.314	<0.001	<0.25	<0.025
Old Septic Tank Leach Field	<0.125	3.64	<0.025	0.715	0.364	0.0018	<0.125	<0.025
New Septic Tank Leach Field	0.130	4.13	<0.025	1.14	0.482	<0.0005	<0.125	<0.025

[a]The value in parentheses is the TCLP regulatory level in mg/L for each analyte.

Activities Scheduled for Next Quarter: During the next quarter, phase II and phase III activities will be completed; the final report for phase IV will be written; and phase V will be conducted. Phase V will involve removal of the shale oil storage tanks and oil shale retort(s), as well as groundwater sampling. Because phase IV data show that metals have been added to the North Site soil, drilling of groundwater sampling wells and analysis of groundwater samples from the area will provide useful information for evaluating any effects of the metals on the area's groundwater quality. In addition, the shale oil storage tanks will be steam cleaned and sold or given away. Soil that is presently under the shale oil storage tanks and in the berm around the tanks will be sampled and analyzed to determine if removal of this material is necessary. Phase IV data show that the soil in the area around the storage tanks contains semivolatile organic compounds that are not naturally present in the North Site soil.

References:

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U.S. EPA, 1986, Method 7060: Arsenic (Atomic Absorption, Furnace Technique). Test Methods for Evaluating Solid Waste: Physical/ Chemical Methods (SW-846), Vol. 1A, 3rd Ed.

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U.S. EPA, 1990, Toxicity Characteristic Leaching Procedure (Method 1311). Federal Register, March 29, 55: 11798-11877.

U.S. EPA, 1991, Statement of Work for Organic Analysis. U.S.EPA Contract Laboratory Program, Document Number OLM01.0, including revision OLM01.8.

Form EIA-459E

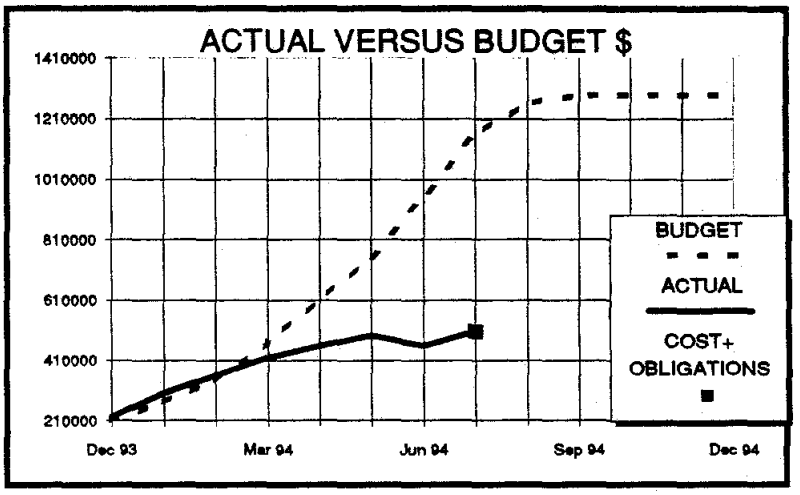
ACCOUNT STATUS REPORT

Month/Year
JULY 1994

Title	Base Program
Contract No	DE-FC21-93MC30126
Client	DOE
Contract Type	Cooperative Agreement
Account Value	
Proposal No	
Account No	

Description: Task 6.1
North Site Remediation

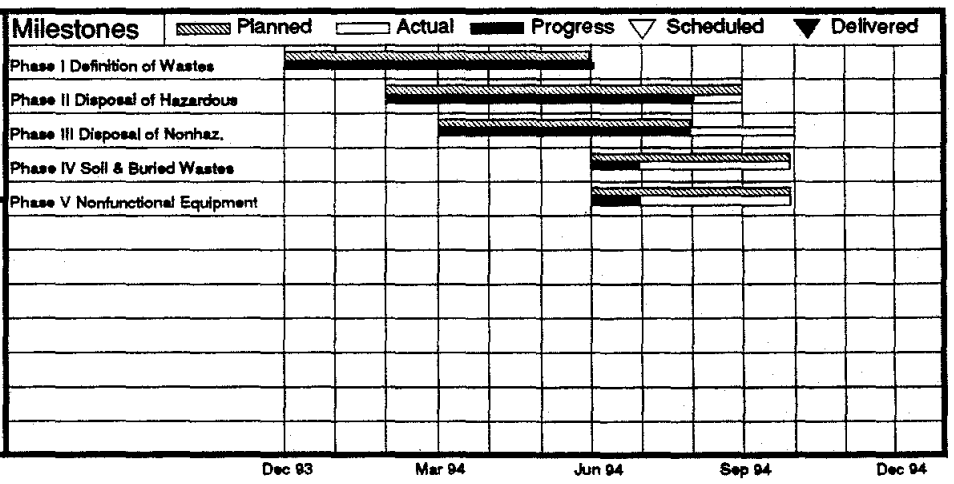
Essential Elements of Information	Yes	No	Customer Notfid	Customer Appvd
I. Meeting Performance Requirements				
II. On Schedule				
III. Within Contractual Cost				
A. Overrun $				
B. Scope Change $				
1. Funds Authorized				
2. Work Started				
IV. Adequate Funding				



Key Personnel

Proj Mgr:	Smith, Verne
Task Mgr:	Merriam, Norm
Sub Task Mgr:	
Proj Admin:	

	Date
Contract Start	02/02/93
Contract Complete	02/01/98
Plan Approved	09/30/93
Last Review	
Next Review	



PROGRAM HIGHLIGHTS

Budget vs Actual Table

	May 94	Jun 94	Jul 94
Budget	751000.00	951000.00	1158000.00
Cost	492594.24	457423.01	506820.13
Variance	258405.76	493576.99	651179.87

F-Formal
I-Informal

Approved _____ Project Manager

_____ Vice President

DISCLAIMER

Mention of specific brand names or models of equipment is for information only and does not imply endorsement of any particular brand.