Base Program on Energy Related Research

**Quarterly Report
May - July 1995**

August 1995

Work Performed Under Contract No.: DE-FC21-93MC30126

For
U.S. Department of Energy
Office of Fossil Energy
Morgantown Energy Technology Center
Morgantown, West Virginia

By
Western Research Institute
University of Wyoming Research Corporation
Laramie, Wyoming

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Morgantown, West Virginia 26507-0880

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University of Wyoming Research Corporation
P.O. Box 3395
Laramie, Wyoming 82071

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TASK 1.0 OIL AND GAS

SUBTASK 1.1

CROW™ PROCESS MODELING

Lyle A. Johnson
Charles G. Mones

May – July 1995

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. The four subtasks that have been identified and the specific objectives are:

- development a numerical simulator through the modification of an existing thermal EOR simulator to describe the transport of organic materials in aqueous environments,
- design and conduct physical simulations that will provide data for the verification of the developed numerical simulator,
- perform model verification with the data from the physical simulations, and
- project management and reporting of all efforts including the complete documentation of the numerical simulator.

QUARTER OBJECTIVES

The objectives for this quarter were to:

- continue the model verification effort using the results from the test simulations and relative permeability tests, and

- continue documentation of the numerical simulator.

ACCOMPLISHMENTS

- The reactor system was completed, and shakedown testing using a brine solution to track the flow paths in the reactor was also completed.
- Testing using three different nonaqueous phase liquids (NAPL) was completed. Tests used a floating or light nonaqueous phase liquid (LNAPL), a sinking or dense nonaqueous phase liquid (DNAPL), and a nonaqueous phase with a density nearly the same as that of water (NAPL).
- Relative permeability testing was completed for a LNAPL and a NAPL.
- Model modification is being done using the data from the two-dimensional tests and the relative permeability tests for history matching and verification.

ACTIVITIES FOR NEXT QUARTER

- Continue model verification using the results from the two-dimensional simulations and the relative permeability tests.
- Continue documentation and preparation of the final report for the numerical simulator.

PROCEDURES

The primary steps being taken in this task are:

- model development;
- physical simulations;
- model verification; and

- management and reporting.

Subtask 1 is the modification of an existing thermal EOR simulator to incorporate the phenomena peculiar to the CROW process, including, but not limited to, the inclusion of a convection-diffusion transport mechanism. This will assist in the ability to describe the transport of organic materials in an aqueous environment. This subtask will be used initially to identify the parameters for subtask 2.

Subtask 2 is the conduct of the physical simulations necessary to provide the data for the verification of the numerical simulator developed in subtask 1. The subtask includes the development and shakedown of the reactor system deemed best able to provide the required data. Three scenarios of organic contamination in an aquifer are to be 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 that of water, resulting in a suspended phase within an aquifer. Also in this subtask will be the determination of the relative permeabilities for the organic liquids used in the physical simulations.

Subtask 3 is the verification of the developed numerical simulator using the data produced in subtask 2. Any further modifications of the numerical simulator necessary to history match the produced data will also be done in this subtask.

Subtask 4 is the project management required to ensure the proper execution of the task and the reporting of the accomplishments. This subtask also includes the documentation of the numerical simulator and the inclusion of the documentation into the final task report.

RESULTS

The CROW model developed during the first-year funding extended the existing multiphase, multicomponent, three-dimensional, thermal simulator that was developed for petroleum reservoirs to describe the transport of organic materials in aqueous environments. The model has the ability to describe the fate of organic materials by Arrhenius-type, first-order kinetics, as well as phase equilibria relationships. These capabilities are necessary to describe the speciation of the oil by bioremediation or steam stripping operations. Because of the model's thermal aspects, all reservoir and fluid properties are temperature-dependent. the model is also able

to perform field simulations for one, two, and three dimensions with variable grid spacings, and the use of vertical or horizontal wells.

To conduct the two-dimensional tests, two vessels 0.9 m (3 ft) long, 0.6 m (2 ft) high and .79 cm (2 in) thick was constructed. One vessel was constructed of 0.64-cm (0.25-in) Plexiglas and the other of 0.64-cm (0.25-in) aluminum sheet. The Plexiglas vessel was for ambient-temperature tests and the aluminum vessel for elevated-temperature tests. Slotted and screened pipes of varying lengths were installed from the top to simulate the injection well. Similar slotted and screened pipes are installed from the bottom to simulate the extraction well. A throttle valve controls the extracted fluid flow rate.

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. Each test was operated at a predetermined temperature, flow rate and time to ensure that all tests were conducted in a similar manner.

Samples were taken throughout the reactor as the reactor was loaded and after the tests were completed. These samples were extracted to determine the organic saturation distribution before and after the tests. The data from all the physical simulations were compiled and material balances performed for all tests.

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 two double-headed positive displacement pumps for fluid injection. The positive displacement pumps are precalibrated to deliver the specified injection rates of organic material and water. For the elevated temperature tests, heat tapes on the injection lines and guard heaters on the cell provide 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 hrs.

The verification of the numerical simulator has begun as has the documentation of the simulator. Preliminary modifications of the numerical simulator have been completed, and initial runs using the data from the initial 2-D physical simulations have been completed. Based on these runs, minor modifications to the simulator have been completed.

The next step is the validation of the simulator using data from the mixed-phase NAPL contaminants from a wood treatment facility. Also to be used will be the relative permeability curves developed for the mixed-phase fluid.

Data generated from the 2-D physical simulations were reviewed. Efforts were concentrated primarily on the runs using Bell Pole oil, which simulated suspended oil cases. Initially, this was done because relative permeability data were available with Bell Pole oil. Later the review of this data was expanded to include the runs done using Stroudsburg oil, which simulated sinking oil cases. To date, modeling simulations are being made of an ambient run and a high-temperature, 71°C (160°F), run using Bell Pole oil.

Three areas of concern with these data were soon apparent. First, poor material balance closures existed throughout these tests. Several different techniques had been employed to improve the closures, such as eliminating all negative numbers, calculating a grid saturation from surrounding grids for abnormal appearing saturations and eliminating all high and low saturation numbers. None of these techniques gave a consistent, acceptable, material balance closure.

In general, it appeared that the initial measured oil saturations were too low. For the two modeling simulations currently in progress, recalculated initial conditions were used. It was assumed that the residual oil saturations and the produced oil values were accurate. It was further assumed that the amount of material loaded into the reactor was accurate and that the flexing of the reactor walls in the immediate saturated area of the box was minimal. With these assumptions, the initial oil and water saturation and porosity were calculated. The calculated oil saturations and porosities were higher than the values previously reported (Table 1).

Table 1. Bell Pole Condition Comparison

Run	CMBAMB	CMB160
Temperature	Ambient	71°C (160°F)
Original Porosity	38%	38%
New Porosity	43%	50%
Original Initial Oil Saturation		29.0%
	39.6%	
New Initial Oil Saturation	50.0%	44.0%

The second area of concern with the physical simulation data involved the amount of spreading of the oil. Modeling simulations conducted prior to the physical simulations predicted significant oil movement in the vertical direction. However, modeling runs made with actual physical simulation data do not predict the degree of spreading seen in these tests.

The third area of concern is with the Bell Pole ambient temperature physical simulation. This test was important for comparison using the ambient temperature relative permeability data generated with Bell Pole oil. In this test, significant vertical movement of the oil was observed; however, no measurable oil was produced. Any modeling simulation that comes close to matching the vertical movement of the oil predicts a relatively large amount of oil production.

Relative Permeability

Early modeling simulations were conducted using a theoretical relative permeability curve calculated for an unconsolidated sand by Corey's equation (Corey, 1954). An ambient and a 60°C (140°F) relative permeability curve were developed by WRI in the laboratory, using 20-40 sand and Bell Pole oil. These two WRI-derived relative permeability curves had higher residual oil saturations than those calculated using Corey's relationship. Using the WRI-derived relative permeability curves to simulate the 2-D tests yielded predictions with even less vertical oil movement than was predicted using Corey's relative permeability curve. However, oil production predictions for the high-temperature case were lower and closer to actual oil production.

Capillary Pressure

Initially, capillary pressure was ignored in the model simulations. However, review of the literature indicates that a significant contribution to vertical oil movement is due to capillary forces (Jones and Roszelle, 1978, Johnson and Bossler, 1959). During this quarter, a capillary pressure function was added to the model. Preliminary runs with capillary pressure added demonstrates a better match with the high temperature Bell Pole physical simulation. However, the model still predicts less vertical oil movement than was observed in the physical simulations.

REFERENCES

Corey, A.T., November 1954, *Producers Monthly*, 38.

Johnson, E.F. and D.P. Bossler, 1959, Calculation of Relative Permeability from Displacement Experiments, *Trans., AIME*, 216, 370-372.

Jones, S.C. and W.O. Roszelle, May 1978, Graphical Techniques for Determining Relative Permeability From Displacement Experiments, *Journal of Petroleum Technology*, 807-817.

SUBTASK 1.2

MISCIBLE\IMMISCIBLE GAS INJECTION PROCESSES

Lyle A. Johnson
Francis M. Carlson

May - July 1995

OBJECTIVE

The objective of this subtask is to develop a predictive model for the miscible\immiscible gas injection process with emphasis on the use of CO₂ as the injected gas. Data for the verification of the model will be obtained through the conduct of physical simulations designed with the use of the numerical simulator.

QUARTER OBJECTIVES

No work was planned for this quarter.

ACTIVITIES NEXT QUARTER

The start of the main efforts involving this subtask is scheduled for September 1995, with the preliminary modeling effort to be conducted at METC.

PROCEDURES

This subtask will be composed of four parts.

- The first part will be the selection and acquisition of a numerical simulator. The numerical simulator will be used to develop the experimental plan and operational procedures for the physical simulations.
- The second part will be the conduct of physical simulations to provide detailed data for the validation of the simulator.
- Next will be the validation of the numerical simulator using the history matching of the physical simulations. The model will be modified as needed to provide the necessary history matches.
- The final part will be the documentation of the numerical and physical simulations in a final topical report.

RESULTS

The numerical simulator selected for use in this subtask is the numerical simulator developed by the Computer Modeling Group (CMG). The simulator was selected because its capability of taking into consideration the solubility of CO₂ in the aqueous phase and to allow for relative permeability hysteresis. Based on discussions with personnel at the Morgantown Energy Technology Center(METC), it was decided that the initial simulations using the CMG simulator would be conducted by WRI personnel at the METC facilities since the simulator is presently available there.

Based on the initial simulations, an experimental plan for the physical simulations will be developed and the decision as to whether to continue to conduct the modeling effort at METC or to acquire the simulator at WRI will be made.

SUBTASK 1.3

DEVELOPMENT OF A PORTABLE DATA ACQUISITION SYSTEM AND COALBED METHANE SIMULATOR

Charles G. Mones

May – July 1995

OBJECTIVES

The objectives of this subtask 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 subtask is divided into three relevant activities:

- development of a data acquisition system;
- development of a coalbed methane simulator; and
- laboratory work to improve model physics and to gain a competitive advantage.

QUARTER OBJECTIVES

No work was planned for this subtask during this quarter.

SUBTASK 1.4

TANK BOTTOM WASTE PROCESSING USING THE TABORR™ PROCESS

Robert M. Satchwell

May – July 1995

OBJECTIVES

The objective of this project is to develop information for use in the successful deployment of Western Research Institute's (WRI's) patented TaBoRR™ technology. To accomplish this objective, work is being conducted in areas of technology support, design and operation of a laboratory process unit, numerical modeling of the process, and economic analysis.

QUARTER OBJECTIVES

The objectives for the quarter were to:

- analyze data obtained from the laboratory demonstration unit;
- perform a safety analysis and review system (SARS) for the laboratory demonstration unit;
- continue testing tank bottom wastes in the laboratory demonstration unit with samples from different locations;
- perform a SARS for the field demonstration unit prior to the shakedown tests;
- perform shakedown and operational tests of the field demonstration unit to acquire data and samples for analysis;
- provide analysis of the data collected for the preparation of reports to regulatory agencies for permitting purposes; and
- prepare assessment of the processing options and procedures for optimization purposes.

ACCOMPLISHMENTS

- Analysis of the data from the laboratory demonstration unit has been performed.
- A test plan for the operation of the field demonstration unit has been completed.
- The SARS has been completed for the field unit.
- Environmental permitting for using the field demonstration unit for a 15-day shakedown period and a 30-day test period has been completed.
- Further work has been performed on the field demonstration unit. The field unit has been moved to the field site and plumbing of natural gas and electrical wiring has been completed.

ACTIVITIES FOR NEXT QUARTER

- perform a SARS for the laboratory demonstration unit;
- continue testing of tank bottom wastes in the laboratory demonstration unit with samples from different locations;
- perform a shakedown and operational tests of the field demonstration unit to acquire data and samples;
- provide assessment of the processing options and procedures for optimization purposes; and
- provide a final report based on the data collected for the issuing of a permit from regulatory agencies.

RESULTS

The following activities were conducted during the reporting period:

A test plan for the operation of the field demonstration unit has been completed. This plan includes a description of the process and controls, information to be generated and analyses to be performed, as well as results to be determined from operation of the unit. This plan also includes procedures for shakedown, startup, shutdown, and normal operations. Emergency protocols are reviewed in these procedures.

The data have been analyzed from the tests performed using the laboratory unit. Based on the data and analyses, modifications to the laboratory unit are being performed. Since the objective of testing the laboratory unit was to verify the

operation of the field unit, further experiments using the laboratory unit have been postponed until data have been obtained from the field demonstration unit.

The SARS has been completed for the field unit. Various personnel from WRI and a representative from the Department of Energy visited the site. During this visit, a complete tour, with discussions of the unit operations, was conducted. This tour was followed by an analysis and discussion of all safety and health issues affecting personnel in the vicinity of the unit during operating periods. The results of this SARS have been implemented in the shakedown, startup, and operation of the field demonstration unit.

The most significant result of this work is the placement of the field demonstration unit at a tank bottom waste site. The unit is being assembled and is ready for operation at the site during the next quarter. Variances for digging and installing natural gas supply lines and electrical power were obtained and the lines are being installed.

In summary, the operation and successful tests using the laboratory unit demonstrate that the fundamental concept and design work associated with the TaBoRR process can be successful in remediating and recovering a crude oil distillate cut from tank bottom wastes.

Laboratory processing shows that water can be successfully removed by a flash process, and oil can be recovered by distillation. Yet to be demonstrated with the field unit are the viable operating parameters and their associated recoveries and efficiencies. After results have been obtained from the field unit, further laboratory testing will be performed to measure the differences in operation of the field unit compared to the laboratory unit.

TASK 2.0 ADVANCED SYSTEMS APPLICATIONS

SUBTASK 2.1

DEVELOPMENT AND OPTIMIZATION OF A PROCESS FOR THE PRODUCTION OF A PREMIUM SOLID FUEL FROM WESTERN U.S. COALS

Norm Merriam

May – July 1995

OBJECTIVES

The objective of this task is to develop a process for the economically attractive and environmentally sound production of a premium fuel from low-rank western coal.

QUARTER OBJECTIVES

No activities were planned for this quarter.

SUBTASK 2.4

PROCESS SUPPORT AND DEVELOPMENT

David Sheesley

May – July 1995

OBJECTIVE

The objective of this subtask is to obtain support leading to development of a COMPCOALTM pilot plant.

QUARTER OBJECTIVES

No work was planned for this quarter.

SUBTASK 2.5

EASTERN SHALE OIL RESIDUE AS AN ASPHALT ADDITIVE

Ken Thomas
Mike Harnsberger

May – July 1995

OBJECTIVES

The objectives of this task are to determine whether or not an asphalt modifier produced from eastern shale oil is beneficial in 1) reducing age hardening and 2) reducing moisture damage susceptibility in conventional asphalt concrete used in public roads. Several subtasks have been identified. The specific objectives are:

- preparation of an experimental plan;
- acquisition and preparation of an eastern shale oil residue suitable for evaluation;
- preparation of a sample matrix that will be the subject of testing and evaluation;
- testing and evaluation of samples that have been subjected to aging tests;
- testing and evaluation of samples that have been subjected to successive freeze-thaw cycling; and
- preparation of a report that discusses the results obtained and the conclusions drawn.

QUARTER OBJECTIVES

The objective was to complete the draft final report on this subtask.

ACCOMPLISHMENTS

The draft final report will be submitted to DOE in September.

TASK 3.0 ENVIRONMENTAL TECHNOLOGIES

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SUBTASK 3.1

SOLID WASTE MANAGEMENT

Alan E. Bland
Terry H. Brown

May – July 1995

OBJECTIVES

Project objectives are to develop the fundamental data and technologies by which industry can assess and implement economical and technically viable ash management strategies and plans for clean coal technology (CCT) ashes.

QUARTER OBJECTIVES

The objectives for the quarter were:

- continue acquisition, chemical characterization and geotechnical testing of ashes from a number of fluidized bed combustion (FBC) facilities; and
- initiate the assessment of ettringite conversion to thaumasite and other minerals; and
- continue the materials compatibility testing of FBC ash based controlled low-strength flowable fill material (CLSFFM).

ACCOMPLISHMENTS

- A number of FBC facilities have agreed to supply ash for the geotechnical, conditioning and chemical hydration reaction testing, including: (1) TVA (bituminous coal- and petroleum coke-fired FBC); (2) NISCO (petroleum coke-

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fired); (3) Tri-State Nucla (low-sulfur subbituminous coal-fired); and (4) Pt. Aconi (high-sulfur bituminous coal-fired). These are in addition to the two PFBC ashes from Karhula and AEP Tidd. Ash from the NISCO high-sulfur petroleum coke-fired FBC facility has been delivered, and chemical, physical and geotechnical testing has been initiated. Ashes from the Tri-State facility are in delivery, and the ashes from the Pt. Aconi facility are being negotiated related to customs and transport issues from Canada.

- Experimental testing to assess the conversion of ettringite to other minerals, such as thaumasite, through the introduction of carbonate and/or soluble silica into the crystal structure has been delayed until next quarter.
- Additional testing of the use of Montana-Dakota Utility (MDU) ash in the formulation of controlled density flowable fill has been conducted. Materials compatibility testing using galvanized piping, copper piping, rebar and Type I portland cement with and without pozzolan addition has been initiated. Material test coupons were embedded in the MDU flowable fill. For comparative purposes, material test coupons were also embedded in the local soil material and in conventional flowable fill. The embedded materials are being allowed to cure for 14 days and then will be processed through wet/dry cycles. At 30-day intervals, the material test coupons are examined for evidence of corrosion.
- Comments were received from the U.S. Department of Energy (USDOE) related to the FY '94 interim topical report, and a revised version is being transmitted on a confidential basis to US DOE (METC).

ACTIVITIES FOR NEXT QUARTER

- Continue acquisition, chemical characterization and geotechnical testing of ashes from a number of FBC facilities, specifically the TVA facility, the Tri-State Nucla facility, and the Pt. Aconi FBC facility.
- Initiate the assessment of ettringite conversion to thaumasite and other minerals.
- Write report on the results of testing of FBC ash-based CLSFFM, including mix design and proportioning, geotechnical properties, and materials compatibility testing.

PROCEDURES

Standard ASTM procedures for the geotechnical testing are to be used, including ASTM D-698 and 1557 for moisture-density relationship, 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, TGA, DSC, SEM and XRD techniques.

RESULTS

Activity 3.1.1 – Evaluation of the Chemical, Physical and Geotechnical Properties of Various CCT Ashes.

A number of FBC facilities have agreed to supply ash for the geotechnical, conditioning and chemical hydration reaction testing. Ashes for the project include (1) TVA (bituminous coal- and petroleum coke-fired FBC); (2) NISCO (petroleum coke-fired); (3) Tri-State Nucla (low-sulfur subbituminous coal-fired); and (4) Pt. Aconi (high-sulfur bituminous coal-fired). These are in addition to the two PFBC ashes from Karhula and AEP Tidd. Ash from the NISCO high-sulfur petroleum coke-fired FBC facility has been delivered, and chemical, physical and geotechnical testing has been initiated. Ashes from the Tri-State facility are in delivery, and the ashes from the Pt. Aconi facility are being negotiated related to customs and transport issues from Canada.

Standard geotechnical properties of the TVA ashes have been determined, including moisture-density relationships (proctors), unconfined compressive strength, and dimensional stability. The strength development and expansion for the TVA ashes appear to be controlled by the amount of free lime available for ettringite formation and the anhydrite available for gypsum formation. Samples of the cured ashes have been acetone-dried and preserved for chemical evaluations employing TGA and XRD techniques.

Activity 3.1.2 – Stability and Modifications of Hydration Reactions

The stability of the reaction products appears to be sensitive to pH and reactant concentrations/equilibrium. The instability of the CCT ashes results from the hydration of anhydrite to form gypsum, the formation of ettringite, and the slow conversion of ettringite to thaumasite. Evaluation of methods for the identification and/or quantification of the appropriate hydration phases (portlandite, gypsum, ettringite/thaumasite) has been conducted. Ettringite synthesized in the laboratory

has been analyzed by a number of analytical techniques, of which high-resolution TGA appears the most promising for quantification purposes.

Ettringite was prepared for subsequent testing under carbonate and soluble silica conditions. This testing was designed to assess the conversion of pure ettringite to thaumasite or other potential hydration reaction products. Testing was delayed and is expected to be initiated in the next quarter.

Activity 3.1.3 – Methods for Control of CCT Ash Hydration Reactions for Stable Ash Disposal or Use

Several methods for the stabilization of CCT ashes have been developed and appropriate invention disclosures written. *The nature of these processes and their disclosures are therefore confidential and restricted to US DOE and WRI only.* Copies of the disclosures have been filed with the US DOE Patent Office.

An experimental testing plan for evaluation of the stability performance of different treatment processes has been developed. Testing was delayed and is expected to be initiated in the next quarter.

Activity 3.1.4 – Effect of Conditioning Media on Properties of Ashes.

The use of alternate water sources for conditioning CFBC ashes could provide relief to often scarce fresh water supplies, as well as provide cost savings for the treatment and disposal of the alternate water sources. Other waters being considered include coal pile runoff, cooling tower blowdown, and wastewater treatment concentrate. Preliminary testing with these materials has been conducted by AME and others for private clients. The results from earlier preliminary testing were promising, but a rigorous scientific study is required before implementation.

No work on this activity was conducted during the quarter, due to lack of availability of ash materials for the testing.

Activity 3.1.5 – Production of CLSFFM from CCT Ash.

WRI, DOE and Montana Dakota Utilities have entered into a jointly funded project to examine the technical feasibility of producing CLSFFM from CFBC ash from the Heskitt plant in North Dakota. Mix design testing was conducted. Two design mixes have been developed that can closely meet the strength development requirements for

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a structural fill and excavatable fill application. Materials compatibility testing using galvanized piping, copper piping, rebar and Type I portland cement with and without pozzolan addition has been initiated. Material test coupons were embedded in the MDU flowable fill. For comparative purposes, material test coupons were also embedded in the local soil material and in conventional flowable fill. The embedded materials are being allowed to cure for 14 days and then will be processed through wet/dry cycles. At predetermined intervals, the material test coupons will be examined for evidence of corrosion. The preliminary results indicate no significant corrosion with any of the flowable fill materials

SUBTASK 3.2

REMEDIATION OF CONTAMINATED SOILS (Haz-Flote™)

Terry H. Brown

May – July 1995

OBJECTIVES

The primary objective of this task is to develop physical and chemical treatments to remove inorganic and organic compounds from contaminated materials. The project is divided into four subtasks:

- the acquisition of equipment and materials for the construction of the soil washing systems to be used in the remediation tests;
- the preliminary evaluation of washing and remediation techniques for materials contaminated with metals and hydrocarbons;
- the determination of physical and chemical treatment options for remediating mercury contaminated soils associated with oil and gas pipeline locations; and
- technical project management and reporting.

QUARTER OBJECTIVES

The objectives for this quarter were:

- implement the health and safety program;
- conduct attrition scrubber testing of the mercury contaminated materials using various combinations of reagents; and
- visit a pilot-scale column flotation unit operated by MinnovEX Technologies.

ACCOMPLISHMENTS

- The health and safety program specifically oriented to the remediation of mercury contaminated soils is ongoing.

- The attrition scrubber testing is continuing using various combinations of reagents for removal of mercury from the contaminated materials.

ACTIVITIES FOR NEXT QUARTER

- The attrition scrubber testing of the contaminated materials using combinations of reagents and reagent concentrations, scrubbing time, and scrubbing temperature will continue.
- Arrangements will be made to visit a pilot-scale column flotation unit to gain insight on procedures that can be used to increase efficiency of the column operation and to reduce turbulence that our system is experiencing.

PROCEDURES

The procedures used to do the work accomplished during this quarter included:

- The scrubber tests were conducted using a wrist-action shaker with combinations of acids, bases, and oxidizing agents as scrubbing reagents

RESULTS

- The health and safety plan has been implemented.
- Laboratory methods continue to be evaluated to improve our ability to allow good mercury mass balance determinations. The use of various oxidizing agents and acid conditions have resulted in the removal of about 80% of the mercury (using the best combinations) from the contaminated soils during attrition scrubbing. Modifications of the procedure are currently being evaluated to enhance the efficiencies of removal.

SUBTASK 3.3

THE SYN-AG™ PROCESS: COAL COMBUSTION ASH MANAGEMENT OPTION

Alan E. Bland

May – July 1995

OBJECTIVES

Project objectives 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. The specific objectives are:

- develop and document the use of additives for a range of conventional coal combustion ashes;
- determine the optimum curing conditions for the Syn-Ag process;
- verify the properties of the aggregate produced from the Syn-Ag process; and
- determine the process costs, including capital and operating costs, for the Syn-Ag process.

QUARTER OBJECTIVES

The objectives for the quarter were:

- conduct testing of chemical additives for the production of lightweight Syn-Ag product; and
- assess the effect of aging on the performance of spray dryer ashes used in Syn-Ag process.

ACCOMPLISHMENTS

- Disclosures have been written, and patent applications are being considered. Copies of the disclosures have been supplied to the US DOE Patent Office. *As a*

Contains Confidential and Restricted Information

result, all information about the Syn-Ag process remains confidential to WRI and protected therein.

- Additional ash material has been obtained from the Craig Plant and the Laramie River Station for lightweight Syn-Ag production and testing. However, testing was delayed and is expected to be initiated during the next quarter.
- Comments were received from US DOE related to FY '94 Interim Topical Report, and revised version is being transmitted on a confidential basis to US DOE (METC).

PROCEDURES

Standard ASTM procedures for the geotechnical testing were used, including ASTM D-698 and 1557 for moisture-density relationship, ASTM C-109 (modified) for unconfined compressive strength, and ASTM C-157 for dimensional stability (expansion/shrinkage) testing. LA Abrasion resistance procedures follow ASTM C-131. Chemical characterization used ASTM wet chemical methods, as well as standard ICAP, XRF and XRD techniques.

ACTIVITIES FOR NEXT QUARTER

- Conduct testing of chemical additives for the production of lightweight Syn-Ag product.
- Assess the effect of aging on the performance of spray dryer ashes used in Syn-Ag process.

RESULTS

Activity 3.3.1 – Additive Development Tests for Range of Coal Combustion Ashes

Plans were made for the assessment of additives for the production of lightweight Syn-Ag product. Additional ash from the Tri-State Craig Plant and the BEC Laramie River Station has been acquired for the additional testing. Chemical modifiers were also acquired. Testing was delayed and is expected to be initiated during the next quarter.

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Activity 3.3.2 – Evaluation of Curing Conditions

No further activity during the quarter.

Activity 3.3.3 – Verification of the Syn-Ag Process

No additional testing during the quarter.

Activity 3.3.4 – Economic Assessment of the Syn-Ag Process

No activity during the quarter.

SUBTASK 3.4

THE MAXI-ACID™ PROCESS: IN-SITU AMELIORATION OF ACID MINE DRAINAGE

Terry H. Brown

May – July 1995

OBJECTIVE

The objective of this task is to develop a method for the in-situ amelioration of acid mine drainage problems by removing the readily reactive potential acidity from the system under controlled conditions and following with a treatment(s) designed to prevent or reduce additional generation of acid. The overall task will be done in three subtasks:

- laboratory simulation and method development;
- design and modeling of the processes including the containment system; and
- application of the technology in a field trial.

QUARTER OBJECTIVE

The objective for this quarter was to continue the laboratory investigations.

ACCOMPLISHMENTS

The work accomplished includes:

- Evaluations of the acid-generating capabilities of materials containing high levels of potential acidity (pyritic materials) using humidity cells are ongoing.

- Coal containing high levels of pyritic sulfur has been collected from a mine site in Montana.

ACTIVITIES FOR THE NEXT QUARTER

- Continue evaluations of the influence of environmental conditions on acid and alkalinity production.
- The leaching pad will be designed and constructed.
- A modified Soxhlet apparatus will be constructed and used for weathering evaluations.

PROCEDURES

The procedures used to do the work accomplished during this quarter included:

- Weathering evaluations were made using humidity cells with hydrogen peroxide and sodium hypochlorite as oxidizing agents for the oxidation of the acid-forming materials.
- Weathering evaluations continue to be done using humidity cells with deionized water.

RESULTS

The work accomplished includes: (1) continued evaluations of the acid-generating capabilities of materials containing high levels of potential acidity (pyritic materials) using humidity cells; and (2) the impact of H_2O_2 and sodium hypochlorite on soil materials that contain high levels of potential acidity in humidity cells.

The acid-generating capacity of the acid-forming materials are currently being evaluated using a humidity cell technique. The intention of this work is to provide a baseline for our continued effort with Maxi-Acid™ and to determine whether or not the enhancement of oxidation can result in the removal of the potential acidity from the acid-forming materials in a reasonable time frame. The acid-forming materials used

in this study had an initial pH of 3.44 and an EC of 3.24 mS/cm. After seven days of oxidation, the pH of the material decreased to 2.75 and tended to fluctuate between 2.46 and 3.06 during the following 301 days of humidity cell oxidation (Figure 1). There appears to be an apparent tendency for increasing pH values with the increased time of oxidation (Figure 1). The EC of the material increased to 8.87 mS/cm after seven days of oxidation and tended to decrease with time to 301 days of the humidity cell weathering (Figure 2).

The impact of hydrogen peroxide and sodium hypochlorite on the soil materials containing large amounts of potential acidity was very similar. The structure of the soil peds was impacted, and the pyritic materials were oxidizing throughout the test. The sodium hypochlorite seemed to have less impact on soil structure compared to the hydrogen peroxide treatment, however in either case the soil structure was destroyed. Additional testing of these compounds will be done using the leaching pad.

Figure 1. Change in pH with Time (Oxidizing Conditions)

Figure 2. Change in EC with Time

SUBTASK 3.5

SPILL TEST FACILITY DATA BASE

David Sheesley

May - July 1995

OBJECTIVES

The goals are to:

- archive spill test facility results from the National HAZMAT Spill Test Facility (STF);
- update the data base references to spill control technology documents and other data residing on the data base;
- archive and monitor literature significant for hazardous spill incidents; and
- transfer this information to Clean Air Act Amendments (CAAA) participants of the U.S. Environmental Protection Agency, (EPA) Contract Number 68D30018 "Research Program for the Development of Emergency Response Technologies" and the industry, other federal and state agencies, and HazMat teams.

BACKGROUND

As mandated through various legislation, the STF program is to provide testing capability for the development of tools for the protection of workers, the public and the environment. It is also to maintain data for health and safety research in the interest of the nation. The 1986 Title III Superfund Amendments Reauthorization Act (SARA) language directed the Department of Energy (DOE) to develop technology and a data base transfer system as part of an outreach of the STF-related activities. The Clean Air Act Amendments (CAAA) of 1990 directed the DOE and EPA to support a program to develop new data for the risk management of air toxics. The laws also directed the EPA and the DOE to test and evaluate technologies that can be used to respond to liquefied gaseous and other hazardous substance spills that threaten public health or

the environment. The testing and evaluation of technologies and a system to provide the technology transfer are essential to the mission for emergency response technology development at the National HAZMAT Spill Test Facility in Nevada.

This experimental plan for data management and archival for the National Spill Test Facility results includes activities to convert the DOE data base to a form that can be both interactive and accessible to the public, as well as to Desert Research Institute (DRI), the DOE, EPA, DOT, and other stakeholders.

QUARTER OBJECTIVES

The data management/archival work this quarter has included work in:

- the subject-indexed bibliography;
- existing DOE data files from past tests;
- data files to be generated in future tests;
- and results of the EPA/DOE CAAA-STF collaborative research and development program (significant hazardous spill data).

ACCOMPLISHMENTS

Activity was heavy in the first part of this reporting period to document the significant data from activity between industry and the federal government in the planning of a joint series of tests scheduled for August and September of this year. Activity then has tapered off in this project because team participants are implementing a field project.

Documents, Test Plans, Meteorology, and Chemical Properties Data

The overall objective of this task is to develop a data base for industry and the public that includes data on the simulation of accidental releases of fuels and chemicals. Data from simulated releases of chemicals are used to evaluate the performance of tools for risk management planning. The WRI chemical spills technology program for industry includes data acquisition for hydrocarbon and chemical spill prediction and mitigation development. Included is the companion objective to ensure that Clean Air Act

Amendment data development by the EPA at the national HAZMAT Spill Test Facility are made available to the chemical and petrochemical industry for health and safety programs.

In 1993, an EPA-WRI project provided data on a continuous CO₂ release at a known rate with good mass balance between what was released and detected in a downstream instrument array. These results allow WRI and other principal investigators to analyze scenarios of controlled chemical spills under selected meteorological conditions and simulate a physical setting approximating a typical industrial site.

In April 1995, the Petroleum Environmental Research Forum (PERF), DOE and the EPA reached a consensus to conduct a major field experiment in August 1995. With these tests PERF is simulating the industrial site condition in a combined experiment to be done with EPA. Selection of an approximate one-tenth industrial site scale is a significant objective of the project.

WRI and PERF will carry out the dense gas dispersion field experiments with the EPA at the STF in August and September, 1995. The cooperative effort between WRI, the PERF sponsors and the EPA comprises wind tunnel studies, data analysis, and model development and evaluation. The objective will be to capture data from a simulated spill or gas release under given meteorology conditions using chemical sensors as designed by the test sponsors. This work attests to the ability of industry and government to work together in experiments to collect important data.

Detailed engineering and final cost estimating has been completed for a design for heterogeneous roughness elements (obstacles) and up to three different sized homogeneous roughness elements and arrays to examine the effect of roughness on the dispersion of dense clouds of hazardous gases. A test matrix for release rate/duration, stability class, and roughness/obstacle arrays is under review.

The experimental design was aided by the data from one year of data acquisition from an eight-level instrumented 24-meter tower that has been made available in the data base in this quarter. This has improved the ability to determine atmospheric stability and to develop good estimates for the vertical fluxes of heat and momentum, which improves the interpretation of spill data for evaluation of modeling tools. An example is how the determination of atmospheric stability from vertical heat flux from the tower differs from an assessment based on less rigorous weather observations. With

confidence placed in the tower data, our objective is to develop a plan to determine values of the surface roughness length, which is a major issue in the projection of dense cloud dispersion for risk management planning.

The following examples also show how the data base has been used for the design plan:

- Analysis of EPA 1993 Dense Gas Field Test data over the flat terrain at NTS:

Egami et al. (February, 1995). This report gives details of the four field tests, including observed concentration, vertical and lateral profiles, and source and meteorological information.

Briggs (January, 1995). This paper for the AIChE New Orleans meeting suggests some analytical formulas for dense gas dispersion and tests them with the 1993 NTS data.

- Industry-EPA Wind Tunnel Studies of surface roughness simulation:

Snyder (March, 1995) investigated simulation of surface roughnesses of several width-to-height-to-spacing combinations in the EPA wind tunnel. This so-called uniform roughness array (URA) will be constructed at NTS.

Subsequent studies by EPA have not been reported in formal reports but have produced useful results. For example, the EPA has analyzed wind observations in the roughness grid to observe the effectiveness of "roughness equivalence."

WRI data from 1993 are being used to assist in the planning for the monitor placement and the source emissions magnitude and timing for 1995 tests. Comparisons are made with 1993 STF field tests and with SLAB model predictions using these data.

The physical simulation is being assembled at the STF under WRI management to collect new data for the STF data base. The operations plan for conduct of experiments to simulate an industrial facility has been completed at WRI. WRI has fabricated the "roughness grid," using the data from the site and the bibliography. Future research needs of current related programs are being met through data provided to the data

base from instrumented array(s) installed at designated distances from the CO₂ release source in the EPA-PERF-WRI experiments.

Bibliography and Documents Archival

- The spill bibliography has been updated continually, as WRI maintains a clearinghouse for spill test facility related data.
- The bibliography activity has been further defined.
- Citations are being accumulated for the bibliography with the intent of publishing and distributing them as widely as possible so that the papers may be read by industry.
- Copies of reports, published and unpublished, have been collected.
- Publications received from the Health and Safety Executive of Great Britain or any other international organizations as a result of an exchange arrangement are being incorporated.

Figure 1. National Spill Test Data Base Work Flow Diagram

TASK 4.0 APPLIED ENERGY SCIENCE

SUBTASK 4.1

HEAVY OIL/PLASTICS CO-PROCESSING

Frank Guffey
F. Alan Barbour

May – July 1995

OBJECTIVES

The project objectives are to:

- perform a series of experiments to collect data from a bench-scale reactor designed to duplicate heavy oil/plastics co-processing at a smaller scale; and
- perform a preliminary evaluation of the concept.

QUARTER OBJECTIVES

The objective for this quarter was to complete the physical upgrade of the reactor system, contingent on the delivery of the necessary supplies and equipment to complete the activity.

ACCOMPLISHMENTS

The physical upgrade of the bench-scale reactor system has been completed. This activity includes:

- modification of the reactor vessels;
- installation of all piping;

- installation and wiring of all thermocouples and controllers; and
- installation and wiring of the pump, timers, and solenoid valves.

In addition, the cold flow tests have been completed. The cold flow tests verified operation of the pump, solenoid valves, and timers.

ACTIVITIES FOR NEXT QUARTER

The activities for next quarter will be:

- to conduct the hot flow tests to demonstrate the operation of the bench-scale reactor at operating temperatures; and
- to begin the experiments for coprocessing waste plastics with a heavy oil.

PROCEDURES

The procedure for the cold flow tests was to operate the bench-scale reactor at ambient temperature to test the operation of the fluid handling capabilities of the unit. The heavy oil was pumped through the unit and the displacement of oil was measured to calibrate the pump.

RESULTS

The fluid handling capabilities of the bench-scale reactor worked well at ambient temperatures; no major problems were encountered. The pumping rate for the pump at ambient temperature (with no back pressure) is 0.98 L/min (0.26 gal/min). This is about twice the specification of the pump, but the pump specifications are at 1.72×10^5 pascals (25 psi) back pressure. The higher-than-specification flow rate will not affect operation of the bench-scale reactor because it was planned to circulate the oil from the solubilization tank, through the pump, and back into the solubilization tank. The heavy oil plastics feed solution will be fed to the reactors by operation of a pair of solenoid valves that will close the flow back to the solubilization tank and open flow to the reactors. There is sufficient flexibility in the control timer to deliver approximately one gallon per hour to the reactors.

SUBTASK 4.2

FOSSIL FUEL AND HYDROCARBON CONVERSION USING HYDROGEN-RICH PLASMAS

Francis P. Miknis
Will Grimes

May – July 1995

OBJECTIVE

The objective of this subtask is to develop an innovative, noncatalytic method for directly converting fossil fuel materials to hydrogen-rich fuels while simultaneously reducing the heteroatom contents.

ACCOMPLISHMENTS

There was no activity on this subtask during the quarter.

ACTIVITIES FOR NEXT QUARTER

Activities next quarter include an investigation into the effects of an inhomogeneous magnetic field on microwave desulfurization.

PROCEDURES

Fossil fuel hydrocarbon materials are exposed to microwave-generated plasmas to produce improved hydrogen-rich liquid fuels. Experiments are conducted on heavy crude oils and resids with plasmas generated from hydrogen and methane. Experiments are conducted in a pressure range of 0 to 10 torr, flow rates of 0 to 10 cc/min, and variable microwave power of up to 200 watts (joule/sec). Produced and distilled liquids are trapped in a dry ice/methanol bath; gases are analyzed by GC. Simulated distillations and GC/MS and NMR analyses are made on the liquid products from selected experiments to determine the extent of hydrogenation, methanation and heteroatom removal that results from exposure to different plasmas under various conditions.

TASK 6.0 REMEDIATION

SUBTASK 6.1

NORTH SITE REMEDIATION

Norm Merriam

May – July 1995

OBJECTIVES

The overall objectives of this subtask are to clean up the WRI north site in a cost-effective and environmentally sound manner. The objectives for the individual phases are:

Phase I - Definition of Waste Streams

Phase II - Disposal of Hazardous Wastes

Phase III - Disposal of Nonhazardous Wastes

Phase IV - Sampling of Soil and Removal of Buried Wastes

Phase V - Decontamination and Removal of Equipment

Phase Va - Groundwater Monitoring

QUARTER OBJECTIVES

Our objectives for this quarter were to:

- send out bids to dismantle the 9.1-tonne (10-ton) retort and begin this activity;
- remove the above-ground portions of the foundations of the 136-tonne (150-ton) retort; and
- evaluate the results of second groundwater sampling.

ACCOMPLISHMENTS

- **Phase I** is complete.
- **Phase II** is about 99% complete. A draft of the final topical report was submitted to DOE in June.
- **Phase III** is about 95% complete. Soil from berms for shale oil storage tanks was spread in May. Surfaces from disturbed areas were seeded with native grasses. Most seeded areas are growing nicely.
- **Phase IV** is complete.
- **Phase V** is about 85% complete. The above-ground portion of the foundation of the 136-tonne (150-ton) retort were removed. A contractor was selected, and dismantling of the 9.1-tonne (10-ton) retort started in July.
- **Phase Va - Groundwater Monitoring** is about 65% complete. Analyses of the second quarterly set of water samples show no problems with groundwater. Concrete pads were poured at wellheads for monitoring wells to prevent intrusion of groundwater.
- Monthly reports are submitted.
- Topical reports are prepared as phases are completed.

ACTIVITIES FOR NEXT QUARTER

- The third quarterly set of water samples will be collected in August.
- Dismantling of the 9.1-tonne (10-ton) retort will continue.

SUBTASK STATUS REPORT

Contract No: DE-FC21-93MC30126
 Client: U.S. Department of Energy
 Contract Start: February 2, 1993
 Contract Complete: February 1, 1998
 Subtask Manager: Johnson, L.
 Description: Subtask 1.2 - Miscible-Immiscible Gas Injection Processes

CUMULATIVE ACCRUED EXPENDITURES (\$)

	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Approved Budget	150,000	185,000	220,000	254,500
Expenditures	4,507	4,711		
Remaining Budget	249,993	249,789		

EXPENDITURES VERSUS APPROVED BUDGET

Milestones		Planned	Actual	Progress	Scheduled	Delivered
95-1.2	Miscible/Immiscible Processes					
95-1.2A	Experimental Plan				▽	
95-1.2B	Topical Report					▽

Timeline: Feb 1, May 1, Aug 1, Nov 1, Feb 1, 1995, 1996

SUBTASK STATUS REPORT

Contract No: DE-FC21-93MC30126
 Client: U.S. Department of Energy
 Contract Start: February 2, 1993
 Contract Complete: February 1, 1998
 Subtask Manager: Bland, A.
 Description: Subtask 3.1 - Solid Waste Management

CUMULATIVE ACCRUED EXPENDITURES (\$)

	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Approved Budget	35,500	70,500	105,500	139,500
Expenditures	56,567	78,512		
Remaining Budget	82,933	60,988		

EXPENDITURES VERSUS APPROVED BUDGET

SUBTASK STATUS REPORT

Contract No: DE-FC21-93MC30126
 Client: U.S. Department of Energy
 Contract Start: February 2, 1993
 Contract Complete: February 1, 1998
 Subtask Manager: Brown, T.
 Description: Subtask 3.2 - Remediation of Contaminated Soils (Haz-Flote)

CUMULATIVE ACCRUED EXPENDITURES (\$)

	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Approved Budget	40,500	81,000	121,500	162,500
Expenditures	25,315	58,084		
Remaining Budget	137,185	104,416		

EXPENDITURES VERSUS APPROVED BUDGET

SUBTASK STATUS REPORT

Contract No: DE-FC21-93MC30126
 Client: U.S. Department of Energy
 Contract Start: February 2, 1993
 Contract Complete: February 1, 1998
 Subtask Manager: Bland, A.
 Description: Subtask 3.3 - Syn-Ag Process: Coal Combustion Ash Management Option

CUMULATIVE ACCRUED EXPENDITURES (\$)

	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Approved Budget	21,500	44,500	66,500	90,500
Expenditures	17,838	21,447		
Remaining Budget	72,662	69,053		

EXPENDITURES VERSUS APPROVED BUDGET

SUBTASK STATUS REPORT

Contract No: DE-FC21-93MC30126
 Client: U.S. Department of Energy
 Contract Start: February 2, 1993
 Contract Complete: February 1, 1998
 Subtask Manager: Brown, T.
 Description: Subtask 3.4 - Maxi-Acid Process: In-Situ Amelioration of Acid Mine Drainage Problems

CUMULATIVE ACCRUED EXPENDITURES (\$)

	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Approved Budget	42,500	84,000	125,500	164,500
Expenditures	17,880	26,356		
Remaining Budget	146,620	138,144		

EXPENDITURES VERSUS APPROVED BUDGET

SUBTASK STATUS REPORT

Contract No: DE-FC21-93MC30126
 Client: U.S. Department of Energy
 Contract Start: February 2, 1993
 Contract Complete: February 1, 1998
 Subtask Manager: Guffey, F.
 Description: Subtask 4.1 - Heavy Oil/Plastics Coprocessing

CUMULATIVE ACCRUED EXPENDITURES (\$)

	Quarter 1	Quarter 2	Quarter 3	Quarter 4
Approved Budget	40,000	82,000	124,000	164,500
Expenditures	28,110	60,119		
Remaining Budget	136,390	104,381		

EXPENDITURES VERSUS APPROVED BUDGET

Milestones	Planned	Actual	Progress	Scheduled	Delivered
95-4.1 Heavy Oil/Plastics Recycling					
95-4.1A Topical Report					

Feb 1 May 1 Aug 1 Nov 1 Feb 1
 1995 1996

CONTRACT STATUS REPORT

Contract No:	DE-FC21-93MC30126
Client:	U.S. Department of Energy
Contract Start:	February 2, 1993
Contract Complete:	February 1, 1998
Reporting Period:	Year 3

CUMULATIVE ACCRUED EXPENDITURES (\$)

	<u>Quarter 1</u>	<u>Quarter 2</u>	<u>Quarter 3</u>	<u>Quarter 4</u>
Approved Budget	976,000	976,000	976,000	976,000
Expenditures (Cumulative)	150,217	250,229	—	—
Remaining Budget	825,783	725,771	—	—

EXPENDITURES VERSUS APPROVED BUDGET

CONTRACT STATUS REPORT
 Contract No. DE-FC93MC30126
 Contract Start: February 2, 1993
 Contract Complete: February 1, 1998
 Reporting Period: Through 2nd Quarter, 3rd Year

Subtask	Budget Prior years	Budget Yr 3	Total Budget	Expenses to 4/30/95	Expenses			Total Expenses	Balance
					May	June	July		
Current Year Subtasks									
1.2	0	254,500	254,500	4,507	169	35	0	4,711	249,789
3.1	552,498	139,500	691,998	487,943	7,786	9,860	4,299	509,887	182,111
3.2	279,574	162,500	442,074	218,635	5,332	11,023	16,414	251,404	190,670
3.3	93,021	90,500	183,521	48,365	1,736	2,082	790	52,974	130,547
3.4	66,557	164,500	231,057	67,275	3,056	4,466	954	75,751	155,306
4.1	113,782	164,500	278,282	142,644	8,673	12,246	11,090	174,653	103,629
Subtotals	1,105,432	976,000	2,081,432	469,358	26,752	39,712	33,547	1,069,380	1,012,052
2nd Year Subtasks									
1.1	471,163	0	471,163	389,536	6,257	11,505	11,513	419,311	51,852
1.4	588,275	0	588,275	370,634	16,428	15,157	14,417	416,636	171,639
2.1	127,835	0	127,835	97,640	0	18	0	97,658	30,177
2.5	66,145	0	66,145	31,924	3,274	3,343	2,542	41,083	25,062
2.6	108,405	0	108,405					0	108,405
3.5	186,539	0	186,539	201,693	(43,648)	(13,466)	2,892	147,470	39,069
3.6	16,400	0	16,400					0	16,400
4.2	81,447	0	81,447	69,011	1,858	208	0	71,077	10,370
6.1	1,432,908	0	1,432,908	955,424	30,384	23,039	14,776	1,023,633	409,275
Subtotals	3,079,117	0	3,079,117	2,115,862	14,533	39,804	46,140	2,216,868	862,249
Other ⁽¹⁾	948,359	0	948,359	751,367	1,628	300	0	752,766	195,593
Totals	5,132,908	976,000	6,108,908	3,836,599	42,913	79,816	79,686	4,039,014	2,069,894

⁽¹⁾ Completed or carryover subtasks

CONTRACT STATUS REPORT

Contract No: DE-FC21-93MC30126
 Client: U.S. Department of Energy
 Contract Start: February 2, 1993
 Contract Complete: February 1, 1998
 Reporting Period: Cumulative Through 2nd Quarter, 3rd Year

APPROVED BUDGET

<u>Year 1 (3/93)</u>	<u>Year 1 (12/93) Cleanup</u>	<u>Year 2 (4/94)</u>	<u>Year 2 (9/94) Cleanup</u>	<u>Year 3 (2/95)</u>
\$ 1,950,000	\$ 828,000	\$ 1,750,000	\$ 604,908	\$ 976,000

Total Approved Budget: \$ 6,108,908
 Total Expenditures Through 7/95: \$ 4,039,014
 Remaining Budget: \$ 2,069,894

EXPENDITURES VERSUS APPROVED BUDGET

DISCLAIMER

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