TECHNICAL PROGRESS REPORT
for
APRIL TO JUNE 2005
NOVEL CONCEPTS RESEARCH IN GEOLOGIC
STORAGE OF CO₂
PHASE III

THE OHIO RIVER VALLEY CO₂ STORAGE PROJECT

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ABSTRACT

As part of the Department of Energy's (DOE) initiative on developing new technologies for storage of carbon dioxide in geologic reservoirs, Battelle has been investigating the feasibility of CO₂ sequestration in the deep saline reservoirs in the Ohio River Valley region. In addition to the DOE, the project is being sponsored by American Electric Power (AEP), BP, The Ohio Coal Development Office (OCDO) of the Ohio Air Quality Development Authority, and Schlumberger. The main objective of the project is to demonstrate that CO₂ sequestration in deep formations is feasible from engineering and economic perspectives, as well as being an inherently safe practice and one that will be acceptable to the public. In addition, the project is designed to evaluate the geology of deep formations in the Ohio River Valley region in general and in the vicinity of AEP's Mountaineer Power Plant in particular, in order to determine their potential use for conducting a long-term test of CO₂ disposal in deep saline formations.

The current technical progress report summarizes activities completed for the April through June 2005 period of the project. As discussed in the report, the technical activities focused on development of injection well design, initial engineering assessment of CO₂ capture systems, preparing a Class V Underground Injection Control permit, assessment of monitoring technologies, and preparation of a NEPA Environmental Assessment. In addition, work has progressed on reservoir simulations and the risk assessment tasks. Overall, the project is proceeding to pilot demonstration phase, and a strong team has been assembled to accomplish this undertaking.

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EXECUTIVE SUMMARY

This is a Quarterly Technical Progress Report for Contract DE-AC26-98FT40418. It has been prepared in accordance with the requirements of the National Energy Technology Laboratory (NETL). The reporting period for the current document is April through June 2005.

The purpose of this project is to evaluate the geology of deep formations in the Ohio River Valley region and to conduct a long-term test of carbon dioxide injection/storage in deep saline formations at an active power plant site. As discussed in the report, the technical activities focused on development of injection well design, initial engineering assessment of CO₂ capture systems, preparing a Class V Underground Injection Control permit, assessment of monitoring technologies, and preparation of a NEPA Environmental Assessment. In addition, work has progressed on reservoir simulations and the risk assessment tasks. Overall, the project is proceeding to pilot demonstration phase, and a strong team has been assembled to accomplish this undertaking.

1.0 INTRODUCTION

The main objective of this project is to evaluate the geology of deep formations in the Ohio River Valley region and to conduct a long-term test of carbon dioxide injection/storage in deep saline formations at an active power plant site. This work supports the overall project objective of demonstrating that CO₂ sequestration in deep formations is feasible from engineering and economic perspectives, as well as being an inherently safe practice and one that will be acceptable to the public. Following is a description of the progress accomplished for April through June 2005.

2.0 EXPERIMENTAL

Activities undertaken during the reporting period include development of injection well design, initial engineering assessment of CO₂ capture systems, preparing a Class V Underground Injection Control permit, assessment of monitoring technologies, and preparation of a NEPA Environmental Assessment. In addition, work has progressed on reservoir simulations and the risk assessment tasks. Major accomplishments were related to the following topics:

- Development of a reservoir testing plan for the Copper Ridge “b-zone” in the AEP #1 test well. The plan is aimed at assessing storage potential in the Copper Ridge dolomite and confirming long-term storage capacity of the Rose Run sandstone. Personnel and equipment are being assembled for the testing, which is scheduled for September 2005.
- Meetings with AEP to assess design of the pilot scale capture, injection, and storage system. Several suitable locations for a slipstream capture system and pipeline to the injection well were screened during a visit to the Mountaineer plant with an engineering firm and AEP personnel.
- Discussions with several companies to discuss CO₂ capture for the system. In addition to follow-up contacts with MHI, AEP and Battelle have identified contact points at Fluor for development of a pilot capture system.
- Continued work on Class V Underground Injection Control injection permit. The permit has been completed up to final injection and monitoring plans, which are under development.
- Preparation of a NEPA Environmental Assessment. Discussions were held with DOE to finalize the NEPA requirements for the project. Accordingly, an Environmental Assessment was selected and completed documenting the project’s potential environmental impacts, which were concluded to be minor.
- Comprehensive review of CO₂ storage monitoring technologies as they apply to the Mountaineer site. This survey is being completed to aid in development of a monitoring plan.
- Continued work on reservoir simulations and risk assessment. Well over 25 scenarios are being run on reservoir simulations and a FEP risk assessment process is being completed.

3.0 RESULTS AND DISCUSSION

The following sections summarize the major activities and their outcomes for the reporting period under each task of the project.

Task 1 – Geologic Data Assessment

Task 1 includes subsurface geologic assessment in the vicinity of the field site based on pre-existing information. All activities under Task 1 of the Statement of Work have been completed, and Battelle has developed a thorough understanding of the geologic framework for the site for deep saline reservoirs, caprock formations, and coal seams. An Interim Topical Report on the findings was submitted to NETL on August 3, 2003.

Task 2 – Seismic Survey

The main tasks related to the seismic survey have been completed including: design of a survey through injection well site, acquisition of 11 miles of seismic reflection data, processing of the data, interpretation of the results, analysis of the feasibility of seismic monitoring of CO₂ in the region, and reporting. Remaining elements of task 2 pursued during this quarter were continued evaluation of 4-D seismic monitoring costs and logistics. In addition, related monitoring methods such as vertical seismic profile were reviewed to see if they are applicable to this site. As a result of the work completed by WesternGeco and Battelle, a technical note describing modifications to the basic equation used for modeling seismic monitoring of CO₂ in the reservoir has been submitted to Journal of Geophysics for publication. In addition, a platform presentation on the evaluation of seismic monitoring was also made at the 4th National Conference on Carbon Sequestration. During June, a preliminary scope of work was developed to allow WesternGeco to evaluate seismic survey monitoring options for future injection scenarios.

Task 3 – Borehole Drilling and Testing

The primary activities remaining on the borehole drilling and testing consist of additional reservoir testing and completion of a site characterization report as the data and interpretation on individual aspects are completed. A preliminary plan for follow-on reservoir tests was developed. The plan focuses on tests in an isolated portion of the Copper Ridge Dolomite “b-zone” where a significant amount of transmissivity was observed in previous reservoir tests using single packers on large sequential portions of the open borehole. Since the Copper Ridge is a carbonate rock formation, demonstration of storage potential in this unit could establish significant sequestration reserves previously considered unsuitable for sequestration. The plan also involves confirmatory long-term injection tests in the potential reservoirs. Preparation of the draft site characterization report continues as the chapters on individual activities are finalized. The report was reviewed by Battelle’s QA/QC officer and is currently under technical review by AEP and Battelle staff.

Task 4 – Reservoir Simulations

Now that the field characterization has been substantially completed, a series of reservoir simulations with actual injection scenarios to support the permitting, well design, risk assessment, monitoring, and possible full-scale injection were compiled during this quarter. More than 25 scenarios have been identified that incorporate a range of formation parameters, injection pressures, anisotropy, and injection formations. An advanced parallel processing version of the STOMP-CO₂ code has been completed at PNNL so that a larger number of more complex simulations can be run. Given the number of scenarios, the simulations should be completed sometime in fall 2006.

Task 5 – Design the Future Injection and Monitoring Facility and Prepare Regulatory Permits

Activities continue to focus on application of a CO₂ injection system at the Mountaineer site. Battelle continued assessment of various aspects of the design of the capture and injection system in collaboration with AEP, Schlumberger, and other well field specialists.

- A meeting was held in May with AEP personnel at the Mountaineer plant to scout potential locations for a capture facility. In addition, routing of CO₂ pipeline to the injection well was surveyed. Based on the initial assessment, there are several suitable locations for a capture system and pipeline to the injection well. A slipstream capture concept was also tentatively agreed upon at the meeting. Overall, there are no logistical roadblocks to engineering a small pilot-scale system.
- Several different injection well completion designs are being assessed based on engineering, material, and economic feasibility. Figure 1 shows a preliminary schematic design of one of the possible options being considered for the injection system.
- During June, Battelle staff and a representative of Trimeric, an engineering contractor, met with AEP Mountaineer staff to further review potential locations for the pilot CO₂ capture plant. Based on this site visit, several key issues were used to rank possible locations.
- Discussions were continued with several companies to discuss CO₂ capture for the system. In addition to follow-up contacts with MHI, AEP and Battelle have identified contact points at Fluor and Dow for development of a pilot capture system.
- Work on a Class V Underground Injection Control permit for the Mountaineer site continued. The permit has been mostly completed pending final well completion and monitoring specifications. No complications were foreseen in the permitting that could affect the project.
- A NEPA Environmental Assessment was prepared summarizing the potential impacts to human health and the environment presented by the CO₂ capture, injection, and storage project. Conclusions of the EA were that no significant environmental impacts are anticipated from the proposed project. The project is a pilot-scale injection of relatively small volumes of CO₂ in deep rock formations that are isolated from the surface by multiple containment intervals. Extensive monitoring is planned to assess the injection fluid. In addition, several layers of safety are designed into the injection system to prevent accidental release. The project is located at an existing industrial power plant and no major changes are anticipated to the site. The EA report is currently in review by a Battelle NEPA specialist and will be submitted to AEP for review followed by submission to DOE NEPA officials.
- The testing of high sulfur coal samples sent to Mitsubishi Heavy Industry (MHI) has been completed. The results of the testing and an updated basic design for a 30 t/day capture system were presented by Mr. Ishida of MHI in a meeting at Battelle on April 11. The completed results were also summarized in the report received during late April. Based on this, MHI has developed a basic design for the capture system that incorporates additional SO₂ scrubbing using sodium hydroxide, capture, and compression of CO₂. The testing shows that the output CO₂ is essentially food grade. MHI has also made some additional process improvements to further reduce the overall cost. The next step in this effort is to finalize the basic design for the system and also work with other capture technology vendors so that the different systems can be compared. In

addition to follow-up contacts with MHI, contact was made with development of a pilot capture system and other potential vendors were identified (e.g., Dow).

- A comprehensive assessment of monitoring technologies currently available is being prepared to help in selecting the MMV options for the potential future injection phases. The review includes a detailed literature search of existing CO₂ injection facilities (e.g., Sleipner, In Salah, Weyburn, Frio, and the Permian Basin EOR projects) to evaluate the monitoring techniques used at those facilities.

Figure 1. Preliminary schematic of CO₂ capture, injection, and storage system.

Task 6 – Risk Assessment and Stakeholder Interactions

Major stakeholder interaction-related activities included:

- Stakeholder Interactions – A summary of the project was published in the IEA Greenhouse Gas R&D Programme newsletter.
- Risk Assessment – Work was started on using the FEP (Facilities, Events, and Processes) database to determine the risk assessment pathways that may be applicable in the Ohio River Valley Region.

Task 7 – Project Briefings and Meetings

- Presented the project status at the EPA CO₂ Modeling workshop in Houston
- Prepared a project overview poster and a presentation along with proceeding paper on the seismic modeling work for the Fourth Annual Conference on Carbon Capture and Sequestration
- Participated in the Wellbore Integrity Workshop in Houston
- Presented at the Indo-US Forum on CO₂ Sequestration in Hyderabad, India
- Project staff participated in the MRCSP meeting at Alum Creek, Ohio
- Presented a project overview to the Ohio State Auditor and the former Attorney General, Ms. Betty Montgomery

Task 8 – Building the Regional Geologic Framework

Battelle continues to monitor ongoing or planned drilling activity in the region for opportunities to fill gaps in geologic data for deeper formations with the long-term goal of building a geologic framework for potential storage and containment zones in the Ohio River Valley region. We are currently looking at SW New York/NW Pennsylvania/NE Ohio area where drilling is active.

Collaborative Risk Assessment Research with CRIEPI, Japan

Battelle and CRIEPI (Japan's Central Research Institute for Electric Power Industry) have been working on a joint project funded by the Japanese Government. The objective the effort is to obtain data from Mountaineer site and surrounding area for research on CO₂ behavior in rocks shallower than 3000 ft, where CO₂ may move into a gas phase. As part of this effort, drilling of a 3000-ft deep borehole in southeastern Ohio was completed. This drilling was undertaken jointly with Knox Energy, an independent oil and gas company in Ohio, and the well will be converted to a gas well. The field effort included two runs of wireline logging and collection of 300 ft of conventional core from various intervals. The cores and data are being used for laboratory experiments on CO₂-rock interactions and to help understand the geology of the shallow intervals in the Appalachian Basin. The results will be presented in a technical paper.

4.0 CONCLUSION

The project remains on track to complete all major tasks. Overall, the project is proceeding to pilot demonstration phase, and a strong team has been assembled to accomplish this undertaking. During the reporting period substantial progress was made in the planning and design of a pilot-scale CO₂ capture and injection demonstration at the Mountaineer site. As a first-of-a-kind system, this work involves numerous challenges, but a diverse range of resources are being utilized to meet the challenges.

4.1 Future Activities

During the fourth quarter of fiscal year 2005, the major focus of the project will continue on CO₂ injection system design, a detailed design for the capture test facility, and follow-on reservoir testing in the Copper Ridge “b-zone.” Design basis and detailed design for the capture system using MHI technology and at least one other technology supplier will be pursued. Efforts on the injection and monitoring system design will be expanded to include MMV options review and design of a lateral injection system. Modeling and risk assessment methods will be maintained. Site testing and field information will be used to develop a program for the injection phase of the project and discussion of the future pathways with the project sponsors.

5.0 REFERENCES

No references cited.