UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

OFFICE OF
AIR AND RADIATION

June 29, 2012

Mr. Stephen Carpenter
Designated Representative

SECARB Phase III Anthropogenic Test
31.06486 N, 88.18201 W
Mobile County, Alabama

Re: Submission in support of an exemption from 40 CFR Part 98, Subpart RR as a research and development project for Southeast Regional Carbon Sequestration Partnership (SECARB) Phase III Anthropogenic Test in Alabama

Dear Mr. Carpenter:

The United States Environmental Protection Agency (EPA) has reviewed the December 6, 2011 submission and the April 20, 2012 Response to Request for Additional Information by Advanced Resources International, Inc in support of an exemption for SECARB's Phase III Anthropogenic Test in Alabama from 40 CFR Part 98, Subpart RR as a research and development project. EPA approves the exemption of SECARB's Phase III Anthropogenic Test in Alabama from 40 CFR Part 98, Subpart RR, as discussed below.

EPA has determined that the project meets the definition of a "research and development project" at 40 CFR 98.449. In making its determination, EPA considered the submitted information, including the purpose of the project, the planned duration of the project, and the planned amount of CO_2 to be injected. EPA concluded that the duration of the project (April 1, 2012 to April 1, 2015), and estimated injection volume (183,500 tons per year for three years) is consistent with the research purpose of the project which is to test the capability and integrity of saline sandstone reservoir units in the Lower Cretaceous Paluxy formation for safely storing CO_2, and to test various monitoring technologies and reservoir simulators. EPA believes that the monitoring technologies, including the modular borehole monitoring system, spinner surveys, time lapse crosswell seismic surveys and others are being implemented in a novel approach that is consistent with the definition of "research and development project" at 40 CFR 98.449. Furthermore, as noted in the preamble to the final Subpart RR rule, "[s]mall and large-scale projects meeting the criteria for an exemption, such as the current Regional Carbon Sequestration Partnership projects supported by the Office of Fossil Energy at the [Department of Energy], would be considered R&D for the purposes of this exemption from reporting for the duration of the R&D activity".

Therefore EPA approves the exemption of the project at SECARB's Phase III Anthropogenic Test in Alabama from 40 CFR Part 98, Subpart RR. The project is exempted from 40 CFR Part

98, Subpart RR until April 1, 2015, which is the end date of injection for the R&D project as stated in the submission request.

EPA's determination relies on the accuracy and completeness of the information provided in your December 6, 2011 and April 20, 2012 submissions. If any of the information provided by Advanced Resources International, Inc in the aforementioned submissions significantly changes, you must re-submit a request for a research and development project exemption from 40 CFR Part 98, Subpart RR for this project. This decision is appealable under 40 CFR Part 78.

If you have any questions regarding this determination, please write to ghgreporting@epa.gov and a member of the EPA's Greenhouse Gas Reporting Program will respond.

Sincerely,

Anhar Karimjee, Chief
Greenhouse Gas Reporting Branch

Attachment 1- SECARB's Phase III Anthropogenic Test in Alabama Research and Development Exemption Request

Attachment 2 - SECARB's Phase III Anthropogenic Test in Alabama Response to Request for Additional Information

e-GGRT Subpart RR: R&D Project Exemption Request

Facility Information

Facility Name	SECARB Phase III Anthropogenic Test
Address	31.06486 N, 88.18201 W Mobile County AL 00000
Owners and Operators	Denbury Onshore, LLC
Designated Representative	Steven Carpenter Mr.
Alternate Designated Representative	

Submission Information

Submitted By (Date)	Steven Carpenter (December 6, 2011 - 15:24 PM)
Certified By (Date)	Steven Carpenter (December 6, 2011 - 15:24 PM)

Request Details

Name of Project	SECARB Phase III Anthropogenic Test
CO2 Injection (for R&D) Start Date	April 1, 2012
CO2 injection (for R&D) End Date	April 1, 2015
Class of Underground Injection Control permit	Class V
Underground Injection Control permit Start Date	November 22, 2011
Underground Injection Control permit End Date	November 22, 2016
Source and type of funding	This is a federal government funded project through the Office of Fossil Energy at DOE-NETL.
Research Purpose - Include Planned Annual CO2 Injection Volumes	The purpose of the Class V experimental technology injection well(s) is to test the capability and integrity of saline sandstone reservoirs units in the Lower Cretaceous Paluxy Formation for safely storing carbon dioxide (CO2) through a small volume injection research project funded primarily by the US Department of Energy. The CO2 injection wells are critical components of a CO2 storage research project conducted by the U.S. Department of Energy (DOE) Southeast Regional Carbon Sequestration Partnership (SECARB), the Electric Power Research Institute (EPRI) and the Southern Company to demonstrate commercial-scale storage of CO2 captured from an existing coal-fired power plant (SECARB Project). The project represents a major step toward demonstrating the viability of integrating carbon capture and storage to mitigate climate change. A thorough monitoring and verification program will track the movement of the injected CO2 and ensure that it is safely and permanently stored. The results from this research may support a future reduction in the emissions of greenhouse gases into the Earths atmosphere through the demonstration of successful integrated capture and geologic storage of CO2.

CLOSE Window

Advanced Resources
International, Inc.

20 April 2012

Lisa Bacanskas, on behalf of EPA GS Reporting

RE: Subpart RR R&D Project Exemption Request – e-GGRT
Facility Name: SECARB Phase III Anthropogenic Test
Facility Address: 31.06486 N, 88.18201 W, Mobile County AL 00000

Submitted via email to: gsreporting@epa.gov

Dear Ms. Bacanskas,

We are in receipt of your request for further clarification regarding the Subpart RR R&D exemption submittal facility identified above. Pursuant to your request, the following is offered.

Injection volume: What are the planned annual CO2 injection volumes and the total injection volume for the project?

Applicant Response: *Under the research project, it is intended that injection of up to 182,500 tons of CO_2 per year (500 metric tons or 148,000 gallons or approximately 9.6 million cubic feet per day) is planned for up to 3 years. The total maximum for the research project will be 547,500 tons of CO_2.*

Research purpose: EPA requests more detail regarding the research purpose of the research project to better inform our evaluation. The December 6, 2011 submission states that the purpose of the research project is to test the capability and integrity of saline sandstone reservoirs units in the Lower Cretaceous Paluxy formation for safely storing CO_2. The submission also mentions that a thorough monitoring and verification program will track the movement of the injected CO_2 and ensure that it is safely and permanently stored. Are there any monitoring technologies (novel or proven in other applications) that will be tested at the research project?

Applicant Response: *Yes, there are techniques that will be assessed as part of this research project.*

Research purpose: Please describe the research and how it will contribute to safe and effective long-term containment of CO2 in geologic formations. Are there any injection or operational practices that will be tested, validated and verified? If so, describe the research and how it will contribute to safe and effective long-term containment of CO2 in geologic formations.

Applicant Response: *The research project will test a full suite of new and innovative technologies to monitor the CO_2 plume, the resulting pressure increase in the subsurface, and CO_2 leakage. Most of the technologies being tested are experimental and would generate valuable information on emerging monitoring options for future GS projects. These include:*

> ***Modular Borehole Monitoring (MBM) System*** *– The research project will provide the initial field site for the test of the MBM system being developed by Lawrence Berkley National Laboratory and funded by the Carbon Capture Project (an industry lead research collaboration consisting of seven major energy companies and EPRI; http://www.co2captureproject.org/). The purpose of the MBM system and its field test is to engineer a multi-sensor monitoring tool that can be deployed in a deep well for the purpose of making multiple integrated measurements to assess subsurface fluid (CO_2 and brine) movement and detect leakage. The MBM system would include a dedicated seismic geophone array for imaging CO_2 migration, a distributed temperature perturbation array for detecting near-well leakage, down-hole pressure gauge for monitoring the pressure front, and a u-tube reservoir fluid sampling tool for measuring changes in water chemistry and detecting tracers for enhanced reservoir characterization. The MBM system would be deployed in the research project's monitoring well (D-9-8 #2) and would be used to assess changes in inter-well formation saturation with time, sweep efficiency and CO_2-induced changes in the geochemistry of formation fluids. The successful test of this novel MBM system would provide future GS operators with a robust, cost effective monitoring tool to measure the fate and transport of CO_2 in geologic storage reservoirs.*

CO_2 Injection Surveys *– The research project will utilize multiple CO_2 injection survey methodologies (i.e. spinner surveys, temperature surveys, and/or neutron logging) to measure the inflow of CO_2 into the numerous, stacked sandstone units of the Paluxy Saline Formation Injection Zone. Typically, spinner and other surveys are applied in producing wells and not in CO_2 injection wells where the use of these tools is much more challenging. The data from this effort would be used to inform best practices for future GS operators and are key inputs for reservoir simulations.*

Widely Spaced Time Lapse Crosswell Seismic *– The unique "stacked" nature of this GS test presents challenges for CO_2 monitoring. For example, injection into multiple sandstone units less than 50 feet thick presents challenges for some monitoring technologies such as time-lapse surface seismic. As such, the research project would test the applicability of using alternative high precision, down-hole time-lapse seismic methods at progressively wider spacing for monitoring and tracking the CO_2 plume. Crosswell seismic would be attempted between the research project's primary injection well (Injection Well #1 - D-9-7 #2) and the research project's monitoring well (D-9-8 #2). These wells would be located approximately 1,000 feet apart, which extends the current distance limit for using detailed crosswell seismic for monitoring of CO_2. In addition, offset and walk-away vertical seismic profile (VSP) surveys would be performed utilizing the seismic array deployed as part of the MBM. If the results of the seismic surveys are successful, then this experiment would provide valuable information to future GS operators on the spacial limits of using crosswell seismic for CO_2 monitoring and a side-by-side comparison of three seismic survey techniques that have different accuracies and resolutions.*

CO_2 Tracers *– The efficient and reliable utilization of tracers added to injected CO_2 is still an emerging, experimental technology. The degree to which tracers partition between the CO_2 and the reservoir's components (liquid, gas, and solid*

phases) is unknown and field data on this phenomenon would be valuable in determining the use of tracers as a CO_2 monitoring tool. The research project would add tracers to the injected CO_2 and track the movement of the tracers and the CO_2 using the u-tube monitoring tool. Data on the performance of different CO_2 monitoring tracers and the frequency of taking bottom hole samples in tracking CO_2 would be useful to future GS operators in determining the best available tracer and sampling technology.

***Comparison of Groundwater Sampling Methodologies** – Groundwater sampling and analyses are an integral component of evaluating formation geochemistry and detecting CO_2 leakage. Groundwater monitoring is expected to play a significant role in satisfying regulatory requirements for geologic storage of CO_2 and data comparing different monitoring methodologies are currently lacking. The research project will deploy different sampling technologies (e.g., u-tube, gas-lift, pumping and wireline sampling) in the research project's monitoring well (D-9-8#2) to evaluate the impact that sampling methodology has on groundwater quality, caused by sample depressurization during deep well sampling. A technical comparison of the analytical results and the economics of each sampling method would be evaluated during the study and would be useful to future GS operators in determining the best available sampling methodologies.*

***Reservoir Simulators as Monitoring Tools** – The large amount of monitoring data would be used to calibrate the state-of-the-art compositional reservoir simulator to be used by the research project for predicting reactive transport of CO_2 in the subsurface, including the mobilization of metal and organic constituents, the potential for early-time mineralization of the CO_2 and the extent of "pore space" trapping in this type of saline formation. The duration of the injection test (up to three years of injection with up to three years of post-injection monitoring), would allow the research project to calibrate the compositional reservoir simulation multiple times, improving the model's ability to predict the behavior of CO_2 in the subsurface. The outcomes of these experiments would*

inform future GS operators on the state of current simulators and the major uncertainties in CO_2 plume prediction.

In addition to the extensive efforts on testing new, novel CO_2 monitoring tools and methodologies, the research project also has several research objectives that would lead to more efficient and safer CO_2 injection and storage practices, as follows:

Innovative CO_2 Injection Well Designs and Injection Practices. *The research project would test the following set of experimental well construction and operating designs at the GS test site:*

Limiting the Areal Extent (AOR) of the CO_2 Plume. *Left to nature, the injected CO_2, being less dense than saline water, would gravitate to the top of the formation and move, as a thin interval, far from the CO_2 injection well creating a large Area of Review (AOR). In practice, the larger the AOR, the more potential exists for intersecting potential geological features or abandoned wells that could lead to CO_2 leakage. Therefore, a smaller plume size and subsequent limited AOR would minimize the potential for CO_2 leakage. The "stacked" nature of the Paluxy sandstone units provides an outstanding reservoir setting for testing the concept of efficiently using reservoir architecture to limit the areal extent of the CO_2 plume. In addition, this new design concept, if proven workable, would also help optimize the utilization of the highest quality GS sites where multiple "stacked" storage zones are likely to exist. However, without linking well completion design to the reservoir architecture, these benefits would not be realized. The research project will investigate multiple well completion strategies in order to achieve and optimize the "stacked" CO_2 plume concept to produce the minimal achievable AOR. The results of this novel method would inform future GS operators on optimal injection operations to minimize the areal extent of CO_2 plumes.*

Integrating Reservoir Modeling, CO_2 Monitoring and Well Design to Verify the Optimized AOR Concept. *To verify the CO_2 injection concept discussed*

above, the research project will use a full array of CO_2 monitoring technologies (discussed above) plus state-of-the-art compositional reservoir simulation to guide our design of the CO_2 injection strategy to optimize the AOR. These simulation results would also be used to tune the research project's CO_2 monitoring program. The results of this effort would inform future GS operators on modeling best practices for injection design.

Understanding the Challenges of Conducting CO_2 Injection Coupled with CO_2 Capture. *The unique integrated nature of the research project - where CO_2 would be supplied by an experimental post-combustion capture unit at a coal-fired power plant -will generate valuable new data on the effects of CO_2 supply interruptions (due to forced and planned plant outages) on the GS portion of the test. Changes in CO_2 injection rate and pressure, caused by dynamic changes in capture plant operations, would present unique challenges to the injection operations and CO_2 monitoring efforts. The information from this set of experiments would provide valuable data for future commercial-scale GS operators.*

Research purpose: Will the GS project result in any published research or public engagement? If so, please provide the proposed plans for disseminating the research results to the broader community.

Applicant Response: *Yes, the research will result in the dissemination of public domain knowledge. This research is funded by DOE and as part of that research, a public dissemination is required. The research project will be written up in technical papers presented at conferences. The information will become the property of DOE, which will distribute knowledge gained to the general public. Lastly, the research team is participating in the SECARB-Ed public outreach forum to ensure that the valuable knowledge gained from this research is shared with the community at large.*

Should you have any questions or require any additional information, please feel free to contact me at your convenience.

Sincerely,

Advanced Resources International, Inc.

Steven M. Carpenter
Vice President

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