PRE-OPERATIONAL TESTING PROGRAM
40 CFR 146.87
GULF COAST SEQUESTRATION
PROJECT GOOSE LAKE

Contents

1.0 Facility Information

Facility name: Project Goose Lake
Well Numbers 1 and 2

Facility contact: Benjamin Heard, Principal
2417 Shell Beach Drive, Lake Charles, LA 70601
(713) 320-2497; bheard@gcscarbon.com

Well location: (bottom hole) Calcasieu and Cameron Parish, Louisiana – Datum WGS84 [redacted]

2.0 Introduction

[redacted]

The proposed Injection Zone, the Upper Frio Formation, consists of over 1,200 ft thick interbedded sands and shales. The Confining Zone is the overlying shale-rich Anahuac Formation, which is an extremely low permeability marine shale, around 900 ft thick.

To obtain the necessary permits from the EPA to commence full scale CO_2 injection operations, GCS must first undertake a comprehensive pre-operational data acquisition program across both the injection and confining zones to substantiate geological and reservoir modelling assumptions that form the current basis for well construction, injection rates, injection volumes, CO_2 migration (and associated pressure pulse) and surface facilities designs.

This data acquisition document is for the first well drilled in the program [redacted] which will have exhaustive data collection and analysis according to the guidance given in EPA 816-R-13-004. These data will be used to reduce uncertainties and validate/update geologic models and validate/update reservoir engineering/simulation inputs. [redacted]

3.0 Pre-Injection Testing Plan – Injection Well 1

[redacted] The pre-operational testing plan is identical in both injectors, with the exception being the cutting of conventional core samples, discussed further in Section 3.3.3.1.

Both injection wells are anticipated to reach total depth (TD) with three hole intervals (see Figures 3.0-1 and 3.0-2). [redacted]

Data acquisition is not performed in the conductor hole.

[redacted]

[redacted]

[redacted]

3.1 Deviation Checks

Deviation measurements will be conducted approximately every 500 ft while drilling surface hole, and approximately every 100 ft during construction of the remainder of the well.

3.2 Tests and Logs Performed During Drilling

3.2.1 Logging Summary and Data Reporting

Logs will be run, surveys conducted, and tests performed to determine/verify the depth, thickness, porosity, permeability, lithology, and chemistry of any formation fluids in all relevant geologic formations:

1. Upper Frio Formation (Injection Zone)
2. Anahuac Formation (Confining Zone)

3. Miocene interval (Secondary Confining Zone)
4. Base of the lowermost underground source of drinking water (USDW)

3.3 Data Acquisition

[redacted] the logs and other downhole tools run, and the approximate combination in which they will be run, as well as the technical information that the tools will deliver.

3.3.1 Conductor Hole Interval

[redacted]

3.3.2 Surface Hole Interval

[redacted]

3.3.2.1 Surface Hole Logging

[redacted]

[redacted]

3.3.3 Injection Hole Interval

[redacted]

3.3.3.1 Coring

[redacted]

[redacted]

[redacted]

[redacted]

3.3.3.1.1 Confining and Secondary Confining Zone – Injector Well No.1

[redacted]

3.3.3.1.2 Injection Zone – Injector Well No.1

[redacted]

3.3.3.1.3 Lower Confining Zone

[redacted]

3.3.3.2 Rotary Sidewall Core Acquisition

[redacted]

3.3.3.3 Core Analysis

[redacted]

3.3.3.3.1 Confining Zone Rock Strength

[redacted]

3.3.3.3.2 Geochemical analysis and modeling

[redacted]

[redacted]

3.3.3.3.3 Optional Analyses

[redacted]

3.3.3.3.4 Reporting

[redacted]

3.3.3.4 Logging

[redacted]

Finally, if log analysis reveals either Upper Frio (Injection Zone) or Anahuac Formation [redacted]

[redacted]

3.3.3.4.1 Reporting

Report results will be used to update the model and to modify data collection programs in successive wells. After the conclusions of drilling, GCS will prepare a report that includes an interpretation of the results of the logs. The report will be in electronic format and will include:

- The date and time of each test, the date of wellbore completion, and the date of installation of all casings and cements
- Chart (graphical) results of each log and any supplemental data
- The name of the logging company and log analyst and information on their qualifications
- Interpretation of the well logs by the log analyst, including any assumptions, determination of porosity, permeability, lithology, thickness, depth, and formation fluid salinity of relevant geologic formations
- Any changes in interpretation of site stratigraphy based on formation testing logs

The results of the fluid analyses will help reduce uncertainty, improve the model, and define the AoR. Documentation guidelines will be followed. When this phase of work is complete, the following information will be submitted:

1. Type of sampling equipment used and field procedure
2. If the sample was pumped, flow rate, type of pump, location of the pump, and geochemical modeling results indicating the likely geochemical makeup of the fluids at downhole conditions
3. Data for field measurements (pH, SC, temperature, pressure)
4. Laboratory results, including QA samples
5. Notes on any anomalous data

3.3.3.5 Fracture Pressure

3.3.3.5.1 Acquisition

[redacted]

[redacted]

3.3.3.5.2 Reporting

[redacted]

3.4 Tests and Logs Performed During and after Casing Installation

3.4.1 Surface Hole Interval Logging and Testing

[redacted]

[redacted]

3.4.2 *Injection Hole Interval Logging and Testing*

[redacted]

[redacted]

3.4.3 Demonstration of mechanical integrity

Table 3.4.3-1 provides a summary of the pre-operational tests to be performed on the Injection Well 1 prior to injection. Gulf Coast Sequestration will notify EPA least 30 days prior to conducting the test and provide a detailed description of the testing procedure. Notice and the opportunity to witness these tests/logs shall be provided to EPA at least 48 hours in advance of a given test/log.

This work will be conducted in Injector Wells No. 1 and 2.

3.4.3.1 Hydrogeologic Testing

[redacted]

3.4.3.1.1 Pressure Fall-Off Test

[redacted]

3.4.3.1.2 Pump Test or Injectivity Test

[redacted]

[redacted]

[redacted].

3.4.3.2 Reporting

Documentation guidelines will be followed by submitting the requested information at the conclusion of testing. Data submitted for both the fall-off test and injectivity or pump test include:

- Raw pressure data
- Flow data from the injection part of the test. For the Injectivity or pump test, include rates and times
- Test parameters (injection time, shut-in time, fluid viscosity, temperature, wellbore diameter, pressure gauge type and location)
- Semi-log plots used for data analysis
- Parameters calculated from the analysis
- Discussions of the results, including data quality and any anomalous values

3.4.3.3 Fiber Optic Cable Installation

[redacted]

4.0 Pre-Injection Testing Plan – Deep Monitoring Well TBD

[redacted]

4.1 Deviation Checks

Deviation measurements will be conducted approximately every 500 ft while drilling surface hole, and approximately every 1,000 ft during construction of the remainder of the well if the monitoring well happens to be vertical. Deviated Monitoring wells will have deviation checks approximately every 100 ft when drilling below surface hole.

4.2 Tests and Logs

4.2.1 To be performed during drilling

[redacted]

[redacted]

4.2.2 To be performed during and after casing installation

[redacted]

4.2.3 Demonstration of mechanical integrity

Table 4.2.3-1 provides a summary of the MITs to be performed on the deep monitoring well(s), after installation and prior to commencing CO_2 injection operations.

4.2.3.1 Pre-Operational Testing Schedule, In-Zone wells

[redacted]

[redacted]

4.2.3.2 Fiber Optic Cable Installation

[redacted]

5.0 Annulus Pressure Test Procedures for Injection Well No. 1

The injection tubing and packer will be installed. The packer seal against the long string casing wall will be tested by applying pressure to the annulus between the casing and injection tubing above the packer; the test (second test) will be charted to record that no leakage occurs. In addition, the fiber optic cable attached to the outside of the long string casing will be able to monitor the temperature along the entire length of the casing (distributed array temperature) and will detect any leakage by showing a temperature change at the leak point. A tubing plug will be installed in an internal profile seat near the bottom of the tubing string, and pressure will be applied above it to test (third test) the tubing integrity. Test pressure will not exceed 80% of the tubing burst rating.

These three pressure tests satisfy the requirements of 40 CFR 146.89(a)(1), with the first test occurring shortly after the well is drilled and the other two tests (packer and tubing) after all permits for injection have been obtained and the injection well has been completed.

Gulf Coast Sequestration LLC will notify EPA least 30 days prior to conducting these tests and provide a detailed description of the testing procedure. Notice and the opportunity to witness these tests/logs shall be provided to EPA at least 48 hours in advance of a given test/log.

6.0 Annulus Pressure Test Procedures for Monitoring Well TBD

Similar to the Class VI injection well, the In-Zone monitoring well will have tubing and a packer set inside the long string casing. The packer seal against the long string casing wall will be tested by applying pressure to the annulus between the casing and injection tubing above the packer; the test will be charted to record that no leakage occurs.

7.0 Pressure Fall-Off Test Procedures:

A short-term injection/falloff test will be performed to analyze reservoir permeability, determine injection potential, and evaluate skin damage (completion efficiency) of the wellbore for each well. The initial test will provide a baseline standard for each well to measures the effects of CO_2 injection into the near wellbore. Subsequently, a pressure falloff test will be performed every five years or more frequently if required by the UIC Program Director [40 CFR 146.90(f)]. All this information will help improve the model and provide learnings for future data collection.

A falloff test is conducted by a long period of injection, followed by a long period of well shut in. Pressures are monitored prior to injection, during injection, and the observed drop of time period until the formation reaches the initial static pressures. The test will be designed in accordance with the USEPA Region 6 UIC Pressure Falloff Testing Guidance (Third Revision – August 8, 2002). The wells will be shut-in for a sufficient period to allow for static conditions (*i.e.,* no injection prior to test). Two gauges will be installed downhole at the injection interval to obtain the initial bottomhole pressure. Continuous injection will occur at a steady pre-defined rate for an acceptable duration to produce a measurable pressure transient that will produce a falloff test. The gauges downhole will monitor the flowing bottomhole pressures. The well will be shut in at the wellhead (to minimize wellbore storage effects). The pressure falloff will be monitored until the well reaches radial flow (pressure response for the reservoir) and a final bottomhole pressure is measured. Note, no injection will occur from offset wells during the pressure falloff tests. The injection will be isolated to the well actively being tested.

In performing a falloff test analysis, a series of plots and calculations will be prepared to QA/QC the test, identify flow regimes, and determine well completion and reservoir parameters. It will also be used to compare formation characteristics such as transmissivity and skin factor of the near-wellbore for changes over time. Skin effects due to drilling and completion (possible damage from perforation) will be assessed for the wells injectivity and potential well cleanouts in the future. These tests can also measure drops in pressure due to potential damage/leakage over time. In CO_2, it is anticipated that pressure drops may indicate multiple fluid phases. The analysis will be designed to consider all parameters.

Reports will be submitted to the EPA within 30 days of the test [40 CFR 146.91 (e) and 146.91 (b)(3)].

8.0 References

- Schlumberger, 2016 https://www.slb.com/resource-library/case-study/co/intellizone-compact-usdoe-cs
- Schlumberger, 2021 Fiber-Optic Borehole Seismic Solution Records VSP Using Cemented Fibers in Well Completions (slb.com)
- Underground Injection Control (UIC) Class VI Well Site Characterization Guidance 2013
- (USEPA, 2002): U.S. Environmental Protection Agency, Region 6, UIC Pressure Falloff Testing Guideline, Third Revision, August 8, 2002