Application Number: 45054
Plan Revision: December 2025

Certified 12/1/2025 by:
Lonquist Sequestration, LLC
Louisiana Firm No. EF7423

Ben H. Bergman P.E.

STATE OF LOUISIANA
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ATTACHMENT D

CONSTRUCTION DETAILS

1. FACILITY INFORMATION

Facility name: River Parish Sequestration – RPN 1

Facility contact: Andrew Chartrand, VP, Regulatory and Environmental
1333 West Loop South, Suite 810, Houston, TX 77027
832-696-0052, andrew.chartrand@blueskyinfrastructure.com

Well name/location:

Well Name	Parish/State	Latitude (NAD27)	Longitude (NAD27)
RPN-1-INJ	Ascension, LA	30° 6' 9.04" N	91° 3' 45.37" W

RPN-1-INJ Area Monitoring Wells:

Well	Latitude (NAD27)	Longitude (NAD27)
RPN-1-AZ	30° 6' 9.42" N	91° 3' 44.97" W
RPN-1-WS1	30° 6' 30.32" N	91° 3' 16.35" W
RPN-1-WS2	30° 5' 45.04" N	91° 3' 34.04" W
RPN-1-WS3	30° 6' 10.34" N	91° 4' 19.84" W

Additional Injection Wells in the North Fairway (not included in this permit):

Well	Parish/State	Latitude (NAD27)	Longitude (NAD27)
RPN-2-INJ	Assumption, LA	30° 2' 9.29" N	91° 0' 53.87" W
RPN-3-INJ	Assumption, LA	30° 4' 12.66" N	91° 4' 40.73" W
RPN-4-INJ	Iberville, LA	30° 4' 22.53" N	91° 7' 12.60" W
RPN-5-INJ	Iberville, LA	30° 4' 31.68" N	91° 9' 7.70" W

The construction details for the following wells are described in this attachment:

- New injection wells:
  - RPN-1-INJ
- Monitoring wells:
  - RPN-1-AZ
  - RPN-1-WS1
  - RPN-1-WS2
  - RPN-1-WS3

2. WELL CONSTRUCTION DETAILS – RPN-1-INJ

The well construction diagrams for injection well RPN-1-INJ are shown in **Figures 2-1** and **2-2. Tables 2-1, 2-2, 2-3,** and **2-4** show the respective well construction details. **Appendix 2-1** details the drilling procedures for RPN-1-INJ.

Table 2-1. Open Hole Diameters and Intervals – RPN-1-INJ

Name	Depth Interval feet (ft) Total Vertical Depth	Open Hole Diameter (in.)	Comment	Cement	
				Lead	Tail
Conductor	Refusal[1]	20	Drive Pipe	None	None
Surface	0 – 2,800	17-1/2	New drilled hole and casing to depth below USDW	Yield (cu.ft/sk): 1.6 Sacks: 465 Depths[3]: 0-600 Portland Cement	Yield (cu.ft/sk): 1.03 Sacks[4]: 2995 Depths[3]: 600-2,800 Portland Cement
Tapered Production String[2] Section 1 (Upper)	0 – 3,830	12-1/4	New drilled hole and casing	Yield (cu.ft/sk): 1.6 Sacks: 777 Depths[3]: 0-3,556 CorrosaCem Reduced Portland Cement or Equivalent	Yield (cu.ft/sk): 1.13 Sacks: 95 Depths[3]: 3,556-3,830 CorrosaLock or Equivalent Acid-Resistant Cement
Tapered Production String[2] Section 2 (Galvanic Crossover)	3,830 – 4,640	12-1/4	New drilled hole and casing	None	Yield (cu.ft/sk): 1.13 Sacks: 281 Depths[3]: 3,830-4,640 CorrosaLock[5] or Equivalent Acid-Resistant Cement
Tapered Production String[2] Section 3 (Crossover and Injection Interval)	4,640 – 10,385	10-3/4	New drilled hole and casing	None	Yield (cu.ft/sk): 1.13 Sacks[4]: 2313 Depths[3]: 4,640-10,385 CorrosaLock[5] or Equivalent Acid-Resistant Cement

1. Refusal, or ~200 blows per foot of advancement via hydraulic ram.
2. The Tapered Production String is one continuous (mono-bore) string and refers to the 9-5/8” outer diameter casing string that crosses over to 7” (outer diameter). The crossover from 9-5/8” to 7” occurs from 4,640’ to 4,660’ total vertical depth. For simplicity, it is broken up into three sections that represent the significant construction specifications for each casing grade.
3. Depth interval in feet measured depth for the lead or tail section of cement in the corresponding casing interval.
4. Includes cement for the casing shoe track
5. CorrosaLock is a resin blend cement designed specifically for CO_2 applications. It is acid resistant with low permeability to provide chemical resistance to CO_2 degradation.

ft = feet; in. = inches; cu.ft/sk = cubic feet of cement volume per sack

Table 2-2. Casing Specifications – RPN-1-INJ

Name	Depth Interval feet (ft) Total Vertical Depth	Outside Diameter (in.)	Inside Diameter (in.)	Weight (ppf)	Grade (API)	Design Coupling (Short or Long Threaded)	Thermal Conductivity (W/m / deg-C)	Burst Strength (psi)	Collapse Strength (psi)	Tensile Strength (pounds)
Conductor (Drive Pipe)	Refusal[1]	20	18.75	129.33	X-42	Welded	45	2,360	1,300	1,598,000
Surface	0 – 2,800	13-3/8	12.415	68	J-55	BTC	45	3,450	1,950	1,069,000
Tapered Production String[2] Section 1 (Upper)	0 – 3,830	9-5/8	8.681	47	L-80	*VAM TOP	45	6,870	4,760	1,086,000
Tapered Production String[2] Section 2 (Galvanic Crossover)	3,830 - 4,640	9-5/8	8.681	47	CR25 80ksi	*VAM SLIJ-II	26	6,870	4,760	780,000
Tapered Production String[2] Section 3 (Crossover and Injection Interval)	4,640 – 10,385	7.0	6.184	29	CR25 110ksi	*VAM TOP	16	11,540	8,530	929,000

1. Refusal, or ~200 blows per foot of advancement via hydraulic ram.
2. The Tapered Production String is one continuous (mono-bore) string and refers to the 9-5/8” outer diameter casing string that crosses over to 7” (outer diameter). The crossover from 9-5/8” to 7” occurs from 4,640’ to 4,660’ total vertical depth. For simplicity, it is broken up into three sections that represent the significant construction specifications for each casing grade.

*Or equivalent premium connection

ft = feet
in. = inches
ppf = pounds per feet
ksi = kilopounds per square inch
psi = pounds per square inch
API = American Petroleum Institute
VAM = Vallourec & Mannesmann Tubes
BTC = buttress thread and coupling
CR25 = 25-Chromium
W/m / deg-C = Watts per meter per Degree Celsius.

Table 2-3. Tubing Specifications – RPN-1-INJ

Name	**Depth Interval (ft)**	**Outside Diameter (in.)**	**Inside Diameter (in.)**	**Weight (ppf)**	**Grade (API)**	**Design Coupling (Short or Long Threaded)**	**Burst strength (psi)**	**Collapse strength (psi)**	**Tensile Strength** pounds
Injection tubing	0 – 4,620	7	6.184	29	25 Chromium 110 ksi	*VAM TOP	11,540	8,530	929,000

* Or equivalent premium connection.
ft = feet
in. = inches
ppf = pounds per feet
ksi = kilopounds per square inch
psi = pounds per square inch
API = American Petroleum Institute
VAM = Vallourec & Mannesmann Tubes

Table 2-4. Packer Specifications – RPN-1-INJ

Packer Type and Material	**Packer Setting Depth (ft)**	**Length (in.)**	**Nominal Casing Weight (ppf)**	**Packer Main Body Outer Diameter (in.)**	**Packer Inner Diameter (in.)**
Permanent Production Liner Top Packer – 25CR80 with AFLAS sealing elements	~4,620	69.24	29	8.472	6.164

Tensile Rating (lbs)	**Burst Rating (psi)**	**Collapse Rating (psi)**	**Max. Casing Inner Diameter (in.)**	**Min. Casing Inner Diameter (in.)**
165,000	8,077	7,046	8.681	8.681

ft = feet
in. = inches
ppf = pounds per feet
ksi = kilopounds per square inch
psi = pounds per square inch
API = American Petroleum Institute
lbs = pounds

3. WELL CONSTRUCTION DETAILS – RPN-1-AZ

The well construction diagram for well RPN-1-AZ is shown in **Figure 3-1. Tables 3-1,** and **3-2** show the respective well construction details. Tables showing the injection tubing and packer specifications are not provided, as the well does not contain injection tubing and does not include a packer.

Table 3-1. Open Hole Diameters and Intervals – RPN-1-AZ

Name	Depth Interval feet (ft) Total Vertical Depth	Open Hole Diameter (in.)	Comment	Cement	
				Type: Lead	Type: Tail
Conductor	Refusal[1]	13.375	Drive Pipe	None	None
Surface	0 – 1,500	12-1/4	New drilled hole and casing to depth below USDW	Yield (cu.ft/sk): 1.6 Sacks: 262 Depths[2]: 0-600 Portland Cement	Yield (cu.ft/sk): 1.18 Sacks: 643 Depths[2]: 600-1,500 Portland Cement
Long-string	0 – 4,153	7-7/8	New drilled hole and casing	Yield (cu.ft/sk): 1.6 Sacks: 157 Depths[2]: 0-1,300 Portland Cement	Yield (cu.ft/sk): 1.18 Sacks: 529 Depths[2]: 1,300-4,153 Portland Cement

1. Refusal, or ~200 blows per foot of advancement via hydraulic ram.
2. Depth interval in feet measured depth for the lead or tail section of cement in the corresponding casing interval.
3. Includes cement for the casing shoe track

ft = feet
in. = inches
cu.ft/sk = cubic feet of cement volume per sack

Table 3-2. Casing Specifications – RPN-1-AZ

Name	Depth Interval (ft)	Outside Diameter (in.)	Inside Diameter (in.)	Weight (ppf)	Grade (API)	Design Coupling (Short or Long Threaded)	Thermal Conductivity (W/m / deg-C)	Burst Strength (psi)	Collapse Strength (psi)	Tensile Strength pounds
Conductor	Refusal[1]	13.375	12.347	72	N-80	Welded	45	5,380	2,670	1,661,000
Surface	0 – 1,500	8-5/8	8.097	24	J-55	STC (short)	45	2,950	1,370	244,000
Long-string	0 – 4,153	5-1/2	5.012	14	J-55	BTC (long)	45	4,270	3,120	172,000

1. Refusal, or ~200 blows per foot of advancement via hydraulic ram.

ft = feet
in. = inches
ppf = pounds per feet
psi = pounds per square inch
API = American Petroleum Institute
STC = short thread casing
BTC = buttress thread and coupling
W/m / deg-C = Watts per meter per Degree Celsius.

4. WELL CONSTRUCTION DETAILS – RPN-1-WS1

The well construction diagram for well RPN-1-WS1 is shown in **Figure 4-1. Tables 4-1,** and **4-2** show the respective well construction details. Tables showing the injection tubing and packer specifications are not provided, as the well does not contain injection tubing and does not include a packer.

Table 4-1. Open Hole Diameters and Intervals – RPN-1-WS1

Name	Depth Interval feet (ft) Total Vertical Depth	Open Hole Diameter (in.)	Comment	Cement
Conductor	Refusal[1]	9.625	Drive Pipe	None
Surface	0 – 895	8-1/2	New drilled hole and casing below base of USDW.	Yield (cu.ft/sk): 1.18 Sacks: 392 Portland Cement

1. Refusal, or ~200 blows per foot of advancement via hydraulic ram.
ft = feet; in. = inches; cu.ft/sk = cubic feet of cement volume per sack

Table 4-2. Casing Specifications – RPN-1-WS1

Name	Depth Interval (ft)	Outside Diameter (in.)	Inside Diameter (in.)	Weight (ppf)	Grade (API)	Design Coupling (Short or Long Threaded)	Thermal Conductivity (W/m / deg-C)	Burst Strength (psi)	Collapse Strength (psi)	Tensile Strength pounds
Conductor	Refusal[1]	9.625	8.921	36	J-55	Welded	45	3,520	2,020	564,000
Surface	0 – 895	4-1/2	4.09	9.5	J-55	STC (short)	45	4,380	3,310	152,000

1. Refusal, or ~200 blows per foot of advancement via hydraulic ram.

ft = feet
in. = inches
ppf = pounds per feet
psi = pounds per square inch
API = American Petroleum Institute
STC = short thread casing
W/m / deg-C = Watts per meter per Degree Celsius.

5. WELL CONSTRUCTION DETAILS – RPN-1-WS2

The well construction diagram for well RPN-1-WS2 is shown in **Figure 5-1. Tables 5-1,** and **5-2** show the respective well construction details. Tables showing the injection tubing and packer specifications are not provided, as the well does not contain injection tubing and does not include a packer.

Table 5-1. Open Hole Diameters and Intervals – RPN-1-WS2

Name	Depth Interval feet (ft) Total Vertical Depth	Open Hole Diameter (in.)	Comment	Cement
Conductor	Refusal[1]	9.625	Drive Pipe	None
Surface	0 – 856	8-1/2	New drilled hole and casing below base of USDW.	Yield (cu.ft/sk): 1.18 Sacks: 374 Portland Cement

1. Refusal, or ~200 blows per foot of advancement via hydraulic ram.
ft = feet; in. = inches
cu.ft/sk = cubic feet of cement volume per sack

Table 5-2. Casing Specifications – RPN-1-WS2

Name	Depth Interval (ft)	Outside Diameter (in.)	Inside Diameter (in.)	Weight (ppf)	Grade (API)	Design Coupling (Short or Long Threaded)	Thermal Conductivity (W/m / deg-C)	Burst Strength (psi)	Collapse Strength (psi)	Tensile Strength pounds
Conductor	Refusal[1]	9.625	8.921	36	J-55	Welded	45	3,520	2,020	564,000
Surface	0 – 856	4-1/2	4.09	9.5	J-55	STC (short)	45	4,380	3,310	152,000

1. Refusal, or ~200 blows per foot of advancement via hydraulic ram.

ft = feet
in. = inches
ppf = pounds per feet
psi = pounds per square inch
API = American Petroleum Institute
STC = short thread casing
W/m / deg-C = Watts per meter per Degree Celsius.

6. WELL CONSTRUCTION DETAILS – RPN-1-WS3

The well construction diagram for well RPN-1-WS3 is shown in **Figure 6-1**. **Tables 6-1,** and **6-2** show the respective well construction details. Tables showing the injection tubing and packer specifications are not provided, as the well does not contain injection tubing and does not include a packer.

Table 6-1. Open Hole Diameters and Intervals – RPN-1-WS3

Name	Depth Interval feet (ft) Total Vertical Depth	Open Hole Diameter (in.)	Comment	Cement
Conductor	Refusal[1]	9.625	Drive Pipe	None
Surface	0 – 821	8-1/2	New drilled hole and casing below base of USDW.	Yield (cu.ft/sk): 1.18 Sacks: 357 Portland Cement

1. Refusal, or ~200 blows per foot of advancement via hydraulic ram.
ft = feet; in. = inches
cu.ft/sk = cubic feet of cement volume per sack

Table 6-2. Casing Specifications – RPN-1-WS3

Name	Depth Interval (ft)	Outside Diameter (in.)	Inside Diameter (in.)	Weight (ppf)	Grade (API)	Design Coupling (Short or Long Threaded)	Thermal Conductivity (W/m / deg-C)	Burst Strength (psi)	Collapse Strength (psi)	Tensile Strength pounds
Conductor	Refusal[1]	9.625	8.921	36	J-55	Welded	45	3,520	2,020	564,000
Surface	0 – 821	4-1/2	4.09	9.5	J-55	STC (short)	45	4,380	3,310	152,000

1. Refusal, or ~200 blows per foot of advancement via hydraulic ram.
ft = feet
in. = inches
ppf = pounds per feet
psi = pounds per square inch
API = American Petroleum Institute
STC = short thread casing
W/m / deg-C = Watts per meter per Degree Celsius.

Figures

Figure Index

Appendix 2-1

APPENDIX 2-1

NARRATIVE DESCRIPTION OF DRILLING PROCEDURES FOR RPN-1-INJ

The following step-by-step drilling procedures would be implemented during the installation of each section of the casing listed in **Table 2-2** for the injector well, RPN-1-INJ.

20 inch Conductor Drive

1. Build location
2. Construct cellar for drilling operations
3. Move-in rig to drive conductor on location
4. Position rig on marked well center
5. Rig up hydraulic hammer and drive adaptor
6. Spud well, drive 20 inch to planned depth ~200 feet (200 blows/feet)
7. Cut & dress conductor pipe as required

13-3/8 inch Surface Casing

8. Move in drilling rig and equipment
9. PU 17-1/2 inch bit/BHA
10. Clean-out conductor as needed
11. Drill 17-½ inch hole with WBM and sweeps as needed
12. Drill to TD of ~2,800 feet with estimated ~ 9.0 – 9.2 ppg (pounds per gallon) WBM
13. Notify CES at least 48 hours prior to anticipated casing test, and CES will be provided the opportunity to witness the test.
14. Run open hole wireline logs described in Attachment E, Table 3.3-1: Injection Well Open Hole Logging Plan, trips 1 – 3 to determine USDW
15. Submit log to C&E or OPC confirming base USDW and at least one non-USDW sand prior to setting casing
16. Upon approval from C&E or OPC, run 13-3/8 inch casing with centralizers to TD (or deeper as determined by open hole logs)

17. Move-in cementing company and rig-up cementing equipment
18. Mix and pump cement
19. Cement casing to surface and pump top-off cement job as required
20. WOC
21. Make 13-5/8 inch rough cut, laid down 13-5/8 inch cut off
22. Weld on 13-3/8 inch SOW x 13-5/8 inch 5M - CSG Head
23. Test Well head to 1,500 psi (pounds per square inch)
24. Run cased hole logs described in Attachment E, Table 3.3-2: Injection Well Cased Hole Logging Plan, trip 1 to evaluate cement bond

9-5/8 inch x 7 inch Production Casing

25. Install 13-5/8 inch 5 M x 13-5/8 inch 10M adaptor spool
26. Install 13-5/8 inch, 10M BOP and pressure test BOP to 5,000 psi (pounds per square inch) using test plug
27. Pressure test with chart recorder the 13-5/8 inch casing to 1,000 psi (pounds per square inch) for 60 minutes
28. Sign and submit form CSG-T and pressure chart to IMD
29. RIH with 12-1/4 inch bit & BHA
30. Drill out shoe, changeover to OBM
31. Perform Formation Integrity Test (Pressure TBD)
32. Drill to Core interval depth for Upper Confinement Shale Interval
33. Circulate hole clean
34. Pull out of hole. Stand Back BHA
35. Drill ahead with 12-1/4 inch bit to 3,000 feet (Core Point #1)
36. Core from 3,000 feet – 3,030 feet TVD and POOH (Core #1)
37. Run in hole with 12-1/4 inch bit & BHA
38. Ream through cored interval (Core #1) then Drill ahead with 12-1/4 inch bit to 4,130 feet (Core Point #2)
39. Core from 4,130 feet – 4,190 feet TVD and POOH (Core #2)

40. Ream through cored interval (Core #2) then Drill ahead with 12-1/4 inch bit to 4,500 feet (Core Point #3)
41. Core from 4,500 feet – 4,560 feet TVD and POOH (Core #3)
42. Ream through cored interval (Core #3) then drill 12-1/4 inch hole section to TD of ~4,640
43. Increase MW as needed throughout hole section
44. Circulate hole clean
45. Pull out of hole. Stand Back BHA.
46. RIH with 8.5 inch core assembly
47. Core from 4,640 feet – 4,700 feet TVD and POOH (Core #4)
48. Core from 4,700 feet – 4,730 feet TVD and POOH (Core #5)
49. Ream through cored interval (Core #4 & Core #5) then drill ahead with 10-3/4 inch bit to 5,757 feet (Core Point #6)
50. Core from 5,757 feet – 5,817 feet TVD and POOH (Core #6)
51. Ream through cored interval (Core #6) then drill ahead with 10-3/4 inch bit to 6,400 feet (Core Point #7)
52. Core from 6,400 feet – 6,430 feet TVD and POOH (Core #7)
53. Ream through cored interval (Core #7) then drill ahead with 10-3/4 inch bit to 6,576 feet (Core Point #8)
54. Core from 6,576 feet – 6,606 feet TVD and POOH (Core #8)
55. Core from 6,606 feet – 6,636 feet TVD and POOH (Core #9)
56. Ream through cored interval (Core #8, & #9) then drill ahead with 10-3/4 inch bit to 7,364 feet (Core Point #10)
57. Core from 7,364 feet – 7,394 feet TVD and POOH (Core #10)
58. Core from 7,394 feet – 7,424 feet TVD and POOH (Core #11)
59. Ream through cored interval (Core #10 & #11) then drill ahead with 10-3/4 inch bit to 7,580 feet (Core Point #12)
60. Core from 7,580’ – 7,610’ TVD and POOH (Core #12)
61. Ream through cored interval (Core #12) then drill ahead with 10-3/4” bit to 7,890’ (Core Point #13)
62. Core from 7,890 feet – 7,920 feet TVD and POOH (Core #13)

63. Ream through cored interval (Core #13) then drill ahead with 10-3/4 inch bit to 8,117 feet (Core Point #14)
64. Core from 8,117 feet – 8,177 feet TVD and POOH (Core #14)
65. Ream through cored interval (Core #14) then drill ahead with 10-3/4 inch bit to 9,065 feet (Core Point #15)
66. Core from 9,065 feet – 9,095 feet TVD and POOH (Core #15)
67. Ream through cored interval (Core #15) then drill ahead with 10-3/4 inch bit to 9,227 feet (Core Point #16)
68. Core from 9,227 feet – 9,287 feet TVD and POOH (Core #16)
69. Ream through cored interval (Core #16) then drill ahead with 10-3/4 inch bit to 9,510 feet (Core Point #17)
70. Core from 9,510 feet – 9,540 feet TVD and POOH (Core #17)
71. Ream through cored interval (Core #17) then drill ahead with 10-3/4 inch bit to 9,710 feet (Core Point #18)
72. Core from 9,710 feet – 9,740 feet TVD and POOH (Core #18)
73. Ream through cored interval (Core #18) then drill ahead with 10-3/4 inch bit to 9,990 feet (Core Point #19)
74. Core from 9,990 feet – 10,020 feet TVD and POOH (Core #19)
75. Ream through cored interval (Core #19) then drill ahead with 10-3/4 inch bit to 10,280 feet (Core Point #20)
76. Core from 10,280 feet – 10,310 feet TVD and POOH (Core #20)
77. Ream through cored interval (Core #20) then drill ahead with 10-3/4 inch bit to TD (10,385 feet)
78. Circulate hole clean & condition hole/mud for open hole logging.
79. Pull out of hole. Stand Back BHA.
80. Rig up wireline unit and run open hole logs described in Attachment E, Table 3.3-1: Injection Well Open Hole Logging Plan, trips 4 – 11 to conduct formation evaluation
81. Rig down logging company.
82. Run in hole with 12-1/4 inch bit & BHA to 4,640 feet
83. Circulate and condition hole in preparation to run production casing
84. Pull out of hole. Stand back drill pipe and BHA, lay down 12-1/4 inch bit & stabilizers

85. Run in hole with 10-3/4 inch bit & BHA to 10,385 feet TD
86. Circulate and condition hole in preparation to run production casing
87. Pull out of hole laying down drill pipe, BHA and bit
88. Rig-up 9-5/8 inch & 7" casing running tools
89. Run in hole with 7 inch 25CR casing with 7 inch 25CR Polished Bore Receptacle (or other corrosion resistant grade as supported by testing and in coordination w/ C&E) with centralizers and fiber optic line.
90. Cross-over to 9-5/8 inch 25CR casing (or other corrosion resistant grade as supported by testing and in coordination w/ C&E) with fiber optic line to ~ 225 feet above the Upper Confinement Shale Interval. RIH with 9-5/8 inch L-80 casing with fiber optic line to 10,385 feet TD
91. Land 9-5/8 inch hanger in B-section of wellhead
92. Cement production casing to surface in 2 stages utilizing a DV tool in the 9 5/8" section with Acid resistant cement to +/- 500 feet above Upper Confinement Shale Interval. Displace cement w/ Brine
93. WOC
94. Run cased hole logs described in Attachment E, Table 3.3-2: Injection Well Cased Hole Logging Plan, trips 2 – 6 to evaluate cement bond and casing integrity
95. Pressure test with chart recorder the 9-5/8 inch x 7 inch production casing to 2,500 psi (pounds per square inch) for 60 minutes. Pressure at the bottom of the 9-5/8" string should not exceed 75% of the 9-5/8" burst pressure. If the density of the fluid in the well at the time of the test is greater than 10 lb/gal the applied pressure at surface for the test will need to be recalculated.
96. Sign and submit form CSG-T and pressure chart to IMD
97. Break BOPE at wellhead connection.
98. Lay down 13-5/8 inch 5 M x 13-5/8 inch 10M adaptor spool
99. Nipple BOPE
100. Install B-Section of Wellhead
101. Test well head to 4000 psi (pounds per square inch)
102. Start completion phase of well construction

Appendix 2-2

APPENDIX 2-2

H014478 – CORROSALOCK CEMENT DATA SHEET

H014658 – CORROSALOCK CASE STUDY

DATA SHEET

HALLIBURTON

Cementing Solutions
Cement Systems and Additives

CorrosaLock™ Cement System

Resin modified cement solution for corrosive CO_2 environments.

FEATURES

- Significantly reduces permeability compared to conventional Portland cement slurry designs
- Delivers enhanced elasticity and shear bond strength

BENEFITS

- Resistant to chemical alteration caused by carbonation and other corrosion reactions
- Combats the effects of stress induced by downhole conditions and injection operations
- Provides enhanced bonding between the formation, cement, and casing

Overview

Cementing wells for carbon capture, utilization, and storage (CCUS) presents unique challenges to barrier integrity and long-term stored CO_2 containment. CCUS projects aim for permanent underground CO_2 storage, which requires long-term cement sheath chemical and mechanical stability. Factors like temperature and pressure cycles and chemical interactions can impact the cement integrity over time. CO_2 produces carbonic acid in the presence of water, which can degrade conventional Portland cement. Cement used with CCUS applications must be resistant to CO_2 exposure.

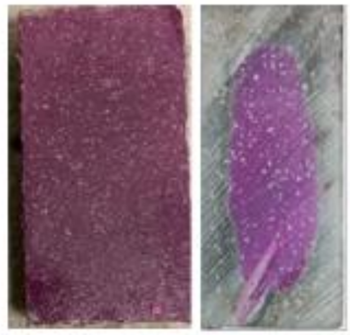
CCUS involves the injection of CO_2 deep into subsurface formations, typically at significant pressure. For this reason, cement slurry design and placement techniques must ensure proper bonding of cement to the wellbore and formation to provide a reliable and impermeable seal. Halliburton has decades of experience with the design of annular barriers for corrosive environments. We recognize the importance of proper material selection and best practices for long-term CO_2 storage. CorrosaLock™ cement system is part of the Halliburton CCUS solutions portfolio. The system is tailored to provide excellent chemical resistance to CO_2 and enhanced mechanical properties that minimize the impact of cyclic loading on the mechanical integrity of the cement barrier.

Reduced permeability provides superior corrosion resistance

The CorrosaLock cement system is a composite of Portland-based cement and the proprietary Halliburton WellLock® resin system. The cement component of the composite is tailored based on Halliburton's slurry design best practices. Portland cement is minimized, and the blend is supplemented with CO_2 resistant materials to meet performance requirements. A specified volume of WellLock resin and cement are blended to yield a system that provides a significant permeability reduction. The resin system helps in two ways. First, a portion of the resin creates a film on the composite system's surface, which creates a coating effect to help with bonding. Second, the resin creates small spheres that occupy the pore space within the composite system's matrix. This reduces the system's effective porosity and forms an adhesive layer to

DATA SHEET

protect the cement grains from CO_2 degradation. The combined coating effect and matrix enhancement benefits result in a greatly reduced permeability composite system, which can provide superior corrosion resistance in dry and aqueous supercritical CO_2 environments.



Phenolphthalein, a pH stain, provides visual cues of carbonation. Purple represents unaltered cement. The results of CorrosaLock cement (left) after one month of static supercritical CO_2 exposure at 100°F exhibit no noticeable CO_2 chemical alteration compared to conventional Portland cement (right).

Enhanced mechanical properties deliver long-term barrier integrity

Incorporation of resin into the design enhances cement sheath elasticity and shear bond strength compared to conventional cement systems. Improved shear bond strength allows the CorrosaLock system to provide increased anchoring to the casing and the formation. This can significantly minimize the risk of debonding, which can cause gas migration and integrity loss. Additionally, the cement sheath is more crack-resistant to better withstand the downhole forces during cyclic injection.

CCUS solutions portfolio

The Halliburton CCUS solutions portfolio includes non-Portland, modified Portland, and reduced Portland products. These solutions use tailored chemistries, pure resin, cement and resin composites, and additives to enhance mechanical properties. They also reduce the set cement permeability and deliver an improved CO_2-resistant barrier with long-term integrity. The CorrosaLock system is part of our modified Portland solutions portfolio.

Significant permeability reduction and enhanced mechanical properties provide superior corrosion resistance in CO_2 environments.

Post-exposure mechanical properties results

SAMPLE	1 WEEK	1 MONTH	5 MONTHS
Compressive strength (psi)	7,638	7,471	8,104
Young's modulus (psi)	1.83E+06	1.71E+06	2.02E+06
Poisson's ratio (-)	0.276	0.242	0.265

No noticeable deviation in the CorrosaLock™ cement system mechanical properties after five months of supercritical CO_2 exposure.

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CASE STUDY

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North America

Corrosion-Resistant Cement Systems Achieve Zonal Isolation in CO_2 Storage Well

CorrosaLock™ and CorrosaCem™ cement systems successfully placed on production liner in CCUS well

CHALLENGES

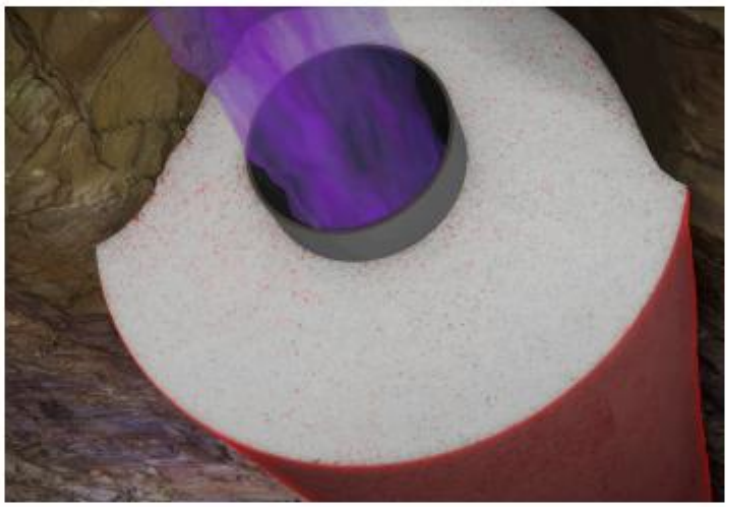
- Design and deploy cement barrier to ensure long-term integrity in CO_2-laden, corrosive environment.
- Achieve full coverage in wellbore where lost circulation is anticipated.

SOLUTION

- Deploy CorrosaLock™ cement system lead followed by CorrosaCem™ cement system tail.

RESULTS

- Achieved CO_2 corrosion-resistant barriers.
- Successfully placed CorrosaLock™ and CorrosaCem™ cement systems.
- Maintained full circulation throughout operation.



CorrosaLock™ cement system provides a significant permeability reduction and enhanced mechanical properties to enable superior corrosion resistance in CO_2 environments.

Overview

With the industry focus on a low-carbon future, carbon capture, utilization, and storage (CCUS) is a rapidly growing market. Regulatory bodies, such as the Environmental Protection Agency (EPA), require operators to fulfill specific and rigorous requirements to obtain permits for CCUS wells.

Challenge

An operator in North America required a CO_2 corrosion-resistant cement system to obtain a CCUS well permit. The primary purpose of this well is to

CASE STUDY

store the CO_2 captured from a nearby treating facility. The CO_2 is a natural byproduct from natural gas production of nearby wells. Injection of excess CO_2 back to the subsurface formation was planned. Because of a relatively low fracture gradient in the injection section, lost circulation also posed a challenge.

Solution

To address the corrosive nature of the injected stream, along with slim equivalent circulating density (ECD) margins, a relatively low-density/low-rheology 13.5-lbm/gal CorrosaLock™ cement system lead and 14-lbm/gal CorrosaCem™ cement system tail were deployed. The CorrosaLock corrosion-resistant system is a composite mixture of Portland-based cement and Welllock® resin additive. The resin component helps enhance the system's mechanical properties by increasing elasticity, which helps mitigate the effect of cyclic loading on the cement sheath. Inclusion of resin also reduces the permeability and porosity of the composite system, which enhances corrosion resistance. The CorrosaCem cement system is a reduced Portland system with cement replaced by supplementary cementitious materials (SCMs) that do not react with CO_2 to help improve CO_2 corrosion resistance. Additives to reduce permeability and further enhance corrosion resistance were also included. Additionally, CorrosaCem cement is designed with additives that enhance elasticity to help improve resistance to mechanical failure caused by cyclic injection operations.

Results

Full circulation was maintained throughout pumping and displacement operations. A total of 64 bbl of CorrosaLock cement lead and 60 bbl of CorrosaCem cement tail slurries were effectively placed over the entire length of the liner. Low-pressure and high-pressure liner top tests were successfully performed. Additionally, a successful negative test was performed. A cement bond log (CBL) verified the quality of the cement sheath behind the liner and confirmed excellent cement coverage throughout the wellbore.

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