

**Underground Injection Control
Carbon Sequestration
Class VI Permit Application**

**Plugging Plan
40 CFR 146.92(b)
Section 9.0**

**NexGen Carbon Oklahoma, LLC
Vanguard CCS Hub**

June 2025

INJECTION WELL PLUGGING PLAN [40 CFR 146.92(b)]

Vanguard CCS Hub

INSTRUCTIONS

This template provides a suggested outline and recommendations for the Injection Well Plugging Plan. Permit applicants are not required to use this template. This document does not substitute for promulgated provisions or regulations, nor is it a regulation itself, and it does not impose legally-binding requirements on the U.S. Environmental Protection Agency (EPA), states, or the regulated community.

Note that references to EPA's Class VI Rule in the code of federal regulations (CFR) are provided in this template. States with Class VI primacy have requirements that are at least as stringent as EPA's. If your Class VI well is in a primacy state, consult your permitting authority about any additional requirements for what must be included in the plan.

In this template, instructions or suggestions appear in *blue text*. These are provided to assist with site- and project-specific plan development. These are recommendations and are not required elements of the federal Class VI Rule.

Please delete the *blue text* and replace the yellow highlighted text before submitting your document. Similarly, please adjust the example text and tables throughout as necessary (e.g., by adding or removing rows or columns). Appropriate figures, references, etc. should also be included to support the text of the plan.

Remember that, pursuant to 40 CFR 146.94(a) of the federal Class VI Rule, the requirement to maintain and implement an approved Injection Well Plugging Plan is directly enforceable regardless of whether the requirement is a condition of the permit. For more information, see EPA's Class VI guidance documents at <https://www.epa.gov/uic/class-vi-guidance-documents>. It is the responsibility of the owner or operator to maintain records of previous revisions to this plan.

To avoid duplicative reporting, you are encouraged to provide relevant cross-references to other submissions made with the GSDT.

Facility Information

Facility name: Vanguard CCS Hub

Vanguard I-1
Vanguard I-2
Vanguard I-3
Vanguard I-4
Vanguard I-5
Vanguard I-6
Vanguard I-8
Vanguard I-9
Vanguard I-10
Vanguard I-12

Facility contact: Marc Thomas, President & COO

Plan revision number: 0
Plan revision date: 6/24/2025

600 Rockmead Drive, Suite 112
Kingwood, TX 77339
(346) 576-8215
marcthomass@nexgencarbon.com

Well locations: Osage County, Oklahoma

Vanguard I-1: Lat 36.633288°N, Lon -96.571029°W (NAD 83)
Vanguard I-2: Lat 36.660083°N, Lon -96.534652°W (NAD 83)
Vanguard I-3: Lat 36.664329°N, Lon -96.586951°W (NAD 83)
Vanguard I-4: Lat 36.710244°N, Lon -96.542370°W (NAD 83)
Vanguard I-5: Lat 36.744047°N, Lon -96.533843°W (NAD 83)
Vanguard I-6: Lat 36.724157°N, Lon -96.489526°W (NAD 83)
Vanguard I-8: Lat 36.823356°N, Lon -96.620496°W (NAD 83)
Vanguard I-9: Lat 36.849167°N, Lon -96.592912°W (NAD 83)
Vanguard I-10: Lat 36.893849°N, Lon -96.578026°W (NAD 83)
Vanguard I-12: Lat 36.785641°N, Lon -96.594085°W (NAD 83)

Table of Contents

INJECTION WELL PLUGGING PLAN [40 CFR 146.92(b)]	2
Table of Contents	4
List of Figures	4
List of Tables	4
Acronyms and Abbreviations	5
9.0 Injection and Monitoring Well Plugging Plan.....	6
9.1 Planned Tests or Measures to Determine Bottom-Hole Reservoir Pressure in the Injectors.....	7
9.2 Planned External Mechanical Integrity Test(s).....	7
9.3 Information on Plugs.....	7
9.4 Narrative Description of Plugging Procedures.....	8
9.4.1 Notifications, Permits, and Inspections	8
9.4.2 Plugging Procedures	8
9.4.3 Attachment 1 – Additional P&A Wellbore Diagrams	25

List of Figures

- Figure 9-1**—Wellbore Diagram of the proposed abandonment design for Vanguard I-1. 11
Figure 9-2—Diagram of the proposed abandonment design for Vanguard IZM-1 17
Figure 9-3—Diagram of the proposed abandonment design for Vanguard AZM-1 21

List of Tables

- Table 9-1**—Planned mechanical integrity tests prior to plugging the injection well. 7
Table 9-2—Plugging Details – Vanguard I-1 10
Table 9-3—Cement plug details for Vanguard injection wells 12
Table 9-4—Vanguard IZM-1 plugging details 15
Table 9-5—Cement plug details for Vanguard IZM-1 through Vanguard IZM-7 18
Table 9-6—Vanguard AZM-1 plugging details 20
Table 9-7—Cement plug details for Vanguard above-zone monitoring wells 23

Acronyms and Abbreviations

A

AoR	area of review
API	American Petroleum Institute

B

BHP	Bottom hole pressure
-----	----------------------

C

C	Celsius
CO ₂	carbon dioxide
CRA	corrosion resistant alloys

D

DAC	Direct attach copper
DAT	Digital audio tape
DF	design factor

E

ECD	equivalent circulating density
EPA	Environmental Protection Agency

F

F	Fahrenheit
ft	foot or feet

H

H ₂ S	hydrogen sulfide
------------------	------------------

I

in	inch or inches
----	----------------

K

KIPS	equivalent of 1,000 pounds of force
ksi	thousand pounds per square inch

L

lbm/ft	pounds per foot
--------	-----------------

M

Mta	million tons per annum (year)
-----	-------------------------------

O

OBM	oil based mud
OEM	Original equipment manufacturer

P

ppf	Pounds per foot
PPG	pounds per gallon
psi	pounds per square inch
psi/ft	pounds per square inch per foot

S

SCADA	Supervisory Control and Data Acquisition
-------	--

T

TOC top of cement

U

UCZ Upper confining zone

USDW underground source of drinking water

W

w/m watts per meter

WBD Wellbore diagram

WBM water based mud

9.0 Injection and Monitoring Well Plugging Plan

The plugging and abandonment (P&A) of the injection wells, and all monitoring wells, will follow the procedures outlined in this document. Once the Project is completed or the Injection Well reaches the end of its operational life, it will be plugged and abandoned in compliance with 40 CFR 146.92 as well as all applicable state and local regulations.

Monitoring wells will continue to be active until a demonstration of non-endangerment to Underground Sources of Drinking Water (USDWs) is approved by the UIC Program Director, as required by 40 CFR §146.93(b)(3). Upon receiving approval for site closure, NexGen will plug all monitoring wells, in compliance with 40 CFR 146.92 as well as all applicable state and local regulations.

The design of the plugging process and materials will be specifically formulated to ensure the prevention of fluid migration, account for the corrosive nature of CO₂-water mixtures, and safeguard USDWs. Any necessary updates to the plugging procedure, based on new information, will be submitted to the UIC Program Director for review and approval before implementation. The finalized plugging plan will be provided to the UIC Program Director at least 60 days before the well is plugged.

Upon receiving approval of the Injection Well plugging plan, the well will be flushed with a kill-weight buffer fluid. A minimum of three tubing volumes will be circulated through the well without exceeding fracture pressure. Prior to plugging, bottomhole pressure readings will be taken, and the well will undergo logging and pressure testing to confirm mechanical integrity. Should any mechanical integrity issues be identified, repairs will be completed before the plugging process proceeds. The detailed plugging procedures are provided in this document.

Upon receiving approval of the Monitoring Well plugging plan, and prior to plugging, the well will undergo logging and pressure testing to confirm the CO₂ plume and mechanical integrity. Should any mechanical integrity issues be identified, repairs will be completed before the plugging process proceeds. The detailed plugging procedures are provided in this document.

During abandonment, all casing strings will remain cemented to surface as constructed and will not be retrieved. All tubulars will be removed, followed by the placement of abandonment mud and cement plugs to seal the wells.

To complete abandonment, all casing strings will be cut at least three feet (3 ft) below ground level. A steel plate with the required permit information will then be welded to the top of the casing.

9.1 Planned Tests or Measures to Determine Bottom-Hole Reservoir Pressure in the Injectors

After ceasing injection, bottomhole pressure (BHP) measurements will be derived using the historical and current BHP data taken directly from the injection well, prior to starting the P&A procedure. NexGen will use the final recorded static bottomhole pressure to calculate the density of workover fluid required to safely complete the proposed plug and abandon procedure.

9.2 Planned External Mechanical Integrity Test(s)

External mechanical integrity will be demonstrated through approved temperature or acoustic logging methods. NexGen will conduct at least one of the tests listed in **Table 9-1** to verify final external mechanical integrity prior to plugging the injection well as required by 40 CFR 146.92(a).

Table 9-1—Planned mechanical integrity tests prior to plugging the injection well.

Test Description	Locations
Casing Pressure Test	The casing by tubing annulus will be pressure-tested to 500 psi for 30 minutes. A passing test will show no discernable drop in pressure (< 10%) over the test period.
Temperature/Acoustic Log (Injector only)	Wireline conveyed temperature survey through tubing. A passed test shows no temperature anomalies which may indicate fluid or gas movement behind the casing.
Pulse Neutron Log or equivalent (IZM Wells only)	Wireline conveyed logs through casing. Measurements to confirm that the plume has reached stabilization
USIT/CBL (All wells)	After tubing is removed, log from casing TD to surface. The log will be evaluated and will be considered passing if the cement behind the long string is of sufficient quantity and quality to prevent fluid migration from any one formation to another.

9.3 Information on Plugs

NexGen Carbon Oklahoma, LLC will use the materials and methods outlined below (9.4.2.1 - 9.4.2.3) to plug the injection wells. The volume and depth of the plugs will depend on the final geological assessment and downhole conditions of the well as assessed during construction. The cement(s) formulated for plugging will be compatible with the carbon dioxide stream. The cement formulation and required certification documents will be submitted to the agency with the well plugging plan. The owner or operator will report the wet density and will retain duplicate samples of the cement used for each plug.

Volume calculations for these plugs have been calculated using the inner diameter of each string (per the casing specification sheet) and the lengths of plugs planned. The volume and placement

depths of the plugs will be finalized based on the geological and downhole conditions confirmed during well-construction and the final required cement volumes will be calculated based on the dimensions of the final long string casing. The balance method will be employed for plug placement to achieve proper positioning and ensure structural integrity and to confirm plug placement and stability, the upper section of each cement plug will be tagged. NexGen will also report the wet density of each cement batch and retain duplicate samples to ensure quality control.

9.4 Narrative Description of Plugging Procedures

9.4.1 Notifications, Permits, and Inspections

In alignment with the requirements of 40 CFR 146.92(c), NexGen will notify the appropriate regulatory agency at least 60 days before initiating any well plugging activities. Any updates to the Well Plugging Plans will also be submitted at that time. Inspections related to plugging operations will be made available to regulatory authorities upon request.

Once the plugging and abandonment process is finalized, NexGen will provide a closure report to the relevant regulatory agencies within 60 days of completing the plugging activities for each well. This report will certify that the well was plugged in accordance with all applicable regulations and will include documentation for any newly identified or constructed wells within the Area of Review (AoR).

Certification of Closure:

Following the completion of plugging and abandonment, NexGen CCS will submit a certification to the regulatory body, endorsed by both the facility and a licensed professional engineer. This engineer will have current registration and expertise in drilling engineering, as well as familiarity with the unique conditions of injection well construction. The certification will affirm that the injection well has been properly plugged in compliance with all regulatory standards.

Retention of Records:

Plugging reports will be submitted to the local authorized regulatory body within 30 days of well plugging and abandonment. NexGen CCS will retain copies of these reports for a minimum of 10 years following site closure, in accordance with 40 CFR 146.92(d).

9.4.2 Plugging Procedures

The specific plugging procedures for the Vanguard I-1 injection well, the Vanguard IZM-1 in-zone monitoring well, and the Vanguard AZM-1 above zone monitoring well, are described in detail in this section. All other injection, in-zone, and above-zone well plugging details will follow the same procedures. Note: The wells will be plugged in accordance with 40CFR 146.92(b).

9.4.2.1 Vanguard I-1 Injection Well Plugging Procedures

Pre- Plugging Procedures

- After ceasing injection, bottomhole pressure measurements will be taken by using the historical and current BHP data taken from the injection well, prior to starting the P&A procedure on the well. Use the final recorded static bottomhole pressure to calculate the density of workover fluid required to safely complete the proposed plug and abandon procedure.
- Run active pulsed-neutron log through tubing to TD. Production logging tools (PLTs) such as tracers, noise or temperature logs could be run in substitution.
- Kill well with the calculated density of the workover fluid based on BHP survey in Step 1. A minimum of three tubing volumes will be injected into the formation ensuring not to exceed 90% of fracture pressure.
- Ensuring tubing pressure is zero, pressure test casing/ tubing annulus to 300 psi or pressure required.
- If a loss of mechanical integrity is indicated, the well will be repaired prior to proceeding further with the plugging operations.
- Bleed casing pressure to 0 psi. If the tubing and casing pressures are stable at 0 psi, continue with well plugging procedures for the Arbuckle CO₂ injection zone.

Plugging Procedures

1. ND tree and NU BOP's. Test BOPs as per regulations.
2. MIRU wireline and run tubing punch to punch hole in tubing just above the packer. Rig down wireline.
3. Circulate well and tubing annulus with kill weight fluid.
4. Make up a landing joint to tubing hanger and attempt to release retrievable packer
 - a. If packer cannot be retrieved, cut and pull tubing as deep as possible, then attempt to fish packer out of hole
 - i. If the packer cannot be fished out of hole, RIH with a milling assembly and attempt to reach the plugback total depth.
5. POOH laying down tubing and packer.
6. Pick up 6 1/8" bit on workstring.
7. RIH with bit to TD.
8. Circulate hole to kill weight fluid.
9. Ensuring well is dead, POOH, racking back the workstring.
10. Rig up wireline pressure control equipment and logging tools.
11. Run casing inspection log and cement bond log from 7" casing point to surface.
12. Rig down wireline.
13. Evaluate logs and confirm wellbore integrity.

RIH open-ended to TD. Set balanced plug #1 from TD to 2,944ft. Use a total of approximately 137 sacks of cement per **Table 9-2**.

14. Displace cement with calculated workover fluid. Allow cement to set and tag top of cement. If cement top is not tagged at 2,944', place more cement until that depth is achieved.
15. Circulate 72ppf abandonment mud from 2,944ft to 854ft.

Move work string to 854ft and set cement plug #2. Set balanced plug #2 from 854' to surface with 116 sacks cement per **Table 9-2**.

16. Cut casing off 3 feet below ground level. Clean cellar and weld on plate with required well information. Clean location.

Table 9-2 lists the individual cement-plug details for P&A of the Vanguard I-1 well, and **Figure 9-1** shows its proposed abandonment configuration.

The nine remaining injection wells follow a similar P&A scheme; their specific plug details are in **Table 9-3**, and their abandonment diagrams are in **Attachment 1 – Additional P&A Wellbore Diagrams**.

Table 9-2—Plugging details – Vanguard I-1.

	Plug # 1	Plug # 2
Casing Diameter (OD inches)	7	7
Casing Weight (ppf)	26	26
Casing Diameter (ID inches)	6.276	6.276
Casing Volume (cf/ft)	0.2148	0.2148
Base Plug Depth (ft)	3,724	854
Top Plug Depth (ft)	2,944	0.00
Plug Height (ft)	780	854
Cement Volume Req'd (cf)	168	183
Cement Type	EverCrete equivalent	or EverCrete equivalent
Slurry Weight (ppg)	14.5	12.5
Cement Yield (cf/sk)	1.22	1.58
Cement Req'd (sx)	137	116
Method of Placement	Balanced Plug	Balanced Plug

Plan revision number: 0
Plan revision date: 6/24/2025

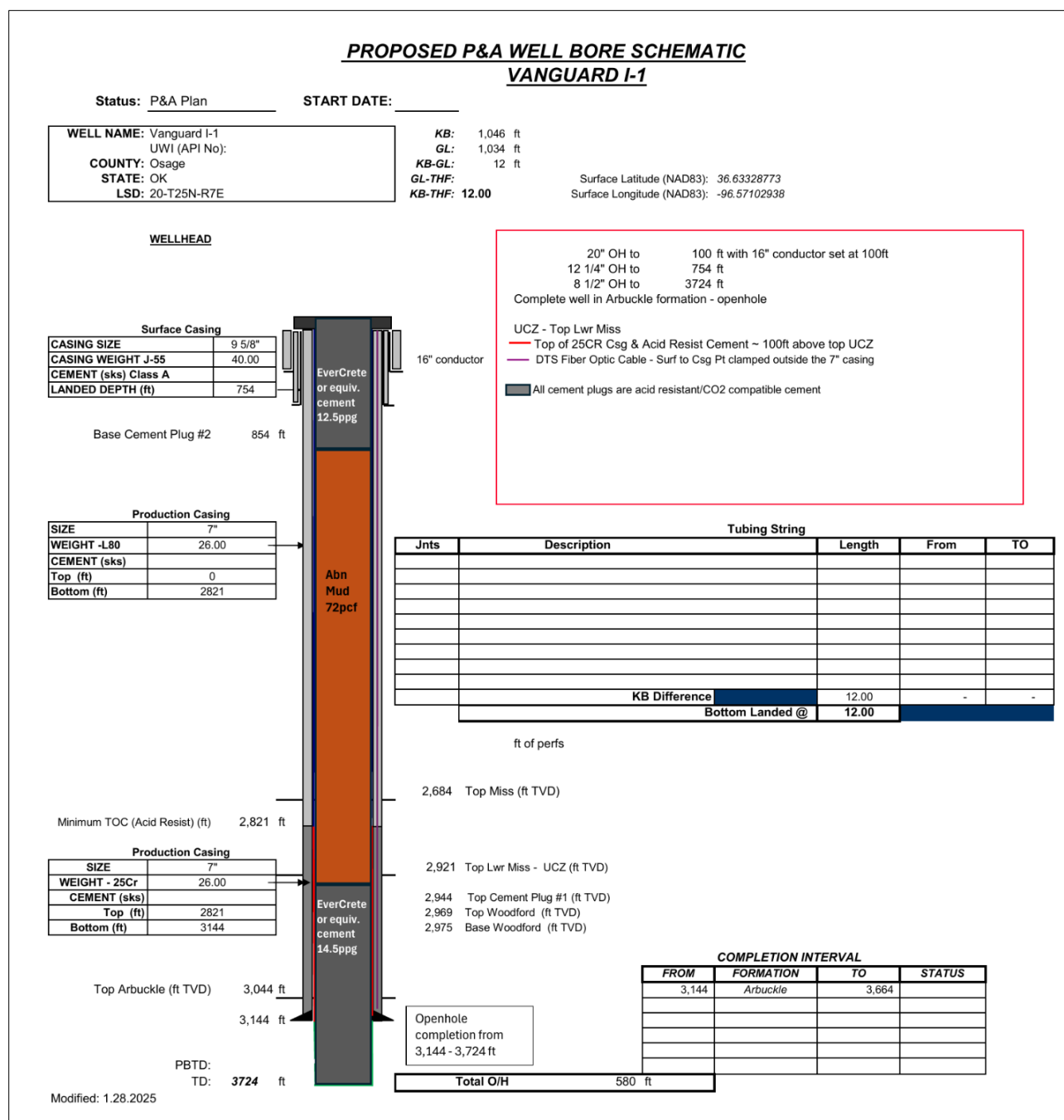


Figure 9-1—Wellbore Diagram of the proposed abandonment design for Vanguard I-1.

Table 9-3—Cement plug details for Vanguard I-1, Vanguard I-2, Vanguard I-3, Vanguard I-4, Vanguard I-5, Vanguard I-6, Vanguard I-8, Vanguard I-9, Vanguard I-10 and Vanguard I-12

	I-1		I-2		I-3		I-4	
	Plug # 1	Plug # 2	Plug # 1	Plug # 2	Plug # 1	Plug # 2	Plug # 1	Plug # 2
Casing Diameter (OD inches)	7	7	7	7	7	7	7	7
Casing Weight (ppf)	26	26	26	26	26	26	26	26
Casing Diameter (ID inches)	6.276	6.276	6.276	6.276	6.276	6.276	6.276	6.276
Casing Volume (cf/ft)	0.2148	0.2148	0.2148	0.2148	0.2148	0.2148	0.2148	0.2148
Base Plug Depth (ft)	3,724	854	3,611	786	3,848	1,016	3,589	876
Top Plug Depth (ft)	2,944	-	2,845	-	3,080	-	2,932	-
Plug Height (ft)	780	854	766	786	768	1,016	658	876
Cement Volume Req'd (cf)	168	183	164	169	165	218	141	188
Cement Type	EverCrete or equivalent	EverCrete or equivalent	EverCrete or equivalent	EverCrete or equivalent	EverCrete or equivalent	EverCrete or equivalent	EverCrete or equivalent	EverCrete or equivalent
Slurry Weight (ppg)	14.5	12.5	14.5	12.5	14.5	12.5	14.5	12.5
Cement Yield (cf/sk)	1.22	1.58	1.22	1.58	1.22	1.58	1.22	1.58
Cement Req'd (sx)	137	116	135	107	135	138	116	119
Method of Placement	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug

	I-5		I-6		I-8	
	Plug # 1	Plug # 2	Plug # 1	Plug # 2	Plug # 1	Plug # 2
Casing Diameter (OD inches)	7	7	7	7	7	7
Casing Weight (ppf)	26	26	26	26	26	26
Casing Diameter (ID inches)	6.276	6.276	6.276	6.276	6.276	6.276
Casing Volume (cf/ft)	0.2148	0.2148	0.2148	0.2148	0.2148	0.2148

Plan revision number: 0
Plan revision date: 6/24/2025

	I-5		I-6		I-8	
Base Plug Depth (ft)	3,536	865	3,404	668	1,217	
Top Plug Depth (ft)	2,912	-	2,759	-	3,147	-
Plug Height (ft)	624	865	644	668	685	1,217
Cement Volume Req'd (cf)	134	186	138	143	147	261

Cement Type	EverCrete or equivalent	EverCrete or equivalent	EverCrete or equivalent	EverCrete or equivalent	EverCrete or equivalent	EverCrete or equivalent
Slurry Weight (ppg)	14.5	12.5	14.5	12.5	14.5	12.5
Cement Yield (cf/sk)	1.22	1.58	1.22	1.58	1.22	1.58
Cement Req'd (sx)	110	118	113	91	121	165
Method of Placement	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug

	I-9		I-10		I-12	
	Plug # 1	Plug # 2	Plug # 1	Plug # 2	Plug # 1	Plug # 2
Casing Diameter (OD inches)	7	7	7	7	7	7
Casing Weight (ppf)	26	26	26	26	26	26
Casing Diameter (ID inches)	6.276	6.276	6.276	6.276	6.276	6.276
Casing Volume (cf/ft)	0.2148	0.2148	0.2148	0.2148	0.2148	0.2148
Base Plug Depth (ft)	3,901	1,154	3,808	1,084	3,832	1,158
Top Plug Depth (ft)	3,148	-	3,008	-	3,145	-
Plug Height (ft)	753	1,154	800	1,084	687	1,158
Cement Volume Req'd (cf)	162	248	172	233	148	249
Cement Type	EverCrete or equivalent	EverCrete equivalent	or EverCrete equivalent	or EverCrete equivalent	or EverCrete equivalent	or EverCrete equivalent
Slurry Weight (ppg)	14.5	12.5	14.5	12.5	14.5	12.5

Plan revision number: 0
Plan revision date: 6/24/2025

	I-9		I-10		I-12	
Cement Yield (cf/sk)	1.22	1.58	1.22	1.58	1.22	1.58
Cement Req'd (sx)	133	157	141	147	121	157
Method of Placement	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug

9.4.2.2 Vanguard IZM-1 In-Zone Monitoring Well Plugging Procedures

1. Rig up wireline pressure control equipment and logging tools.
2. Run casing inspection log and cement bond log from TD to surface.
3. Run active pulsed-neutron log, or equivalent, from TD to 200ft above the Top Mississippian.
4. Record BH pressure and temperature from behind casing pressure gauges and DTS fiber.
5. Ensuring casing pressure is zero, pressure test casing to 300 psi or pressure required.
6. If a loss of mechanical integrity is indicated, the well will be repaired prior to proceeding further with the plugging operations.
7. Bleed casing pressure to 0 psi. If the casing pressure is stable at 0 psi, continue with well plugging procedures.
8. MIRU service rig and ND tree.

Pick up and RIH with 3 ¾" bit on work string to TD. Circulate 2 bottoms up and set balanced plug #1 from TD to 2,858ft. Use a total of approximately 88 sacks of cement per **Table 9-4**.

9. Displace cement from work string. Allow cement to set and tag top of cement. If cement top is not tagged at 2,858', place more cement until that depth is achieved.
10. Circulate 72ppf abandonment mud from 2,588ft to 860ft.

Move work string to 860ft and set cement plug #2. Set balanced plug #2 from 860' to surface with 33 sacks cement per **Table 9-4**.

11. Cut casing off 3 feet below ground level. Clean cellar and weld on plate with required well information. Clean location.

Table 9-4 contains individual cement plug details for the P&A of Vanguard IZM-1 well. **Figure 9-2** is the proposed abandonment configuration diagram for Vanguard IZM-1. The six remaining in-zone monitoring wells follow a similar P&A scheme; their specific plug details and their abandonment diagrams are in **Attachment 1 – Additional P&A Wellbore Diagrams**. **Table 9-5** contains the individual cement plug details for the P&A of Vanguard IZM-1 through Vanguard IZM-7.

Table 9-4—Vanguard IZM-1 Plugging Details

	Plug # 1	Plug # 2
Casing Diameter (OD inches)	4.5	4.5
Casing Weight (ppf)	11.6	11.6
Casing Diameter (ID inches)	4	4
Casing Volume (cf/ft)	0.0873	0.0873
Base Plug Depth (ft)	4,085	860
Top Plug Depth (ft)	2,858	0.00
Plug Height (ft)	1,226	860
Cement Volume Req'd (cf)	107	75
Cement Type	EverCrete or equivalent	Class G
Slurry Weight (ppg)	14.5	12.6
Cement Yield (cf/sk)	1.22	2.26

Plan revision number: 0
Plan revision date: 6/24/2025

	Plug# 1	Plug# 2
Cement Req'd (sx)	88	33
Method of Placement	Balanced Plug	Balanced Plug

Plan revision number: 0
Plan revision date: 6/24/2025

PROPOSED P&A WELLBORE DIAGRAM
Vanguard IZM-1 Monitoring Well (In Zone)

Status: P&A Plan **START DATE:** _____

WELL NAME: Vanguard IZM-1
UWI (API No):
COUNTY: Osage
STATE: OK
LSD: 30-T25N-R7E

KB: 1,020 ft
GL: 1,008 ft
KB-GL: 12 ft
GL-THF:
KB-THF: 12.00

Surface Latitude (NAD83): 36.6085269
Surface Longitude (NAD83): -96.59376008

WELLHEAD

Surface Casing		
CASING SIZE		7.00
CASING WEIGHT J-55		23.00
CEMENT (sks) Class A		100
LANDED DEPTH (ft)		760

Base Cement Plug #2	860 ft
---------------------	--------

Production Casing	
SIZE (in)	4 1/2"
WEIGHT (ppf) - L80	11.60

Stage 2	
CEMENT (sks) Class G	90
Top (ft)	0
Bottom (ft)	1850

DV Tool (ft)	1,650
--------------	-------

Production Casing	
SIZE	4 1/2"
WEIGHT (ppf) - L80	11.60

Stage 1 - Lead	
CEMENT (sks) Class G	70
Top (ft)	1650
Bottom (ft)	2858

Stage 1 - Tail	
CEMENT (sks) Acid Resist	125
Top (ft)	2858
Bottom (ft)	4085

PBTD:
TD: 4,085

Modified: 1.28.2025

16th conductor

Class G
cement
12.6 ppg

Abn
Mud
72pcf

EverCrete
or equiv.
cement
14.5ppg

4,185 Top Basement (TVD)

20" OH to	100 ft with 16", 64ppf, H40 conductor set at 100ft
8 1/2" OH to	760 ft
6 1/8" OH to	4085 ft
DV Tool	1650 ft

1st Permeable zone above - Top Miss
UCZ - Top Lwr Miss

- TEC cable for behind casing quartz pressure gauges
- DTS Fiber Optic Cable - Surf to Csg Pt clamped outside the 4.5" casing

Tubing String				
Jnts	Description	Length	From	TO
	n/a			
	KB Difference	12.00	-	-
	Bottom Landed @	12.00		

2,721 Top Miss (ft TVD)

2,858 TOCement Plug #1 (Acid Resist) (ft)

2,958 Top Lwr Miss - UCZ (ft TVD)

3,110 Top Arbuckle - Injection Zone (TVC

Figure 9-2—Diagram of the proposed abandonment design for Vanguard IZM-1

Table 9-5—Cement plug details for Vanguard IZM-1 through Vanguard IZM-7

	IZM-1		IZM-2		IZM-3		IZM-4	
	Plug # 1	Plug # 2	Plug # 1	Plug # 2	Plug # 1	Plug # 2	Plug # 1	Plug # 2
Casing Diameter (OD inches)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Casing Weight (ppf)	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6
Casing Diameter (ID inches)	4	4	4	4	4	4	4	4
Casing Volume (cf/ft)	0.0873	0.0873	0.0873	0.0873	0.0873	0.0873	0.0873	0.0873
Base Plug Depth (ft)	4,085	860	3,287	373	3,926	1,045	3,592	677
Top Plug Depth (ft)	2,858	-	2,431	-	2,837	-	2,645	-
Plug Height (ft)	1,226	860	856	373	1,090	1,045	947	677
Cement Volume Req'd (cf)	107	75	75	33	95	91	83	59
Cement Type	EverCrete or equivalent	Class G	EverCrete or equivalent	Class G	EverCrete or equivalent	Class G	EverCrete or equivalent	Class G
Slurry Weight (ppg)	14.5	12.6	14.5	12.6	14.5	12.6	14.5	12.6
Cement Yield (cf/sk)	1.22	2.26	1.22	2.26	1.22	2.26	1.22	2.26
Cement Req'd (sx)	88	33	61	14	78	40	68	26
Method of Placement	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug

Plan revision number: 0
Plan revision date: 6/24/2025

	IZM-5		IZM-6		IZM-7	
	Plug # 1	Plug # 2	Plug # 1	Plug # 2	Plug # 1	Plug # 2
Casing Diameter (OD inches)	4.5	4.5	4.5	4.5	4.5	4.5
Casing Weight (ppf)	11.6	11.6	11.6	11.6	11.6	11.6
Casing Diameter (ID inches)	4	4	4	4	4	4
Casing Volume (bbls/ft)	0.0873	0.0873	0.0873	0.0873	0.0873	0.0873
Base Plug Depth (ft)	4,239	1,318	4,055	1,114	4,053	1,125
Top Plug Depth (ft)	3,139	-	2,929	-	2,906	-
Plug Height (ft)	1,100	1,318	1,126	1,114	1,147	1,125
Cement Volume Req'd (cf)	96	115	98	97	100	98
Cement Type	EverCrete or equivalent	Class G	EverCrete or equivalent	Class G	EverCrete or equivalent	Class G
Slurry Weight (ppg)	14.5	12.6	14.5	12.6	14.5	12.6
Cement Yield (cf/sk)	1.22	2.26	1.22	2.26	1.22	2.26
Cement Req'd (sx)	79	51	81	43	82	43
Method of Placement	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug

9.4.2.3 Vanguard AZM-1 Above-Zone Monitoring Well Plugging Procedures

1. Rig up wireline pressure control equipment and logging tools.
2. Run casing inspection log and cement bond log from TD to surface.
3. Run active pulsed-neutron log, or equivalent, from TD to 200ft above the Top Mississippian.
4. Ensuring tubing pressure is zero, pressure test casing to 300 psi or pressure required.
5. Record BH temperature from DTS fiber.
6. Ensuring casing pressure is zero, pressure test casing to 300 psi or pressure required.
7. If a loss of mechanical integrity is indicated, the well will be repaired prior to proceeding further with the plugging operations.
8. Bleed casing pressure to 0 psi. If the casing pressure is stable at 0 psi, continue with well plugging procedures.
9. MIRU service rig and ND tree.

Pick up and RIH with 3 ¾" bit on work string to TD. Circulate 2 bottoms up and set balanced plug #1 from TD to 2,582ft. Use a total of approximately 17 sacks of cement per **Table 9-6**.

10. Displace cement from work string. Allow cement to set and tag top of cement. If cement top is not tagged at 2,582', place more cement until that depth is achieved.

11. Circulate 72ppf abandonment mud from 2,582ft to 851ft.

Move work string to 851ft and set cement plug #2. Set balanced plug #2 from 851' to surface with 33 sacks cement per **Table 9-6**.

12. Cut casing off 3 feet below ground level. Clean cellar and weld on plate with required well information. Clean location.

Table 9-6 contains individual cement plug details for the P&A of Vanguard AZM-1 well. **Figure 9-3** is the proposed abandonment configuration diagram for Vanguard AZM-1. The nine remaining above-zone monitoring wells follow a similar P&A scheme; their specific plug details and their abandonment diagrams are in **Attachment 1 – Additional P&A Wellbore Diagrams**. **Table 9-7** contains the individual cement plug details for the P&A for all ten (10) above-zone monitoring wells.

Table 9-6—Vanguard AZM-1 Plugging Details

	Plug # 1	Plug # 2
Casing Diameter (OD inches)	4.5	4.5
Casing Weight (ppf)	11.6	11.6
Casing Diameter (ID inches)	4	4
Casing Volume (cf/ft)	0.0873	0.0873
Base Plug Depth (ft)	2,819	851
Top Plug Depth (ft)	2,582	0.00
Plug Height (ft)	237	851
Cement Volume Req'd (cf)	21	74
Cement Type	EverCrete equivalent	or Class G
Slurry Weight (ppg)	14.5	12.6
Cement Yield (cf/sk)	1.22	2.26

Plan revision number: 0
Plan revision date: 6/24/2025

Cement Req'd (sx)	17	33
Method of Placement	Balanced Plug	Balanced Plug

PROPOSED WELL BORE DIAGRAM
Vanguard AZM-1 Monitoring Well (Above Zone)

Status: P&A Plan **START DATE:** _____

WELL NAME: Vanguard AZM-1
UWI (API No):
COUNTY: Osage
STATE: OK
LSD: 20-T25N-R7E

KB: 1,046 ft
GL: 1,034 ft
KB-GL: 12 ft
GL-THF: Surface Latitude (NAD83): 36.6332778
KB-THF: 12.00 Surface Longitude (NAD83): -96.57017788

WELLHEAD

Surface Casing		
CASING SIZE		7.00
CASING WEIGHT J-55		23.00
CEMENT (sks) Class A		100
LANDED DEPTH (ft)		751

Base Cement Plug #2	851 ft
---------------------	--------

Production Casing	
SIZE (in)	4 1/2"
WEIGHT (ppf) - L80	11.60

Stage 2	
CEMENT (sks) Class G	100
Top (ft)	0
Bottom (ft)	1650

DV Tool (ft)	1,650
--------------	-------

Production Casing	
SIZE	4 1/2"
WEIGHT (ppf) 25Cr80ksi Prem Conn	11.60

Stage 1 - Lead	
CEMENT (sks) Class G	60
Top (ft)	1650
Bottom (ft)	2582

Stage 1 - Tail	
CEMENT (sks) Acid Resist	40
Top (ft)	2582
Bottom (ft)	2819

PBTD:
TD: 2,819

Modified: 1.28.2025

16" conductor

Class G
cement
12.6ppg

Abn
Mid
72pcf

EverCrete
equiv.
cement
14.5ppg

20" OH to	100 ft with 16", 64ppf, H40 conductor set at 100ft
8 1/2" OH to	751 ft
6 1/8" OH to	2819 ft
DV Tool	1650 ft

UCZ - Top Lwr Miss
1st Permeable zone above - Top Miss

— Top of 25CR Csg & Acid Resist Cement ~ 100ft above top of permeable Top Miss
— DT/DAS Fiber Optic Cable - Surf to Csg Pt clamped outside the 4.5" casing

Tubing String				
Jnts	Description	Length	From	TO
	n/a			
	KB Difference	12.00		
	Bottom Landed @	12.00	-	-

2,582 TOCement Plug #1 (Acid Resist) (ft)

2,682 Top Miss (ft TVD)

2,919 Top Lwr Miss - UCZ (ft TVD)

2,987 Top Woodford (ft TVD)

2,973 Base Woodford (ft TVD)

Figure 9-3—Diagram of the proposed abandonment design for Vanguard AZM-1

Plan revision number: 0
Plan revision date: 6/24/2025

Table 9-7—Cement plug details for Vanguard CCS Hub above zone monitoring wells.

	AZM-1		AZM-2		AZM-3		AZM-4	
	Plug # 1	Plug # 2	Plug # 1	Plug # 2	Plug # 1	Plug # 2	Plug # 1	Plug # 2
Casing Diameter (OD inches)	4.5	4.5	4.5	4.5	4.5	4.5	4.5	4.5
Casing Weight (ppf)	11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6
Casing Diameter (ID inches)	4	4	4	4	4	4	4	4
Casing Volume (cf/ft)	0.0873	0.0873	0.0873	0.0873	0.0873	0.0873	0.0873	0.0873
Base Plug Depth (ft)	2,819	851	2,726	782	2,947	1,012	2,813	873
Top Plug Depth (ft)	2,582	-	2,525	-	2,707	-	2,615	-
Plug Height (ft)	237	851	201	782	239	1,012	198	873
Cement Volume Req'd (cf)	21	74	18	68	21	88	17	76
Cement Type	EverCrete or equivalent	Class G	EverCrete or equivalent	Class G	EverCrete or equivalent	Class G	EverCrete or equivalent	Class G
Slurry Weight (ppg)	14.5	12.6	14.5	12.6	14.5	12.6	14.5	12.6
Cement Yield (cf/sk)	1.22	2.26	1.22	2.26	1.22	2.26	1.22	2.26
Cement Req'd (sx)	17	33	14	30	17	39	14	34
Method of Placement	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug

	AZM-5		AZM-6		AZM-8	
	Plug # 1	Plug # 2	Plug # 1	Plug # 2	Plug # 1	Plug # 2
Casing Diameter (OD inches)	4.5	4.5	4.5	4.5	4.5	4.5
Casing Weight (ppf)	11.6	11.6	11.6	11.6	11.6	11.6
Casing Diameter (ID inches)	4	4	4	4	4	4
Casing Volume (cf/ft)	0.0873	0.0873	0.0873	0.0873	0.0873	0.0873
Base Plug Depth (ft)	2,800	859	2,643	667	3,039	1,218
Top Plug Depth (ft)	2,579	-	2,436	-	2,784	-

Plan revision number: 0
Plan revision date: 6/24/2025

	AZM-5		AZM-6		AZM-8	
Plug Height (ft)	221	859	207	667	254	1,218
Cement Volume Req'd (cf)	19	75	18	58	22	106
Cement Type	EverCrete or equivalent	Class G	EverCrete or equivalent	Class G	EverCrete or equivalent	Class G
Slurry Weight (ppg)	14.5	12.6	14.5	12.6	14.5	12.6
Cement Yield (cf/sk)	1.22	2.26	1.22	2.26	1.22	2.26
Cement Req'd (sx)	16	33	15	26	18	47
Method of Placement	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug

	AZM-9		AZM-10		AZM-12	
	Plug # 1	Plug # 2	Plug # 1	Plug # 2	Plug # 1	Plug # 2
Casing Diameter (OD inches)	4.5	4.5	4.5	4.5	4.5	4.5
Casing Weight (ppf)	11.6	11.6	11.6	11.6	11.6	11.6
Casing Diameter (ID inches)	4	4	4	4	4	4
Casing Volume (cf/ft)	0.0873	0.0873	0.0873	0.0873	0.0873	0.0873
Base Plug Depth (ft)	3,054	1,153	2,913	1,083	3,068	1,159
Top Plug Depth (ft)	2,787	-	2,629	-	2,836	-
Plug Height (ft)	267	1,153	283	1,083	232	1,159
Cement Volume Req'd (cf)	23	101	25	95	20	101
Cement Type	EverCrete or equivalent	Class G	EverCrete or equivalent	Class G	EverCrete or equivalent	Class G
Slurry Weight (ppg)	14.5	12.6	14.5	12.6	14.5	12.6
Cement Yield (cf/sk)	1.22	2.26	1.22	2.26	1.22	2.26
Cement Req'd (sx)	19	45	20	42	17	45
Method of Placement	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug	Balanced Plug

9.4.3 Attachment 1 – Additional P&A Wellbore Diagrams

For all other wellbore diagrams, see **Attachment 1 – NexGen_P&A_WBDs_Inj_AZM_IzM_Portfolio.pdf** (separate PDF).