UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION VIII
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SUBJECT: **GROUNDWATER PROGRAM GUIDANCE NO. 40:** Plugging and Abandonment Requirements For Class II Injection Wells

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Region VIII Class II Well Operators

Region VIII Delegated Class II UIC Programs

I. Introduction

This guidance is intended to provide information about the Environmental Protection Agency (EPA) requirements for developing and submitting Class II injection well plugging and abandonment (P&A) plans for Region VIII approval. GROUNDWATER PROGRAM GUIDANCE NO. 41 discusses Region VIII requirements for financial responsibility. Although EPA plugging and abandonment requirements can be found in the Code of Federal Regulations (CFR) Title 40 (40 CFR) Parts 144, 146, and 147, those regulations provide, at best, some non-specific guidelines for plugging and abandoning injection wells. This guidance discusses the following topics.

- P&A Plan Information Requirements
- Methods And Technical Considerations
- P&A Plans And Financial Responsibility
- Post-P&A Reporting Requirements

When EPA first promulgated final underground injection control (UIC) regulations in 1984 under the Safe Drinking Water Act (SDWA), it provided for protection of all aquifers or parts of aquifers which meet the definition of an underground source of drinking water (USDW), except where exempted (see 40 CFR 144.7 and 146.4). A USDW is defined by EPA as an aquifer or its portion: which supplies any public water system; or which

contains a sufficient quantity of ground water to supply a public water system and currently supplies drinking water for human consumption or has a total dissolved solids (TDS) concentration of less than 10,000 mg/l, and is not an exempted aquifer. P&A plans are developed and implemented in order to assure the prevention of movement of fluids into or between USDWs after an injection well has served its useful life.

Although EPA plugging and abandonment requirements address the protection of USDWs, other local, state, tribal, and federal agencies may require plugs to be set for additional reasons. For example, other regulatory agencies may require additional plugs to address the following objectives:

1. Protect surface soils and surface waters from contamination by formation fluid migration to the surface;
2. Isolate oil, gas, or mineral-bearing formations;
3. Isolate well problems (junk split casing, etc.);
4. Isolate casing shoes, or casing stubs;
5. Isolate injection/disposal intervals; and
6. Minimize conflict with surface land use.

Bureau of Land Management (BLM) well plugging requirements may be found in 43 CFR Part 3160. It is the operator's responsibility to be aware of all required plugs and include them in the P&A plan. All plugs should be shown on the well schematic submitted as part of the EPA's required P&A plan.

II. Information Needed to Develop a P&A Plan

Well construction and geologic information is needed to develop a P&A Plan and is required by the EPA to evaluate whether the proposed plugging procedures will be adequate to protect all USDWs. This information generally is included as part of the permit application and must be referenced in the P&A plan.

The applicant must provide a completed EPA Form 7520-14 and other information that supports the proposed P&A plan. Other information includes: all Well Completion and Sundry Notice Reports; the daily drilling log (through completion); cased and open hole logs with log headers; a brief narrative description of the plugging and abandonment procedures; and a schematic diagram for both of the following:

1) The **Existing Well Configuration,** that shows hole size, all surface, intermediate and long string casing(s), depth to top of cement and how determined, depth of all perforated intervals, and depth of intervals of all repairs and/or cement "squeezes." The

Information Needed to Develop a P&A Plan (continued)

schematic also should show and identify by formation name and top and bottom depth:

- all water-bearing zones (show TDS of each zone),
- all confining zones, and
- all hydrocarbon-bearing zones.

2) The Proposed **Well Configuration After Plugging And Abandonment**, that shows hole size, all surface, intermediate and long string casing(s), the placement of any and all bridge plugs, all repairs and/or cement "squeezes", any unusual conditions (e.g. 'junk' in hole, etc.), all retainers and cement plugs, all perforations, and a description of the fluid to remain between plugs. The schematic should show and identify by formation name and top and bottom depth:

- all water-bearing zones (show TDS of each zone),
- all confining zones, and
- all hydrocarbon-bearing zones.

Documentation provided must identify hole size and strings of casing by size, weight, and setting depth. Cement information should describe the number of sacks used and the type of cement. When available, include a complete cement bond log (CBL). At a minimum, include a CBL that covers the interval from a section of free pipe directly above the top of cement continuing unbroken through the cemented interval and on down to total depth. Also include the CBL 'log header' that records all logging parameters.

Several methods for obtaining TDS values accepted by the EPA are listed below. Alternate methods and sources of information may be accepted upon approval.

- Open hole log analyses.
- Water analyses of samples recovered from "swab" tests.
- Drill stem test (DST) water recovery analyses generally are not acceptable unless it can be shown that the water in the chamber was not contaminated by drilling or other fluids.
- Produced water analyses from nearby wells

Confining zones are those geologic formations, or parts of formations, which provide an effective barrier to the migration of fluids above, between and below USDWs and other fluid bearing geologic formations.

III. Methods and Technical Considerations

Plugging and abandonment operations commence in the lowermost interval and proceed sequentially up the wellbore to the surface. Discussions of plug placement techniques and cementing materials are available in the SPE Monograph, Cementing, edited by Dwight K. Smith and Well Cementing, edited by Erik B. Nelson.

A. PLUG PLACEMENT CONSIDERATIONS

EPA's key objective for injection well abandonment is to protect all USDWs. Critical intervals, such as USDWs, water-bearing zones, hydrocarbon-bearing zones, and confining zones may require separate plugs to adequately isolate and protect all USDWs. **If there is more than 2,000 mg/liter difference of TDS between individual exposed USDWs, they must be isolated from each other.** In a case where all USDWs are within 2,000 mg/l TDS of each other, isolation may be accomplished by setting a plug at the base of the lowermost USDW. A surface plug of at least 50 feet must be set inside and outside of the casing, to prevent surface water runoff from entering the plugged and abandoned wellbore and to seal all possible pathways for fluid migration into the subsurface via the well.

Uncemented longstring casing intervals frequently exist in older wells, and all exposed critical intervals must be isolated by placing cement behind pipe. Uncased (exposed) intervals also may occur if the longstring casing is cut and pulled during abandonment operations. Other agencies may require that the remaining casing 'stub' is sealed off before isolating other zones uphole.

B. PLUG LENGTH AND COVERAGE CONSIDERATIONS

Cement plugs must extend at least 50 feet above and below each zone being isolated. In some cases, for example where a zone is greater than 100 feet thick, placing a minimum 100 feet plug at the top and base of the interval may be adequate (rather than cementing across the entire geologic horizon). The volume of cement to be used for adequate plug coverage should be calculated using the desired plug length, the casing diameter, the hole diameter based on caliper logs, and must include allowances for cement contamination by wellbore fluids or cementing spacers and any unusual wellbore conditions.

C. CEMENT TYPE AND WELL FLUID CONSIDERATIONS

The wellbore fluid should be at static equilibrium prior to

cement plug placement operations. Control measures such as

Methods and Technical Considerations (continued)

spotting viscous high density mud pills, pumping lost circulation material, or other methods may be necessary to achieve static equilibrium. **Water-based muds, or brines containing a plugging gel, with a density of at least 9.2 lb/gal should be used during plugging operations, and should remain between plugs in the well after cement plug placement.**

Class A, C, G, or H cements typically are used in well plugging operations. The selection of cement for plugging depends on the well depth, formation temperatures, formation properties, and wellbore mud properties. Cement additives such as accelerators and retarders may be added to enhance or control the properties of the cement slurry, however, volume-extending additives and 'gel' cements must not be used for cement plugs.

D. PLUG PLACEMENT METHODS

1. Isolating the injection zone: Several methods may be employed to isolate the injection zone from the rest of the wellbore. These include:

- **For Open Hole Completions**:

  Using a cement retainer. The injection zone may be isolated by setting a cement retainer 50-100 feet above the casing shoe and squeezing cement below the retainer. The amount of cement used must be adequate to fill both the casing and the open hole interval to at least 50 feet below the casing shoe. At least 20 feet of cement also should be left on top of the retainer.

  Using a Cast Iron Bridge Plug (CIBP). A CIBP set 50-100 feet above the casing shoe may effectively isolate the open-hole interval. At least 20 feet of cement also should be left on top of the bridge plug.

  Setting a Balanced Plug. The balanced plug method involves pumping cement slurry through drill pipe, coiled tubing, work string, or production tubing until the level of cement outside is equal to that inside the drill pipe/tubing string. The pipe then is pulled slowly from the slurry, leaving behind the cement plug. To minimize cement contamination by wellbore fluids, fluid spacers should be used both ahead of and behind the slurry, especially if the wellbore fluid is incompatible with the cement slurry. Plug

placement must be verified by tagging the top of the plug after the cement has had adequate time to set. If a bridge

Methods and Technical Considerations (continued)

plug is used at the base of the cement plug, tagging the top of the plug is not necessary.

- **For Cased Hole Completions**

  Using a cement retainer. The injection zone may be isolated by setting a cement retainer 50-100 feet above the injection perforations and squeezing cement below the retainer. The amount of cement used must be adequate to fill the casing between the retainer and the perforations, and should allow for some extra cement to be squeezed into the perforations. At least 20 feet of cement also should be left on top of the retainer.

  Using a Cast Iron Bridge Plug (CIBP). A CIBP set 50-100 feet above the top injection perforation may effectively isolate the injection interval. At least 20 feet of cement should also be left on top of the bridge plug.

  Setting a Balanced Plug. The balanced plug method involves pumping cement slurry through drill pipe, coiled tubing, work string, or production tubing until the level of cement outside is equal to that inside the drill pipe/tubing string. The pipe then is pulled slowly from the slurry, leaving behind the cement plug. To minimize cement contamination by wellbore fluids, fluid spacers should be used both ahead of and behind the slurry, especially if the wellbore fluid is incompatible with the cement slurry. Plug placement must be verified by tagging the top of the plug after the cement has had adequate time to set. If a bridge plug is used at the base of the balanced plug, tagging the top of the plug is not necessary.

2. Isolating up-hole zones: Several methods may be employed to isolate up-hole zones from the rest of the wellbore. These include:

- **For Uncased (Open Hole) Intervals**

  Setting a Balanced Plug. The balanced plug method involves pumping cement slurry through drill pipe, coiled tubing, work string, or production tubing until the level of cement

outside is equal to that inside the drill pipe/tubing string. The pipe then is pulled slowly from the slurry, leaving behind the cement plug. To minimize cement contamination by wellbore fluids, fluid spacers should be used both ahead of and behind the slurry, especially if the

Methods and Technical Considerations (continued)

wellbore fluid is incompatible with the cement slurry. Plug placement must be verified by tagging the top of the plug after the cement has had adequate time to set.

Using a Dump Bailer. The dump bailer containing a measured quantity of cement is lowered into the well on wireline. The bailer opens by electrical activation. Because cement contamination can occur when setting plugs with a dump bailer, use of this method is discouraged. If this method is chosen, the operator may be required to take additional special measures to ensure the quality of the cement plug. These measures may vary depending on site-specific conditions, and may add considerable time to the plugging operation and approval. Dump-bailed plug placement must be verified by tagging the top of the plug after the cement has had adequate time to set.

- **For Uncemented, Cased Hole Intervals**

Cement Squeeze Method. The cement squeeze method often is used to isolate intervals where uncemented casing exists through the interval to be plugged. This method requires that the casing be perforated and cement forced through these perforations into the space between the casing and the formation face. Several methods may be employed for squeeze cementing, but the method that assures the most accurate placement of cement is the **block squeeze.** Normally, a block squeeze involves two sets of perforations; one at the base of the interval to be cemented, and the other set of perforations at the top of the interval. Usually a cement retainer is set immediately above the lower set of perforations, and cement is pumped through the retainer via the tubing or workstring. As cement passes through the retainer, it is forced out the lower set of perforations and upward through the casing/open-hole annulus. Fluid returns are taken through the top set of perforations, allowing mud and cement to flow back into the casing. Evidence of a good cement job can be seen when cement is circulated out of the casing. After cement has been squeezed behind casing, the inside of the casing can be cemented by leaving cement on top of the retainer. When used in conjunction with a cement

retainer, a plug set in this manner does not require tagging.

- **For Cemented Cased Hole Intervals**

Setting a Balanced Plug. The balanced plug method involves pumping cement slurry through drill pipe, coiled tubing,

Methods and Technical Considerations (continued)

work string, or production tubing until the level of cement outside is equal to that inside the drill pipe/tubing string. The pipe then is pulled slowly from the slurry, leaving behind the cement plug. To minimize cement contamination by wellbore fluids, fluid spacers should be used both ahead of and behind the slurry, especially if the wellbore fluid is incompatible with the cement slurry. Plug placement must be verified by tagging the top of the plug after the cement has had adequate time to set. If a bridge plug is used at the base of the cement plug, tagging the top of the plug is not necessary.

Using a Dump Bailer. The dump bailer containing a measured quantity of cement is lowered into the well on wireline. The bailer opens upon impact (i.e., striking the bridge plug, cement retainer, etc.) or by electrical activation. Typically, the dump bailer method is used for placing cement on top of mechanical plugs such as a cement retainer or cast iron bridge plug. Unless used in conjunction with a cement retainer or bridge plug, plug placement must be verified by tagging the top of the plug after the cement has had adequate time to set.

Other Methods:

Special abandonment procedures may be necessary for wells with unusual surface or downhole conditions. Procedures for such wellbore conditions are considered beyond the scope of this document. Operators must address fluid migration potential associated with the unusual conditions in their plugging programs and assure that USDWs are protected. If special procedures are needed, the operator must develop procedures and receive written approval from EPA prior to initiating the plugging operation.

E. DOCUMENTATION OF WELL ABANDONMENT

All well work records (wellbore clean outs, tubing movements, casing repair work, plug setting records, pipe tallies, etc.), procedures used, and rig operation reports should be documented and maintained by the operator in a permanent well file, and copies supplied to EPA and other appropriate regulatory

agencies as required. Permits and other authorization documents also should be preserved in the operator's permanent file. The operator that plugged the well should preserve the permanent file as the operator of record. If the well property is acquired by another operator, that operator should assume responsibility for preserving the permanent well file and become the operator of record. If the operator of record ceases doing business and no other survivor assumes responsibility for the permanent well

Methods and Technical Considerations (continued)

files, the operator should send the permanent well files to the appropriate regulatory agency as custodian.

IV. P&A Plans and Financial Responsibility

The P&A plan provided by the operator, when approved by the EPA, provides a basis on which to determine the amount of financial responsibility (bonding) required. GROUNDWATER PROGRAM GUIDANCE NO. 41 discusses Region VIII requirements for financial responsibility. UIC regulations require that an operator provide an adequate demonstration of financial responsibility to cover costs for plugging and abandoning an injection well. The required financial responsibility reflects the cost that the EPA would incur if required to plug the well. Failure to provide a complete P&A Plan and/or failure to establish an acceptable demonstration of financial responsibility may result in the EPA denying a UIC permit application or taking enforcement action. An enforcement action may include civil administrative penalties of up to $5,000 per day for each violation up to a maximum penalty of $125,000, or civil judicial penalties of up to $25,000 for each day for each violation. In addition, if the violation is willful, criminal penalties may be prosecuted in accordance with Title 18 of the United States Code.

V. Post-Plugging and Abandonment Reporting Requirements

Within sixty (60) days after the plugging and abandonment of a well, the owner or operator shall submit a Plugging Record (EPA Form 7520-13) to the Regional Administrator through the Region VIII UIC Program office at Mail Code 8ENF-T-UIC. The Plugging Record must be certified as accurate and complete by the person who performed the plugging operation.

Financial Responsibility previously established with the EPA by means of a Surety Bond, Trust Fund, or Letter of Credit for plugging costs may be released to the operator, or may be applied to update the operator's financial responsibility coverage.