



Underground Injection Control Geologic Sequestration Rule Training Workshop: Class VI Program Elements Overview

Acronyms

AoR	Area of Review
CFR	Code of Federal Regulations
EPA	Environmental Protection Agency
E&RR	Emergency and Remedial Response
ER	Enhanced Recovery
FR	Financial Responsibility
GS	Geologic Sequestration
MIT	Mechanical Integrity Test

Acronyms used in the GS Rule Elements portion of the training include:

AoR: Area of Review

CFR: Code of Federal Regulations

EPA: Environmental Protection Agency

E&RR: Emergency and Remedial Response

ER: Enhanced Recovery

FR: Financial Responsibility

GS: Geologic Sequestration

MIT: Mechanical Integrity Test

Acronyms (cont'd.)

PISC	Post-Injection Site Care
PWS	Public Water System
PWSS	Public Water System Supervision
RA	Regional Administrator (EPA)
RCRA	Resource Conservation and Recovery Act
SDWA	Safe Drinking Water Act
TDS	Total Dissolved Solids
UIC	Underground Injection Control
USDW	Underground Source of Drinking Water

3

Other acronyms used in the GS Rule Elements portion of the training include:

PISC: Post-Injection Site Care

PWS: Public Water System

PWSS: Public Water System Supervision

RA: Regional Administrator (EPA)

RCRA: Resource Conservation and Recovery Act

SDWA: Safe Drinking Water Act

TDS: Total Dissolved Solids

UIC: Underground Injection Control

USDW: Underground Source of Drinking Water

Definitions

Area of review - region surrounding the GS project where USDWs may be endangered by injection; delineated using computational modeling

Carbon dioxide plume - underground extent of injected CO₂ stream

Carbon dioxide stream - CO₂ captured from an emission source, including incidental associated substances and substances added to improve injectivity

Confining zone - geologic formation (or group or part) stratigraphically overlying the injection zone that acts as barrier to fluid movement

4

Definitions of important words and concepts are:

Area of Review: the region surrounding the geologic sequestration project where USDWs may be endangered by the injection activity. The area of review is required to be delineated using computational modeling that accounts for the physical and chemical properties of all phases of the injected carbon dioxide stream and displaced fluids, and is based on available site characterization, monitoring, and operational data as set forth in 40 CFR 146.84 of the Class VI regulations. Note that this is different from AoR in other well classes which allow for a fixed radius from the well to be delineated

Carbon dioxide plume: the extent underground, in three dimensions, of an injected carbon dioxide stream.

Carbon dioxide stream: carbon dioxide that has been captured from an emission source (e.g., a power plant), plus incidental associated substances derived from the source materials and the capture process, and any substances added to the stream to enable or improve the injection process. This Class VI definition does not apply to any carbon dioxide stream that meets the definition of a hazardous waste under 40 CFR 261.

Confining zone: a geologic formation, group of formations, or part of a formation stratigraphically overlying the injection zone(s) that acts as barrier to fluid movement. For Class VI wells operating under an injection depth waiver, confining zone means a geologic formation, group of formations, or part of a formation stratigraphically **overlying and underlying** the injection zone(s) i.e both above and below, since the injection zone is not below the lowermost USDW.

Note: Injection depth waivers are for western United States deep USDWs.

Definitions (cont'd.)

Geologic sequestration - long-term containment of gaseous, liquid, or supercritical carbon dioxide stream in subsurface geologic formations

Geologic sequestration project - injection wells used to emplace a carbon dioxide stream beneath the lowermost formation containing a USDW

Injection interval - portion of injection zone in which the injection well is screened, perforated, or otherwise allows for movement of injectate into the formation

5

Geologic sequestration: the long-term containment of a gaseous, liquid, or supercritical carbon dioxide stream in subsurface geologic formations. This term does not apply to carbon dioxide capture or transport.

Geologic sequestration project means an injection well or wells used to emplace a carbon dioxide stream beneath the lowermost formation containing a USDW; or, wells used for geologic sequestration of carbon dioxide that have been granted a waiver of the injection depth requirements pursuant to requirements at 40 CFR 146.95; or, wells used for geologic sequestration of carbon dioxide that have received an expansion to the areal extent of an existing Class II enhanced oil recovery or enhanced gas recovery aquifer exemption pursuant to 40 CFR 146.4 and 144.7(d). It includes the subsurface three-dimensional extent of the carbon dioxide plume, associated area of elevated pressure, and displaced fluids, as well as the surface area above that delineated region.

Injection interval: the portion of the injection zone in which the injection well is screened, perforated, or otherwise allows for movement of injectate into the formation.

Definitions (cont'd.)

Injection zone - geologic formation of sufficient areal extent, thickness, porosity, and permeability to receive carbon dioxide through a well

Pressure front - zone of elevated pressure created by subsurface carbon dioxide injection

USDW - aquifer that supplies or contains sufficient ground water to supply a PWS that is currently used as drinking water for human consumption, or that contains fewer than 10,000 mg/l TDS and is not an exempted aquifer



Injection zone: a geologic formation, group of formations, or part of a formation that is of sufficient areal extent, thickness, porosity, and permeability to receive carbon dioxide through a well or wells associated with a geologic sequestration project.

Pressure front: the zone of elevated pressure that is created by the injection of carbon dioxide into the subsurface. For the purposes of this subpart, the pressure front of a carbon dioxide plume refers to a zone where there is a pressure differential sufficient to cause the movement of injected fluids or formation fluids into a USDW.

Underground Source of Drinking Water (USDW): an aquifer or portion of an aquifer that supplies any public water system or that contains a sufficient quantity of ground water to supply a public water system, and currently supplies drinking water for human consumption, or that contains fewer than 10,000 mg/l total dissolved solids and is not an exempted aquifer.

Class VI Program Elements Overview

- Purpose of Class VI permit application process
- General Class VI permit information
- Unique elements of Class VI Program
- GS Rule Elements

7

A few slides follow with information on **general Class VI permit information**, since Class VI permits are different from permits written for the existing UIC well classes. We will highlight some of the unique elements of the Class VI Program based on the UIC GS Rule. Then, information will be presented on the major sections of 40 CFR 146 Subpart H.

Purpose

- Class VI permit application process is designed to:
 - Initiate dialogues with owners/operators
 - Establish permit conditions
 - Ensure owners/operators site, construct, operate, monitor, and close Class VI wells in a manner that ensures USDW protection

8

With the Class VI permit application, the UIC Program Director will receive maps, geologic cross sections, and other data describing the subsurface geology and the general vertical and lateral limits of all USDWs within the delineated area of review (AoR) for the Class VI injection well. The site characterization process collects fundamental geologic information used to identify potential risks and eliminate unacceptable sites. For example, sites found to have significant seismic risks or sites that lack an adequate confining zone due to extensive transmissive faults or fractures would be determined unacceptable. Data and information collected during site characterization also provides important technical input to the development of well construction and operating plans, provides geologic data and parameters for use in the AoR delineation models, and establishes baseline information on the site geochemistry, geophysics, and hydrogeology for comparison to future site monitoring data collected over the life of the GS project.

Any geologic site information provided by the owner or operator will be checked by the UIC Program Director for consistency, as well as compared against available industry standards or regional geologic information. The UIC Program Director may request additional information if he or she observes inconsistencies in the submitted information or suspects that information may not accurately represent the subsurface. The UIC Program Director may also ensure that the methods of analysis are specified and that quality assurance information is provided where applicable.

Class VI Permit – General Information

- Class VI wells authorized by permit
 - UIC Program Director reviews and determines whether to grant permit
- Issued for facility operating life + PISC period
- UIC Program Director must review at least once every 5 years

40 CFR 144.18 and 144.36(a)

9

Class VI wells are authorized by permit. No rule authorization is allowed [40 CFR 144.18]. The UIC Program Director will first review the permit application materials to determine whether Class VI well construction should be approved. Then he or she will review additional materials submitted by the potential owner/operator to determine if well operation may be authorized. Even Class II wells previously authorized by rule must have a Class VI permit if re-permitting as a Class VI injection well is required or intended.

Class VI permits are issued for the operating life of the GS facility and the post-injection site care period (PISC). The UIC Program Director must review each Class VI operating permit at least once every 5 years to determine whether it needs to be modified, revoked and reissued, or terminated [40 CFR 144.36(a)].

Class VI Permit – General Information (cont'd.)

- Area permits are not allowed
- Class VI permits cannot be automatically transferred from the permittee to a new owner/operator

40 CFR 144.33(a)(5) and 144.38(b)

10

Class VI permits may not be automatically transferred from the permittee to a new owner or operator.

Area permits are not allowed for Class VI wells. The discussion on this in the GS Rule preamble is found at 75 FR 77274-77275.

Class VI Permit – General Information (cont'd.)

- Aquifer exemptions may only be used if a Class II well currently operating under an aquifer exemption is re-permitted as a Class VI well
 - Owner/operator or UIC Program Director must request, and the EPA Administrator must approve, expansion of existing exemption

40 CFR 144.7 and 146.4

11

Permitting for Class VI wells differs from that of other UIC Program injection well classes in various ways, and the UIC Program Director will need to be aware of these differences when evaluating Class VI permit applications:

Aquifer exemptions may only be granted for Class VI injection wells if the owner or operator or UIC Program Director requests, and the EPA Administrator approves, a request to expand an existing Class II aquifer exemption for a Class VI well. An aquifer exemption for a Class II well may only be expanded for Class VI injection if: 1) the aquifer does not currently serve as a source of drinking water; 2) the total dissolved solids content of the ground water is more than 3,000 mg/L and less than 10,000 mg/L; and, 3) the aquifer is not reasonably expected to supply a PWS in the future. Other than those EPA-approved aquifer exemption expansions that meet the criteria in 40 CFR 146.4(d), new aquifer exemptions will not be issued for Class VI injection wells.

The owner or operator of a Class II well that requests an expansion of the areal extent of an existing aquifer exemption must define and describe all aquifers or partial aquifers to be exempted. In their request, the owner or operator must use narrative descriptions, illustrations, maps, or other means to define the aquifer and also utilize clear geographic terms, including but not limited to, vertical and lateral limits, to describe the aquifer. These expansion requests are considered substantial program revisions that require a rulemaking process/update to 40 CFR 147. See the rule preamble at 75 FR 77253-77257 for more details. Additionally, the forthcoming UIC Program Class II-Class VI Transition Guidance will discuss program revisions and aquifer exemptions in depth. The Draft Primacy Application and Implementation Manual discusses program revisions as well.

Class VI Program – Unique Elements

- Geologic site characterization requirements
- Requirements for the construction and operation of the wells:
 - Construction with injectate-compatible materials
 - Alarms and shutoff systems to prevent fluid movement into unintended zones

40 CFR 146.86(b)(1) and 146.88(e)(2) & (3)

12

The elements of the GS Rule and the Class VI Program build upon the existing UIC regulatory framework, with modifications based on the unique nature of carbon dioxide injection for GS. We'll discuss these unique aspects in greater detail later in the presentation, but the highlights include:

- Comprehensive geologic site characterization to ensure that GS wells are appropriately sited;
- Requirements for the construction and operation of the wells that include construction with injectate-compatible corrosion resistant materials and installation of alarms and automatic surface shutoff systems to prevent fluid movement into unintended zones (for onshore wells, and additional down-hole shut-off systems may be required at the Director's discretion). For offshore wells located within state territorial waters, alarms and automatic down-hole shut-off systems are required.

Class VI Program – Unique Elements (cont'd.)

- Periodic re-evaluation of the AoR and subsequent project plans updates if needed
- Rigorous testing and monitoring of each GS project
 - Mechanical integrity testing of injection wells
 - Ground water monitoring
 - Tracking location of injected carbon dioxide plume and elevated pressure

40 CFR 146.84(e), 146.89, and 146.90(d) & (g)

13

- Periodic reevaluation of the area of review (AoR) delineation in order to incorporate monitoring and operational data and verify that the carbon dioxide is moving as predicted within the subsurface is required, at a minimum of every five years. The AoR requirements will be discussed in more detail later, but the total area being re-evaluated will be dependent on where the project is related to its lifecycle, the areal extent could easily include several miles depending on the volume of carbon dioxide injected, reservoir and geologic environment of the project. Project plans will be discussed throughout the presentations, and the AoR reevaluations may trigger specific project plan updates.
- Rigorous testing and monitoring of each GS project using a combination of testing methods, including mechanical integrity testing, ground water monitoring, and tracking of the location of the injected carbon dioxide using direct and indirect methods is required.

Class VI Program – Unique Elements (cont'd.)

- Clarified and expanded financial responsibility requirements
- Extended post-injection monitoring and site care
- Process addressing injection depth on a site-specific basis, accommodating injection into various formations while ensuring that *all* USDWs are protected

40 CFR 146.85, 146.93, and 146.95

14

- The UIC GS Rule also clarified and expanded the financial responsibility requirements to ensure that funds will be available for corrective action, well plugging, PISC, closure, and emergency and remedial response;
- The UIC Class VI GS Rule includes extended post-injection monitoring and site care to track the location of the injected carbon dioxide and monitor subsurface pressures until it can be demonstrated that USDWs are no longer endangered;
- Additionally, the UIC GS Rule includes a process to address the injection depth requirements on a site-specific basis and accommodate injection into various formation types while ensuring that all USDWs at all depths are protected;

Class VI Program – Unique Elements (cont'd.)

- Considerations for permitting wells transitioning from Class II to Class VI
- Requirements for development, implementation, periodic amendments to site-specific GS project plans to guide the operation of Class VI injection wells

40 CFR 144.19, 146.84(b), 146.90,
146.92(b), 146.93(a), and 146.94(a)

15

- The UIC GS Rule includes considerations for permitting wells that are transitioning from Class II enhanced recovery (ER) to Class VI that clarify the point at which the primary purpose of carbon dioxide injection transitions from ER to long-term storage. Note: This transition/re-permitting consideration can be a Program Director decision based on increased risk to USDWs if the owner/operator does not self-identify/initiate the permit transition process.
- The UIC GS Rule also contains requirements for the development, implementation, and periodic amendment of a series of project-specific plans to guide the operation and management of Class VI injection wells and GS projects over a long period of time; the plans are a required part of a Class VI permit application and become part of the permit conditions for the Class VI injection well. Plans can be revised over the lifetime of the Class VI injection well – modifications to the plans are considered permit modifications and would require both UIC Program Director approval and public notification as per 40 CFR 144.39 of the UIC Class VI GS Rule.

Five Project Plans: Overview

1. AoR and Corrective Action Plan
2. Testing and Monitoring Plan
3. Injection Well Plugging Plan
4. PISC and Site Closure Plan
5. Emergency and Remedial Response Plan



16

Here is a list of the plans which we will refer to in more detail throughout our discussion of the rule elements.

The UIC Program Director will receive these site-specific plans with a Class VI permit application.

As we'll discuss, all of the plans are related and should be developed and reviewed in the context of each other and the context of site-specific information.

The Project Plan Development Guidance (draft available on the EPA's website at <http://water.epa.gov/type/groundwater/uic/class6/gsguidedoc.cfm>) discusses each of these project plans in detail.