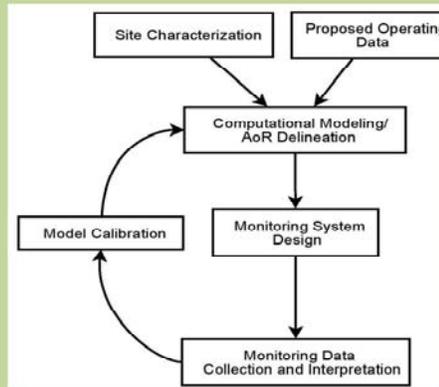


Underground Injection Control Geologic Sequestration Rule Training Workshop: Site Characterization (40 CFR 146.83)

Purpose: Site Characterization

- Identifies potential risks and eliminates unacceptable sites
- Informs construction and operating plans and AoR delineation
- Establishes information for comparison to monitoring data



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- The purpose of the site characterization process is to identify potential risks and eliminate unacceptable sites for Class IV injection wells (i.e., sites with potential seismic risk or sites that contain transmissive faults or fractures).
- Data and information collected during site characterization also informs the development of Class VI well construction and operating plans, and provides geologic data for use in the AoR delineation computer models,
- Site Characterization data also establishes information for comparison to geochemical, geophysical, and hydrogeologic monitoring data collected over the life of the injection project.

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 AoR as part of a Class VI permit application package.

Any geologic site information provided by the owner or operator may be checked by the Director for consistency, as well as compared against available industry standards or regional geologic information. The 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 Director may also ensure that the methods of analysis are specified and that quality assurance information (e.g., duplicate measurements) is/are provided where applicable.

Purpose: Site Characterization

- Demonstrates to the UIC Program Director:
 - Injection zone
 - Sufficient areal extent, thickness, porosity, and permeability to receive anticipated volume of carbon dioxide

40 CFR 146.83(a)(1)

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Owners or operators of proposed Class VI injection wells are responsible for demonstrating to the UIC Program Director that the injection wells and GS operations are located in areas with suitable geology for safe and effective GS.

Specifically, the owner's or operator's site characterization efforts must demonstrate that the geologic system includes an **injection zone** of sufficient areal extent, thickness, porosity, and permeability to receive the total anticipated volume of the carbon dioxide stream.

Purpose: Site Characterization (cont'd.)

– Confining zone(s)

- Free of transmissive faults/fractures
- Sufficient areal extent and integrity to contain carbon dioxide stream and displaced formation fluids
- Allow injection at max proposed pressures/volumes without initiating or propagating fractures

40 CFR 146.83(a)(2)

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The site characterization information included in a Class VI permit application must also demonstrate that **confining zone(s)** are free of transmissive faults or fractures and are of sufficient areal extent and integrity to prevent the upward (or downward, if requesting an injection depth waiver) migration of the injected carbon dioxide stream and displaced formation fluids, and allow injection at proposed maximum pressures and volumes without initiating or propagating fractures in the confining zones.

Site Characterization: UIC Program Director Reviews

- Maps, cross sections, and illustrations
- Information on faults/fractures
- Depth, areal extent, thickness, mineralogy, permeability, porosity, and capillary pressure of injection/confining zones
 - With the permit application

40 CFR 146.82(a)(3)(i) - 146.82(a)(3)(iii)

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The next four slides cover the required information that the UIC Program Director will review when receiving a Class VI permit application:

- Geologic and topographic maps and cross sections of the area of review that describe and support available assessments of the geology and hydrogeology of the region in general, and of the injection and confining zones, specifically – as mentioned briefly in the previous slides. Ideally, there will be at least two cross sections, oriented perpendicular to each other
- The UIC Program Director will have to compare the submitted permit application information for consistency against other available maps and geologic information, and may request additional information if inconsistencies are observed.
- The location and orientation of known or suspected faults and fractures that may transect the confining zone(s) in the AoR and a determination that they would not interfere with containment. The owner or operator may also provide an evaluation of the transmissive properties of any major faults that penetrate the confining zones.
- Information on depth, areal extent, mineralogy, porosity, permeability and thickness of both the injection zone and the confining zone or zones proposed to be used in the GS project

Site Characterization: UIC Program Director Reviews (cont'd.)

- Data on geology/facies changes
 - With the permit application
- Maps and stratigraphic cross sections of the AoR

40 CFR 146.82(a)(3)(i), 146.82(a)(3)(iii), and 146.82(a)(5)

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The Director will review submitted data from the required **facies** analysis of core samples (e.g., mineralogy, lithology, grain size, texture), borehole logs (e.g., density or gamma ray logs), and possibly seismic survey data to determine the characteristics of the rock units and their depositional environments. The owner or operator will also need to submit geologic maps and accompanying stratigraphic cross sections and columns, well logs, and wireline logs. Correlation between these various data sources provides a 3D representation of the subsurface stratigraphy.

The submitted maps and stratigraphic cross sections, along with accompanying materials, should demonstrate that the stratigraphy (the sequence of subsurface formations) is appropriate for GS. They should also demonstrate that the injection zone can safely receive, and the confining zone(s) can effectively contain, carbon dioxide. These materials must show the vertical and lateral limits of all USDWs within and around the AoR, the drinking water wells and springs within the AoR and their positions relative to the injection zone(s), and the direction of ground water flow where known (including both vertical and horizontal flow in all USDWs and aquifers).

Data and information that characterize the mineralogy of both the injection and confining zones through laboratory testing based on cuttings and samples collected during drilling.

Site Characterization: UIC Program Director Reviews (cont'd.)

- Geomechanical information
- Information on seismic history/seismicity
- Baseline geochemical data
 - With the permit application

40 CFR 146.82(a)(3)(iv)-(v) and 146.82(a)(6)

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The UIC Program Director will review the submitted geomechanical information on fractures, stress, ductility, rock strength, and *in situ* fluid pressures of confining zones. The owner or operator must submit data regarding pore pressure, *in situ* stresses (e.g., magnitude and orientation of the vertical stress, minimum and maximum horizontal stress), rock strength, and faults and fractures.

The Director will also review submitted information on seismicity, including a history of seismic events in the region, their magnitudes, epicenters, depths of focus, and whether they caused movement along faults that intersect the injection or confining zones.

Geochemical data on subsurface formations, including all USDWs in the AoR, to identify the geochemical compatibility of the injection zone and the carbon dioxide stream, the potential for wellbore-corrosive conditions, and the potential for leaching and mobilization of contaminants from the injection zone.

Note that in order to conduct certain site characterization activities (e.g., drilling of an exploratory well) the state or injection well permitting authority may require additional activities, such as obtaining a strat well permit, outside the scope of the UIC GS Rule requirements but still necessary in order to collect the necessary site characterization data in order to apply for a Class VI injection well permit.

Also, the information submitted to the UIC Program Director with the permit application is public and will be made available for comment. If there is information provided in the permit application that is considered confidential business information (CBI), the owner/operator and the UIC Program Director should determine how to best proceed with the required public notice and comment process.

Site Characterization: UIC Program Director Reviews (cont'd.)

- Proposed formation testing program/plan
 - Determine if formation can safely receive injectate and if formation fluids are compatible
- Proposed stimulation program
 - With the permit application

40 CFR 146.82(a)(8) & 146.82(a)(9)

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Additional information that the UIC Program Director will review includes the proposed formation testing program describing planned collection and analysis of chemical and physical characteristics of fluids in both the injection zone and the confining zone(s). The proposed formation testing program specifies formations in which testing and monitoring take place, sampling depths and anticipated depths of screened intervals of monitoring wells

The formation testing program needs to include sampling and analysis methods to be used for fluid and solid samples collected during drilling. EPA recommends that the owner/operator develop plans for analyzing the solids in the injection zone and the confining zone(s) for chemical composition and mineralogy, porosity, permeability, capillary pressure, and geomechanical properties.

There may also be a proposed stimulation program submitted with a Class VI permit application. Owners or operators seeking to stimulate the injection well, perhaps by using in-situ formation stress testing or by hydraulic fracturing, must indicate this in a proposed stimulation program to be submitted with the permit application. The proposed stimulation program must demonstrate that stimulation activities will not compromise the integrity of the confining zone(s).

Directors may request additional information, and must be notified prior to all stimulation activities throughout the life of the GS project. Directors may want to review stimulation plans, assess the fluids to be used, witness the activity, or make requirements that obtained pressure data from the test be submitted for review prior to any stimulation activity. Any prior stimulation performed for wells located in oil and gas fields should be included with the Class VI permit application materials (ie. The number of times prior stimulation was performed, controls in place during stimulation, and pressure during stimulation, etc.)

Additional Confining Zones

- UIC Program Director may require characterization of additional zones
 - If known or suspected faults/fractures may interfere with containment
- Further impede vertical fluid movement, ensure carbon dioxide containment, provide additional zones for monitoring, and protect USDWs

40 CFR 146.83(b)

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If the Director determines that known or suspected faults and fractures may transect the confining zone(s) and interfere with containment of the storage site, then he or she may require that the owner/operator identify and characterize secondary, additional confining zones that will impede vertical fluid movement and ensure containment of carbon dioxide. In certain geologic settings, these zones may be appropriate to ensure USDW protection and allow for pressure dissipation. Additional confining zones may also provide further opportunities for monitoring, mitigation, and remediation.

Some Class VI Program Site Characterization Resources

- For more information on site characterization, refer to:
 - Draft UIC Program Class VI Primacy Application and Implementation Manual
 - Draft UIC Program Class VI Site Characterization Guidance
 - EPA's Class VI Web site:
<http://water.epa.gov/type/groundwater/uic/class6/gclass6wells.cfm>

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Some Class VI Program site characterization resources available are:

- The Draft UIC Class VI Primacy Application and Implementation Manual.
- The Draft UIC Class VI Site Characterization Guidance.
- And EPA's Class VI website at:
<http://water.epa.gov/type/groundwater/uic/class6/gclass6wells.cfm>.