The US Regulatory Framework for CCS

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Enforcement through Primacy

permanent.access.gpo.gov/.../uic/primacy.html
Underground Injection

- Safe Drinking Water Act (SDWA) passed in 1974
- Protect public health by regulates underground injection beneath Underground Sources of Drinking Water (USDWs)

- USDW:
  - \( \leq 10,000 \text{ mg/L total dissolved solids} \)
  - Limited volume production
Underground Injection Control (UIC)

Six classes of injection wells defined:

- Class I – Hazardous wastes, industrial non-hazardous liquids, or municipal wastewater below USDW (549)
- Class II – Brines and fluids associated with oil and gas production (143,951)
- Class III – Solution mining (18,505)
- Class IV – Hazardous or radioactive waste above USDW – Banned (32)
- Class V – Non-hazardous fluids above USDW, shallow on-site disposal, experimental (600,000-800,000)
- Class VI – Injection of CO₂ into underground subsurface rock formations for long-term storage, or geologic sequestration (December 2010).
Class I

Class II

Class III

Class IV

Class VI

www.epa.gov
Class V

In your community, there may be industrial waste disposal wells, storm water drainage wells, large-capacity septic systems, and other Class V wells. They are regulated and are not allowed to endanger drinking water resources.
Previous Framework

- $\text{CO}_2$ sequestration wells permitted as Class I, II, or V depending on volume and injection locations.

- Class I and V permits issued for both large- and small-scale saline reservoir sequestration projects.

- Class II well permits issued for CO2 Enhanced Oil Recovery (EOR), regardless of CCS.
Operating in a Complex Regulatory Context

- Permitting in an emerging regulatory framework
- Illinois (USEPA Region 5) has primacy: IEPA
  - UIC Class I, III, IV, V
  - UIC Class II through Illinois Department of Natural Resources – Mines and Minerals Oil and Gas Division
- Most recent new Illinois permit for a Class I Non-Hazardous well was issued in 1970s
- Shared common goal to see that projects were not slowed down by permitting process
- Class V guidance for experimental wells issued
- Class VI finalized December 2010, States apply for primacy by September 2011, reapply for Class VI permits by December 2011. Unlikely Illinois will apply for primacy, permit reverts to US EPA Region V
Example: Permitting a CCS Demonstration Project

- Corn processing plant
- CO₂ source is ethanol production facility
- Storage of 1 million tonnes CO₂ over three years
- One injection zone monitoring well
- Four regulatory shallow groundwater wells
- Area of review 2.5 miles
IBDP Permit Requirements

- Permit for 1 million metric tones CO$_2$ injection
- Permit for project duration
- Reaplication if used as commercial well, under new regulatory conditions
- Well Construction
  - Casing – chrome steel grades in contact with CO$_2$
  - Cement – CO$_2$ resistant cement
  - Surface, intermediate, and long-string cemented to surface
  - Operations – continuous recording of injection pressure, injection rate, temperature, annular space pressure
  - Closure – cement to surface
- CO$_2$ Composition
  - As stated in permit application – 99.98% pure
  - Grab samples required annually
Permit Requirements (Cont.)

- Monitoring
  - 4 regulatory shallow groundwater monitoring wells
  - Determine lowermost USDW
  - Injection pressure to be determined (submitted in completion report)
  - Injection rate up to 1,200 tons/day
  - Corrosion plan (completion report)
  - Injection zone – demonstrate no cross contamination

- Mechanical Integrity
  - MIT every 5 years
  - Annual annulus pressure test
  - Temperature survey every two years
  - Well annulus pressure – 400 psi minimum
  - Pressure differential – 100 psi differential between tubing and annulus during injection
New Developments

- In December 2010, the United States Environmental Protection Agency (US EPA) finalized rules for the regulation of CO$_2$ injection wells for CO$_2$ sequestration within the UIC program.

- Guidance documents continue to be developed
Class VI Permitting

- Class VI Rule covers all aspects of CO$_2$ sequestration from pre-injection to post-injection site care (PISC).
- Nineteen of the 21 items required under the Class VI Rule that need to be included in the permit are specific to CCS.
Unique to Class VI Regulations

- Geologic site characterization requirements
- Requirements for well construction and operation
- Periodic re-evaluation of Area of Review and project plan updates if needed
- Rigorous testing and monitoring of:
  - Mechanical integrity of injection wells
  - Groundwater quality
  - Tracking plume and elevated pressure
Unique to Class VI (cont.)

- Clarified and expanded financial responsibility
- Extended post-injection monitoring and site care
- Requirements for development, implementation, periodic amendments to project plans:
  - Area of Review and Corrective Action Plan
  - Testing and Monitoring Plan
  - Injection Well Plugging Plan
  - Post-Injection Site Closure Plan
  - Emergency and Remedial Response Plan
Class VI Permit Process

- Application
  - Site Characterization – identification and protection of lowermost USDW
  - Maps- geologic, hydrologic
  - Models- static/reservoir/hydrogeologic
  - Area of Review
  - Plans
  - Designs

- Well Construction and Testing-MIT

- Public Engagement Process

- Final Permit Approval

- Testing, and Reporting, Updates,
Public Engagement Process

- Public notice of permit application
- Public comment period
- Public can request public hearing
- Public hearing
- Public comment period
- Response to comments
- Public issuance of draft permit
- Public comment period
- Respond to comments
- Public appeal period for final permit
Information Required

- Map showing injection well
- Area of review
  - Number or name, and location of any and all wells,
  - Surface bodies of water, springs, mines (surface and subsurface), quarries, water wells,
- Surface features including structures intended for human occupancy, State, Tribal, and Territory boundaries, and roads.
- Faults, if known or suspected.
Information Required (continued)

- Data on the depth, areal extent, thickness, mineralogy, porosity, permeability, and capillary pressure of the injection and confining zone(s); including geology/facies changes based on field data which may include geologic cores, outcrop data, seismic surveys, well logs, and names and lithologic descriptions.

- Geomechanical information on fractures, stress, ductility, rock strength, and in situ fluid pressures within the confining zone(s).
Information Required (continued)

- Seismic history including the presence and depth of seismic sources and a determination that the seismicity would not interfere with containment.

- Geologic and topographic maps and cross sections illustrating regional geology, hydrogeology, and the geologic structure of the local area.
Numerical Injection Modeling to Delineate Area of Review

Duguid et al. Schlumberger Carbon Services
Injection Well Construction Requirements

- Casing and cement or other materials used in the construction:
  - Sufficient structural strength
  - Designed for the life of the geologic sequestration project
  - Compatible with fluids expected to contact well

- Cement and cement additives:
  - Compatible with CO$_2$ stream and formation fluids
  - Sufficient quality & quantity to maintain integrity over design life of project
  - At least one long string casing:
    - Using sufficient number of centralizers
    - Must extend to the injection zone
    - Must be cemented by circulating cement to the surface in one or more stages

- Tubing and packer materials:
  - Must be compatible with fluids expected to come into contact with
CO$_2$ Injection Well

- Well Head
- Cement
- Surface casing
- Injection tubing
- Pressurized annulus
- Long-string casing
- Cement
- Packer
- Perforations
- Confining zone
- Injection Zone
- Lowest USDW