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## **CO<sub>2</sub> Underground Injection Regulations: Selected Differences for Enhanced Oil Recovery and Geologic Sequestration**

Underground injection and storage of carbon dioxide (CO<sub>2</sub>) has been proposed as a solution for mitigating CO<sub>2</sub> emissions into the atmosphere from stationary sources burning fossil fuels. In this process, CO<sub>2</sub> is compressed into a fluid (supercritical) state and injected underground for enhanced oil recovery (EOR) or for geologic sequestration (GS). Both operations use wells to place CO<sub>2</sub> into deep subsurface geologic formations, but they are regulated differently both by the U.S. Environmental Protection Agency (EPA) and states. Recent discussions in Congress regarding underground carbon storage, including debate about tax credits for geologic sequestration and EOR CO<sub>2</sub> injection, have raised interest in the similarities and differences between these operations and associated regulations.

### **Enhanced Oil Recovery (EOR)**

EOR is a process used in the oil industry since the 1970s whereby certain fluids are injected underground to increase production from partially depleted oil reservoirs. CO<sub>2</sub> has become the most common injection fluid used in EOR projects. The CO<sub>2</sub> can be pumped out for reuse after injection, although some of the CO<sub>2</sub> remains trapped underground. There are more than 134,000 EOR wells injecting CO<sub>2</sub> in the United States, predominantly in California, Texas, Kansas, Illinois, and Oklahoma.

Most CO<sub>2</sub> injected for EOR comes from naturally occurring underground CO<sub>2</sub> reservoirs, but roughly 20% comes from industrial sources. The CO<sub>2</sub> is typically injected into an aging oil reservoir using the existing well infrastructure from the original oil production process. According to a 2019 National Energy Technology Laboratory report, between 30% and 40% of the CO<sub>2</sub> is generally considered to be stored after each injection cycle, depending on the reservoir characteristics.

### **Geologic Sequestration of CO<sub>2</sub>**

GS of CO<sub>2</sub> is envisioned as the long-term containment of supercritical CO<sub>2</sub> in subsurface geologic formations. The intent is to permanently trap the injected CO<sub>2</sub> underground, either in its injected form or through geochemical transformation. GS projects, including research projects and large-scale demonstration projects, may use CO<sub>2</sub> captured from large stationary sources, such as coal-fired power plants or industrial facilities. The CO<sub>2</sub> is compressed and injected through wells into geologic formations, typically saline reservoirs a half a mile or more below the earth's surface. CO<sub>2</sub> injection for GS generally involves higher injection pressures, larger expected fluid volumes, and different physical and chemical properties of the injection stream compared to EOR injection.

To prevent endangerment of underground sources of drinking water (USDWs), EPA regulations for GS require that these formations meet certain criteria for receiving and retaining expected high volumes and pressures of injected CO<sub>2</sub> without leaking.

Two EPA-permitted wells are currently operating for GS in the United States, both located at a facility in Illinois.

### **EPA and State Program Regulations**

The Safe Drinking Water Act (SDWA) directs EPA to regulate underground injection activities to prevent endangerment of USDWs (42 U.S.C. §300h). EPA has issued regulations for six classes of underground injection wells based on type and depth of fluids injected and potential for endangerment of USDWs. Class II wells are used to inject fluids related to oil and gas production, including injection of CO<sub>2</sub> for EOR. Class VI wells are used to inject CO<sub>2</sub> for GS.

SDWA Section 1421 requires that EPA regulations for state Underground Injection Control (UIC) programs include requirements for inspection, monitoring, recordkeeping, and reporting. Accordingly, EPA's UIC regulations specify minimum requirements for siting, construction, operation, monitoring and testing, closure, corrective action, financial responsibility, and reporting and recordkeeping (40 C.F.R. §§144-148).

### **State Primacy**

SDWA directs EPA to delegate primary responsibility for program administration and enforcement (primacy) for UIC programs to states, territories, and tribes that meet statutory requirements. For Class II wells only, states can assume primacy under either SDWA Section 1422 or Section 1425. States delegated primacy under Section 1422 must meet EPA regulatory requirements promulgated under Section 1421. Sixteen states have Section 1422 primacy. Two of these states have EOR wells, which are therefore subject to EPA's regulations. In addition, EPA directly administers Class II UIC programs in 10 states, five of which have EOR wells.

Section 1425 allows states to administer their own Class II UIC program without meeting EPA's regulatory requirements provided the state demonstrates that its program meets certain requirements under SDWA Section 1421 and represents an effective program to prevent endangerment of USDWs (42 U.S.C. §300h-4). Twenty-four states and three tribes have Class II primacy under Section 1425. Nearly 99% of Class II wells for EOR are located in these states and tribal lands.

Primacy for Class VI wells is available under Section 1422 only. EPA has delegated Class VI primacy to one state, North Dakota. On April 14, 2020, EPA proposed to grant Class VI primacy to Wyoming as well (85 *Federal Register* 20621).

**Table 1. EOR and Permanent GS Injection Wells**

	Enhanced Oil Recovery	Geologic Sequestration
<b>EPA Well Class</b>	Class II	Class VI
<b>Purpose</b>	Injecting CO <sub>2</sub> into aging oil fields for EOR	Injecting CO <sub>2</sub> into geologic formations for permanent CO <sub>2</sub> storage
<b>Number of Wells</b>	134,650	2
<b>CO<sub>2</sub> Volume Injected</b>	68 million tons/year (as of 2014)	1.3 million total (one project in IL [2019 data])
<b>SDWA Primacy States</b>	40 (16 under §1422 24 under §1425)	1

**Notes:** Number of permitted EOR wells is approximate and based on 2018 EPA data. CO<sub>2</sub> volume based on most recent data available. SDWA = Safe Drinking Water Act.

### Selected Differences in EPA Regulation

For Class II EOR wells, under UIC regulations (40 C.F.R. §§144-147), all new wells require a permit and are subject to permitting standards for construction, operation, financial responsibility, mechanical integrity, and corrective action. Pre-existing EOR wells, in contrast, are generally authorized by rule for the lifetime of the project and must follow EPA regulatory requirements for reporting, casing and cementing, monitoring, well plugging and abandonment, and financial responsibility. EPA guidance recommends that rule-authorized EOR well operations be reviewed every five years.

In 1981, EPA issued guidance for states seeking Section 1425 primacy regarding permitting, technical criteria, and enforcement mechanisms. These are not regulatory requirements, as Section 1425 gives states significant discretion in implementing their own Class II programs.

Regulations for Class VI GS wells require individual permits (40 C.F.R. §§146.81-146.95). The regulations specify requirements and technical standards to prevent CO<sub>2</sub> leaks that could endanger USDWs under conditions unique to permanent sequestration. Because of differences in CO<sub>2</sub> injection characteristics and the potential impact on USDWs, Class VI regulations include more specific and more comprehensive permitting, construction, operating, and closure requirements than do EPA Class II requirements.

Examples of EPA *permitting* requirements for GS wells, which are not required for EOR wells, include:

- Information on potential seismicity (earthquakes) in the area of the proposed injection site;
- Demonstration that the formation's confining zone (which limits fluid movement) is free of faults or fractures and can contain the injected CO<sub>2</sub> and other formation fluids (e.g., brine) without initiating or propagating fractures in the formation; and
- Well plugging, closure, site care, and emergency and remedial response plans.

Select EPA *construction and operating* requirements for GS wells only:

- Use of materials and performance standards suitable for CO<sub>2</sub> contact for the life of the project,
- Specific mechanical integrity testing to demonstrate that there is no significant leakage or fluid movement into a USDW,
- Continuous monitoring of CO<sub>2</sub> injection pressure,
- Analysis of CO<sub>2</sub> stream characteristics,
- Testing and monitoring of the underground CO<sub>2</sub> plume and pressure front,
- Periodic monitoring of ground water quality above the confining zone(s), and
- More frequent (semi-annual) reporting of testing and monitoring data and reporting of more specific information on the CO<sub>2</sub> stream and pressure.

Select EPA *post-injection* requirements for GS wells only:

- Continuous monitoring of the underground CO<sub>2</sub> plume and pressure front, and
- Post-injection site care for 50 years after injection.

### Transition from Class II EOR to Class VI GS Wells

To protect USDWs from injected CO<sub>2</sub> or movement of other fluids in an underground formation, EOR wells must transition to Class VI GS wells under certain conditions (40 CFR §144.19). Class II well owners or operators who inject CO<sub>2</sub> primarily for long-term storage (rather than oil production) must obtain a Class VI permit when there is an increased risk to USDWs compared to prior Class II operations using CO<sub>2</sub>. The Class VI program director (EPA or primacy state) determines whether a Class VI permit is required based on site-specific risk factors associated with USDW endangerment. No transition has yet been required.

### Greenhouse Gas Emissions Reporting Rule

EOR and GS wells are subject to different regulatory requirements under EPA's Greenhouse Gas Reporting Program. Under Subpart RR of the program rule (40 C.F.R. §98), GS well permit holders must report the amount of CO<sub>2</sub> sequestered; develop and implement a monitoring, reporting, and verification plan to verify sequestration; and collect data on CO<sub>2</sub> surface emissions from the operation. Subpart UU of the rule, which applies to EOR wells, requires permit holders to report the amount and source of CO<sub>2</sub> received (rather than injected).

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