CARB LCFS Requirements vs. UIC Class VI Permitting

This document summarizes California Air Resources Board (CARB) Low Carbon Fuel Standard (LCFS) requirements for "Sequestration Site Certification"[1] compared to analogous requirements under the U.S. Environmental Protection Agency (EPA) Underground Injection Control (UIC) Class VI program.

The following list includes **required reports** for **CARB Sequestration Site Certification application,** the *analogous U.S. EPA Class VI requirements/reports*, and highlights key requirements unique to CARB.

Report 1. Site-Based Risk Assessment

- *Analogous U.S. EPA Class VI Report:* None
- **LCFS Protocol Sections:** C.1.1.2.b; C.2.2

Key CARB unique requirements

» Carbon dioxide (CO_2) retention analysis (modeling) must be performed to comply with requirement that "only sites in which the fraction of CO_2 retained in the storage complex is very likely (greater than 90% probability of occurrence) to exceed 99% over 100 years post-injection will be eligible to receive Permanence Certification."

» A Risk Management Plan must be provided that "summarize[s] the activities evaluated for risk, what those risks are, how they are ranked, and the steps the CCS Project Operator will take to manage, monitor, avoid, or minimize those risks."

Report 2. Geologic Evaluation

- *Analogous U.S. EPA Class VI Report:* Narrative Application Report (Attachment A)
- **LCFS Protocol Sections:** C.1.1.2.b; C.2.1; C.2.3

Key CARB unique requirements

» The injection depth must be a minimum of 2,600 feet below ground or the depth corresponding to CO_2 existing in a supercritical state.

» A Formation Testing and Well Logging Plan must be provided as a separate plan to be included within the Geologic Evaluation report; this plan overlaps with other CARB requirements.

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Note: Report and attachment numbers and letters are provided as examples only; neither CARB nor the U.S. EPA is prescriptive in this nomenclature. Also, these CARB-unique requirements are relative to the federal U.S. EPA Class VI standards and are not compared at this stage to requirements for states with UIC Class VI primacy.

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Report 3. Storage Complex and Corrective Action Plan

- *Analogous U.S. EPA Class VI Report:* AoR and Corrective Action Plan (Attachment B)
- **LCFS Protocol Sections:** C.2.4

Key CARB unique requirements

» The areal extent of the LCFS Storage Complex is interpreted to be defined by the CO_2 plume, whereas the U.S. EPA Class VI Area of Review (AoR) is defined by the maximum extent of both the CO_2 plume and the pressure front. (The Class VI rules allow for the calculation of a risk-based AoR, which can reduce the size of the AoR.)

» History matching the pressure distribution is required for the computational model used to delineate the Storage Complex.

» Preferably an open-source computational code is used for modeling and the code must be available to CARB. The code must be validated by a third party.

» "System response to leakage" must be modeled, and results must be used in both the risk assessment and the testing and monitoring design.

» Sensitivity analyses are required by CARB, whereas they are recommended by U.S. EPA in the AoR and Corrective Action guidance document.

» The computational model must account for the dissolved phase of the CO_2 plume (in water and, as applicable, oil), in addition to the supercritical/free-gas phase.

» Unscheduled plume extent reevaluations are required following an earthquake of magnitude 2.7 or greater within a 1-mile radius of the Storage Complex [C.2.4.4.1(d)(1)].

Report 4. Baseline Testing and Monitoring Plan

- *Analogous U.S. EPA Class VI Report:* None
- **LCFS Protocol Section:** C.2.5

Key CARB unique requirements

» Baseline (pre-injection) monitoring is required to be performed for "no less than one year" prior to the application for Project Certification.

» Monitoring "including but not limited to downhole pressure, sequestration zone fluid chemistry, soil-gas composition, vegetation type and density, and fresh and overburden water chemistry and pressure" is required in the baseline monitoring.

» A Baseline Testing and Monitoring Report must be submitted summarizing the baseline data with the application for Project Certification.

Report 5. Well Construction Plan

- *Analogous U.S. EPA Class VI Report:* The U.S. EPA template includes well construction information in the Narrative Report (Attachment A) but is often submitted as a separate attachment.
- **LCFS Protocol Section:** C.3.1

Key CARB unique requirements

» CARB specifies 'wellheads and valve' requirements, whereas the U.S. EPA Class VI regulations (40 CFR 146.86) does not list corresponding requirements.

» "Routine well maintenance must be conducted at a minimum of every six months. Routine maintenance consists of wellhead valve maintenance and measurement of casing annular pressures. If a significant deviation such that the mechanical integrity of the well is compromised or may become compromised, the appropriate remediation plan must be triggered."

Report 6. Pre-Injection Testing Plan

- *Analogous U.S. EPA Class VI Report:* Pre-Operational Testing Plan
- **LCFS Protocol Section:** C.3.2

Key CARB unique requirements: None

Report 7. Well Operating Plan

- *Analogous U.S. EPA Class VI Report:* The U.S. EPA template includes well operating information in the Narrative Report (Attachment A) and AoR and Corrective Action Plan (Attachment B) but is often submitted as a separate attachment.
- **LCFS Protocol Section:** C.3.3

Key CARB unique requirements

» The CCS Project Operator must ensure that injection pressure does not exceed 80 percent of the fracture/parting pressure (compared to 90 percent in U.S. EPA Regulations at 40 CFR 146.88); the CCS Project Operator may propose an alternative injection pressure with a required demonstration in the Plan "that provides an explanation for why injecting below 80 percent of the fracture/parting pressure is not feasible, and why an alternative pressure must be used."

Report 8. Testing and Monitoring Plan

- *Analogous U.S. EPA Class VI Report:* Testing and Monitoring Plan (Attachment C)
- **LCFS Protocol Section:** C.4.1, C.4.2, C.4.3

Key CARB unique requirements

» Continuous fluid composition and density monitoring [C.4.3.1.2.(d).(2)]

» Internal mechanical integrity test at least once every five years [C.4.2.(b).(1)]

» Monitoring, Measurement and Verification Plan [C.4.3.2]

» Project 'verification' by a CARB-accredited oil and gas system specialist [C.4.3.2.4]

» Surface air monitoring including broad aerial monitoring and targeted monitoring around wellbores [C.4.3.2.2(d) and (e)]

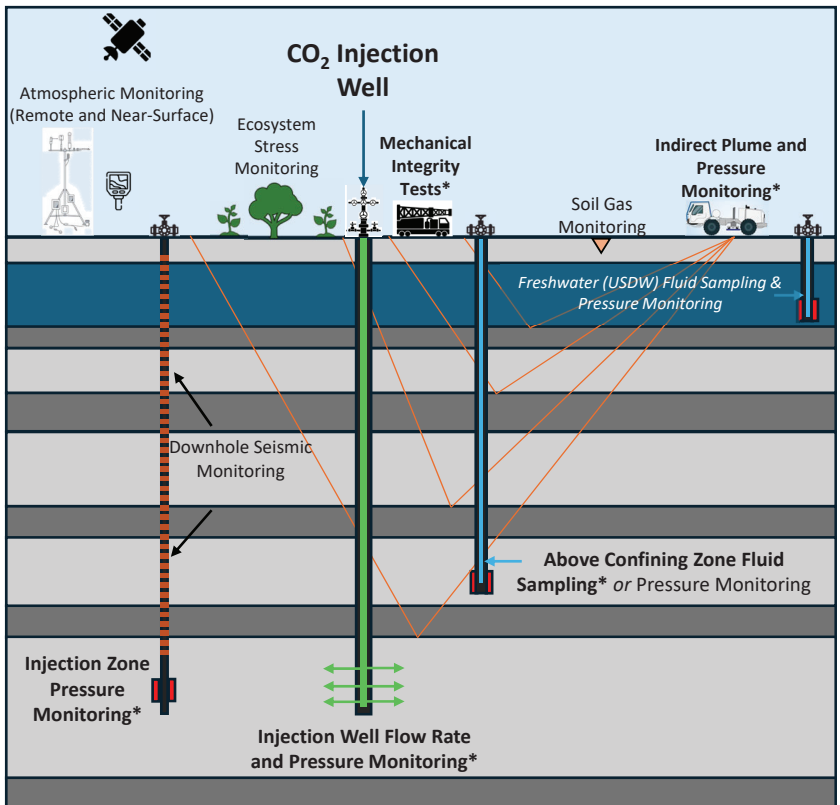
» Soil gas monitoring in the event leakage is detected [C.4.3.2.2.(g)]

» Near-surface electrical conductivity surveys must be "considered" in the event of potential leakage [C.4.3.2.2.(h)]

» Ecosystem stress monitoring [C.4.3.2.2(f)]

» Permanent downhole seismic monitoring system [C.4.3.2.3]

» Inspection and Leak Detection Program for monitoring wellheads and valves [C.4.3.1.6]



CARB LFCS Site Certification Monitoring Schematic

Italics denotes monitoring that may be driven by risk assessment results.
Bold* denotes monitoring approaches that are also required by U.S. EPA Class VI rules.

Report 9. Well Plugging and Abandonment Plan

- *Analogous U.S. EPA Class VI Report:* Injection Well Plugging Plan (Attachment D), Post-Injection Site Care and Closure Plan (Attachment E; for monitoring wells)
- **LCFS Protocol Section:** C.5.1

Key CARB unique requirements: None

Report 10. Post-Injection Site Care and Site Closure Plan

- *Analogous U.S. EPA Class VI Report:* Post-Injection Site Care and Closure Plan (Attachment E)
- LCFS Protocol Section: C.5.2

Key CARB unique requirements

» Near-surface (e.g., air) monitoring [C.5.2.(b).(3).(G).(1)]

» A minimum of 100 years of post-injection site care (PISC) monitoring is required by CARB [C.5.2.(b).(2)], whereas the U.S. EPA (40 CFR 146.93) default for the PISC time frame is 50 years. The U.S. EPA allows for a demonstration during the initial application that the time frame can be shorter, and also allows for a demonstration during the actual post-injection time frame to shorten the monitoring period. After 15 years, if a stabilization demonstration can be made, CARB monitoring may be limited to surface monitoring.

Report 11. Emergency and Remedial Response Plan

- *Analogous U.S. EPA Class VI Report:* Emergency and Remedial Response Plan (Attachment F)
- **LCFS Protocol Section:** C.6

Key CARB unique requirements: None

Report 12. Financial Responsibility Demonstration

- *Analogous U.S. EPA Class VI Report:* Financial assurance demonstration
- **LCFS Protocol Section:** C.7

Key CARB unique requirements

- According to Townsend and Havercroft (2019)[2], the text on financial mechanisms is identical, except that the U.S. EPA financial mechanism only needs to cover the cost of endangerment to drinking water resources and not the broader definition of environment and public health as specified in the LCFS Protocol.

Report 13. Legal Understanding Demonstration

- *Analogous U.S. EPA Class VI Report:* None
- **LCFS Protocol Section:** C.9

Key CARB unique requirements

- Proof of exclusive right to use the pore space in the sequestration zone for permanently storing CO_2.

Third-Party Peer Review

- *Analogous U.S. EPA Class VI Report:* None
- **LCFS Protocol Section:** C.1.1.1

Key CARB unique requirements

- Requirement for third-party review, to be organized and paid for by applicant with CARB approval of reviewer.

[1] Per the CARB "Carbon Capture and Sequestration Protocol under the Low Carbon Fuel Standard," dated August 13, 2018
[2] https://www.globalccsinstitute.com/wp-content/uploads/2019/05/LCFS-and-CCS-Protocol_digital_version-2.pdf