

**WAC 173-218-115 Specific requirements for Class V wells used to inject carbon dioxide for permanent geologic sequestration. (1) Permit required:**

(a) Class V UIC wells used for the geologic sequestration of carbon dioxide are not rule authorized and must obtain a state waste discharge permit under chapter 173-216 WAC, State waste discharge permit program or chapter 173-226 WAC, Waste discharge general permit program.

(b) Class V injection wells used for the geologic sequestration of carbon dioxide may directly discharge into an aquifer only if:

(i) The aquifer contains "naturally nonpotable groundwater" as defined in WAC 173-200-020(18) and is beneath the lowermost geologic formation containing potable groundwater within the vicinity of the geologic sequestration project area;

(ii) The operator has obtained a permit under the state waste discharge permit program or the waste discharge general permit program establishing enforcement limits which may exceed the groundwater quality criteria, as allowed under WAC 173-200-050 (3) (b) (vi);

(iii) The operator uses all known, available and reasonable methods of prevention, control and treatment (AKART) to remove contaminants, such as sulfur compounds and other contaminants, from the injected CO<sub>2</sub>. Geologic sequestration of carbon dioxide shall not be used for the disposal of non-CO<sub>2</sub> contaminants that can be removed with known treatment technologies; and

(iv) The operator is in compliance with all conditions of their state waste discharge permit or their waste discharge general permit.

(2) **Permit application:** A licensed geologist or engineer shall conduct the geologic and hydrogeologic evaluations required under this section. Technical evaluations shall reflect the best available scientific data as well as existing geologic, geophysical, geomechanical, geochemical, hydrogeological and engineering data available on the proposed project area. Existing data may be used in evaluations provided their source and chronology is identified and the effects of any subsequent modifications due to natural (seismic or other) or human induced (hydraulic fracturing, drilling or other) events are analyzed. The waste discharge permit application, under chapter 173-216 or 173-226 WAC, for a permit authorizing the geologic sequestration of carbon dioxide shall include information supporting the demonstration required by WAC 173-200-050 (3) (b) (vi) and all of the following:

(a) A description of how the project will address:

(i) All jurisdictional boundaries within ten miles of the geologic sequestration project boundary such as: International borders, state borders, local jurisdictions, tribal land, national parks or state parks;

(ii) Accessibility for operations and monitoring in areas where access is restricted by: Shorelines, flood plains, urban or other development, and any other natural or man-made limiting factors;

(iii) Active Holocene faults within five miles and seismic risks;

(b) A current site map showing:

(i) The boundaries of the geologic sequestration project which shall be calculated to include the area containing ninety-five percent of the injected CO<sub>2</sub> mass one hundred years after the completion of all CO<sub>2</sub> injection or the plume boundary at the point in time when expansion is less than one percent per year, whichever is greater, or another method approved by the department;

- (ii) Location and well number of all proposed CO<sub>2</sub> injection wells;
  - (iii) Monitoring wells;
  - (iv) Location of all other wells including cathodic protection boreholes; and
  - (v) Location of all pertinent surface facilities, including atmospheric monitoring within the boundary of the project;
- (c) A technical evaluation of the proposed project, including but not limited to, the following:
- (i) The names and lithologic descriptions of the geologic containment system;
  - (ii) The name, description, and average depth of the reservoir or reservoirs to be used for the geologic containment system;
  - (iii) A geophysical, geomechanical, geochemical and hydrogeologic evaluation of the geologic containment system, including:
    - (A) An evaluation of all existing information on all geologic strata overlying the geologic containment system including, the immediate caprock containment characteristics as well as those of other caprocks if included in the containment system and all designated subsurface monitoring zones;
    - (B) Geophysical data and assessments of any regional tectonic activity, local seismicity and regional or local fault zones; and
    - (C) A comprehensive description of local and regional structural or stratigraphic features;
  - (iv) The evaluation shall focus on the proposed geologic sequestration reservoir or reservoirs and a description of mechanisms of geologic containment, including but not limited to:
    - (A) Rock properties;
    - (B) Regional pressure gradients;
    - (C) Structural features; and
    - (D) Absorption characteristics or geochemical reaction/mineralization processes, with regard to the ability to prevent migration of CO<sub>2</sub> beyond the proposed geologic containment system;
  - (v) The evaluation shall also identify:
    - (A) Any productive oil and natural gas zones occurring stratigraphically above, below, or within the geologic containment system;
    - (B) All water-bearing horizons known in the immediate vicinity of the geologic sequestration project;
    - (C) The evaluation shall include a method to identify unrecorded wells that may be present within the project boundary;
  - (vi) The evaluation shall include exhibits, plans and maps showing the following:
    - (A) All wells, including but not limited to, water, oil, and natural gas exploration and development wells, injection wells and other man-made subsurface structures and activities, including any mines, within one mile of the geologic sequestration project;
    - (B) All man-made surface structures that are intended for temporary or permanent human occupancy within one mile of the geologic sequestration project;
    - (C) Any regional or local faulting within the boundary of the geologic sequestration project;
    - (D) An isopach map of the proposed CO<sub>2</sub> storage reservoir or reservoirs that make up the geologic containment system;
    - (E) An isopach map of the primary and any secondary caprock or containment barrier;

(F) A structure map of the top and base of the storage reservoir or reservoirs that make up the geologic containment system;

(G) Identification of all structural spill points or stratigraphic discontinuities controlling the isolation of CO<sub>2</sub> or associated fluids;

(H) An evaluation of the potential displacement of in situ fluids and the potential impact on groundwater resources, if any; and

(I) Structural and stratigraphic cross-sections that describe the geologic conditions at the geologic containment system;

(vii) An operations and maintenance plan including, but not limited to, a diagram of the entire injection system and a description of the proposed operating and maintenance procedures;

(viii) A review of the data of public record for all wells within the geologic sequestration project boundary which penetrate the geologic containment system including the primary and/or all other cap-rocks and those wells that penetrate these geologic formations within one mile of the geologic sequestration project boundary, or any other distance deemed necessary by the department. This review shall determine if all abandoned wells have been plugged in a manner that prevents the movement of CO<sub>2</sub> or associated native fluids away from the geologic containment system;

(ix) The proposed maximum bottom hole injection rate and injection pressure to be used at the geologic containment system. The maximum allowed injection pressure shall be no greater than eighty percent of the formation fracture pressure as determined by a mini-frac injection test or multiple-stage, minimum threshold fracture injection test or other method approved by the department. The geologic containment system shall not be subjected to injection pressures in excess of the calculated fracture pressure even for short periods of time. Higher operating pressures may only be allowed if approved in writing by the department;

(x) The proposed maximum long-term geologic containment system pressure and the necessary technical data to support the proposed geologic containment system storage pressure request;

(xi) The evaluation and data quality shall be sufficient to establish with a high degree of confidence that the geologic containment system has sufficient capacity, injectivity and other geologic characteristics to permanently sequester CO<sub>2</sub>;

(d) The predicted extent of the injected CO<sub>2</sub> plume determined with modeling tools acceptable to the department that use all available geologic and reservoir engineering information, and the projected response and storage capacity of the geologic containment system. The assumptions used in the model and a discussion of the uncertainty associated with the estimate shall be clearly presented;

(e) An analysis and selection of proposed treatment technology for non-CO<sub>2</sub> contaminant that identifies the technology which meets the requirement that all known, available and reasonable methods of prevention, control and treatment (AKART) to remove contaminants from the injected CO<sub>2</sub>;

(f) A detailed description of the proposed project public safety and emergency response plan. The plan shall detail the safety procedures concerning the facility and residential, commercial, and public land use within one mile, or any other distance as deemed necessary by the department, of the boundary of geologic sequestration project area. The public safety and emergency response procedures shall include contingency plans for leakage from any well, flow lines, or oth-

er permitted facility. The public safety and emergency response procedures also shall identify specific contractors and equipment vendors capable of providing necessary services and equipment to respond to incidents such as: Injection well leaks or loss of containment from injection wells or releases from the geologic containment system. These emergency response procedures shall be updated as necessary throughout the operational life of the permitted storage facilities;

(g) A detailed worker safety plan that addresses safety training and safe working procedures at the facility;

(h) A corrosion monitoring and prevention plan for all wells and surface facilities;

(i) A leak detection and monitoring plan for all wells and surface facilities. The approved leak detection and monitoring plan shall define the threshold for determining that a leak has occurred and shall address:

(i) Identification of any failure of the containment system;

(ii) Identification of release to the atmosphere;

(iii) Identification of degradation of any groundwater or surface water resources; and

(iv) Identification of migration of CO<sub>2</sub> or other contaminants into any overlying oil and natural gas reservoirs;

(j) A geologic sequestration project leak detection and monitoring plan using subsurface measurements to monitor movement of the CO<sub>2</sub> plume both within and to detect migration outside of the permitted geologic containment system. This must include:

(i) Collection of baseline information on formation pressure and background concentrations in groundwater, surface soils, and chemical composition of in situ waters within the geologic containment system and monitoring zone(s);

(ii) Monitoring of pressure responses and other appropriate information immediately above caprock of the geologic containment system;

(k) The approved subsurface leak detection and monitoring plan shall be based on the site-specific characteristics as documented by materials submitted in the permit application and shall address:

(i) Identification of any failure in the containment system;

(ii) Identification of release to the atmosphere;

(iii) Identification of degradation of any ground or surface water resources; and

(iv) Identification of migration of CO<sub>2</sub> or other contaminants into any overlying oil and natural gas reservoirs;

(l) A risk assessment that identifies and quantifies hazards, probabilities, features, events and processes that might result in undesirable impacts to public health and the environment;

(m) A mitigation and remediation plan that identifies trigger thresholds and corrective actions to be taken prior to a containment system failure, if groundwater quality in the monitoring zone or above is degraded, or if carbon dioxide is released to the atmosphere. The mitigation and remediation plan must conform to the standards set by subsection (8) of this section and must be approved by the department before injection begins;

(n) The proposed well casing, cementing and integrity testing program;

(o) A closure and post-closure plan, including a closure and post-closure cost estimate;

(p) The application shall designate a financial assurance mechanism sufficient to cover the cost to the department for the abandonment of the project or remediation of facility leaks should the operator not perform as required or cease to exist;

(q) The application shall designate a financial assurance mechanism sufficient to provide financial assurance to the department to cover the plugging and abandonment or the remediation of a CO<sub>2</sub> injection and/or subsurface observation well should the operator not perform as required in accordance with the permit or cease to exist;

(r) The payment of the application fee; and

(s) Any other information that the department requires.

(3) **Geologic sequestration well standards.** (Note: In statutory references to chapter 344-12 WAC, the word "gas" shall include all injected carbon dioxide for geologic sequestration, including supercritical CO<sub>2</sub>.) Wells used for geologic sequestration projects must meet the following:

(a) Casing materials and cement must be designed and tested to withstand the reactive fluids and expected conditions encountered during the geologic sequestration project, including the post-closure period.

(b) Minimum standards for construction and maintenance of wells. Chapter 173-160 WAC.

(c) Drilling fluid standards of WAC 344-12-098.

(d) Directional or other appropriate surveys shall be completed for all wells to verify location at depth.

(e) Wells must be logged with appropriate geophysical methods which include: Cement bonding and evaluation logs, and casing inspection logs. In addition a standard suite of wireline logs shall be run on each well to document physical properties of the well, the well integrity and any potential leakage points. The wireline logging suite must include: Gamma ray, resistivity, temperature, formation pressure, both p- and v-sonic and neutron-density. The department may approve alternate logging suites that provide equivalent information or allow the use of improved methods as new technologies are developed.

(f) All collected geologic data, including geophysical logs, geologists logs, mud logs, and drilling logs, core, drill cuttings, and all other logs and surveys shall be submitted to the department of natural resources, division of geology and earth resources, within thirty days after well completion. Submitted information shall include one paper and one digital copy of logs. (Note: The department of natural resources maintains geologic records in the state to enhance the scientific, economic and environmental values of the people of the state.)

(g) One paper and one digital copy of all reports and data collected from surface geological and geophysical surveys of sequestration sites shall be submitted to the department of natural resources, division of geology and earth resources within thirty days after completion.

(h) Wells that are completed within or below the geologic containment system must in addition:

(i) Meet the well casing and cementing standards of WAC 344-12-087;

(ii) Verify the integrity of cement behind casings, including the location of any channels, contamination or missing cement, by a cement map that incorporates data from a cement bond log, a variable density

display, and an ultrasonic image, unless an alternative evaluation has been approved in writing by the department;

(iii) Meet the blowout prevention standards of WAC 344-12-092;

(iv) Wells shall be periodically tested to assess their structural integrity. Annual tests shall include wireline surveys for casing integrity/corrosion assessment and other appropriate tests. An injection well casing pressure test will be conducted prior to use and retested at least once prior to each permit renewal or when casing integrity/corrosion assessments identify risks. Any finding of inadequate structural integrity shall be reported to the department within twenty-four hours.

(i) Notify the department thirty days prior to beginning any substantial work on wells including, deepening, repair or closure. Advance notice period may be reduced by the department when the work is intended to address immediate threats to public health, safety or the environment.

(4) **Permit terms and conditions.** All terms and conditions listed in WAC 173-216-110, state waste discharge permit program, apply. In addition, the following terms and conditions shall apply to injection permits for the geologic sequestration of carbon dioxide:

(a) To be issued a permit, an applicant must demonstrate the following:

(i) That the geology, including geochemistry, of the site and all proposed plans developed for the permit application will:

(A) Provide "permanent sequestration" of carbon dioxide as defined by WAC 173-407-110; and

(B) The caprock and other features of the geologic containment system have the appropriate characteristics to prevent migration of carbon dioxide, other contaminants and nonpotable water.

(ii) A monitoring program has been developed to identify leakage from the geologic containment system to the atmosphere, surface water and groundwater. The monitoring program must be able to identify groundwater quality degradation in aquifers prior to degradation of any potable aquifer. The monitoring program shall include observations in the monitoring zone(s) that can identify migration to aquifers as close stratigraphically to the geologic containment system as practicable.

(iii) Design and construction standards of all facility structures and wells are sufficient to prevent migration of carbon dioxide or nonpotable water that will degrade water quality or impact beneficial uses outside the geologic containment system.

(iv) All known, available and reasonable methods of prevention, control and treatment (AKART) will be used to remove contaminants from the injected CO<sub>2</sub>. Geologic sequestration of carbon dioxide shall not be used for the disposal of non-CO<sub>2</sub> contaminants that can be removed with known treatment technologies.

(b) Pilot studies at potential geologic sequestration project sites shall be encouraged to collect site characterization, risk assessment and feasibility information. Permits for pilot studies may be issued without meeting all the Class V geologic sequestration project requirements only when:

(i) The pilot study is for a limited time duration;

(ii) Public health and the environment are protected;

(iii) The pilot study will collect detailed site-specific information used to establish the feasibility of permanent sequestration in developing a permit application that meets the standards of this sec-

tion. The pilot study permit shall be based upon an operator submitted pilot study plan that addresses:

(A) Site-specific geologic information including reasons for selecting a site as a potential geologic sequestration project;

(B) Site-specific hydrogeologic information that includes information on potable aquifers and how their water quality will be protected;

(C) A detailed plan of work for the pilot study that includes monitoring and quarterly reporting;

(D) The information to be gained by the study;

(E) The total quantity of CO<sub>2</sub> to be injected and an estimated injection schedule for the study. CO<sub>2</sub> injections for pilot studies shall be limited to no more than 1,000 metric tons CO<sub>2</sub>, unless the operator demonstrates in the plan that a larger quantity is necessary to determine the feasibility and risks of a project;

(F) The procedures to be implemented to protect public health and the environment;

(iv) Pilot study permits shall not be used for a full scale carbon sequestration project. Injection of carbon dioxide associated with a pilot study permit shall be of limited quantity and duration, not to exceed five years.

(c) The permit shall include an injection pressure limitation and a maximum working pressure in the geologic containment system, calculated from information provided in the application, that assures that the pressure in the injection zone does not initiate new fractures or propagate existing fractures in the injection zone or caprock. In no case shall the injection pressure initiate fractures in the caprock or cause the movement of injected fluids or formation fluids into shallower aquifers. Controlled artificial fracturing of the injection zone of the geologic containment system may be allowed with a plan that has been approved by the department.

(d) If the operator identifies leakage in excess of the thresholds established in the mitigation and remediation plan, water quality degradation in shallower aquifers or leaks to the surface, including those around wells or within well casing, the operator must:

(i) Notify the department within twenty-four hours;

(ii) Take all necessary actions to protect public health, safety and the environment;

(iii) Stop injecting immediately, until the project obtains approval for redefining the geologic containment system and its relevant dimensions by the department;

(iv) Implement the mitigation and remediation plan to arrest and reverse environmental impacts. Amendments to the mitigation plan shall be developed in consultation with the department;

(e) Monitoring for geologic sequestration projects shall include:

(i) Characterization of injected fluids;

(ii) Continuous recording of injection pressure, flow rate and volume;

(iii) Continuous recording of pressure on annulus between tubing and long string casing;

(iv) Monitoring zone leak detection identified in (a)(ii) of this subsection;

(v) Sufficient monitoring to confirm the spatial distribution of the CO<sub>2</sub> in the subsurface.

(f) Quarterly reports shall be submitted to the department that include the following:

- (i) Physical, chemical and other relevant characterization of the injected fluids;
- (ii) Monthly average, maximum and minimum values for injection pressure, flow rate, volume injected and annular pressure;
- (iii) Updated data for modeling that will project and/or establish the spatial distribution of CO<sub>2</sub> in the subsurface;
- (iv) Results from monitoring zone leak detection;
- (v) Results from any other tests/work completed during the reporting period, such as mechanical integrity tests, geophysical surveys, acoustic monitoring, well repairs, etc.
- (g) Annual reports shall be submitted to the department that include:

- (i) A summary of the data collected throughout the year, including any trends, observations, predictions as well as calculated spatial distribution of injected CO<sub>2</sub>;

- (ii) List of all noncompliance with the permit along with an explanation of the cause(s) and subsequent remedial measures taken;

- (iii) Updated modeling based on the monitoring observations and measurements including a summary of calculated spatial distribution of CO<sub>2</sub> and all other conditions in the subsurface necessary to establish the effectiveness of the geologic containment system, as well as a discussion of history matching and an assessment of the model's accuracy to date. Updated projections of project response and capacity based on operational experience, including all new geologic data and information;

- (iv) Observed anomalies from predicted behavior shall be identified and explained;

- (v) Discussion of suggested changes in project management or suggested amendment of permit conditions;

- (vi) A report on the financial assurance account which includes updated calculation of cost estimates for all closure and post-closure activities and documentation that the account is adequately funded to cover the calculated cost.

(5) **Closure.** If all of the project's carbon dioxide injections are interrupted for a period of one hundred eighty consecutive days, the operator shall begin implementing the approved closure plan. Injection project management may include injection and resting periods possibly exceeding one hundred eighty days for individual injection wells. The closure triggers are for the entire injection facility, not individual wells. The department may extend this one hundred eighty day period, in writing, upon the request of the operator, if the operator demonstrates that carbon dioxide injection will resume within a period of not more than two years. The operator shall review and amend the closure plan as needed, at a minimum the plan shall be reviewed at each permit renewal. Proposed amendments shall be effective only after approved in writing by the department. Approval of proposed amendments shall not delay the commencement of closure activities using the most recent approved closure plan. If the operator fails to begin closure, or is not able to begin closure, the department shall use the financial assurance account to begin closure activities.

(6) **Post-closure activities.** The operator is obligated to renew and be covered under permit and pay all appropriate permit fees throughout the post-closure period. The operator shall continue all required monitoring and reporting throughout the closure and post-closure period. The operator shall review and amend the post-closure plan as needed, at a minimum the plan shall be reviewed at each permit re-

newal. The post-closure period shall continue until the department determines that modeling and monitoring demonstrate that conditions in the geologic containment system indicate that there is little or no risk of future environmental impacts and there is high confidence in the effectiveness of the containment system and related trapping mechanisms. The post-closure period shall be complete only after the operator has received written approval from the department. If the operator fails to or is not able to continue the post-closure activities as required, the department shall use the financial assurance account to complete post-closure activities. Any funds remaining in the financial assurance account shall be released to the operator upon the department's approval of the completion of the post-closure period.

(7) **Financial assurance.**

(a) The owner or operator shall establish a closure and post-closure account to cover all closure and post-closure expenses. The performance security held in the account may be:

(i) Bank letters of credit;

(ii) Cash deposits;

(iii) Negotiable securities;

(iv) An assignment of savings account;

(v) A savings certificate in a Washington bank;

(vi) A corporate surety bond executed in favor of the department by a corporation authorized to do business in the state of Washington; or

(vii) Other financial instruments or performance security acceptable to the department.

(b) The department may for any reason refuse any performance security not deemed adequate.

(c) The cost of the closure and post-closure activities shall be calculated using current cost of hiring a third party to close all existing facilities and to provide post-closure care, including monitoring identified in the closure and post-closure plan.

(d) The closure and post-closure cost estimate shall be revised annually to include any changes in the facility and to include cost changes due to inflation.

(e) The obligation to maintain the account for closure and post-closure care survives the termination of any permits and the cessation of injection. The requirement to maintain the closure and post-closure account is enforceable regardless of whether the requirement is a specific condition of the permit.

(8) **Mitigation and remediation.** Each project must develop a mitigation and remediation plan that identifies trigger thresholds and corrective actions to be taken if the containment system fails, if water quality outside the geologic containment system is degraded, if carbon dioxide is released to the atmosphere or if any other factor poses an unacceptable risk to public health or the environment. A mitigation and remediation plan must be approved by the department before injection begins and amended as needed. The operator shall review and amend the mitigation and remediation plan as needed, at a minimum the plan shall be thoroughly reviewed at each permit renewal. The mitigation and remediation plan shall:

(a) Define leakage (i.e., trigger threshold), leak detection and identification;

(b) Address caprock and spill-point leaks;

(c) Address well bore leaks from project wells or previously unidentified wells;

(d) Identify immediate responses to protect public health, safety and the environment;

(e) Provide a detailed list of notifications and surveys;

(f) Address remedial measures such as: Well repairs, reduced injection pressure, reservoir or formation pressure, creation of a pressure barrier through increased pressure above geologic containment system, interception, recovery and reinjection of CO<sub>2</sub> or the removal of injected materials;

(g) Address redefining the geologic containment system or closure and abandonment of the sequestration project.

[Statutory Authority: Chapter 80.80 RCW. WSR 08-14-011 (Order 07-11), § 173-218-115, filed 6/19/08, effective 7/20/08.]