OIL & GAS BOARD / GEOLOGIC STORAGE OF CARBON DIOXIDE ADMINISTRATIVE CODE

CHAPTER 400-8-1
GENERAL

400-8-1-.30 Injection Well Construction and Completion Standards.

1. The storage operator shall ensure that all injection wells are constructed and completed to prevent movement of the carbon dioxide stream or fluids into underground sources of drinking water or outside the authorized storage reservoir. Further, the storage operator shall ensure that all injection wells are constructed and completed to protect Alabama's natural resources. The injection wells must be constructed and completed in a way that allows the use of appropriate testing devices and workover tools. The casing and cement or other materials used in the construction of each new injection well must be designed for the well's life expectancy. In determining and specifying casing and cementing requirement , all of the following factors must be considered:

a. Depth to the injection zone;
b. Injection pressure, external pressure, internal pressure, and axial loading;
c. Hole size;
d. Size and grade of all casing strings (wall thickness, external diameter, nominal weight, length, joint specification, and construction material);
e. Corrosiveness of the carbon dioxide stream and formation fluids;
f. Down-hole temperatures;
g. Lithology of injection and confining zone;
h. Type or grade of cement and cement additives; and
i. Quantity, chemical composition, and temperature of the carbon dioxide stream.

2. Surface casing in all newly drilled carbon dioxide injection and subsurface observation wells drilled below the underground source of drinking water must be set fifty (50) feet below the base of the lowermost underground source of drinking water and cemented.
3. The long string casing in all injection and subsurface observation wells must be cemented. Sufficient cement must be used on the long string casing to fill the annular space behind the casing to the surface and a sufficient number of centralizers shall be used to assure a good cement job. The long string casing must extend to the injection zone.
4. Any liner set in the well bore must be cemented with a sufficient volume of cement to fill the annular space.
5. All cements used in the cementing of casings in injection and subsurface observation well must be of sufficient quality to maintain well integrity in the carbon dioxide injection environment. Circulation of cement may be accomplished by staging. The Board may approve an alternative method of cementing in cases where the cement cannot he recirculated to the surface,

provided the storage operator can demonstrate by using logs that the cement does not allow fluid movement behind the well bore.
6. All casings must meet the standards specified in any of the following publications, which are hereby adopted by reference:

a. The most recent American Petroleum Institute publication on performance properties of casing, tubing and drill pipe;
b. Specifications for casing and tubing as published by the American Petroleum Institute; or
c. Other equivalent casing as approved by the Board.

7. All casings used in new wells must be new casing or reconditioned casing of a quality equivalent to new casing and that has been pressure-tested.
8. The location and amount of cement behind casings must be verified by an evaluation method approved by the Board. The evaluation method must be capable of evaluating cement quality radially and identifying the location of channels to ensure that underground sources of drinking water are not endangered.
9. All injection wells must be completed with and injection must be through tubing and packer. In order for the Board to determine and specify requirements for tubing and packer, the storage operator shall submit the following information:

a. Depth of setting;
b. Characteristics of the carbon dioxide stream (chemical content, corrosiveness, temperature, and density) and formation fluids;
c. Maximum proposed injection pressure;
d. Maximum proposed annular pressure;
e. Proposed injection rate (intermittent or continuous) and volume and mass of the carbon dioxide stream;
f. Size of tubing and casing;
g. Tubing tensile, burst, and collapse strengths; and
h. Any other information or tests that the Board may require.

10. All tubing strings must meet industry standards. All tubing must be new tubing or reconditioned tubing of a quality equivalent to new tubing and that has been pressure-tested.
11. All wellhead components, including the casinghead and tubing head, valves, and fittings, must be made of steel having operating pressure ratings sufficient to exceed the maximum injection pressures computed at the wellhead and to withstand the corrosive nature of carbon dioxide. Each flow line connected to the wellhead must be equipped with a manually operated positive shutoff valve located on or near the wellhead.
12. All packers, packer elements, or similar equipment critical to the containment of carbon dioxide must be of a quality sufficient to withstand exposure to carbon dioxide.
13. All injection wells must have at all times an accurate, operating pressure gauge or pressure recording device. Gauges must be calibrated as required by the Board and evidence of such calibration must be available to the Board upon request.
14. All newly drilled wells must establish internal and external mechanical integrity and continued mechanical integrity through periodic testing. All

other wells to be used as injection wells must demonstrate mechanical integrity prior to use for injection and be tested on an ongoing basis.

a. Pressure tests. Injection wells, equipped with tubing and packer as required, must be pressure-tested. A testing plan must be submitted to the Board for prior approval. At a minimum, the pressure must be applied to the tubing casing annulus at the surface for a period of thirty minutes and must have no decrease in pressure greater than ten percent of the required minimum test pressure. The packer must be set at a depth at which the packer will be opposite a cemented interval of the long string casing and must be set no more than fifty (50) feet above the uppermost perforation or open hole for the storage reservoirs; and
b. The Board may require additional testing, such as a bottom hole temperature and pressure measurements, tracer survey, temperature survey, gamma ray log, neutron log, noise log, casing inspection log, or a combination of two or more of these surveys and logs, to demonstrate mechanical integrity.

15. The Board has the authority to witness all mechanical integrity tests conducted by the storage operator.
16. If an injection well fails to demonstrate mechanical integrity by an approved method, the storage operator shall immediately shut in the well, report the failure to the Board, and commence isolation and repair of the leak. The operator shall, within ninety days or as otherwise directed by the Board, perform one of the following:

a. Repair and retest the well to demonstrate mechanical integrity; or
b. Properly plug the well.

17. All injection wells must be equipped with shutoff systems designed to alert the operator and shut in wells when necessary.
18. Additional requirements may be required by the Board to address specific circumstances and types of projects.

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