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**Chapter I —Environmental Protection Agency**  
**Subchapter D —Water Programs**

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## PART 146—UNDERGROUND INJECTION CONTROL PROGRAM: CRITERIA AND STANDARDS

**Authority:** Safe Drinking Water Act, 42 U.S.C. 300f *et seq.*; Resource Conservation and Recovery Act, 42 U.S.C. 6901 *et seq.*

**Source:** 45 FR 42500, June 24, 1980, unless otherwise noted.

## Subpart A—General Provisions

### § 146.1 Applicability and scope.

- (a) This part sets forth technical criteria and standards for the Underground Injection Control Program. This part should be read in conjunction with 40 CFR parts 124, 144, and 145, which also apply to UIC programs. 40 CFR part 144 defines the regulatory framework of EPA administered permit programs. 40 CFR part 145 describes the elements of an approvable State program and procedures for EPA approval of State participation in the permit programs. 40 CFR part 124 describes the procedures the Agency will use for issuing permits under the covered programs. Certain of these procedures will also apply to State-administered programs as specified in 40 CFR part 145.
- (b) Upon the approval, partial approval or promulgation of a State UIC program by the Administrator, any underground injection which is not authorized by the Director by rule or by permit is unlawful.

(Clean Water Act, Safe Drinking Water Act, Clean Air Act, Resource Conservation and Recovery Act: 42 U.S.C. 6905, 6912, 6925, 6927, 6974)

[45 FR 42500, June 24, 1980, as amended at 48 FR 14293, Apr. 1, 1983]

### § 146.2 Law authorizing these regulations.

The Safe Drinking Water Act, 42 U.S.C. 300f et seq. authorizes these regulations and all other UIC program regulations referenced in 40 CFR part 144. Certain regulations relating to the injection of hazardous waste are also authorized by the Resource Conservation and Recovery Act, 42 U.S.C. 6901 et seq.

[58 FR 63898, Dec. 3, 1993]

### § 146.3 Definitions.

The following definitions apply to the underground injection control program.

**Abandoned well** means a well whose use has been permanently discontinued or which is in a state of disrepair such that it cannot be used for its intended purpose or for observation purposes.

**Administrator** means the Administrator of the United States Environmental Protection Agency, or an authorized representative.

**Application** means the EPA standard national forms for applying for a permit, including any additions, revisions or modifications to the forms; or forms approved by EPA for use in approved States, including any approved modifications or revisions. For RCRA, application also includes the information required by the Director under § 122.25 (contents of Part B of the RCRA application).

**Aquifer** means a geological formation, group of formations, or part of a formation that is capable of yielding a significant amount of water to a well or spring.

**Area of review** means the area surrounding an injection well described according to the criteria set forth in § 146.06 or in the case of an area permit, the project area plus a circumscribing area the width of which is either  $\frac{1}{4}$  of a mile or a number calculated according to the criteria set forth in § 146.06.

**Casing** means a pipe or tubing of appropriate material, of varying diameter and weight, lowered into a borehole during or after drilling in order to support the sides of the hole and thus prevent the walls from caving, to prevent loss of drilling mud into porous ground, or to prevent water, gas, or other fluid from entering or leaving the hole.

**Catastrophic collapse** means the sudden and utter failure of overlying “strata” caused by removal of underlying materials.

**Cementing** means the operation whereby a cement slurry is pumped into a drilled hole and/or forced behind the casing.

**Cesspool** means a “drywell” that receives untreated sanitary waste containing human excreta, and which sometimes has an open bottom and/or perforated sides.

**Confining bed** means a body of impermeable or distinctly less permeable material stratigraphically adjacent to one or more aquifers.

**Confining zone** means a geological formation, group of formations, or part of a formation that is capable of limiting fluid movement above an injection zone.

**Contaminant** means any physical, chemical, biological, or radiological substance or matter in water.

**Conventional mine** means an open pit or underground excavation for the production of minerals.

**Director** means the Regional Administrator, the State director or the Tribal director as the context requires, or an authorized representative. When there is no approved State or Tribal program, and there is an EPA administered program, “Director” means the Regional Administrator. When there is an approved State or Tribal program, “Director” normally means the State or Tribal director. In some circumstances, however, EPA retains the authority to take certain actions even when there is an approved State or Tribal program. (For example, when EPA has issued an NPDES permit prior to the approval of a State program, EPA may retain jurisdiction over that permit after program approval; see § 123.69). In such cases, the term *Director* means the Regional Administrator and not the State or Tribal director.

**Disposal well** means a well used for the disposal of waste into a subsurface stratum.

**Drywell** means a well, other than an improved sinkhole or subsurface fluid distribution system, completed above the water table so that its bottom and sides are typically dry except when receiving fluids.

**Effective date of a UIC program** means the date that a State UIC program is approved or established by the Administrator.

**Environmental Protection Agency (“EPA”)** means the United States Environmental Protection Agency.

**EPA** means the United States “Environmental Protection Agency.”

**Exempted aquifer** means an aquifer or its portion that meets the criteria in the definition of “underground source of drinking water” but which has been exempted according to the procedures of § 144.8(b).

**Existing injection well** means an “injection well” other than a “new injection well.”

**Experimental technology** means a technology which has not been proven feasible under the conditions in which it is being tested.

**Facility or activity** means any “HWM facility,” UIC “injection well,” NPDES “point source,” or State 404 dredge and fill activity, or any other facility or activity (including land or appurtenances thereto) that is subject to regulation under the RCRA, UIC, NPDES, or 404 programs.

**Fault** means a surface or zone of rock fracture along which there has been displacement.

**Flow rate** means the volume per time unit given to the flow of gases or other fluid substance which emerges from an orifice, pump, turbine or passes along a conduit or channel.

**Fluid** means material or substance which flows or moves whether in a semisolid, liquid, sludge, gas, or any other form or state.

**Formation** means a body of rock characterized by a degree of lithologic homogeneity which is prevailing, but not necessarily, tabular and is mappable on the earth's surface or traceable in the subsurface.

**Formation fluid** means "fluid" present in a "formation" under natural conditions as opposed to introduced fluids, such as drilling mud.

**Generator** means any person, by site location, whose act or process produces hazardous waste identified or listed in 40 CFR part 261.

**Ground water** means water below the land surface in a zone of saturation.

**Hazardous waste** means a hazardous waste as defined in 40 CFR 261.3.

**Hazardous Waste Management facility** ("HWM facility") means all contiguous land, and structures, other appurtenances, and improvements on the land used for treating, storing, or disposing of hazardous waste. A facility may consist of several treatment, storage, or disposal operational units (for example, one or more landfills, surface impoundments, or combination of them).

**HWM facility** means "Hazardous Waste Management facility."

**Improved sinkhole** means a naturally occurring karst depression or other natural crevice found in volcanic terrain and other geologic settings which have been modified by man for the purpose of directing and emplacing fluids into the subsurface.

**Indian Tribe** means any Indian Tribe having a Federally recognized governing body carrying out substantial governmental duties and powers over a defined area.

**Injection well** means a "well" into which "fluids" are being injected.

**Injection zone** means a geological "formation", group of formations, or part of a formation receiving fluids through a well.

**Lithology** means the description of rocks on the basis of their physical and chemical characteristics.

**Owner or operator** means the owner or operator of any facility or activity subject to regulation under the RCRA, UIC, NPDES, or 404 programs.

**Packer** means a device lowered into a well to produce a fluid-tight seal.

**Permit** means an authorization, license, or equivalent control document issued by EPA or an "approved State" to implement the requirements of this part and parts 124, 144, and 145. Permit does not include RCRA interim status (§ 122.23), UIC authorization by rule (§§ 144.21 to 144.26 and 144.15), or any permit which has not yet been the subject of final agency action, such as a "draft permit" or a "proposed permit."

**Plugging** means the act or process of stopping the flow of water, oil or gas into or out of a formation through a borehole or well penetrating that formation.

**Plugging record** means a systematic listing of permanent or temporary abandonment of water, oil, gas, test, exploration and waste injection wells, and may contain a well log, description of amounts and types of plugging material used, the method employed for plugging, a description of formations which are sealed and a graphic log of the well showing formation location, formation thickness, and location of plugging structures.

**Point of injection for Class V wells** means the last accessible sampling point prior to waste fluids being released into the subsurface environment through a Class V injection well. For example, the point of injection of a Class V septic system might be the distribution box—the last accessible sampling point before the waste fluids drain into the underlying soils. For a dry well, it is likely to be the well bore itself.

**Pressure** means the total load or force per unit area acting on a surface.

**Project** means a group of wells in a single operation.

**Radioactive waste** means any waste which contains radioactive material in concentrations which exceed those listed in 10 CFR part 20, appendix B, table II column 2.

**RCRA** means the Solid Waste Disposal Act as amended by the Resource Conservation and Recovery Act of 1976 (Pub. L. 94-580, as amended by Pub. L. 95-609, 42 U.S.C. 6901 *et seq.*).

**Sanitary waste** means liquid or solid wastes originating solely from humans and human activities, such as wastes collected from toilets, showers, wash basins, sinks used for cleaning domestic areas, sinks used for food preparation, clothes washing operations, and sinks or washing machines where food and beverage serving dishes, glasses, and utensils are cleaned. Sources of these wastes may include single or multiple residences, hotels and motels, restaurants, bunkhouses, schools, ranger stations, crew quarters, guard stations, campgrounds, picnic grounds, day-use recreation areas, other commercial facilities, and industrial facilities provided the waste is not mixed with industrial waste.

**SDWA** means the Safe Drinking Water Act (Pub. L. 95-523, as amended by Pub. L. 95-190, 42 U.S.C. 300(f) *et seq.*).

**Septic system** means a “well” that is used to emplace sanitary waste below the surface and is typically comprised of a septic tank and subsurface fluid distribution system or disposal system.

**Site** means the land or water area where any facility or activity is physically located or conducted, including adjacent land used in connection with the facility or activity.

**Sole or principal source aquifer** means an aquifer which has been designated by the Administrator pursuant to section 1424 (a) or (e) of the SDWA.

**State Director** means the chief administrative officer of any State, interstate, or Tribal agency operating an “approved program,” or the delegated representative of the State Director. If the responsibility is divided among two or more State, interstate, or Tribal agencies, “State Director” means the chief administrative officer of the State, interstate, or Tribal agency authorized to perform the particular procedure or function to which reference is made.

**Stratum** (plural *strata*) means a single sedimentary bed or layer, regardless of thickness, that consists of generally the same kind of rock material.

**Subsidence** means the lowering of the natural land surface in response to: Earth movements; lowering of fluid pressure; removal of underlying supporting material by mining or solution of solids, either artificially or from natural causes; compaction due to wetting (Hydrocompaction); oxidation of organic matter in soils; or added load on the land surface.

**Subsurface fluid distribution system** means an assemblage of perforated pipes, drain tiles, or other similar mechanisms intended to distribute fluids below the surface of the ground.

**Surface casing** means the first string of well casing to be installed in the well.

**Total dissolved solids** ("TDS") means the total dissolved (filterable) solids as determined by use of the method specified in 40 CFR part 136.

**UIC** means the Underground Injection Control program under Part C of the Safe Drinking Water Act, including an "approved program."

**Underground injection** means a "well injection."

**Underground source of drinking water** (USDW) means an aquifer or its portion:

(1)

(i) Which supplies any public water system; or

(ii) Which contains a sufficient quantity of ground water to supply a public water system; and

(A) Currently supplies drinking water for human consumption; or

(B) Contains fewer than 10,000 mg/l total dissolved solids; and

(2) Which is not an exempted aquifer.

**USDW** means "underground source of drinking water."

**Well** means: A bored, drilled, or driven shaft whose depth is greater than the largest surface dimension; or, a dug hole whose depth is greater than the largest surface dimension; or, an improved sinkhole; or, a subsurface fluid distribution system.

**Well injection** means the subsurface emplacement of fluids through a well.

**Well plug** means a watertight and gastight seal installed in a borehole or well to prevent movement of fluids.

**Well stimulation** means several processes used to clean the well bore, enlarge channels, and increase pore space in the interval to be injected thus making it possible for wastewater to move more readily into the formation, and includes

(1) surging,

(2) jetting,

(3) blasting,

(4) acidizing,

(5) hydraulic fracturing.

**Well monitoring** means the measurement, by on-site instruments or laboratory methods, of the quality of water in a well.

(Clean Water Act, Safe Drinking Water Act, Clean Air Act, Resource Conservation and Recovery Act: 42 U.S.C. 6905, 6912, 6925, 6927, 6974)

[45 FR 42500, June 24, 1980, as amended at 46 FR 43161, Aug. 27, 1981; 47 FR 4998, Feb. 3, 1982; 48 FR 14293, Apr. 1, 1983; 53 FR 37414, Sept. 26, 1988; 64 FR 68573, Dec. 7, 1999]

## § 146.4 Criteria for exempted aquifers.

An aquifer or a portion thereof which meets the criteria for an “underground source of drinking water” in § 146.3 may be determined under § 144.7 of this chapter to be an “exempted aquifer” for Class I-V wells if it meets the criteria in paragraphs (a) through (c) of this section. Class VI wells must meet the criteria under paragraph (d) of this section:

- (a) It does not currently serve as a source of drinking water; and
- (b) It cannot now and will not in the future serve as a source of drinking water because:
  - (1) It is mineral, hydrocarbon or geothermal energy producing, or can be demonstrated by a permit applicant as part of a permit application for a Class II or III operation to contain minerals or hydrocarbons that considering their quantity and location are expected to be commercially producible.
  - (2) It is situated at a depth or location which makes recovery of water for drinking water purposes economically or technologically impractical;
  - (3) It is so contaminated that it would be economically or technologically impractical to render that water fit for human consumption; or
  - (4) It is located over a Class III well mining area subject to subsidence or catastrophic collapse; or
- (c) The total dissolved solids content of the ground water is more than 3,000 and less than 10,000 mg/l and it is not reasonably expected to supply a public water system.
- (d) The areal extent of an aquifer exemption for a Class II enhanced oil recovery or enhanced gas recovery well may be expanded for the exclusive purpose of Class VI injection for geologic sequestration under § 144.7(d) of this chapter if it meets the following criteria:
  - (1) It does not currently serve as a source of drinking water; and
  - (2) The total dissolved solids content of the ground water is more than 3,000 mg/l and less than 10,000 mg/l; and
  - (3) It is not reasonably expected to supply a public water system.

(Clean Water Act, Safe Drinking Water Act, Clean Air Act, Resource Conservation and Recovery Act: 42 U.S.C. 6905, 6912, 6925, 6927, 6974)

[45 FR 42500, June 24, 1980, as amended at 47 FR 4998, Feb. 3, 1982; 48 FR 14293, Apr. 1, 1983; 75 FR 77291, Dec. 10, 2010]

## § 146.5 Classification of injection wells.

Injection wells are classified as follows:

- (a) *Class I.*
  - (1) Wells used by generators of hazardous waste or owners or operators of hazardous waste management facilities to inject hazardous waste beneath the lowermost formation containing, within one quarter ( $\frac{1}{4}$ ) mile of the well bore, an underground source of drinking water.



- (2) Other industrial and municipal disposal wells which inject fluids beneath the lowermost formation containing, within one quarter mile of the well bore, an underground source of drinking water.
  - (3) Radioactive waste disposal wells which inject fluids below the lowermost formation containing an underground source of drinking water within one quarter mile of the well bore.
- (b) **Class II.** Wells which inject fluids:
- (1) Which are brought to the surface in connection with conventional oil or natural gas production and may be commingled with waste waters from gas plants which are an integral part of production operations, unless those waters are classified as a hazardous waste at the time of injection.
  - (2) For enhanced recovery of oil or natural gas; and
  - (3) For storage of hydrocarbons which are liquid at standard temperature and pressure.
- (c) **Class III.** Wells which inject for extraction of minerals including:
- (1) Mining of sulfur by the Frasch process;
  - (2) In situ production of uranium or other metals. This category includes only in-situ production from ore bodies which have not been conventionally mined. Solution mining of conventional mines such as stopes leaching is included in Class V.
  - (3) Solution mining of salts or potash.
- (d) **Class IV.**
- (1) Wells used by generators of hazardous waste or of radioactive waste, by owners or operators of hazardous waste management facilities, or by owners or operators of radioactive waste disposal sites to dispose of hazardous waste or radioactive waste into a formation which within one quarter ( $\frac{1}{4}$ ) mile of the well contains an underground source of drinking water.
  - (2) Wells used by generators of hazardous waste or of radioactive waste, by owners or operators of hazardous waste management facilities, or by owners or operators of radioactive waste disposal sites to dispose of hazardous waste or radioactive waste above a formation which within one quarter ( $\frac{1}{4}$ ) mile of the well contains an underground source of drinking water.
  - (3) Wells used by generators of hazardous waste or owners or operators of hazardous waste management facilities to dispose of hazardous waste, which cannot be classified under § 146.05(a)(1) or § 146.05(d) (1) and (2) (e.g., wells used to dispose of hazardous wastes into or above a formation which contains an aquifer which has been exempted pursuant to § 146.04).
- (e) **Class V.** Injection wells not included in Class I, II, III, IV or VI. Specific types of Class V injection wells are also described in 40 CFR 144.81. Class V wells include:
- (1) Air conditioning return flow wells used to return to the supply aquifer the water used for heating or cooling in a heat pump;
  - (2) Cesspools including multiple dwelling, community or regional cesspools, or other devices that receive wastes which have an open bottom and sometimes have perforated sides. The UIC requirements do not apply to single family residential cesspools nor to non-residential cesspools which receive solely sanitary wastes and have the capacity to serve fewer than 20 persons a day.
  - (3) Cooling water return flow wells used to inject water previously used for cooling;

- (4) Drainage wells used to drain surface fluid, primarily storm runoff, into a subsurface formation;
  - (5) Dry wells used for the injection of wastes into a subsurface formation;
  - (6) Recharge wells used to replenish the water in an aquifer;
  - (7) Salt water intrusion barrier wells used to inject water into a fresh water aquifer to prevent the intrusion of salt water into the fresh water;
  - (8) Sand backfill and other backfill wells used to inject a mixture of water and sand, mill tailings or other solids into mined out portions of subsurface mines whether what is injected is a radioactive waste or not.
  - (9) Septic system wells used to inject the waste or effluent from a multiple dwelling, business establishment, community or regional business establishment septic tank. The UIC requirements do not apply to single family residential septic system wells, nor to non-residential septic system wells which are used solely for the disposal of sanitary waste and have the capacity to serve fewer than 20 persons a day.
  - (10) Subsidence control wells (not used for the purpose of oil or natural gas production) used to inject fluids into a non-oil or gas producing zone to reduce or eliminate subsidence associated with the overdraft of fresh water;
  - (11) Radioactive waste disposal wells other than Class IV;
  - (12) Injection wells associated with the recovery of geothermal energy for heating, aquaculture and production of electric power.
  - (13) Wells used for solution mining of conventional mines such as stopes leaching;
  - (14) Wells used to inject spent brine into the same formation from which it was withdrawn after extraction of halogens or their salts;
  - (15) Injection wells used in experimental technologies.
  - (16) Injection wells used for in situ recovery of lignite, coal, tar sands, and oil shale.
- (f) **Class VI.** Wells that are not experimental in nature that are used for geologic sequestration of carbon dioxide beneath the lowermost formation containing a USDW; or, wells used for geologic sequestration of carbon dioxide that have been granted a waiver of the injection depth requirements pursuant to requirements at § 146.95; or, wells used for geologic sequestration of carbon dioxide that have received an expansion to the areal extent of an existing Class II enhanced oil recovery or enhanced gas recovery aquifer exemption pursuant to §§ 146.4 and 144.7(d) of this chapter.

[45 FR 42500, June 24, 1980, as amended at 46 FR 43161, Aug. 27, 1981; 47 FR 4999, Feb. 3, 1982; 64 FR 68573, Dec. 7, 1999; 75 FR 77291, Dec. 10, 2010]

## § 146.6 Area of review.

The area of review for each injection well or each field, project or area of the State shall be determined according to either paragraph (a) or (b) of this section. The Director may solicit input from the owners or operators of injection wells within the State as to which method is most appropriate for each geographic area or field.

- (a) **Zone of endangering influence.**

- (1) The zone of endangering influence shall be:
  - (i) In the case of application(s) for well permit(s) under § 122.38 that area the radius of which is the lateral distance in which the pressures in the injection zone may cause the migration of the injection and/or formation fluid into an underground source of drinking water; or
  - (ii) In the case of an application for an area permit under § 122.39, the project area plus a circumscribing area the width of which is the lateral distance from the perimeter of the project area, in which the pressures in the injection zone may cause the migration of the injection and/or formation fluid into an underground source of drinking water.
- (2) Computation of the zone of endangering influence may be based upon the parameters listed below and should be calculated for an injection time period equal to the expected life of the injection well or pattern. The following modified Theis equation illustrates one form which the mathematical model may take.

$$r = \left( \frac{2.25 KHt}{S10^x} \right)^{1/2}$$

where:

$$X = \frac{4\pi KH(h_w - h_{bo} \times S_p G_b)}{2.3Q}$$

r = Radius of endangering influence from injection well (length)

k = Hydraulic conductivity of the injection zone (length/time)

H = Thickness of the injection zone (length)

t = Time of injection (time)

S = Storage coefficient (dimensionless)

Q = Injection rate (volume/time)

$h_{bo}$  = Observed original hydrostatic head of injection zone (length) measured from the base of the lowermost underground source of drinking water

$h_w$  = Hydrostatic head of underground source of drinking water (length) measured from the base of the lowest underground source of drinking water

$S_p G_b$  = Specific gravity of fluid in the injection zone (dimensionless)

$\pi$  = 3.142 (dimensionless)

The above equation is based on the following assumptions:

- (i) The injection zone is homogenous and isotropic;
- (ii) The injection zone has infinite area extent;
- (iii) The injection well penetrates the entire thickness of the injection zone;
- (iv) The well diameter is infinitesimal compared to "r" when injection time is longer than a few minutes; and
- (v) The emplacement of fluid into the injection zone creates instantaneous increase in pressure.

(b) **Fixed radius.**

- (1) In the case of application(s) for well permit(s) under § 122.38 a fixed radius around the well of not less than one-fourth ( $\frac{1}{4}$ ) mile may be used.
- (2) In the case of an application for an area permit under § 122.39 a fixed width of not less than one-fourth ( $\frac{1}{4}$ ) mile for the circumscribing area may be used.

In determining the fixed radius, the following factors shall be taken into consideration: Chemistry of injected and formation fluids; hydrogeology; population and ground-water use and dependence; and historical practices in the area.

- (c) If the area of review is determined by a mathematical model pursuant to paragraph (a) of this section, the permissible radius is the result of such calculation even if it is less than one-fourth ( $\frac{1}{4}$ ) mile.

[45 FR 42500, June 24, 1980, as amended at 46 FR 43161, Aug. 27, 1981; 47 FR 4999, Feb. 3, 1982]

## § 146.7 Corrective action.

In determining the adequacy of corrective action proposed by the applicant under 40 CFR 144.55 and in determining the additional steps needed to prevent fluid movement into underground sources of drinking water, the following criteria and factors shall be considered by the Director:

- (a) Nature and volume of injected fluid;
- (b) Nature of native fluids or by-products of injection;
- (c) Potentially affected population;
- (d) Geology;
- (e) Hydrology;
- (f) History of the injection operation;
- (g) Completion and plugging records;
- (h) Abandonment procedures in effect at the time the well was abandoned; and
- (i) Hydraulic connections with underground sources of drinking water.

(Clean Water Act, Safe Drinking Water Act, Clean Air Act, Resource Conservation and Recovery Act: 42 U.S.C. 6905, 6912, 6925, 6927, 6974)

[45 FR 42500, June 24, 1980, as amended at 46 FR 43162, Aug. 27, 1981; 48 FR 14293, Apr. 1, 1983]

## § 146.8 Mechanical integrity.

- (a) An injection well has mechanical integrity if:
  - (1) There is no significant leak in the casing, tubing or packer; and
  - (2) There is no significant fluid movement into an underground source of drinking water through vertical channels adjacent to the injection well bore.
- (b) One of the following methods must be used to evaluate the absence of significant leaks under paragraph (a)(1) of this section:
  - (1) Following an initial pressure test, monitoring of the tubing-casing annulus pressure with sufficient frequency to be representative, as determined by the Director, while maintaining an annulus pressure different from atmospheric pressure measured at the surface;
  - (2) Pressure test with liquid or gas; or
  - (3) Records of monitoring showing the absence of significant changes in the relationship between injection pressure and injection flow rate for the following Class II enhanced recovery wells:
    - (i) Existing wells completed without a packer provided that a pressure test has been performed and the data is available and provided further that one pressure test shall be performed at a time when the well is shut down and if the running of such a test will not cause further loss of significant amounts of oil or gas; or
    - (ii) Existing wells constructed without a long string casing, but with surface casing which terminates at the base of fresh water provided that local geological and hydrological features allow such construction and provided further that the annular space shall be visually inspected. For these wells, the Director shall prescribe a monitoring program which will verify the absence of significant fluid movement from the injection zone into an USDW.
- (c) One of the following methods must be used to determine the absence of significant fluid movement under paragraph (a)(2) of this section:
  - (1) The results of a temperature or noise log; or
  - (2) For Class II only, cementing records demonstrating the presence of adequate cement to prevent such migration; or
  - (3) For Class III wells where the nature of the casing precludes the use of the logging techniques prescribed at paragraph (c)(1) of this section, cementing records demonstrating the presence of adequate cement to prevent such migration;
  - (4) For Class III wells where the Director elects to rely on cementing records to demonstrate the absence of significant fluid movement, the monitoring program prescribed by § 146.33(b) shall be designed to verify the absence of significant fluid movement.
- (d) The Director may allow the use of a test to demonstrate mechanical integrity other than those listed in paragraphs (b) and (c)(2) of this section with the written approval of the Administrator. To obtain approval, the Director shall submit a written request to the Administrator, which shall set forth the proposed test and all technical data supporting its use. The Administrator shall approve the request if it will reliably demonstrate the mechanical integrity of wells for which its use is proposed. Any alternate method approved by the Administrator shall be published in the FEDERAL REGISTER and may be used in all States unless its use is restricted at the time of approval by the Administrator.

- (e) In conducting and evaluating the tests enumerated in this section or others to be allowed by the Director, the owner or operator and the Director shall apply methods and standards generally accepted in the industry. When the owner or operator reports the results of mechanical integrity tests to the Director, he shall include a description of the test(s) and the method(s) used. In making his/her evaluation, the Director shall review monitoring and other test data submitted since the previous evaluation.
- (f) The Director may require additional or alternative tests if the results presented by the owner or operator under § 146.8(e) are not satisfactory to the Director to demonstrate that there is no movement of fluid into or between USDWs resulting from the injection activity.

[45 FR 42500, June 24, 1980, as amended at 46 FR 43162, Aug. 27, 1981; 47 FR 4999, Feb. 3, 1982; 58 FR 63898, Dec. 3, 1993]

### § 146.9 Criteria for establishing permitting priorities.

In determining priorities for setting times for owners or operators to submit applications for authorization to inject under the procedures of § 144.31 (a), (c), (g) or § 144.22(f), the Director shall base these priorities upon consideration of the following factors:

- (a) Injection wells known or suspected to be contaminating underground sources of drinking water;
- (b) Injection wells known to be injecting fluids containing hazardous contaminants;
- (c) Likelihood of contamination of underground sources of drinking water;
- (d) Potentially affected population;
- (e) Injection wells violating existing State requirements;
- (f) Coordination with the issuance of permits required by other State or Federal permit programs;
- (g) Age and depth of the injection well; and
- (h) Expiration dates of existing State permits, if any.

(Clean Water Act, Safe Drinking Water Act, Clean Air Act, Resource Conservation and Recovery Act: 42 U.S.C. 6905, 6912, 6925, 6927, 6974)

[45 FR 42500, June 24, 1980, as amended at 48 FR 14293, Apr. 1, 1983]

### § 146.10 Plugging and abandoning Class I, II, III, IV, and V wells.

- (a) Requirements for Class I, II and III wells.
  - (1) Prior to abandoning Class I, II and III wells, the well shall be plugged with cement in a manner which will not allow the movement of fluids either into or between underground sources of drinking water. The Director may allow Class III wells to use other plugging materials if the Director is satisfied that such materials will prevent movement of fluids into or between underground sources of drinking water.
  - (2) Placement of the cement plugs shall be accomplished by one of the following:
    - (i) The Balance method;
    - (ii) The Dump Bailer method;

- (iii) The Two-Plug method; or
  - (iv) An alternative method approved by the Director, which will reliably provide a comparable level of protection to underground sources of drinking water.
- (3) The well to be abandoned shall be in a state of static equilibrium with the mud weight equalized top to bottom, either by circulating the mud in the well at least once or by a comparable method prescribed by the Director, prior to the placement of the cement plug(s).
- (4) The plugging and abandonment plan required in 40 CFR 144.51(o) and 144.52(a)(6) shall, in the case of a Class III project which underlies or is in an aquifer which has been exempted under § 146.04, also demonstrate adequate protection of USDWs. The Director shall prescribe aquifer cleanup and monitoring where he deems it necessary and feasible to insure adequate protection of USDWs.
- (b) Requirements for Class IV wells. Prior to abandoning a Class IV well, the owner or operator shall close the well in accordance with 40 CFR 144.23(b).
- (c) Requirements for Class V wells.
- (1) Prior to abandoning a Class V well, the owner or operator shall close the well in a manner that prevents the movement of fluid containing any contaminant into an underground source of drinking water, if the presence of that contaminant may cause a violation of any primary drinking water regulation under 40 CFR part 141 or may otherwise adversely affect the health of persons. Closure requirements for motor vehicle waste disposal wells and large-capacity cesspools are reiterated at § 144.89.
- (2) The owner or operator shall dispose of or otherwise manage any soil, gravel, sludge, liquids, or other materials removed from or adjacent to the well in accordance with all applicable Federal, State, and local regulations and requirements.

[64 FR 68573, Dec. 7, 1999]

## Subpart B—Criteria and Standards Applicable to Class I Wells

### § 146.11 Criteria and standards applicable to Class I nonhazardous wells.

This subpart establishes criteria and standards for underground injection control programs to regulate Class I nonhazardous wells.

[53 FR 28148, July 26, 1988]

### § 146.12 Construction requirements.

- (a) All Class I wells shall be sited in such a fashion that they inject into a formation which is beneath the lowermost formation containing, within one quarter mile of the well bore, an underground source of drinking water.
- (b) All Class I wells shall be cased and cemented to prevent the movement of fluids into or between underground sources of drinking water. The casing and cement used in the construction of each newly drilled well shall be designed for the life expectancy of the well. In determining and specifying casing and cementing requirements, the following factors shall be considered:
- (1) Depth to the injection zone;

- (2) Injection pressure, external pressure, internal pressure, and axial loading;
  - (3) Hole size;
  - (4) Size and grade of all casing strings (wall thickness, diameter, nominal weight, length, joint specification, and construction material);
  - (5) Corrosiveness of injected fluid, formation fluids, and temperatures;
  - (6) Lithology of injection and confining intervals; and
  - (7) Type or grade of cement.
- (c) All Class I injection wells, except those municipal wells injecting non-corrosive wastes, shall inject fluids through tubing with a packer set immediately above the injection zone, or tubing with an approved fluid seal as an alternative. The tubing, packer, and fluid seal shall be designed for the expected service.
- (1) The use of other alternatives to a packer may be allowed with the written approval of the Director. To obtain approval, the operator shall submit a written request to the Director, which shall set forth the proposed alternative and all technical data supporting its use. The Director shall approve the request if the alternative method will reliably provide a comparable level of protection to underground sources of drinking water. The Director may approve an alternative method solely for an individual well or for general use.
  - (2) In determining and specifying requirements for tubing, packer, or alternatives the following factors shall be considered:
    - (i) Depth of setting;
    - (ii) Characteristics of injection fluid (chemical content, corrosiveness, and density);
    - (iii) Injection pressure;
    - (iv) Annular pressure;
    - (v) Rate, temperature and volume of injected fluid; and
    - (vi) Size of casing.
- (d) Appropriate logs and other tests shall be conducted during the drilling and construction of new Class I wells. A descriptive report interpreting the results of such logs and tests shall be prepared by a knowledgeable log analyst and submitted to the Director. At a minimum, such logs and tests shall include:
- (1) Deviation checks on all holes constructed by first drilling a pilot hole, and then enlarging the pilot hole by reaming or another method. Such checks shall be at sufficiently frequent intervals to assure that vertical avenues for fluid migration in the form of diverging holes are not created during drilling.
  - (2) Such other logs and tests as may be needed after taking into account the availability of similar data in the area of the drilling site, the construction plan, and the need for additional information, that may arise from time to time as the construction of the well progresses. In determining which logs and tests shall be required, the following logs shall be considered for use in the following situations:
    - (i) For surface casing intended to protect underground sources of drinking water:
      - (A) Resistivity, spontaneous potential, and caliper logs before the casing is installed; and
      - (B) A cement bond, temperature, or density log after the casing is set and cemented.



- (ii) For intermediate and long strings of casing intended to facilitate injection:
  - (A) Resistivity, spontaneous potential, porosity, and gamma ray logs before the casing is installed;
  - (B) Fracture finder logs; and
  - (C) A cement bond, temperature, or density log after the casing is set and cemented.
- (e) At a minimum, the following information concerning the injection formation shall be determined or calculated for new Class I wells:
  - (1) Fluid pressure;
  - (2) Temperature;
  - (3) Fracture pressure;
  - (4) Other physical and chemical characteristics of the injection matrix; and
  - (5) Physical and chemical characteristics of the formation fluids.

[45 FR 42500, June 24, 1980, as amended at 46 FR 43162, Aug. 27, 1981]

### § 146.13 Operating, monitoring and reporting requirements.

- (a) **Operating requirements.** Operating requirements shall at a minimum, specify that:
  - (1) Except during stimulation injection pressure at the wellhead shall not exceed a maximum which shall be calculated so as to assure that the pressure in the injection zone during injection does not initiate new fractures or propagate existing fractures in the injection zone. In no case shall injection pressure initiate fractures in the confining zone or cause the movement of injection or formation fluids into an underground source of drinking water.
  - (2) Injection between the outermost casing protecting underground sources of drinking water and the well bore is prohibited.
  - (3) Unless an alternative to a packer has been approved under § 146.12(c), the annulus between the tubing and the long string of casings shall be filled with a fluid approved by the Director and a pressure, also approved by the Director, shall be maintained on the annulus.
- (b) **Monitoring requirements.** Monitoring requirements shall, at a minimum, include:
  - (1) The analysis of the injected fluids with sufficient frequency to yield representative data of their characteristics;
  - (2) Installation and use of continuous recording devices to monitor injection pressure, flow rate and volume, and the pressure on the annulus between the tubing and the long string of casing;
  - (3) A demonstration of mechanical integrity pursuant to § 146.8 at least once every five years during the life of the well; and
  - (4) The type, number and location of wells within the area of review to be used to monitor any migration of fluids into and pressure in the underground sources of drinking water, the parameters to be measured and the frequency of monitoring.
- (c) **Reporting requirements.** Reporting requirements shall, at a minimum, include:

- (1) Quarterly reports to the Director on:
  - (i) The physical, chemical and other relevant characteristics of injection fluids;
  - (ii) Monthly average, maximum and minimum values for injection pressure, flow rate and volume, and annular pressure; and
  - (iii) The results of monitoring prescribed under paragraph (b)(4) of this section.
- (2) Reporting the results, with the first quarterly report after the completion, of:
  - (i) Periodic tests of mechanical integrity;
  - (ii) Any other test of the injection well conducted by the permittee if required by the Director; and
  - (iii) Any well work over.

(d) ***Ambient monitoring.***

- (1) Based on a site-specific assessment of the potential for fluid movement from the well or injection zone and on the potential value of monitoring wells to detect such movement, the Director shall require the owner or operator to develop a monitoring program. At a minimum, the Director shall require monitoring of the pressure buildup in the injection zone annually, including at a minimum, a shut down of the well for a time sufficient to conduct a valid observation of the pressure fall-off curve.
- (2) When prescribing a monitoring system the Director may also require:
  - (i) Continuous monitoring for pressure changes in the first aquifer overlying the confining zone. When such a well is installed, the owner or operator shall, on a quarterly basis, sample the aquifer and analyze for constituents specified by the Director;
  - (ii) The use of indirect, geophysical techniques to determine the position of the waste front, the water quality in a formation designated by the Director, or to provide other site specific data;
  - (iii) Periodic monitoring of the ground water quality in the first aquifer overlying the injection zone;
  - (iv) Periodic monitoring of the ground water quality in the lowermost USDW; and
  - (v) Any additional monitoring necessary to determine whether fluids are moving into or between USDWs.

[45 FR 42500, June 24, 1980, as amended at 46 FR 43162, Aug. 27, 1981; 47 FR 32129, July 26, 1982; 53 FR 28148, July 26, 1988]

## **§ 146.14 Information to be considered by the Director.**

This section sets forth the information which must be considered by the Director in authorizing Class I wells. For an existing or converted new Class I well the Director may rely on the existing permit file for those items of information listed below which are current and accurate in the file. For a newly drilled Class I well, the Director shall require the submission of all the information listed below. For both existing and new Class I wells certain maps, cross-sections, tabulations of wells within the area of review and other data may be included in the application by reference provided they are current, readily available to the Director (for example, in the permitting agency's files) and sufficiently identified to be retrieved. In cases where EPA issues the permit all the information in this section must be submitted to the Administrator.

- (a) Prior to the issuance of a permit for an existing Class I well to operate or the construction or conversion of a new Class I well the Director shall consider the following:
- (1) Information required in 40 CFR 144.31 and 144.31(g);
  - (2) A map showing the injection well(s) for which a permit is sought and the applicable area of review. Within the area of review, the map must show the number, or name, and location of all producing wells, dry holes, surface bodies of water, springs, mines (surface and subsurface), quarries, water wells and other pertinent surface features including residences and roads. The map should also show faults, if known or suspected. Only information of public record is required to be included on this map;
  - (3) A tabulation of data on all wells within the area of review which penetrate into the proposed injection zone. Such data shall include a description of each well's type, construction, date drilled, location, depth, record of plugging and/or completion, and any additional information the Director may require;
  - (4) Maps and cross sections indicating the general vertical and lateral limits of all underground sources of drinking water within the area of review, their position relative to the injection formation and the direction of water movement, where known, in each underground source of drinking water which may be affected by the proposed injection;
  - (5) Maps and cross sections detailing the geologic structure of the local area;
  - (6) Generalized maps and cross sections illustrating the regional geologic setting;
  - (7) Proposed operating data:
    - (i) Average and maximum daily rate and volume of the fluid to be injected;
    - (ii) Average and maximum injection pressure; and
    - (iii) Source and an analysis of the chemical, physical, radiological and biological characteristics of injection fluids;
  - (8) Proposed formation testing program to obtain an analysis of the chemical, physical and radiological characteristics of and other information on the receiving formation;
  - (9) Proposed stimulation program;
  - (10) Proposed injection procedure;
  - (11) Schematic or other appropriate drawings of the surface and subsurface construction details of the well.
  - (12) Contingency plans to cope with all shut-ins or well failures so as to prevent migration of fluids into any underground source of drinking water;
  - (13) Plans (including maps) for meeting the monitoring requirements in § 146.13(b);
  - (14) For wells within the area of review which penetrate the injection zone but are not properly completed or plugged, the corrective action proposed to be taken under 40 CFR 144.55;
  - (15) Construction procedures including a cementing and casing program, logging procedures, deviation checks, and a drilling, testing, and coring program; and

- (16) A certificate that the applicant has assured, through a performance bond or other appropriate means, the resources necessary to close, plug or abandon the well as required by 40 CFR 122.42(g).
- (b) Prior to granting approval for the operation of a Class I well the Director shall consider the following information:
  - (1) All available logging and testing program data on the well;
  - (2) A demonstration of mechanical integrity pursuant to § 146.8;
  - (3) The anticipated maximum pressure and flow rate at which the permittee will operate;
  - (4) The results of the formation testing program;
  - (5) The actual injection procedure;
  - (6) The compatibility of injected waste with fluids in the injection zone and minerals in both the injection zone and the confining zone; and
  - (7) The status of corrective action on defective wells in the area of review.
- (c) Prior to granting approval for the plugging and abandonment of a Class I well the Director shall consider the following information:
  - (1) The type and number of plugs to be used;
  - (2) The placement of each plug including the elevation of the top and bottom;
  - (3) The type and grade and quantity of cement to be used;
  - (4) The method for placement of the plugs; and
  - (5) The procedure to be used to meet the requirement of § 146.10(c).

(Clean Water Act, Safe Drinking Water Act, Clean Air Act, Resource Conservation and Recovery Act: 42 U.S.C. 6905, 6912, 6925, 6927, 6974)

[45 FR 42500, June 24, 1980, as amended at 46 FR 43162, Aug. 27, 1981; 48 FR 14293, Apr. 1, 1983]

#### **§ 146.15 Class I municipal disposal well alternative authorization in certain parts of Florida.**

- (a) Existing Class I municipal disposal wells in specific geographic regions as defined in paragraph (f) of this section may continue to inject without violating the regulatory prohibitions in Parts 144 and 146 of this chapter against the movement of injection or formation fluids into a USDW, provided that such wells meet the requirements of this section, even if the Director determines they have caused or may cause fluid movement into a USDW. Nothing in this section excuses such Class I municipal disposal wells from meeting all other applicable State and Federal requirements including 40 CFR 144.12(a).
- (b) For purposes of this section, an existing Class I municipal disposal well is defined as a well for which a complete UIC construction permit application was received by the Director on or before December 22, 2005.
- (c) For purposes of this section, the determination that a Class I municipal disposal well has caused or may cause movement of injection or formation fluids into a USDW may be made by the Director based on any relevant data available to him/her, including ground water monitoring data generated pursuant to regulatory requirements governing operation of Class I municipal disposal wells.

- (d) In order for a Class I municipal disposal well to qualify for authorization to inject pursuant to paragraph (a) of this section, the Owner/Operator of that well shall:
  - (1) Develop and implement a pretreatment program that is no less stringent than the requirements of Chapter 62-625, Florida Administrative Code, or have no significant industrial users as defined in that chapter.
  - (2) Treat the injectate using secondary treatment in a manner that is no less stringent than the requirements of Florida Rule 62-600.420(1)(d), and using high-level disinfection in a manner that is no less stringent than the requirements of Florida Rule 62-600.440(5)(a)-(f), within five years after notification by the Director that the well has caused or may cause fluid movement into a USDW.
- (e) Where the Director issued such notice for a well prior to December 22, 2005, in order for that well to qualify for authorization to inject pursuant to paragraph (a) of this section, the Owner/Operator shall:
  - (1) Develop and implement a pretreatment program that is no less stringent than the requirements of Chapter 62-625, Florida Administrative Code, or have no significant industrial users as defined in that chapter; and
  - (2) Treat the injectate using secondary treatment in a manner that is no less stringent than the requirements of Florida Rule 62-600.420(1)(d), and using high-level disinfection in a manner that is no less stringent than the requirements of Florida Rule 62-600.440(5)(a)-(f), within five years after December 22, 2005.
- (f) Authorization to inject wastewater into existing Class I municipal disposal wells pursuant to this section is limited to Class I municipal disposal wells in Florida in the following counties: Brevard, Broward, Charlotte, Collier, Flagler, Glades, Hendry, Highlands, Hillsborough, Indian River, Lee, Manatee, Martin, Miami-Dade, Monroe, Okeechobee, Orange, Osceola, Palm Beach, Pinellas, St. Johns, St. Lucie, Sarasota, and Volusia.

[70 FR 70531, Nov. 22, 2005]

### **§ 146.16 Requirements for new Class I municipal wells in certain parts of Florida.**

Prior to commencing injection, any Class I municipal disposal well in one of the counties identified in § 146.15(f) that is not an existing Class I municipal disposal well as defined in § 146.15(b) of this section shall meet all of the requirements for existing wells seeking authorization to inject pursuant to § 146.15.

[70 FR 70532, Nov. 22, 2005]

## **Subpart C—Criteria and Standards Applicable to Class II Wells**

### **§ 146.21 Applicability.**

This subpart establishes criteria and standards for underground injection control programs to regulate Class II wells.

### **§ 146.22 Construction requirements.**

- (a) All new Class II wells shall be sited in such a fashion that they inject into a formation which is separated from any USDW by a confining zone that is free of known open faults or fractures within the area of review.

(b)

(1) All Class II injection wells shall be cased and cemented to prevent movement of fluids into or between underground sources of drinking water. The casing and cement used in the construction of each newly drilled well shall be designed for the life expectancy of the well. In determining and specifying casing and cementing requirements, the following factors shall be considered:

- (i) Depth to the injection zone;
- (ii) Depth to the bottom of all USDWs; and
- (iii) Estimated maximum and average injection pressures;

(2) In addition the Director may consider information on:

- (i) Nature of formation fluids;
- (ii) Lithology of injection and confining zones;
- (iii) External pressure, internal pressure, and axial loading;
- (iv) Hole size;
- (v) Size and grade of all casing strings; and
- (vi) Class of cement.

(c) The requirements in paragraph (b) of this section need not apply to existing or newly converted Class II wells located in existing fields if:

- (1) Regulatory controls for casing and cementing existed for those wells at the time of drilling and those wells are in compliance with those controls; and
- (2) Well injection will not result in the movement of fluids into an underground source of drinking water so as to create a significant risk to the health of persons.

(d) The requirements in paragraph (b) of this section need not apply to newly drilled wells in existing fields if:

- (1) They meet the requirements of the State for casing and cementing applicable to that field at the time of submission of the State program to the Administrator; and
- (2) Well injection will not result in the movement of fluids into an underground source of drinking water so as to create a significant risk to the health of persons.

(e) Where a State did not have regulatory controls for casing and cementing prior to the time of the submission of the State program to the Administrator, the Director need not apply the casing and cementing requirements in paragraph (b) of this section if he submits as a part of his application for primacy, an appropriate plan for casing and cementing of existing, newly converted, and newly drilled wells in existing fields, and the Administrator approves the plan.

(f) Appropriate logs and other tests shall be conducted during the drilling and construction of new Class II wells. A descriptive report interpreting the results of that portion of those logs and tests which specifically relate to (1) an USDW and the confining zone adjacent to it, and (2) the injection and adjacent formations shall be prepared by a knowledgeable log analyst and submitted to the director. At a minimum, these logs and tests shall include:

- (1) Deviation checks on all holes constructed by first drilling a pilot hole and then enlarging the pilot hole, by reaming or another method. Such checks shall be at sufficiently frequent intervals to assure that vertical avenues for fluid movement in the form of diverging holes are not created during drilling.
- (2) Such other logs and tests as may be needed after taking into account the availability of similar data in the area of the drilling site, the construction plan, and the need for additional information that may arise from time to time as the construction of the well progresses. In determining which logs and tests shall be required the following shall be considered by the Director in setting logging and testing requirements:
  - (i) For surface casing intended to protect underground sources of drinking water in areas where the lithology has not been determined:
    - (A) Electric and caliper logs before casing is installed; and
    - (B) A cement bond, temperature, or density log after the casing is set and cemented.
  - (ii) for intermediate and long strings of casing intended to facilitate injection:
    - (A) Electric porosity and gamma ray logs before the casing is installed;
    - (B) Fracture finder logs; and
    - (C) A cement bond, temperature, or density log after the casing is set and cemented.
- (g) At a minimum, the following information concerning the injection formation shall be determined or calculated for new Class II wells or projects:
  - (1) Fluid pressure;
  - (2) Estimated fracture pressure;
  - (3) Physical and chemical characteristics of the injection zone.

[45 FR 42500, June 24, 1980, as amended at 46 FR 43162, Aug. 27, 1981; 47 FR 5000, Feb. 3, 1982]

### § 146.23 Operating, monitoring, and reporting requirements.

- (a) **Operating requirements.** Operating requirements shall, at a minimum, specify that:
  - (1) Injection pressure at the wellhead shall not exceed a maximum which shall be calculated so as to assure that the pressure during injection does not initiate new fractures or propagate existing fractures in the confining zone adjacent to the USDWs. In no case shall injection pressure cause the movement of injection or formation fluids into an underground source of drinking water
  - (2) Injection between the outermost casing protecting underground sources of drinking water and the well bore shall be prohibited.
- (b) **Monitoring requirements.** Monitoring requirements shall, at a minimum, include:
  - (1) Monitoring of the nature of injected fluids at time intervals sufficiently frequent to yield data representative of their characteristics;
  - (2) Observation of injection pressure, flow rate, and cumulative volume at least with the following frequencies:

- (i) Weekly for produced fluid disposal operations;
- (ii) Monthly for enhanced recovery operations;
- (iii) Daily during the injection of liquid hydrocarbons and injection for withdrawal of stored hydrocarbons; and
- (iv) Daily during the injection phase of cyclic steam operations

And recording of one observation of injection pressure, flow rate and cumulative volume at reasonable intervals no greater than 30 days.

- (3) A demonstration of mechanical integrity pursuant to § 146.8 at least once every five years during the life of the injection well;
- (4) Maintenance of the results of all monitoring until the next permit review (see 40 CFR 144.52(a)(5)); and
- (5) Hydrocarbon storage and enhanced recovery may be monitored on a field or project basis rather than on an individual well basis by manifold monitoring. Manifold monitoring may be used in cases of facilities consisting of more than one injection well, operating with a common manifold. Separate monitoring systems for each well are not required provided the owner/operator demonstrates that manifold monitoring is comparable to individual well monitoring.

(c) **Reporting requirements.**

- (1) Reporting requirements shall at a minimum include an annual report to the Director summarizing the results of monitoring required under paragraph (b) of this section. Such summary shall include monthly records of injected fluids, and any major changes in characteristics or sources of injected fluid. Previously submitted information may be included by reference.
- (2) Owners or operators of hydrocarbon storage and enhanced recovery projects may report on a field or project basis rather than an individual well basis where manifold monitoring is used.

(Clean Water Act, Safe Drinking Water Act, Clean Air Act, Resource Conservation and Recovery Act; 42 U.S.C. 6905, 6912, 6925, 6927, 6974)

[45 FR 42500, June 24, 1980, as amended at 46 FR 43162, Aug. 27, 1981; 47 FR 5000, Feb. 3, 1982; 48 FR 14293, Apr. 1, 1983; 48 FR 31404, July 8, 1983]

## § 146.24 Information to be considered by the Director.

This section sets forth the information which must be considered by the Director in authorizing Class II wells. Certain maps, cross-sections, tabulations of wells within the area of review, and other data may be included in the application by reference provided they are current, readily available to the Director (for example, in the permitting agency's files) and sufficiently identified to be retrieved. In cases where EPA issues the permit, all the information in this section is to be submitted to the Administrator.

- (a) Prior to the issuance of a permit for an existing Class II well to operate or the construction or conversion of a new Class II well the Director shall consider the following:
  - (1) Information required in 40 CFR 144.31 and 144.31(g);



- (2) A map showing the injection well or project area for which a permit is sought and the applicable area of review. Within the area of review, the map must show the number or name and location of all existing producing wells, injection wells, abandoned wells, dry holes, and water wells. The map may also show surface bodies of waters, mines (surface and subsurface), quarries and other pertinent surface features including residences and roads, and faults if known or suspected. Only information of public record and pertinent information known to the applicant is required to be included on this map. This requirement does not apply to existing Class II wells; and
- (3) A tabulation of data reasonably available from public records or otherwise known to the applicant on all wells within the area of review included on the map required under paragraph (a)(2) of this section which penetrate the proposed injection zone or, in the case of Class II wells operating over the fracture pressure of the injection formation, all known wells within the area of review which penetrate formations affected by the increase in pressure. Such data shall include a description of each well's type, construction, date drilled, location, depth, record of plugging and complete, and any additional information the Director may require. In cases where the information would be repetitive and the wells are of similar age, type, and construction the Director may elect to only require data on a representative number of wells. This requirement does not apply to existing Class II wells.
- (4) Proposed operating data:
  - (i) Average and maximum daily rate and volume of fluids to be injected.
  - (ii) Average and maximum injection pressure; and
  - (iii) Source and an appropriate analysis of the chemical and physical characteristics of the injection fluid.
- (5) Appropriate geological data on the injection zone and confining zone including lithologic description, geological name, thickness and depth;
- (6) Geologic name and depth to bottom of all underground sources of drinking water which may be affected by the injection;
- (7) Schematic or other appropriate drawings of the surface and subsurface construction details of the well;
- (8) In the case of new injection wells the corrective action proposed to be taken by the applicant under 40 CFR 122.44;
- (9) A certificate that the applicant has assured through a performance bond or other appropriate means, the resources necessary to close plug or abandon the well as required by 40 CFR 122.42(g);
- (b) In addition the Director may consider the following:
  - (1) Proposed formation testing program to obtain the information required by § 146.22(g);
  - (2) Proposed stimulation program;
  - (3) Proposed injection procedure;
  - (4) Proposed contingency plans, if any, to cope with well failures so as to prevent migration of contaminating fluids into an underground source of drinking water;
  - (5) Plans for meeting the monitoring requirements of § 146.23(b).

- (c) Prior to granting approval for the operation of a Class II well the Director shall consider the following information:
  - (1) All available logging and testing program data on the well;
  - (2) A demonstration of mechanical integrity pursuant to § 146.8;
  - (3) The anticipated maximum pressure and flow rate at which the permittee will operate.
  - (4) The results of the formation testing program;
  - (5) The actual injection procedure; and
  - (6) For new wells the status of corrective action on defective wells in the area of review.
- (d) Prior to granting approval for the plugging and abandonment of a Class II well the Director shall consider the following information:
  - (1) The type, and number of plugs to be used;
  - (2) The placement of each plug including the elevation of top and bottom;
  - (3) The type, grade, and quantity of cement to be used;
  - (4) The method of placement of the plugs; and
  - (5) The procedure to be used to meet the requirements of § 146.10(c).

(Clean Water Act, Safe Drinking Water Act, Clean Air Act, Resource Conservation and Recovery Act: 42 U.S.C. 6905, 6912, 6925, 6927, 6974)

[45 FR 42500, June 24, 1980, as amended at 46 FR 43162, Aug. 27, 1981; 47 FR 5000, Feb. 3, 1982; 48 FR 14293, Apr. 1, 1983]

## Subpart D—Criteria and Standards Applicable to Class III Wells

### § 146.31 Applicability.

This subpart establishes criteria and standards for underground injection control programs to regulate Class III wells.

### § 146.32 Construction requirements.

- (a) All new Class III wells shall be cased and cemented to prevent the migration of fluids into or between underground sources of drinking water. The Director may waive the cementing requirement for new wells in existing projects or portions of existing projects where he has substantial evidence that no contamination of underground sources of drinking water would result. The casing and cement used in the construction of each newly drilled well shall be designed for the life expectancy of the well. In determining and specifying casing and cementing requirements, the following factors shall be considered:
  - (1) Depth to the injection zone;
  - (2) Injection pressure, external pressure, internal pressure, axial loading, etc.;
  - (3) Hole size;
  - (4) Size and grade of all casing strings (wall thickness, diameter, nominal weight, length, joint specification, and construction material);

- (5) Corrosiveness of injected fluids and formation fluids;
  - (6) Lithology of injection and confining zones; and
  - (7) Type and grade of cement.
- (b) Appropriate logs and other tests shall be conducted during the drilling and construction of new Class III wells. A descriptive report interpreting the results of such logs and tests shall be prepared by a knowledgeable log analyst and submitted to the Director. The logs and tests appropriate to each type of Class III well shall be determined based on the intended function, depth, construction and other characteristics of the well, availability of similar data in the area of the drilling site and the need for additional information that may arise from time to time as the construction of the well progresses. Deviation checks shall be conducted on all holes where pilot holes and reaming are used, unless the hole will be cased and cemented by circulating cement to the surface. Where deviation checks are necessary they shall be conducted at sufficiently frequent intervals to assure that vertical avenues for fluid migration in the form of diverging holes are not created during drillings.
- (c) Where the injection zone is a formation which is naturally water-bearing the following information concerning the injection zone shall be determined or calculated for new Class III wells or projects:
  - (1) Fluid pressure;
  - (2) Fracture pressure; and
  - (3) Physical and chemical characteristics of the formation fluids.
- (d) Where the injection formation is not a water-bearing formation, the information in paragraph (c)(2) of this section must be submitted.
- (e) Where injection is into a formation which contains water with less than 10,000 mg/l TDS monitoring wells shall be completed into the injection zone and into any underground sources of drinking water above the injection zone which could be affected by the mining operation. These wells shall be located in such a fashion as to detect any excursion of injection fluids, process by-products, or formation fluids outside the mining area or zone. If the operation may be affected by subsidence or catastrophic collapse the monitoring wells shall be located so that they will not be physically affected.
- (f) Where injection is into a formation which does not contain water with less than 10,000 mg/l TDS, no monitoring wells are necessary in the injection stratum.
- (g) Where the injection wells penetrate an USDW in an area subject to subsidence or catastrophic collapse an adequate number of monitoring wells shall be completed into the USDW to detect any movement of injected fluids, process by-products or formation fluids into the USDW. The monitoring wells shall be located outside the physical influence of the subsidence or catastrophic collapse.
- (h) In determining the number, location, construction and frequency of monitoring of the monitoring wells the following criteria shall be considered:
  - (1) The population relying on the USDW affected or potentially affected by the injection operation;
  - (2) The proximity of the injection operation to points of withdrawal of drinking water;
  - (3) The local geology and hydrology;
  - (4) The operating pressures and whether a negative pressure gradient is being maintained;
  - (5) The nature and volume of the injected fluid, the formation water, and the process by-products; and

- (6) The injection well density.

[45 FR 42500, June 24, 1980, as amended at 46 FR 43163, Aug. 27, 1981; 47 FR 5000, Feb. 3, 1982]

### § 146.33 Operating, monitoring, and reporting requirements.

- (a) **Operating requirements.** Operating requirements prescribed shall, at a minimum, specify that:

- (1) Except during well stimulation injection pressure at the wellhead shall be calculated so as to assure that the pressure in the injection zone during injection does not initiate new fractures or propagate existing fractures in the injection zone. In no case, shall injection pressure initiate fractures in the confining zone or cause the migration of injection or formation fluids into an underground source of drinking water.
- (2) Injection between the outermost casing protecting underground sources of drinking water and the well bore is prohibited.

- (b) **Monitoring requirements.** Monitoring requirements shall, at a minimum, specify:

- (1) Monitoring of the nature of injected fluids with sufficient frequency to yield representative data on its characteristics. Whenever the injection fluid is modified to the extent that the analysis required by § 146.34(a)(7)(iii) is incorrect or incomplete, a new analysis as required by § 146.34(a)(7)(iii) shall be provided to the Director.
- (2) Monitoring of injection pressure and either flow rate or volume semi-monthly, or metering and daily recording of injected and produced fluid volumes as appropriate.
- (3) Demonstration of mechanical integrity pursuant to § 146.08 at least once every five years during the life of the well for salt solution mining.
- (4) Monitoring of the fluid level in the injection zone semi-monthly, where appropriate and monitoring of the parameters chosen to measure water quality in the monitoring wells required by § 146.32(e), semi-monthly.
- (5) Quarterly monitoring of wells required by § 146.32(g).
- (6) All Class III wells may be monitored on a field or project basis rather than an individual well basis by manifold monitoring. Manifold monitoring may be used in cases of facilities consisting of more than one injection well, operating with a common manifold. Separate monitoring systems for each well are not required provided the owner/operator demonstrates that manifold monitoring is comparable to individual well monitoring.

- (c) **Reporting requirements.** Reporting requirements shall, at a minimum, include:

- (1) Quarterly reporting to the Director on required monitoring;
- (2) Results of mechanical integrity and any other periodic test required by the Director reported with the first regular quarterly report after the completion of the test; and
- (3) Monitoring may be reported on a project or field basis rather than individual well basis where manifold monitoring is used.

[45 FR 42500, June 24, 1980, as amended at 46 FR 43163, Aug. 27, 1981; 46 FR 5001, Feb. 3, 1982; 48 FR 31404, July 8, 1983]

## § 146.34 Information to be considered by the Director.

This section sets forth the information which must be considered by the Director in authorizing Class III wells. Certain maps, cross sections, tabulations of wells within the area of review, and other data may be included in the application by reference provided they are current, readily available to the Director (for example, in the permitting agency's files) and sufficiently identified to be retrieved. In cases where EPA issues the permit, all the information in this section must be submitted to the Administrator.

- (a) Prior to the issuance of a permit for an existing Class III well or area to operate or the construction of a new Class III well the Director shall consider the following:
  - (1) Information required in 40 CFR 144.31 and 144.31(g);
  - (2) A map showing the injection well or project area for which a permit is sought and the applicable area of review. Within the area of review, the map must show the number or name and location of all existing producing wells, injection wells, abandoned wells, dry holes, public water systems and water wells. The map may also show surface bodies of waters, mines (surface and subsurface), quarries and other pertinent surface features including residences and roads, and faults if known or suspected. Only information of public record and pertinent information known to the applicant is required to be included on this map.
  - (3) A tabulation of data reasonably available from public records or otherwise known to the applicant on wells within the area of review included on the map required under paragraph (a)(2) of this section which penetrate the proposed injection zone. Such data shall include a description of each well's type, construction, date drilled, location, depth, record of plugging and completion, and any additional information the Director may require. In cases where the information would be repetitive and the wells are of similar age, type, and construction the Director may elect to only require data on a representative number of wells.
  - (4) Maps and cross sections indicating the vertical limits of all underground sources of drinking water within the area of review, their position relative to the injection formation, and the direction of water movement, where known, in every underground source of drinking water which may be affected by the proposed injection:
  - (5) Maps and cross sections detailing the geologic structure of the local area;
  - (6) Generalized map and cross sections illustrating the regional geologic setting;
  - (7) Proposed operating data:
    - (i) Average and maximum daily rate and volume of fluid to be injected;
    - (ii) Average and maximum injection pressure; and
    - (iii) Qualitative analysis and ranges in concentrations of all constituents of injected fluids. The applicant may request Federal confidentiality as specified in 40 CFR part 2. If the information is proprietary an applicant may, in lieu of the ranges in concentrations, choose to submit maximum concentrations which shall not be exceeded. In such a case the applicant shall retain records of the undisclosed concentrations and provide them upon request to the Director as part of any enforcement investigation.
  - (8) Proposed formation testing program to obtain the information required by § 146.32(c).
  - (9) Proposed stimulation program;

- (10) Proposed injection procedure;
  - (11) Schematic or other appropriate drawings of the surface and subsurface construction details of the well;
  - (12) Plans (including maps) for meeting the monitoring requirements of § 146.33(b);
  - (13) Expected changes in pressure, native fluid displacement, direction of movement of injection fluid;
  - (14) Contingency plans to cope with all shut-ins or well failures so as to prevent the migration of contaminating fluids into underground sources of drinking water;
  - (15) A certificate that the applicant has assured, through a performance bond, or other appropriate means, the resources necessary to close, plug, or abandon the well as required by 40 CFR 144.52(a)(7) and
  - (16) The corrective action proposed to be taken under 40 CFR 144.55.
- (b) Prior to granting approval for the operation of a Class III well the Director shall consider the following information:
- (1) All available logging and testing data on the well;
  - (2) A satisfactory demonstration of mechanical integrity for all new wells and for all existing salt solution wells pursuant to § 146.08;
  - (3) The anticipated maximum pressure and flow rate at which the permittee will operate;
  - (4) The results of the formation testing program;
  - (5) The actual injection procedures; and
  - (6) The status of corrective action on defective wells in the area of review.
- (c) Prior to granting approval for the plugging and abandonment of a Class III well the Director shall consider the following information:
- (1) The type and number of plugs to be used;
  - (2) The placement of each plug including the elevation of the top and bottom;
  - (3) The type, grade, and quantity of cement to be used;
  - (4) The method of placement of the plugs; and
  - (5) The procedure to be used to meet the requirements of § 146.10(c).

(Clean Water Act, Safe Drinking Water Act, Clean Air Act, Resource Conservation and Recovery Act: 42 U.S.C. 6905, 6912, 6925, 6927, 6974)

[45 FR 42500, June 24, 1980, as amended at 46 FR 43163, Aug. 27, 1981; 47 FR 5001, Feb. 3, 1982; 48 FR 14293, Apr. 1, 1983]

## Subpart E—Criteria and Standards Applicable to Class IV Injection Wells [Reserved]

## Subpart F—Criteria and Standards Applicable to Class V Injection Wells

### § 146.51 Applicability.

This subpart sets forth criteria and standards for underground injection control programs to regulate all injection not regulated in subparts B, C, D, and E.

- (a) Generally, wells covered by this subpart inject non-hazardous fluids into or above formations that contain underground sources of drinking water. It includes all wells listed in § 146.5(e) but is not limited to those types of injection wells.
- (b) It also includes wells not covered in Class IV that inject radioactive material listed in 10 CFR part 20, appendix B, table II, column 2.

[45 FR 42500, June 24, 1980, as amended at 47 FR 5001, Feb. 3, 1982]

### Subpart G—Criteria and Standards Applicable to Class I Hazardous Waste Injection Wells

**Source:** 53 FR 28148, July 26, 1988, unless otherwise noted.

### § 146.61 Applicability.

- (a) This subpart establishes criteria and standards for underground injection control programs to regulate Class I hazardous waste injection wells. Unless otherwise noted this subpart supplements the requirements of subpart A and applies instead of subpart B to Class I hazardous waste injection wells.

- (b) **Definitions.**

**Cone of influence** means that area around the well within which increased injection zone pressures caused by injection into the hazardous waste injection well would be sufficient to drive fluids into an underground source of drinking water (USDW).

**Existing well** means a Class I well which was authorized prior to August 25, 1988, by an approved State program, or an EPA-administered program or a well which has become a Class I well as a result of a change in the definition of the injected waste which would render the waste hazardous under § 261.3 of this part.

**Injection interval** means that part of the injection zone in which the well is screened, or in which the waste is otherwise directly emplaced.

**New well** means any Class I hazardous waste injection well which is not an existing well.

**Transmissive fault or fracture** is a fault or fracture that has sufficient permeability and vertical extent to allow fluids to move between formations.

### § 146.62 Minimum criteria for siting.

- (a) All Class I hazardous waste injection wells shall be sited such that they inject into a formation that is beneath the lowermost formation containing within one quarter mile of the well bore an underground source of drinking water.
- (b) The siting of Class I hazardous waste injection wells shall be limited to areas that are geologically suitable. The Director shall determine geologic suitability based upon:

- (1) An analysis of the structural and stratigraphic geology, the hydrogeology, and the seismicity of the region;
  - (2) An analysis of the local geology and hydrogeology of the well site, including, at a minimum, detailed information regarding stratigraphy, structure and rock properties, aquifer hydrodynamics and mineral resources; and
  - (3) A determination that the geology of the area can be described confidently and that limits of waste fate and transport can be accurately predicted through the use of models.
- (c) Class I hazardous waste injection wells shall be sited such that:
- (1) The injection zone has sufficient permeability, porosity, thickness and areal extent to prevent migration of fluids into USDWs.
  - (2) The confining zone:
    - (i) Is laterally continuous and free of transecting, transmissive faults or fractures over an area sufficient to prevent the movement of fluids into a USDW; and
    - (ii) Contains at least one formation of sufficient thickness and with lithologic and stress characteristics capable of preventing vertical propagation of fractures.
- (d) The owner or operator shall demonstrate to the satisfaction of the Director that:
- (1) The confining zone is separated from the base of the lowermost USDW by at least one sequence of permeable and less permeable strata that will provide an added layer of protection for the USDW in the event of fluid movement in an unlocated borehole or transmissive fault; or
  - (2) Within the area of review, the piezometric surface of the fluid in the injection zone is less than the piezometric surface of the lowermost USDW, considering density effects, injection pressures and any significant pumping in the overlying USDW; or
  - (3) There is no USDW present.
  - (4) The Director may approve a site which does not meet the requirements in paragraphs (d) (1), (2), or (3) of this section if the owner or operator can demonstrate to the Director that because of the geology, nature of the waste, or other considerations, abandoned boreholes or other conduits would not cause endangerment of USDWs.

### **§ 146.63 Area of review.**

For the purposes of Class I hazardous waste wells, this section shall apply to the exclusion of § 146.6. The area of review for Class I hazardous waste injection wells shall be a 2-mile radius around the well bore. The Director may specify a larger area of review based on the calculated cone of influence of the well.

### **§ 146.64 Corrective action for wells in the area of review.**

For the purposes of Class I hazardous waste wells, this section shall apply to the exclusion of §§ 144.55 and 146.07.

- (a) The owner or operator of a Class I hazardous waste well shall as part of the permit application submit a plan to the Director outlining the protocol used to:
- (1) Identify all wells penetrating the confining zone or injection zone within the area of review; and



- (2) Determine whether wells are adequately completed or plugged.
- (b) The owner or operator of a Class I hazardous waste well shall identify the location of all wells within the area of review that penetrate the injection zone or the confining zone and shall submit as required in § 146.70(a):
  - (1) A tabulation of all wells within the area of review that penetrate the injection zone or the confining zone; and
  - (2) A description of each well or type of well and any records of its plugging or completion.
- (c) For wells that the Director determines are improperly plugged, completed, or abandoned, or for which plugging or completion information is unavailable, the applicant shall also submit a plan consisting of such steps or modification as are necessary to prevent movement of fluids into or between USDWs. Where the plan is adequate, the Director shall incorporate it into the permit as a condition. Where the Director's review of an application indicates that the permittee's plan is inadequate (based at a minimum on the factors in paragraph (e) of this section), the Director shall:
  - (1) Require the applicant to revise the plan;
  - (2) Prescribe a plan for corrective action as a condition of the permit; or
  - (3) Deny the application.
- (d) Requirements:
  - (1) Existing injection wells. Any permit issued for an existing Class I hazardous waste injection well requiring corrective action other than pressure limitations shall include a compliance schedule requiring any corrective action accepted or prescribed under paragraph (c) of this section. Any such compliance schedule shall provide for compliance no later than 2 years following issuance of the permit and shall require observance of appropriate pressure limitations under paragraph (d)(3) until all other corrective action measures have been implemented.
  - (2) New injection wells. No owner or operator of a new Class I hazardous waste injection well may begin injection until all corrective actions required under this section have been taken.
  - (3) The Director may require pressure limitations in lieu of plugging. If pressure limitations are used in lieu of plugging, the Director shall require as a permit condition that injection pressure be so limited that pressure in the injection zone at the site of any improperly completed or abandoned well within the area of review would not be sufficient to drive fluids into or between USDWs. This pressure limitation shall satisfy the corrective action requirement. Alternatively, such injection pressure limitation may be made part of a compliance schedule and may be required to be maintained until all other required corrective actions have been implemented.
- (e) In determining the adequacy of corrective action proposed by the applicant under paragraph (c) of this section and in determining the additional steps needed to prevent fluid movement into and between USDWs, the following criteria and factors shall be considered by the Director:
  - (1) Nature and volume of injected fluid;
  - (2) Nature of native fluids or byproducts of injection;
  - (3) Geology;
  - (4) Hydrology;

- (5) History of the injection operation;
- (6) Completion and plugging records;
- (7) Closure procedures in effect at the time the well was closed;
- (8) Hydraulic connections with USDWs;
- (9) Reliability of the procedures used to identify abandoned wells; and
- (10) Any other factors which might affect the movement of fluids into or between USDWs.

### § 146.65 Construction requirements.

- (a) **General.** All existing and new Class I hazardous waste injection wells shall be constructed and completed to:
  - (1) Prevent the movement of fluids into or between USDWs or into any unauthorized zones;
  - (2) Permit the use of appropriate testing devices and workover tools; and
  - (3) Permit continuous monitoring of injection tubing and long string casing as required pursuant to § 146.67(f).
- (b) **Compatibility.** All well materials must be compatible with fluids with which the materials may be expected to come into contact. A well shall be deemed to have compatibility as long as the materials used in the construction of the well meet or exceed standards developed for such materials by the American Petroleum Institute, The American Society for Testing Materials, or comparable standards acceptable to the Director.
- (c) **Casing and Cementing of New Wells.**
  - (1) Casing and cement used in the construction of each newly drilled well shall be designed for the life expectancy of the well, including the post-closure care period. The casing and cementing program shall be designed to prevent the movement of fluids into or between USDWs, and to prevent potential leaks of fluids from the well. In determining and specifying casing and cementing requirements, the Director shall consider the following information as required by § 146.70:
    - (i) Depth to the injection zone;
    - (ii) Injection pressure, external pressure, internal pressure and axial loading;
    - (iii) Hole size;
    - (iv) Size and grade of all casing strings (well thickness, diameter, nominal weight, length, joint specification and construction material);
    - (v) Corrosiveness of injected fluid, formation fluids and temperature;
    - (vi) Lithology of injection and confining zones;
    - (vii) Type or grade of cement; and
    - (viii) Quantity and chemical composition of the injected fluid.

- (2) One surface casing string shall, at a minimum, extend into the confining bed below the lowest formation that contains a USDW and be cemented by circulating cement from the base of the casing to the surface, using a minimum of 120% of the calculated annual volume. The Director may require more than 120% when the geology or other circumstances warrant it.
- (3) At least one long string casing, using a sufficient number of centralizers, shall extend to the injection zone and shall be cemented by circulating cement to the surface in one or more stages:
  - (i) Of sufficient quantity and quality to withstand the maximum operating pressure; and
  - (ii) In a quantity no less than 120% of the calculated volume necessary to fill the annular space. The Director may require more than 120% when the geology or other circumstances warrant it.
- (4) Circulation of cement may be accomplished by staging. The Director may approve an alternative method of cementing in cases where the cement cannot be recirculated to the surface, provided the owner or operator can demonstrate by using logs that the cement is continuous and does not allow fluid movement behind the well bore.
- (5) Casings, including any casing connections, must be rated to have sufficient structural strength to withstand, for the design life of the well:
  - (i) The maximum burst and collapse pressures which may be experienced during the construction, operation and closure of the well; and
  - (ii) The maximum tensile stress which may be experienced at any point along the length of the casing during the construction, operation, and closure of the well.
- (6) At a minimum, cement and cement additives must be of sufficient quality and quantity to maintain integrity over the design life of the well.

(d) ***Tubing and packer.***

- (1) All Class I hazardous waste injection wells shall inject fluids through tubing with a packer set at a point specified by the Director.
- (2) In determining and specifying requirements for tubing and packer, the following factors shall be considered:
  - (i) Depth of setting;
  - (ii) Characteristics of injection fluid (chemical content, corrosiveness, temperature and density);
  - (iii) Injection pressure;
  - (iv) Annular pressure;
  - (v) Rate (intermittent or continuous), temperature and volume of injected fluid;
  - (vi) Size of casing; and
  - (vii) Tubing tensile, burst, and collapse strengths.
- (3) The Director may approve the use of a fluid seal if he determines that the following conditions are met:
  - (i) The operator demonstrates that the seal will provide a level of protection comparable to a packer;

- (ii) The operator demonstrates that the staff is, and will remain, adequately trained to operate and maintain the well and to identify and interpret variations in parameters of concern;
- (iii) The permit contains specific limitations on variations in annular pressure and loss of annular fluid;
- (iv) The design and construction of the well allows continuous monitoring of the annular pressure and mass balance of annular fluid; and
- (v) A secondary system is used to monitor the interface between the annulus fluid and the injection fluid and the permit contains requirements for testing the system every three months and recording the results.

### **§ 146.66 Logging, sampling, and testing prior to new well operation.**

- (a) During the drilling and construction of a new Class I hazardous waste injection well, appropriate logs and tests shall be run to determine or verify the depth, thickness, porosity, permeability, and rock type of, and the salinity of any entrained fluids in, all relevant geologic units to assure conformance with performance standards in § 146.65, and to establish accurate baseline data against which future measurements may be compared. A descriptive report interpreting results of such logs and tests shall be prepared by a knowledgeable log analyst and submitted to the Director. At a minimum, such logs and tests shall include:
  - (1) Deviation checks during drilling on all holes constructed by drilling a pilot hole which are enlarged by reaming or another method. Such checks shall be at sufficiently frequent intervals to determine the location of the borehole and to assure that vertical avenues for fluid movement in the form of diverging holes are not created during drilling; and
  - (2) Such other logs and tests as may be needed after taking into account the availability of similar data in the area of the drilling site, the construction plan, and the need for additional information that may arise from time to time as the construction of the well progresses. At a minimum, the following logs shall be required in the following situations:
    - (i) Upon installation of the surface casing:
      - (A) Resistivity, spontaneous potential, and caliper logs before the casing is installed; and
      - (B) A cement bond and variable density log, and a temperature log after the casing is set and cemented.
    - (ii) Upon installation of the long string casing:
      - (A) Resistivity, spontaneous potential, porosity, caliper, gamma ray, and fracture finder logs before the casing is installed; and
      - (B) A cement bond and variable density log, and a temperature log after the casing is set and cemented.
    - (iii) The Director may allow the use of an alternative to the above logs when an alternative will provide equivalent or better information; and
  - (3) A mechanical integrity test consisting of:
    - (i) A pressure test with liquid or gas;
    - (ii) A radioactive tracer survey;

- (iii) A temperature or noise log;
  - (iv) A casing inspection log, if required by the Director; and
  - (v) Any other test required by the Director.
- (b) Whole cores or sidewall cores of the confining and injection zones and formation fluid samples from the injection zone shall be taken. The Director may accept cores from nearby wells if the owner or operator can demonstrate that core retrieval is not possible and that such cores are representative of conditions at the well. The Director may require the owner or operator to core other formations in the borehole.
- (c) The fluid temperature, pH, conductivity, pressure and the static fluid level of the injection zone must be recorded.
- (d) At a minimum, the following information concerning the injection and confining zones shall be determined or calculated for Class I hazardous waste injection wells:
  - (1) Fracture pressure;
  - (2) Other physical and chemical characteristics of the injection and confining zones; and
  - (3) Physical and chemical characteristics of the formation fluids in the injection zone.
- (e) Upon completion, but prior to operation, the owner or operator shall conduct the following tests to verify hydrogeologic characteristics of the injection zone:
  - (1) A pump test; or
  - (2) Injectivity tests.
- (f) The Director shall have the opportunity to witness all logging and testing by this subpart. The owner or operator shall submit a schedule of such activities to the Director 30 days prior to conducting the first test.

#### § 146.67 Operating requirements.

- (a) Except during stimulation, the owner or operator shall assure that injection pressure at the wellhead does not exceed a maximum which shall be calculated so as to assure that the pressure in the injection zone during injection does not initiate new fractures or propagate existing fractures in the injection zone. The owner or operator shall assure that the injection pressure does not initiate fractures or propagate existing fractures in the confining zone, nor cause the movement of injection or formation fluids into a USDW.
- (b) Injection between the outermost casing protecting USDWs and the well bore is prohibited.
- (c) The owner or operator shall maintain an annulus pressure that exceeds the operating injection pressure, unless the Director determines that such a requirement might harm the integrity of the well. The fluid in the annulus shall be noncorrosive, or shall contain a corrosion inhibitor.
- (d) The owner or operator shall maintain mechanical integrity of the injection well at all times.
- (e) Permit requirements for owners or operators of hazardous waste wells which inject wastes which have the potential to react with the injection formation to generate gases shall include:
  - (1) Conditions limiting the temperature, pH or acidity of the injected waste; and
  - (2) Procedures necessary to assure that pressure imbalances which might cause a backflow or blowout do not occur.

- (f) The owner or operator shall install and use continuous recording devices to monitor: the injection pressure; the flow rate, volume, and temperature of injected fluids; and the pressure on the annulus between the tubing and the long string casing, and shall install and use:
  - (1) Automatic alarm and automatic shut-off systems, designed to sound and shut-in the well when pressures and flow rates or other parameters approved by the Director exceed a range and/or gradient specified in the permit; or
  - (2) Automatic alarms, designed to sound when the pressures and flow rates or other parameters approved by the Director exceed a rate and/or gradient specified in the permit, in cases where the owner or operator certifies that a trained operator will be on-site at all times when the well is operating.
- (g) If an automatic alarm or shutdown is triggered, the owner or operator shall immediately investigate and identify as expeditiously as possible the cause of the alarm or shutdown. If, upon such investigation, the well appears to be lacking mechanical integrity, or if monitoring required under paragraph (f) of this section otherwise indicates that the well may be lacking mechanical integrity, the owner or operator shall:
  - (1) Cease injection of waste fluids unless authorized by the Director to continue or resume injection.
  - (2) Take all necessary steps to determine the presence or absence of a leak; and
  - (3) Notify the Director within 24 hours after the alarm or shutdown.
- (h) If a loss of mechanical integrity is discovered pursuant to paragraph (g) of this section or during periodic mechanical integrity testing, the owner or operator shall:
  - (1) Immediately cease injection of waste fluids;
  - (2) Take all steps reasonably necessary to determine whether there may have been a release of hazardous wastes or hazardous waste constituents into any unauthorized zone;
  - (3) Notify the Director within 24 hours after loss of mechanical integrity is discovered;
  - (4) Notify the Director when injection can be expected to resume; and
  - (5) Restore and demonstrate mechanical integrity to the satisfaction of the Director prior to resuming injection of waste fluids.
- (i) Whenever the owner or operator obtains evidence that there may have been a release of injected wastes into an unauthorized zone:
  - (1) The owner or operator shall immediately cease injection of waste fluids, and:
    - (i) Notify the Director within 24 hours of obtaining such evidence;
    - (ii) Take all necessary steps to identify and characterize the extent of any release;
    - (iii) Comply with any remediation plan specified by the Director;
    - (iv) Implement any remediation plan approved by the Director; and
    - (v) Where such release is into a USDW currently serving as a water supply, place a notice in a newspaper of general circulation.
  - (2) The Director may allow the operator to resume injection prior to completing cleanup action if the owner or operator demonstrates that the injection operation will not endanger USDWs.

- (j) The owner or operator shall notify the Director and obtain his approval prior to conducting any well workover.

### **§ 146.68 Testing and monitoring requirements.**

Testing and monitoring requirements shall at a minimum include:

- (a) Monitoring of the injected wastes.
  - (1) The owner or operator shall develop and follow an approved written waste analysis plan that describes the procedures to be carried out to obtain a detailed chemical and physical analysis of a representative sample of the waste, including the quality assurance procedures used. At a minimum, the plan shall specify:
    - (i) The parameters for which the waste will be analyzed and the rationale for the selection of these parameters;
    - (ii) The test methods that will be used to test for these parameters; and
    - (iii) The sampling method that will be used to obtain a representative sample of the waste to be analyzed.
  - (2) The owner or operator shall repeat the analysis of the injected wastes as described in the waste analysis plan at frequencies specified in the waste analysis plan and when process or operating changes occur that may significantly alter the characteristics of the waste stream.
  - (3) The owner or operator shall conduct continuous or periodic monitoring of selected parameters as required by the Director.
  - (4) The owner or operator shall assure that the plan remains accurate and the analyses remain representative.
- (b) Hydrogeologic compatibility determination. The owner or operator shall submit information demonstrating to the satisfaction of the Director that the waste stream and its anticipated reaction products will not alter the permeability, thickness or other relevant characteristics of the confining or injection zones such that they would no longer meet the requirements specified in § 146.62.
- (c) Compatibility of well materials.
  - (1) The owner or operator shall demonstrate that the waste stream will be compatible with the well materials with which the waste is expected to come into contact, and submit to the Director a description of the methodology used to make that determination. Compatibility for purposes of this requirement is established if contact with injected fluids will not cause the well materials to fail to satisfy any design requirement imposed under § 146.65(b).
  - (2) The Director shall require continuous corrosion monitoring of the construction materials used in the well for wells injecting corrosive waste, and may require such monitoring for other waste, by:
    - (i) Placing coupons of the well construction materials in contact with the waste stream; or
    - (ii) Routing the waste stream through a loop constructed with the material used in the well; or
    - (iii) Using an alternative method approved by the Director.
  - (3) If a corrosion monitoring program is required:

- (i) The test shall use materials identical to those used in the construction of the well, and such materials must be continuously exposed to the operating pressures and temperatures (measured at the well head) and flow rates of the injection operation; and
  - (ii) The owner or operator shall monitor the materials for loss of mass, thickness, cracking, pitting and other signs of corrosion on a quarterly basis to ensure that the well components meet the minimum standards for material strength and performance set forth in § 146.65(b).
- (d) **Periodic mechanical integrity testing.** In fulfilling the requirements of § 146.8, the owner or operator of a Class I hazardous waste injection well shall conduct the mechanical integrity testing as follows:
  - (1) The long string casing, injection tube, and annular seal shall be tested by means of an approved pressure test with a liquid or gas annually and whenever there has been a well workover;
  - (2) The bottom-hole cement shall be tested by means of an approved radioactive tracer survey annually;
  - (3) An approved temperature, noise, or other approved log shall be run at least once every five years to test for movement of fluid along the borehole. The Director may require such tests whenever the well is worked over;
  - (4) Casing inspection logs shall be run whenever the owner or operator conducts a workover in which the injection string is pulled, unless the Director waives this requirement due to well construction or other factors which limit the test's reliability, or based upon the satisfactory results of a casing inspection log run within the previous five years. The Director may require that a casing inspection log be run every five years, if he has reason to believe that the integrity of the long string casing of the well may be adversely affected by naturally-occurring or man-made events;
  - (5) Any other test approved by the Director in accordance with the procedures in § 146.8(d) may also be used.
- (e) **Ambient monitoring.**
  - (1) Based on a site-specific assessment of the potential for fluid movement from the well or injection zone, and on the potential value of monitoring wells to detect such movement, the Director shall require the owner or operator to develop a monitoring program. At a minimum, the Director shall require monitoring of the pressure buildup in the injection zone annually, including at a minimum, a shut down of the well for a time sufficient to conduct a valid observation of the pressure fall-off curve.
  - (2) When prescribing a monitoring system the Director may also require:
    - (i) Continuous monitoring for pressure changes in the first aquifer overlying the confining zone. When such a well is installed, the owner or operator shall, on a quarterly basis, sample the aquifer and analyze for constituents specified by the Director;
    - (ii) The use of indirect, geophysical techniques to determine the position of the waste front, the water quality in a formation designated by the Director, or to provide other site specific data;
    - (iii) Periodic monitoring of the ground water quality in the first aquifer overlying the injection zone;
    - (iv) Periodic monitoring of the ground water quality in the lowermost USDW; and
    - (v) Any additional monitoring necessary to determine whether fluids are moving into or between USDWs.



- (f) The Director may require seismicity monitoring when he has reason to believe that the injection activity may have the capacity to cause seismic disturbances.

[53 FR 28148, July 26, 1988, as amended at 57 FR 46294, Oct. 7, 1992]

### § 146.69 Reporting requirements.

Reporting requirements shall, at a minimum, include:

- (a) Quarterly reports to the Director containing:
  - (1) The maximum injection pressure;
  - (2) A description of any event that exceeds operating parameters for annulus pressure or injection pressure as specified in the permit;
  - (3) A description of any event which triggers an alarm or shutdown device required pursuant to § 146.67(f) and the response taken;
  - (4) The total volume of fluid injected;
  - (5) Any change in the annular fluid volume;
  - (6) The physical, chemical and other relevant characteristics of injected fluids; and
  - (7) The results of monitoring prescribed under § 146.68.
- (b) Reporting, within 30 days or with the next quarterly report whichever comes later, the results of:
  - (1) Periodic tests of mechanical integrity;
  - (2) Any other test of the injection well conducted by the permittee if required by the Director; and
  - (3) Any well workover.

### § 146.70 Information to be evaluated by the Director.

This section sets forth the information which must be evaluated by the Director in authorizing Class I hazardous waste injection wells. For a new Class I hazardous waste injection well, the owner or operator shall submit all the information listed below as part of the permit application. For an existing or converted Class I hazardous waste injection well, the owner or operator shall submit all information listed below as part of the permit application except for those items of information which are current, accurate, and available in the existing permit file. For both existing and new Class I hazardous waste injection wells, certain maps, cross-sections, tabulations of wells within the area of review and other data may be included in the application by reference provided they are current and readily available to the Director (for example, in the permitting agency's files) and sufficiently identifiable to be retrieved. In cases where EPA issues the permit, all the information in this section must be submitted to the Administrator or his designee.

- (a) Prior to the issuance of a permit for an existing Class I hazardous waste injection well to operate or the construction or conversion of a new Class I hazardous waste injection well, the Director shall review the following to assure that the requirements of this part and part 144 are met:
  - (1) Information required in § 144.31;

- (2) A map showing the injection well for which a permit is sought and the applicable area of review. Within the area of review, the map must show the number or name and location of all producing wells, injection wells, abandoned wells, dry holes, surface bodies of water, springs, mines (surface and subsurface), quarries, water wells and other pertinent surface features, including residences and roads. The map should also show faults, if known or suspected;
- (3) A tabulation of all wells within the area of review which penetrate the proposed injection zone or confining zone. Such data shall include a description of each well's type, construction, date drilled, location, depth, record of plugging and/or completion and any additional information the Director may require;
- (4) The protocol followed to identify, locate and ascertain the condition of abandoned wells within the area of review which penetrate the injection or the confining zones;
- (5) Maps and cross-sections indicating the general vertical and lateral limits of all underground sources of drinking water within the area of review, their position relative to the injection formation and the direction of water movement, where known, in each underground source of drinking water which may be affected by the proposed injection;
- (6) Maps and cross-sections detailing the geologic structure of the local area;
- (7) Maps and cross-sections illustrating the regional geologic setting;
- (8) Proposed operating data;
  - (i) Average and maximum daily rate and volume of the fluid to be injected; and
  - (ii) Average and maximum injection pressure;
- (9) Proposed formation testing program to obtain an analysis of the chemical, physical and radiological characteristics of and other information on the injection formation and the confining zone;
- (10) Proposed stimulation program;
- (11) Proposed injection procedure;
- (12) Schematic or other appropriate drawings of the surface and subsurface construction details of the well;
- (13) Contingency plans to cope with all shut-ins or well failures so as to prevent migration of fluids into any USDW;
- (14) Plans (including maps) for meeting monitoring requirements of § 146.68;
- (15) For wells within the area of review which penetrate the injection zone or the confining zone but are not properly completed or plugged, the corrective action to be taken under § 146.64;
- (16) Construction procedures including a cementing and casing program, well materials specifications and their life expectancy, logging procedures, deviation checks, and a drilling, testing and coring program; and
- (17) A demonstration pursuant to part 144, subpart F, that the applicant has the resources necessary to close, plug or abandon the well and for post-closure care.

- (b) Prior to the Director's granting approval for the operation of a Class I hazardous waste injection well, the owner or operator shall submit and the Director shall review the following information, which shall be included in the completion report:
  - (1) All available logging and testing program data on the well;
  - (2) A demonstration of mechanical integrity pursuant to § 146.68;
  - (3) The anticipated maximum pressure and flow rate at which the permittee will operate;
  - (4) The results of the injection zone and confining zone testing program as required in § 146.70(a)(9);
  - (5) The actual injection procedure;
  - (6) The compatibility of injected waste with fluids in the injection zone and minerals in both the injection zone and the confining zone and with the materials used to construct the well;
  - (7) The calculated area of review based on data obtained during logging and testing of the well and the formation, and where necessary revisions to the information submitted under § 146.70(a) (2) and (3).
  - (8) The status of corrective action on wells identified in § 146.70(a)(15).
- (c) Prior to granting approval for the plugging and abandonment (i.e., closure) of a Class I hazardous waste injection well, the Director shall review the information required in §§ 146.71(a)(4) and 146.72(a).
- (d) Any permit issued for a Class I hazardous waste injection well for disposal on the premises where the waste is generated shall contain a certification by the owner or operator that:
  - (1) The generator of the hazardous waste has a program to reduce the volume or quantity and toxicity of such waste to the degree determined by the generator to be economically practicable; and
  - (2) Injection of the waste is that practicable method of disposal currently available to the generator which minimizes the present and future threat to human health and the environment.

#### § 146.71 Closure.

- (a) **Closure Plan.** The owner or operator of a Class I hazardous waste injection well shall prepare, maintain, and comply with a plan for closure of the well that meets the requirements of paragraph (d) of this section and is acceptable to the Director. The obligation to implement the closure plan survives the termination of a permit or the cessation of injection activities. The requirement to maintain and implement an approved plan is directly enforceable regardless of whether the requirement is a condition of the permit.
  - (1) The owner or operator shall submit the plan as a part of the permit application and, upon approval by the Director, such plan shall be a condition of any permit issued.
  - (2) The owner or operator shall submit any proposed significant revision to the method of closure reflected in the plan for approval by the Director no later than the date on which notice of closure is required to be submitted to the Director under paragraph (b) of this section.
  - (3) The plan shall assure financial responsibility as required in § 144.52(a)(7).
  - (4) The plan shall include the following information:
    - (i) The type and number of plugs to be used;

- (ii) The placement of each plug including the elevation of the top and bottom of each plug;
  - (iii) The type and grade and quantity of material to be used in plugging;
  - (iv) The method of placement of the plugs;
  - (v) Any proposed test or measure to be made;
  - (vi) The amount, size, and location (by depth) of casing and any other materials to be left in the well;
  - (vii) The method and location where casing is to be parted, if applicable;
  - (viii) The procedure to be used to meet the requirements of paragraph (d)(5) of this section;
  - (ix) The estimated cost of closure; and
  - (x) Any proposed test or measure to be made.
- (5) The Director may modify a closure plan following the procedures of § 124.5.
- (6) An owner or operator of a Class I hazardous waste injection well who ceases injection temporarily, may keep the well open provided he:
- (i) Has received authorization from the Director; and
  - (ii) Has described actions or procedures, satisfactory to the Director, that the owner or operator will take to ensure that the well will not endanger USDWs during the period of temporary disuse. These actions and procedures shall include compliance with the technical requirements applicable to active injection wells unless waived by the Director.
- (7) The owner or operator of a well that has ceased operations for more than two years shall notify the Director 30 days prior to resuming operation of the well.
- (b) **Notice of intent to close.** The owner or operator shall notify the Director at least 60 days before closure of a well. At the discretion of the Director, a shorter notice period may be allowed.
- (c) **Closure report.** Within 60 days after closure or at the time of the next quarterly report (whichever is less) the owner or operator shall submit a closure report to the Director. If the quarterly report is due less than 15 days after completion of closure, then the report shall be submitted within 60 days after closure. The report shall be certified as accurate by the owner or operator and by the person who performed the closure operation (if other than the owner or operator). Such report shall consist of either:
- (1) A statement that the well was closed in accordance with the closure plan previously submitted and approved by the Director; or
  - (2) Where actual closure differed from the plan previously submitted, a written statement specifying the differences between the previous plan and the actual closure.
- (d) **Standards for well closure.**
- (1) Prior to closing the well, the owner or operator shall observe and record the pressure decay for a time specified by the Director. The Director shall analyze the pressure decay and the transient pressure observations conducted pursuant to § 146.68(e)(1)(i) and determine whether the injection activity has conformed with predicted values.

- (2) Prior to well closure, appropriate mechanical integrity testing shall be conducted to ensure the integrity of that portion of the long string casing and cement that will be left in the ground after closure. Testing methods may include:
  - (i) Pressure tests with liquid or gas;
  - (ii) Radioactive tracer surveys;
  - (iii) Noise, temperature, pipe evaluation, or cement bond logs; and
  - (iv) Any other test required by the Director.
- (3) Prior to well closure, the well shall be flushed with a buffer fluid.
- (4) Upon closure, a Class I hazardous waste well shall be plugged with cement in a manner that will not allow the movement of fluids into or between USDWs.
- (5) Placement of the cement plugs shall be accomplished by one of the following:
  - (i) The Balance Method;
  - (ii) The Dump Bailer Method;
  - (iii) The Two-Plug Method; or
  - (iv) An alternate method, approved by the Director, that will reliably provide a comparable level of protection.
- (6) Each plug used shall be appropriately tagged and tested for seal and stability before closure is completed.
- (7) The well to be closed shall be in a state of static equilibrium with the mud weight equalized top to bottom, either by circulating the mud in the well at least once or by a comparable method prescribed by the Director, prior to the placement of the cement plug(s).

#### **§ 146.72 Post-closure care.**

- (a) The owner or operator of a Class I hazardous waste well shall prepare, maintain, and comply with a plan for post-closure care that meets the requirements of paragraph (b) of this section and is acceptable to the Director. The obligation to implement the post-closure plan survives the termination of a permit or the cessation of injection activities. The requirement to maintain an approved plan is directly enforceable regardless of whether the requirement is a condition of the permit.
  - (1) The owner or operator shall submit the plan as a part of the permit application and, upon approval by the Director, such plan shall be a condition of any permit issued.
  - (2) The owner or operator shall submit any proposed significant revision to the plan as appropriate over the life of the well, but no later than the date of the closure report required under § 146.71(c).
  - (3) The plan shall assure financial responsibility as required in § 146.73.
  - (4) The plan shall include the following information:
    - (i) The pressure in the injection zone before injection began;
    - (ii) The anticipated pressure in the injection zone at the time of closure;

- (iii) The predicted time until pressure in the injection zone decays to the point that the well's cone of influence no longer intersects the base of the lowermost USDW;
  - (iv) Predicted position of the waste front at closure;
  - (v) The status of any cleanups required under § 146.64; and
  - (vi) The estimated cost of proposed post-closure care.
- (5) At the request of the owner or operator, or on his own initiative, the Director may modify the post-closure plan after submission of the closure report following the procedures in § 124.5.
- (b) The owner or operator shall:
  - (1) Continue and complete any cleanup action required under § 146.64, if applicable;
  - (2) Continue to conduct any groundwater monitoring required under the permit until pressure in the injection zone decays to the point that the well's cone of influence no longer intersects the base of the lowermost USDW. The Director may extend the period of post-closure monitoring if he determines that the well may endanger a USDW.
  - (3) Submit a survey plat to the local zoning authority designated by the Director. The plat shall indicate the location of the well relative to permanently surveyed benchmarks. A copy of the plat shall be submitted to the Regional Administrator of the appropriate EPA Regional Office.
  - (4) Provide appropriate notification and information to such State and local authorities as have cognizance over drilling activities to enable such State and local authorities to impose appropriate conditions on subsequent drilling activities that may penetrate the well's confining or injection zone.
  - (5) Retain, for a period of three years following well closure, records reflecting the nature, composition and volume of all injected fluids. The Director shall require the owner or operator to deliver the records to the Director at the conclusion of the retention period, and the records shall thereafter be retained at a location designated by the Director for that purpose.
- (c) Each owner of a Class I hazardous waste injection well, and the owner of the surface or subsurface property on or in which a Class I hazardous waste injection well is located, must record a notation on the deed to the facility property or on some other instrument which is normally examined during title search that will in perpetuity provide any potential purchaser of the property the following information:
  - (1) The fact that land has been used to manage hazardous waste;
  - (2) The name of the State agency or local authority with which the plat was filed, as well as the address of the Regional Environmental Protection Agency Office to which it was submitted;
  - (3) The type and volume of waste injected, the injection interval or intervals into which it was injected, and the period over which injection occurred.

### **§ 146.73 Financial responsibility for post-closure care.**

The owner or operator shall demonstrate and maintain financial responsibility for post-closure by using a trust fund, surety bond, letter of credit, financial test, insurance or corporate guarantee that meets the specifications for the mechanisms and instruments revised as appropriate to cover closure and post-closure care in 40 CFR part 144, subpart F. The amount of the funds available shall be no less than the amount identified in § 146.72(a)(4)(vi). The

obligation to maintain financial responsibility for post-closure care survives the termination of a permit or the cessation of injection. The requirement to maintain financial responsibility is enforceable regardless of whether the requirement is a condition of the permit.

## Subpart H—Criteria and Standards Applicable to Class VI Wells

**Source:** 75 FR 77291, Dec. 10, 2010, unless otherwise noted.

### § 146.81 Applicability.

- (a) This subpart establishes criteria and standards for underground injection control programs to regulate any Class VI carbon dioxide geologic sequestration injection wells.
- (b) This subpart applies to any wells used to inject carbon dioxide specifically for the purpose of geologic sequestration, *i.e.*, the long-term containment of a gaseous, liquid, or supercritical carbon dioxide stream in subsurface geologic formations.
- (c) This subpart also applies to owners or operators of permit- or rule-authorized Class I, Class II, or Class V experimental carbon dioxide injection projects who seek to apply for a Class VI geologic sequestration permit for their well or wells. Owners or operators seeking to convert existing Class I, Class II, or Class V experimental wells to Class VI geologic sequestration wells must demonstrate to the Director that the wells were engineered and constructed to meet the requirements at § 146.86(a) and ensure protection of USDWs, in lieu of requirements at §§ 146.86(b) and 146.87(a). By December 10, 2011, owners or operators of either Class I wells previously permitted for the purpose of geologic sequestration or Class V experimental technology wells no longer being used for experimental purposes that will continue injection of carbon dioxide for the purpose of GS must apply for a Class VI permit. A converted well must still meet all other requirements under part 146.
- (d) **Definitions.** The following definitions apply to this subpart. To the extent that these definitions conflict with those in § 144.3 or § 146.3 of this chapter these definitions govern for Class VI wells:

**Area of review** means the region surrounding the geologic sequestration project where USDWs may be endangered by the injection activity. The area of review is delineated using computational modeling that accounts for the physical and chemical properties of all phases of the injected carbon dioxide stream and displaced fluids, and is based on available site characterization, monitoring, and operational data as set forth in § 146.84.

**Carbon dioxide plume** means the extent underground, in three dimensions, of an injected carbon dioxide stream.

**Carbon dioxide stream** means carbon dioxide that has been captured from an emission source (e.g., a power plant), plus incidental associated substances derived from the source materials and the capture process, and any substances added to the stream to enable or improve the injection process. This subpart does not apply to any carbon dioxide stream that meets the definition of a hazardous waste under 40 CFR part 261.

**Confining zone** means a geologic formation, group of formations, or part of a formation stratigraphically overlying the injection zone(s) that acts as barrier to fluid movement. For Class VI wells operating under an injection depth waiver, confining zone means a geologic formation, group of formations, or part of a formation stratigraphically overlying and underlying the injection zone(s).

**Corrective action** means the use of Director-approved methods to ensure that wells within the area of review do not serve as conduits for the movement of fluids into underground sources of drinking water (USDW).

**Geologic sequestration** means the long-term containment of a gaseous, liquid, or supercritical carbon dioxide stream in subsurface geologic formations. This term does not apply to carbon dioxide capture or transport.

**Geologic sequestration project** means an injection well or wells used to emplace a carbon dioxide stream beneath the lowermost formation containing a USDW; or, wells used for geologic sequestration of carbon dioxide that have been granted a waiver of the injection depth requirements pursuant to requirements at § 146.95; or, wells used for geologic sequestration of carbon dioxide that have received an expansion to the areal extent of an existing Class II enhanced oil recovery or enhanced gas recovery aquifer exemption pursuant to §§ 146.4 and 144.7(d) of this chapter. It includes the subsurface three-dimensional extent of the carbon dioxide plume, associated area of elevated pressure, and displaced fluids, as well as the surface area above that delineated region.

**Injection zone** means a geologic formation, group of formations, or part of a formation that is of sufficient areal extent, thickness, porosity, and permeability to receive carbon dioxide through a well or wells associated with a geologic sequestration project.

**Post-injection site care** means appropriate monitoring and other actions (including corrective action) needed following cessation of injection to ensure that USDWs are not endangered, as required under § 146.93.

**Pressure front** means the zone of elevated pressure that is created by the injection of carbon dioxide into the subsurface. For the purposes of this subpart, the pressure front of a carbon dioxide plume refers to a zone where there is a pressure differential sufficient to cause the movement of injected fluids or formation fluids into a USDW.

**Site closure** means the point/time, as determined by the Director following the requirements under § 146.93, at which the owner or operator of a geologic sequestration site is released from post-injection site care responsibilities.

**Transmissive fault or fracture** means a fault or fracture that has sufficient permeability and vertical extent to allow fluids to move between formations.

## § 146.82 Required Class VI permit information.

This section sets forth the information which must be considered by the Director in authorizing Class VI wells. For converted Class I, Class II, or Class V experimental wells, certain maps, cross-sections, tabulations of wells within the area of review and other data may be included in the application by reference provided they are current, readily available to the Director, and sufficiently identified to be retrieved. In cases where EPA issues the permit, all the information in this section must be submitted to the Regional Administrator.

- (a) Prior to the issuance of a permit for the construction of a new Class VI well or the conversion of an existing Class I, Class II, or Class V well to a Class VI well, the owner or operator shall submit, pursuant to § 146.91(e), and the Director shall consider the following:

- (1) Information required in § 144.31(e)(1) through (6) of this chapter;



- (2) A map showing the injection well for which a permit is sought and the applicable area of review consistent with § 146.84. Within the area of review, the map must show the number or name, and location of all injection wells, producing wells, abandoned wells, plugged wells or dry holes, deep stratigraphic boreholes, State- or EPA-approved subsurface cleanup sites, surface bodies of water, springs, mines (surface and subsurface), quarries, water wells, other pertinent surface features including structures intended for human occupancy, State, Tribal, and Territory boundaries, and roads. The map should also show faults, if known or suspected. Only information of public record is required to be included on this map;
- (3) Information on the geologic structure and hydrogeologic properties of the proposed storage site and overlying formations, including:
  - (i) Maps and cross sections of the area of review;
  - (ii) The location, orientation, and properties of known or suspected faults and fractures that may transect the confining zone(s) in the area of review and a determination that they would not interfere with containment;
  - (iii) 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;
  - (iv) Geomechanical information on fractures, stress, ductility, rock strength, and in situ fluid pressures within the confining zone(s);
  - (v) Information on the seismic history including the presence and depth of seismic sources and a determination that the seismicity would not interfere with containment; and
  - (vi) Geologic and topographic maps and cross sections illustrating regional geology, hydrogeology, and the geologic structure of the local area.
- (4) A tabulation of all wells within the area of review which penetrate the injection or confining zone(s). Such data must include a description of each well's type, construction, date drilled, location, depth, record of plugging and/or completion, and any additional information the Director may require;
- (5) Maps and stratigraphic cross sections indicating the general vertical and lateral limits of all USDWs, water wells and springs within the area of review, their positions relative to the injection zone(s), and the direction of water movement, where known;
- (6) Baseline geochemical data on subsurface formations, including all USDWs in the area of review;
- (7) Proposed operating data for the proposed geologic sequestration site:
  - (i) Average and maximum daily rate and volume and/or mass and total anticipated volume and/or mass of the carbon dioxide stream;
  - (ii) Average and maximum injection pressure;
  - (iii) The source(s) of the carbon dioxide stream; and
  - (iv) An analysis of the chemical and physical characteristics of the carbon dioxide stream.

- (8) Proposed pre-operational formation testing program to obtain an analysis of the chemical and physical characteristics of the injection zone(s) and confining zone(s) and that meets the requirements at § 146.87;
  - (9) Proposed stimulation program, a description of stimulation fluids to be used and a determination that stimulation will not interfere with containment;
  - (10) Proposed procedure to outline steps necessary to conduct injection operation;
  - (11) Schematics or other appropriate drawings of the surface and subsurface construction details of the well;
  - (12) Injection well construction procedures that meet the requirements of § 146.86;
  - (13) Proposed area of review and corrective action plan that meets the requirements under § 146.84;
  - (14) A demonstration, satisfactory to the Director, that the applicant has met the financial responsibility requirements under § 146.85;
  - (15) Proposed testing and monitoring plan required by § 146.90;
  - (16) Proposed injection well plugging plan required by § 146.92(b);
  - (17) Proposed post-injection site care and site closure plan required by § 146.93(a);
  - (18) At the Director's discretion, a demonstration of an alternative post-injection site care timeframe required by § 146.93(c);
  - (19) Proposed emergency and remedial response plan required by § 146.94(a);
  - (20) A list of contacts, submitted to the Director, for those States, Tribes, and Territories identified to be within the area of review of the Class VI project based on information provided in paragraph (a)(2) of this section; and
  - (21) Any other information requested by the Director.
- (b) The Director shall notify, in writing, any States, Tribes, or Territories within the area of review of the Class VI project based on information provided in paragraphs (a)(2) and (a)(20) of this section of the permit application and pursuant to the requirements at § 145.23(f)(13) of this chapter.
- (c) Prior to granting approval for the operation of a Class VI well, the Director shall consider the following information:
- (1) The final area of review based on modeling, using data obtained during logging and testing of the well and the formation as required by paragraphs (c)(2), (3), (4), (6), (7), and (10) of this section;
  - (2) Any relevant updates, based on data obtained during logging and testing of the well and the formation as required by paragraphs (c)(3), (4), (6), (7), and (10) of this section, to the information on the geologic structure and hydrogeologic properties of the proposed storage site and overlying formations, submitted to satisfy the requirements of paragraph (a)(3) of this section;
  - (3) Information on the compatibility of the carbon dioxide stream with fluids in the injection zone(s) and minerals in both the injection and the confining zone(s), based on the results of the formation testing program, and with the materials used to construct the well;
  - (4) The results of the formation testing program required at paragraph (a)(8) of this section;

- (5) Final injection well construction procedures that meet the requirements of § 146.86;
  - (6) The status of corrective action on wells in the area of review;
  - (7) All available logging and testing program data on the well required by § 146.87;
  - (8) A demonstration of mechanical integrity pursuant to § 146.89;
  - (9) Any updates to the proposed area of review and corrective action plan, testing and monitoring plan, injection well plugging plan, post-injection site care and site closure plan, or the emergency and remedial response plan submitted under paragraph (a) of this section, which are necessary to address new information collected during logging and testing of the well and the formation as required by all paragraphs of this section, and any updates to the alternative post-injection site care timeframe demonstration submitted under paragraph (a) of this section, which are necessary to address new information collected during the logging and testing of the well and the formation as required by all paragraphs of this section; and
  - (10) Any other information requested by the Director.
- (d) Owners or operators seeking a waiver of the requirement to inject below the lowermost USDW must also refer to § 146.95 and submit a supplemental report, as required at § 146.95(a). The supplemental report is not part of the permit application.

#### **§ 146.83 Minimum criteria for siting.**

- (a) Owners or operators of Class VI wells must demonstrate to the satisfaction of the Director that the wells will be sited in areas with a suitable geologic system. The owners or operators must demonstrate that the geologic system comprises:
- (1) An injection zone(s) of sufficient areal extent, thickness, porosity, and permeability to receive the total anticipated volume of the carbon dioxide stream;
  - (2) Confining zone(s) free of transmissive faults or fractures and of sufficient areal extent and integrity to contain the injected carbon dioxide stream and displaced formation fluids and allow injection at proposed maximum pressures and volumes without initiating or propagating fractures in the confining zone(s).
- (b) The Director may require owners or operators of Class VI wells to identify and characterize additional zones that will impede vertical fluid movement, are free of faults and fractures that may interfere with containment, allow for pressure dissipation, and provide additional opportunities for monitoring, mitigation, and remediation.

#### **§ 146.84 Area of review and corrective action.**

- (a) The area of review is the region surrounding the geologic sequestration project where USDWs may be endangered by the injection activity. The area of review is delineated using computational modeling that accounts for the physical and chemical properties of all phases of the injected carbon dioxide stream and is based on available site characterization, monitoring, and operational data.
- (b) The owner or operator of a Class VI well must prepare, maintain, and comply with a plan to delineate the area of review for a proposed geologic sequestration project, periodically reevaluate the delineation, and perform corrective action that meets the requirements of this section and is acceptable to the Director. The requirement to maintain and implement an approved plan is directly enforceable regardless of

whether the requirement is a condition of the permit. As a part of the permit application for approval by the Director, the owner or operator must submit an area of review and corrective action plan that includes the following information:

- (1) The method for delineating the area of review that meets the requirements of paragraph (c) of this section, including the model to be used, assumptions that will be made, and the site characterization data on which the model will be based;
- (2) A description of:
  - (i) The minimum fixed frequency, not to exceed five years, at which the owner or operator proposes to reevaluate the area of review;
  - (ii) The monitoring and operational conditions that would warrant a reevaluation of the area of review prior to the next scheduled reevaluation as determined by the minimum fixed frequency established in paragraph (b)(2)(i) of this section.
  - (iii) How monitoring and operational data (e.g., injection rate and pressure) will be used to inform an area of review reevaluation; and
  - (iv) How corrective action will be conducted to meet the requirements of paragraph (d) of this section, including what corrective action will be performed prior to injection and what, if any, portions of the area of review will have corrective action addressed on a phased basis and how the phasing will be determined; how corrective action will be adjusted if there are changes in the area of review; and how site access will be guaranteed for future corrective action.
- (c) Owners or operators of Class VI wells must perform the following actions to delineate the area of review and identify all wells that require corrective action:
  - (1) Predict, using existing site characterization, monitoring and operational data, and computational modeling, the projected lateral and vertical migration of the carbon dioxide plume and formation fluids in the subsurface from the commencement of injection activities until the plume movement ceases, until pressure differentials sufficient to cause the movement of injected fluids or formation fluids into a USDW are no longer present, or until the end of a fixed time period as determined by the Director. The model must:
    - (i) Be based on detailed geologic data collected to characterize the injection zone(s), confining zone(s) and any additional zones; and anticipated operating data, including injection pressures, rates, and total volumes over the proposed life of the geologic sequestration project;
    - (ii) Take into account any geologic heterogeneities, other discontinuities, data quality, and their possible impact on model predictions; and
    - (iii) Consider potential migration through faults, fractures, and artificial penetrations.
  - (2) Using methods approved by the Director, identify all penetrations, including active and abandoned wells and underground mines, in the area of review that may penetrate the confining zone(s). Provide a description of each well's type, construction, date drilled, location, depth, record of plugging and/or completion, and any additional information the Director may require; and
  - (3) Determine which abandoned wells in the area of review have been plugged in a manner that prevents the movement of carbon dioxide or other fluids that may endanger USDWs, including use of materials compatible with the carbon dioxide stream.

- (d) Owners or operators of Class VI wells must perform corrective action on all wells in the area of review that are determined to need corrective action, using methods designed to prevent the movement of fluid into or between USDWs, including use of materials compatible with the carbon dioxide stream, where appropriate.
- (e) At the minimum fixed frequency, not to exceed five years, as specified in the area of review and corrective action plan, or when monitoring and operational conditions warrant, owners or operators must:
  - (1) Reevaluate the area of review in the same manner specified in paragraph (c)(1) of this section;
  - (2) Identify all wells in the reevaluated area of review that require corrective action in the same manner specified in paragraph (c) of this section;
  - (3) Perform corrective action on wells requiring corrective action in the reevaluated area of review in the same manner specified in paragraph (d) of this section; and
  - (4) Submit an amended area of review and corrective action plan or demonstrate to the Director through monitoring data and modeling results that no amendment to the area of review and corrective action plan is needed. Any amendments to the area of review and corrective action plan must be approved by the Director, must be incorporated into the permit, and are subject to the permit modification requirements at § 144.39 or § 144.41 of this chapter, as appropriate.
- (f) The emergency and remedial response plan (as required by § 146.94) and the demonstration of financial responsibility (as described by § 146.85) must account for the area of review delineated as specified in paragraph (c)(1) of this section or the most recently evaluated area of review delineated under paragraph (e) of this section, regardless of whether or not corrective action in the area of review is phased.
- (g) All modeling inputs and data used to support area of review reevaluations under paragraph (e) of this section shall be retained for 10 years.

### § 146.85 Financial responsibility.

- (a) The owner or operator must demonstrate and maintain financial responsibility as determined by the Director that meets the following conditions:
  - (1) The financial responsibility instrument(s) used must be from the following list of qualifying instruments:
    - (i) Trust Funds.
    - (ii) Surety Bonds.
    - (iii) Letter of Credit.
    - (iv) Insurance.
    - (v) Self Insurance (*i.e.*, Financial Test and Corporate Guarantee).
    - (vi) Escrow Account.
    - (vii) Any other instrument(s) satisfactory to the Director.
  - (2) The qualifying instrument(s) must be sufficient to cover the cost of:
    - (i) Corrective action (that meets the requirements of § 146.84);
    - (ii) Injection well plugging (that meets the requirements of § 146.92);

- (iii) Post injection site care and site closure (that meets the requirements of § 146.93); and
  - (iv) Emergency and remedial response (that meets the requirements of § 146.94).
- (3) The financial responsibility instrument(s) must be sufficient to address endangerment of underground sources of drinking water.
- (4) The qualifying financial responsibility instrument(s) must comprise protective conditions of coverage.
  - (i) Protective conditions of coverage must include at a minimum cancellation, renewal, and continuation provisions, specifications on when the provider becomes liable following a notice of cancellation if there is a failure to renew with a new qualifying financial instrument, and requirements for the provider to meet a minimum rating, minimum capitalization, and ability to pass the bond rating when applicable.
    - (A) **Cancellation** —for purposes of this part, an owner or operator must provide that their financial mechanism may not cancel, terminate or fail to renew except for failure to pay such financial instrument. If there is a failure to pay the financial instrument, the financial institution may elect to cancel, terminate, or fail to renew the instrument by sending notice by certified mail to the owner or operator and the Director. The cancellation must not be final for 120 days after receipt of cancellation notice. The owner or operator must provide an alternate financial responsibility demonstration within 60 days of notice of cancellation, and if an alternate financial responsibility demonstration is not acceptable (or possible), any funds from the instrument being cancelled must be released within 60 days of notification by the Director.
    - (B) **Renewal** —for purposes of this part, owners or operators must renew all financial instruments, if an instrument expires, for the entire term of the geologic sequestration project. The instrument may be automatically renewed as long as the owner or operator has the option of renewal at the face amount of the expiring instrument. The automatic renewal of the instrument must, at a minimum, provide the holder with the option of renewal at the face amount of the expiring financial instrument.
    - (C) Cancellation, termination, or failure to renew may not occur and the financial instrument will remain in full force and effect in the event that on or before the date of expiration: The Director deems the facility abandoned; or the permit is terminated or revoked or a new permit is denied; or closure is ordered by the Director or a U.S. district court or other court of competent jurisdiction; or the owner or operator is named as debtor in a voluntary or involuntary proceeding under Title 11 (Bankruptcy), U.S. Code; or the amount due is paid.
- (5) The qualifying financial responsibility instrument(s) must be approved by the Director.
  - (i) The Director shall consider and approve the financial responsibility demonstration for all the phases of the geologic sequestration project prior to issue a Class VI permit (§ 146.82).
  - (ii) The owner or operator must provide any updated information related to their financial responsibility instrument(s) on an annual basis and if there are any changes, the Director must evaluate, within a reasonable time, the financial responsibility demonstration to confirm that the instrument(s) used remain adequate for use. The owner or operator must maintain financial responsibility requirements regardless of the status of the Director's review of the financial responsibility demonstration.

- (iii) The Director may disapprove the use of a financial instrument if he determines that it is not sufficient to meet the requirements of this section.
- (6) The owner or operator may demonstrate financial responsibility by using one or multiple qualifying financial instruments for specific phases of the geologic sequestration project.
- (i) In the event that the owner or operator combines more than one instrument for a specific geologic sequestration phase (e.g., well plugging), such combination must be limited to instruments that are not based on financial strength or performance (i.e., self insurance or performance bond), for example trust funds, surety bonds guaranteeing payment into a trust fund, letters of credit, escrow account, and insurance. In this case, it is the combination of mechanisms, rather than the single mechanism, which must provide financial responsibility for an amount at least equal to the current cost estimate.
  - (ii) When using a third-party instrument to demonstrate financial responsibility, the owner or operator must provide a proof that the third-party providers either have passed financial strength requirements based on credit ratings; or has met a minimum rating, minimum capitalization, and ability to pass the bond rating when applicable.
  - (iii) An owner or operator using certain types of third-party instruments must establish a standby trust to enable EPA to be party to the financial responsibility agreement without EPA being the beneficiary of any funds. The standby trust fund must be used along with other financial responsibility instruments (e.g., surety bonds, letters of credit, or escrow accounts) to provide a location to place funds if needed.
  - (iv) An owner or operator may deposit money to an escrow account to cover financial responsibility requirements; this account must segregate funds sufficient to cover estimated costs for Class VI (geologic sequestration) financial responsibility from other accounts and uses.
  - (v) An owner or operator or its guarantor may use self insurance to demonstrate financial responsibility for geologic sequestration projects. In order to satisfy this requirement the owner or operator must meet a Tangible Net Worth of an amount approved by the Director, have a Net working capital and tangible net worth each at least six times the sum of the current well plugging, post injection site care and site closure cost, have assets located in the United States amounting to at least 90 percent of total assets or at least six times the sum of the current well plugging, post injection site care and site closure cost, and must submit a report of its bond rating and financial information annually. In addition the owner or operator must either: Have a bond rating test of AAA, AA, A, or BBB as issued by Standard & Poor's or Aaa, Aa, A, or Baa as issued by Moody's; or meet all of the following five financial ratio thresholds: A ratio of total liabilities to net worth less than 2.0; a ratio of current assets to current liabilities greater than 1.5; a ratio of the sum of net income plus depreciation, depletion, and amortization to total liabilities greater than 0.1; A ratio of current assets minus current liabilities to total assets greater than -0.1; and a net profit (revenues minus expenses) greater than 0.
  - (vi) An owner or operator who is not able to meet corporate financial test criteria may arrange a corporate guarantee by demonstrating that its corporate parent meets the financial test requirements on its behalf. The parent's demonstration that it meets the financial test requirement is insufficient if it has not also guaranteed to fulfill the obligations for the owner or operator.

- (vii) An owner or operator may obtain an insurance policy to cover the estimated costs of geologic sequestration activities requiring financial responsibility. This insurance policy must be obtained from a third party provider.
- (b) The requirement to maintain adequate financial responsibility and resources is directly enforceable regardless of whether the requirement is a condition of the permit.
  - (1) The owner or operator must maintain financial responsibility and resources until:
    - (i) The Director receives and approves the completed post-injection site care and site closure plan; and
    - (ii) The Director approves site closure.
  - (2) The owner or operator may be released from a financial instrument in the following circumstances:
    - (i) The owner or operator has completed the phase of the geologic sequestration project for which the financial instrument was required and has fulfilled all its financial obligations as determined by the Director, including obtaining financial responsibility for the next phase of the GS project, if required; or
    - (ii) The owner or operator has submitted a replacement financial instrument and received written approval from the Director accepting the new financial instrument and releasing the owner or operator from the previous financial instrument.
- (c) The owner or operator must have a detailed written estimate, in current dollars, of the cost of performing corrective action on wells in the area of review, plugging the injection well(s), post-injection site care and site closure, and emergency and remedial response.
  - (1) The cost estimate must be performed for each phase separately and must be based on the costs to the regulatory agency of hiring a third party to perform the required activities. A third party is a party who is not within the corporate structure of the owner or operator.
  - (2) During the active life of the geologic sequestration project, the owner or operator must adjust the cost estimate for inflation within 60 days prior to the anniversary date of the establishment of the financial instrument(s) used to comply with paragraph (a) of this section and provide this adjustment to the Director. The owner or operator must also provide to the Director written updates of adjustments to the cost estimate within 60 days of any amendments to the area of review and corrective action plan (§ 146.84), the injection well plugging plan (§ 146.92), the post-injection site care and site closure plan (§ 146.93), and the emergency and remedial response plan (§ 146.94).
  - (3) The Director must approve any decrease or increase to the initial cost estimate. During the active life of the geologic sequestration project, the owner or operator must revise the cost estimate no later than 60 days after the Director has approved the request to modify the area of review and corrective action plan (§ 146.84), the injection well plugging plan (§ 146.92), the post-injection site care and site closure plan (§ 146.93), and the emergency and response plan (§ 146.94), if the change in the plan increases the cost. If the change to the plans decreases the cost, any withdrawal of funds must be approved by the Director. Any decrease to the value of the financial assurance instrument must first be approved by the Director. The revised cost estimate must be adjusted for inflation as specified at paragraph (c)(2) of this section.



- (4) Whenever the current cost estimate increases to an amount greater than the face amount of a financial instrument currently in use, the owner or operator, within 60 days after the increase, must either cause the face amount to be increased to an amount at least equal to the current cost estimate and submit evidence of such increase to the Director, or obtain other financial responsibility instruments to cover the increase. Whenever the current cost estimate decreases, the face amount of the financial assurance instrument may be reduced to the amount of the current cost estimate only after the owner or operator has received written approval from the Director.
- (d) The owner or operator must notify the Director by certified mail of adverse financial conditions such as bankruptcy that may affect the ability to carry out injection well plugging and post-injection site care and site closure.
  - (1) In the event that the owner or operator or the third party provider of a financial responsibility instrument is going through a bankruptcy, the owner or operator must notify the Director by certified mail of the commencement of a voluntary or involuntary proceeding under Title 11 (Bankruptcy), U.S. Code, naming the owner or operator as debtor, within 10 days after commencement of the proceeding.
  - (2) A guarantor of a corporate guarantee must make such a notification to the Director if he/she is named as debtor, as required under the terms of the corporate guarantee.
  - (3) An owner or operator who fulfills the requirements of paragraph (a) of this section by obtaining a trust fund, surety bond, letter of credit, escrow account, or insurance policy will be deemed to be without the required financial assurance in the event of bankruptcy of the trustee or issuing institution, or a suspension or revocation of the authority of the trustee institution to act as trustee of the institution issuing the trust fund, surety bond, letter of credit, escrow account, or insurance policy. The owner or operator must establish other financial assurance within 60 days after such an event.
- (e) The owner or operator must provide an adjustment of the cost estimate to the Director within 60 days of notification by the Director, if the Director determines during the annual evaluation of the qualifying financial responsibility instrument(s) that the most recent demonstration is no longer adequate to cover the cost of corrective action (as required by § 146.84), injection well plugging (as required by § 146.92), post-injection site care and site closure (as required by § 146.93), and emergency and remedial response (as required by § 146.94).
- (f) The Director must approve the use and length of pay-in-periods for trust funds or escrow accounts.

#### **§ 146.86 Injection well construction requirements.**

- (a) **General.** The owner or operator must ensure that all Class VI wells are constructed and completed to:
  - (1) Prevent the movement of fluids into or between USDWs or into any unauthorized zones;
  - (2) Permit the use of appropriate testing devices and workover tools; and
  - (3) Permit continuous monitoring of the annulus space between the injection tubing and long string casing.
- (b) **Casing and cementing of Class VI wells.**
  - (1) Casing and cement or other materials used in the construction of each Class VI well must have sufficient structural strength and be designed for the life of the geologic sequestration project. All well materials must be compatible with fluids with which the materials may be expected to come

into contact and must meet or exceed standards developed for such materials by the American Petroleum Institute, ASTM International, or comparable standards acceptable to the Director. The casing and cementing program must be designed to prevent the movement of fluids into or between USDWs. In order to allow the Director to determine and specify casing and cementing requirements, the owner or operator must provide the following information:

- (i) Depth to the injection zone(s);
  - (ii) Injection pressure, external pressure, internal pressure, and axial loading;
  - (iii) Hole size;
  - (iv) Size and grade of all casing strings (wall thickness, external diameter, nominal weight, length, joint specification, and construction material);
  - (v) Corrosiveness of the carbon dioxide stream and formation fluids;
  - (vi) Down-hole temperatures;
  - (vii) Lithology of injection and confining zone(s);
  - (viii) Type or grade of cement and cement additives; and
  - (ix) Quantity, chemical composition, and temperature of the carbon dioxide stream.
- (2) Surface casing must extend through the base of the lowermost USDW and be cemented to the surface through the use of a single or multiple strings of casing and cement.
  - (3) At least one long string casing, using a sufficient number of centralizers, must extend to the injection zone and must be cemented by circulating cement to the surface in one or more stages.
  - (4) Circulation of cement may be accomplished by staging. The Director may approve an alternative method of cementing in cases where the cement cannot be recirculated to the surface, provided the owner or operator can demonstrate by using logs that the cement does not allow fluid movement behind the well bore.
  - (5) Cement and cement additives must be compatible with the carbon dioxide stream and formation fluids and of sufficient quality and quantity to maintain integrity over the design life of the geologic sequestration project. The integrity and location of the cement shall be verified using technology capable of evaluating cement quality radially and identifying the location of channels to ensure that USDWs are not endangered.

(c) ***Tubing and packer.***

- (1) Tubing and packer materials used in the construction of each Class VI well must be compatible with fluids with which the materials may be expected to come into contact and must meet or exceed standards developed for such materials by the American Petroleum Institute, ASTM International, or comparable standards acceptable to the Director.
- (2) All owners or operators of Class VI wells must inject fluids through tubing with a packer set at a depth opposite a cemented interval at the location approved by the Director.
- (3) In order for the Director to determine and specify requirements for tubing and packer, the owner or operator must submit the following information:
  - (i) Depth of setting;

- (ii) Characteristics of the carbon dioxide stream (chemical content, corrosiveness, temperature, and density) and formation fluids;
- (iii) Maximum proposed injection pressure;
- (iv) Maximum proposed annular pressure;
- (v) Proposed injection rate (intermittent or continuous) and volume and/or mass of the carbon dioxide stream;
- (vi) Size of tubing and casing; and
- (vii) Tubing tensile, burst, and collapse strengths.

**§ 146.87 Logging, sampling, and testing prior to injection well operation.**

- (a) During the drilling and construction of a Class VI injection well, the owner or operator must run appropriate logs, surveys and tests to determine or verify the depth, thickness, porosity, permeability, and lithology of, and the salinity of any formation fluids in all relevant geologic formations to ensure conformance with the injection well construction requirements under § 146.86 and to establish accurate baseline data against which future measurements may be compared. The owner or operator must submit to the Director a descriptive report prepared by a knowledgeable log analyst that includes an interpretation of the results of such logs and tests. At a minimum, such logs and tests must include:
  - (1) Deviation checks during drilling on all holes constructed by drilling a pilot hole which is enlarged by reaming or another method. Such checks must be at sufficiently frequent intervals to determine the location of the borehole and to ensure that vertical avenues for fluid movement in the form of diverging holes are not created during drilling; and
  - (2) Before and upon installation of the surface casing:
    - (i) Resistivity, spontaneous potential, and caliper logs before the casing is installed; and
    - (ii) A cement bond and variable density log to evaluate cement quality radially, and a temperature log after the casing is set and cemented.
  - (3) Before and upon installation of the long string casing:
    - (i) Resistivity, spontaneous potential, porosity, caliper, gamma ray, fracture finder logs, and any other logs the Director requires for the given geology before the casing is installed; and
    - (ii) A cement bond and variable density log, and a temperature log after the casing is set and cemented.
  - (4) A series of tests designed to demonstrate the internal and external mechanical integrity of injection wells, which may include:
    - (i) A pressure test with liquid or gas;
    - (ii) A tracer survey such as oxygen-activation logging;
    - (iii) A temperature or noise log;
    - (iv) A casing inspection log; and
  - (5) Any alternative methods that provide equivalent or better information and that are required by and/or approved of by the Director.

- (b) The owner or operator must take whole cores or sidewall cores of the injection zone and confining system and formation fluid samples from the injection zone(s), and must submit to the Director a detailed report prepared by a log analyst that includes: Well log analyses (including well logs), core analyses, and formation fluid sample information. The Director may accept information on cores from nearby wells if the owner or operator can demonstrate that core retrieval is not possible and that such cores are representative of conditions at the well. The Director may require the owner or operator to core other formations in the borehole.
- (c) The owner or operator must record the fluid temperature, pH, conductivity, reservoir pressure, and static fluid level of the injection zone(s).
- (d) At a minimum, the owner or operator must determine or calculate the following information concerning the injection and confining zone(s):
  - (1) Fracture pressure;
  - (2) Other physical and chemical characteristics of the injection and confining zone(s); and
  - (3) Physical and chemical characteristics of the formation fluids in the injection zone(s).
- (e) Upon completion, but prior to operation, the owner or operator must conduct the following tests to verify hydrogeologic characteristics of the injection zone(s):
  - (1) A pressure fall-off test; and,
  - (2) A pump test; or
  - (3) Injectivity tests.
- (f) The owner or operator must provide the Director with the opportunity to witness all logging and testing by this subpart. The owner or operator must submit a schedule of such activities to the Director 30 days prior to conducting the first test and submit any changes to the schedule 30 days prior to the next scheduled test.

### **§ 146.88 Injection well operating requirements.**

- (a) Except during stimulation, the owner or operator must ensure that injection pressure does not exceed 90 percent of the fracture pressure of the injection zone(s) so as to ensure that the injection does not initiate new fractures or propagate existing fractures in the injection zone(s). In no case may injection pressure initiate fractures in the confining zone(s) or cause the movement of injection or formation fluids that endangers a USDW. Pursuant to requirements at § 146.82(a)(9), all stimulation programs must be approved by the Director as part of the permit application and incorporated into the permit.
- (b) Injection between the outermost casing protecting USDWs and the well bore is prohibited.
- (c) The owner or operator must fill the annulus between the tubing and the long string casing with a non-corrosive fluid approved by the Director. The owner or operator must maintain on the annulus a pressure that exceeds the operating injection pressure, unless the Director determines that such requirement might harm the integrity of the well or endanger USDWs.
- (d) Other than during periods of well workover (maintenance) approved by the Director in which the sealed tubing-casing annulus is disassembled for maintenance or corrective procedures, the owner or operator must maintain mechanical integrity of the injection well at all times.
- (e) The owner or operator must install and use:

- (1) Continuous recording devices to monitor: The injection pressure; the rate, volume and/or mass, and temperature of the carbon dioxide stream; and the pressure on the annulus between the tubing and the long string casing and annulus fluid volume; and
  - (2) Alarms and automatic surface shut-off systems or, at the discretion of the Director, down-hole shut-off systems (e.g., automatic shut-off, check valves) for onshore wells or, other mechanical devices that provide equivalent protection; and
  - (3) Alarms and automatic down-hole shut-off systems for wells located offshore but within State territorial waters, designed to alert the operator and shut-in the well when operating parameters such as annulus pressure, injection rate, or other parameters diverge beyond permitted ranges and/or gradients specified in the permit.
- (f) If a shutdown (i.e., down-hole or at the surface) is triggered or a loss of mechanical integrity is discovered, the owner or operator must immediately investigate and identify as expeditiously as possible the cause of the shutoff. If, upon such investigation, the well appears to be lacking mechanical integrity, or if monitoring required under paragraph (e) of this section otherwise indicates that the well may be lacking mechanical integrity, the owner or operator must:
- (1) Immediately cease injection;
  - (2) Take all steps reasonably necessary to determine whether there may have been a release of the injected carbon dioxide stream or formation fluids into any unauthorized zone;
  - (3) Notify the Director within 24 hours;
  - (4) Restore and demonstrate mechanical integrity to the satisfaction of the Director prior to resuming injection; and
  - (5) Notify the Director when injection can be expected to resume.

#### § 146.89 Mechanical integrity.

- (a) A Class VI well has mechanical integrity if:
- (1) There is no significant leak in the casing, tubing, or packer; and
  - (2) There is no significant fluid movement into a USDW through channels adjacent to the injection well bore.
- (b) To evaluate the absence of significant leaks under paragraph (a)(1) of this section, owners or operators must, following an initial annulus pressure test, continuously monitor injection pressure, rate, injected volumes; pressure on the annulus between tubing and long-string casing; and annulus fluid volume as specified in § 146.88 (e);
- (c) At least once per year, the owner or operator must use one of the following methods to determine the absence of significant fluid movement under paragraph (a)(2) of this section:
- (1) An approved tracer survey such as an oxygen-activation log; or
  - (2) A temperature or noise log.
- (d) If required by the Director, at a frequency specified in the testing and monitoring plan required at § 146.90, the owner or operator must run a casing inspection log to determine the presence or absence of corrosion in the long-string casing.

- (e) The Director may require any other test to evaluate mechanical integrity under paragraphs (a)(1) or (a)(2) of this section. Also, the Director may allow the use of a test to demonstrate mechanical integrity other than those listed above with the written approval of the Administrator. To obtain approval for a new mechanical integrity test, the Director must submit a written request to the Administrator setting forth the proposed test and all technical data supporting its use. The Administrator may approve the request if he or she determines that it will reliably demonstrate the mechanical integrity of wells for which its use is proposed. Any alternate method approved by the Administrator will be published in the FEDERAL REGISTER and may be used in all States in accordance with applicable State law unless its use is restricted at the time of approval by the Administrator.
- (f) In conducting and evaluating the tests enumerated in this section or others to be allowed by the Director, the owner or operator and the Director must apply methods and standards generally accepted in the industry. When the owner or operator reports the results of mechanical integrity tests to the Director, he/she shall include a description of the test(s) and the method(s) used. In making his/her evaluation, the Director must review monitoring and other test data submitted since the previous evaluation.
- (g) The Director may require additional or alternative tests if the results presented by the owner or operator under paragraphs (a) through (d) of this section are not satisfactory to the Director to demonstrate that there is no significant leak in the casing, tubing, or packer, or to demonstrate that there is no significant movement of fluid into a USDW resulting from the injection activity as stated in paragraphs (a)(1) and (2) of this section.

### § 146.90 Testing and monitoring requirements.

The owner or operator of a Class VI well must prepare, maintain, and comply with a testing and monitoring plan to verify that the geologic sequestration project is operating as permitted and is not endangering USDWs. The requirement to maintain and implement an approved plan is directly enforceable regardless of whether the requirement is a condition of the permit. The testing and monitoring plan must be submitted with the permit application, for Director approval, and must include a description of how the owner or operator will meet the requirements of this section, including accessing sites for all necessary monitoring and testing during the life of the project. Testing and monitoring associated with geologic sequestration projects must, at a minimum, include:

- (a) Analysis of the carbon dioxide stream with sufficient frequency to yield data representative of its chemical and physical characteristics;
- (b) Installation and use, except during well workovers as defined in § 146.88(d), of continuous recording devices to monitor injection pressure, rate, and volume; the pressure on the annulus between the tubing and the long string casing; and the annulus fluid volume added;
- (c) Corrosion monitoring of the well materials for loss of mass, thickness, cracking, pitting, and other signs of corrosion, which must be performed on a quarterly basis to ensure that the well components meet the minimum standards for material strength and performance set forth in § 146.86(b), by:
  - (1) Analyzing coupons of the well construction materials placed in contact with the carbon dioxide stream; or
  - (2) Routing the carbon dioxide stream through a loop constructed with the material used in the well and inspecting the materials in the loop; or
  - (3) Using an alternative method approved by the Director;

- (d) Periodic monitoring of the ground water quality and geochemical changes above the confining zone(s) that may be a result of carbon dioxide movement through the confining zone(s) or additional identified zones including:
  - (1) The location and number of monitoring wells based on specific information about the geologic sequestration project, including injection rate and volume, geology, the presence of artificial penetrations, and other factors; and
  - (2) The monitoring frequency and spatial distribution of monitoring wells based on baseline geochemical data that has been collected under § 146.82(a)(6) and on any modeling results in the area of review evaluation required by § 146.84(c).
- (e) A demonstration of external mechanical integrity pursuant to § 146.89(c) at least once per year until the injection well is plugged; and, if required by the Director, a casing inspection log pursuant to requirements at § 146.89(d) at a frequency established in the testing and monitoring plan;
- (f) A pressure fall-off test at least once every five years unless more frequent testing is required by the Director based on site-specific information;
- (g) Testing and monitoring to track the extent of the carbon dioxide plume and the presence or absence of elevated pressure (e.g., the pressure front) by using:
  - (1) Direct methods in the injection zone(s); and,
  - (2) Indirect methods (e.g., seismic, electrical, gravity, or electromagnetic surveys and/or down-hole carbon dioxide detection tools), unless the Director determines, based on site-specific geology, that such methods are not appropriate;
- (h) The Director may require surface air monitoring and/or soil gas monitoring to detect movement of carbon dioxide that could endanger a USDW.
  - (1) Design of Class VI surface air and/or soil gas monitoring must be based on potential risks to USDWs within the area of review;
  - (2) The monitoring frequency and spatial distribution of surface air monitoring and/or soil gas monitoring must be decided using baseline data, and the monitoring plan must describe how the proposed monitoring will yield useful information on the area of review delineation and/or compliance with standards under § 144.12 of this chapter;
  - (3) If an owner or operator demonstrates that monitoring employed under §§ 98.440 to 98.449 of this chapter (Clean Air Act, 42 U.S.C. 7401 et seq.) accomplishes the goals of paragraphs (h)(1) and (2) of this section, and meets the requirements pursuant to § 146.91(c)(5), a Director that requires surface air/soil gas monitoring must approve the use of monitoring employed under §§ 98.440 to 98.449 of this chapter. Compliance with §§ 98.440 to 98.449 of this chapter pursuant to this provision is considered a condition of the Class VI permit;
- (i) Any additional monitoring, as required by the Director, necessary to support, upgrade, and improve computational modeling of the area of review evaluation required under § 146.84(c) and to determine compliance with standards under § 144.12 of this chapter;
- (j) The owner or operator shall periodically review the testing and monitoring plan to incorporate monitoring data collected under this subpart, operational data collected under § 146.88, and the most recent area of review reevaluation performed under § 146.84(e). In no case shall the owner or operator review the testing and monitoring plan less often than once every five years. Based on this review, the owner or

operator shall submit an amended testing and monitoring plan or demonstrate to the Director that no amendment to the testing and monitoring plan is needed. Any amendments to the testing and monitoring plan must be approved by the Director, must be incorporated into the permit, and are subject to the permit modification requirements at § 144.39 or § 144.41 of this chapter, as appropriate. Amended plans or demonstrations shall be submitted to the Director as follows:

- (1) Within one year of an area of review reevaluation;
  - (2) Following any significant changes to the facility, such as addition of monitoring wells or newly permitted injection wells within the area of review, on a schedule determined by the Director; or
  - (3) When required by the Director.
- (k) A quality assurance and surveillance plan for all testing and monitoring requirements.

### **§ 146.91 Reporting requirements.**

The owner or operator must, at a minimum, provide, as specified in paragraph (e) of this section, the following reports to the Director, for each permitted Class VI well:

- (a) Semi-annual reports containing:
- (1) Any changes to the physical, chemical, and other relevant characteristics of the carbon dioxide stream from the proposed operating data;
  - (2) Monthly average, maximum, and minimum values for injection pressure, flow rate and volume, and annular pressure;
  - (3) A description of any event that exceeds operating parameters for annulus pressure or injection pressure specified in the permit;
  - (4) A description of any event which triggers a shut-off device required pursuant to § 146.88(e) and the response taken;
  - (5) The monthly volume and/or mass of the carbon dioxide stream injected over the reporting period and the volume injected cumulatively over the life of the project;
  - (6) Monthly annulus fluid volume added; and
  - (7) The results of monitoring prescribed under § 146.90.
- (b) Report, within 30 days, the results of:
- (1) Periodic tests of mechanical integrity;
  - (2) Any well workover; and,
  - (3) Any other test of the injection well conducted by the permittee if required by the Director.
- (c) Report, within 24 hours:
- (1) Any evidence that the injected carbon dioxide stream or associated pressure front may cause an endangerment to a USDW;
  - (2) Any noncompliance with a permit condition, or malfunction of the injection system, which may cause fluid migration into or between USDWs;



- (3) Any triggering of a shut-off system (i.e., down-hole or at the surface);
  - (4) Any failure to maintain mechanical integrity; or.
  - (5) Pursuant to compliance with the requirement at § 146.90(h) for surface air/soil gas monitoring or other monitoring technologies, if required by the Director, any release of carbon dioxide to the atmosphere or biosphere.
- (d) Owners or operators must notify the Director in writing 30 days in advance of:
  - (1) Any planned well workover;
  - (2) Any planned stimulation activities, other than stimulation for formation testing conducted under § 146.82; and
  - (3) Any other planned test of the injection well conducted by the permittee.
- (e) Regardless of whether a State has primary enforcement responsibility, owners or operators must submit all required reports, submittals, and notifications under subpart H of this part to EPA in an electronic format approved by EPA.
- (f) Records shall be retained by the owner or operator as follows:
  - (1) All data collected under § 146.82 for Class VI permit applications shall be retained throughout the life of the geologic sequestration project and for 10 years following site closure.
  - (2) Data on the nature and composition of all injected fluids collected pursuant to § 146.90(a) shall be retained until 10 years after site closure. The Director may require the owner or operator to deliver the records to the Director at the conclusion of the retention period.
  - (3) Monitoring data collected pursuant to § 146.90(b) through (i) shall be retained for 10 years after it is collected.
  - (4) Well plugging reports, post-injection site care data, including, if appropriate, data and information used to develop the demonstration of the alternative post-injection site care timeframe, and the site closure report collected pursuant to requirements at §§ 146.93(f) and (h) shall be retained for 10 years following site closure.
  - (5) The Director has authority to require the owner or operator to retain any records required in this subpart for longer than 10 years after site closure.

## § 146.92 Injection well plugging.

- (a) Prior to the well plugging, the owner or operator must flush each Class VI injection well with a buffer fluid, determine bottomhole reservoir pressure, and perform a final external mechanical integrity test.
- (b) **Well plugging plan.** The owner or operator of a Class VI well must prepare, maintain, and comply with a plan that is acceptable to the Director. The requirement to maintain and implement an approved plan is directly enforceable regardless of whether the requirement is a condition of the permit. The well plugging plan must be submitted as part of the permit application and must include the following information:
  - (1) Appropriate tests or measures for determining bottomhole reservoir pressure;
  - (2) Appropriate testing methods to ensure external mechanical integrity as specified in § 146.89;
  - (3) The type and number of plugs to be used;

- (4) The placement of each plug, including the elevation of the top and bottom of each plug;
  - (5) The type, grade, and quantity of material to be used in plugging. The material must be compatible with the carbon dioxide stream; and
  - (6) The method of placement of the plugs.
- (c) **Notice of intent to plug.** The owner or operator must notify the Director in writing pursuant to § 146.91(e), at least 60 days before plugging of a well. At this time, if any changes have been made to the original well plugging plan, the owner or operator must also provide the revised well plugging plan. The Director may allow for a shorter notice period. Any amendments to the injection well plugging plan must be approved by the Director, must be incorporated into the permit, and are subject to the permit modification requirements at § 144.39 or § 144.41 of this chapter, as appropriate.
- (d) **Plugging report.** Within 60 days after plugging, the owner or operator must submit, pursuant to § 146.91(e), a plugging report to the Director. The report must be certified as accurate by the owner or operator and by the person who performed the plugging operation (if other than the owner or operator.) The owner or operator shall retain the well plugging report for 10 years following site closure.

### § 146.93 Post-injection site care and site closure.

- (a) The owner or operator of a Class VI well must prepare, maintain, and comply with a plan for post-injection site care and site closure that meets the requirements of paragraph (a)(2) of this section and is acceptable to the Director. The requirement to maintain and implement an approved plan is directly enforceable regardless of whether the requirement is a condition of the permit.
- (1) The owner or operator must submit the post-injection site care and site closure plan as a part of the permit application to be approved by the Director.
  - (2) The post-injection site care and site closure plan must include the following information:
    - (i) The pressure differential between pre-injection and predicted post-injection pressures in the injection zone(s);
    - (ii) The predicted position of the carbon dioxide plume and associated pressure front at site closure as demonstrated in the area of review evaluation required under § 146.84(c)(1);
    - (iii) A description of post-injection monitoring location, methods, and proposed frequency;
    - (iv) A proposed schedule for submitting post-injection site care monitoring results to the Director pursuant to § 146.91(e); and,
    - (v) The duration of the post-injection site care timeframe and, if approved by the Director, the demonstration of the alternative post-injection site care timeframe that ensures non-endangerment of USDWs.
  - (3) Upon cessation of injection, owners or operators of Class VI wells must either submit an amended post-injection site care and site closure plan or demonstrate to the Director through monitoring data and modeling results that no amendment to the plan is needed. Any amendments to the post-injection site care and site closure plan must be approved by the Director, be incorporated into the permit, and are subject to the permit modification requirements at § 144.39 or § 144.41 of this chapter, as appropriate.

- (4) At any time during the life of the geologic sequestration project, the owner or operator may modify and resubmit the post-injection site care and site closure plan for the Director's approval within 30 days of such change.
- (b) The owner or operator shall monitor the site following the cessation of injection to show the position of the carbon dioxide plume and pressure front and demonstrate that USDWs are not being endangered.
  - (1) Following the cessation of injection, the owner or operator shall continue to conduct monitoring as specified in the Director-approved post-injection site care and site closure plan for at least 50 years or for the duration of the alternative timeframe approved by the Director pursuant to requirements in paragraph (c) of this section, unless he/she makes a demonstration under (b)(2) of this section. The monitoring must continue until the geologic sequestration project no longer poses an endangerment to USDWs and the demonstration under (b)(2) of this section is submitted and approved by the Director.
  - (2) If the owner or operator can demonstrate to the satisfaction of the Director before 50 years or prior to the end of the approved alternative timeframe based on monitoring and other site-specific data, that the geologic sequestration project no longer poses an endangerment to USDWs, the Director may approve an amendment to the post-injection site care and site closure plan to reduce the frequency of monitoring or may authorize site closure before the end of the 50-year period or prior to the end of the approved alternative timeframe, where he or she has substantial evidence that the geologic sequestration project no longer poses a risk of endangerment to USDWs.
  - (3) Prior to authorization for site closure, the owner or operator must submit to the Director for review and approval a demonstration, based on monitoring and other site-specific data, that no additional monitoring is needed to ensure that the geologic sequestration project does not pose an endangerment to USDWs.
  - (4) If the demonstration in paragraph (b)(3) of this section cannot be made (i.e., additional monitoring is needed to ensure that the geologic sequestration project does not pose an endangerment to USDWs) at the end of the 50-year period or at the end of the approved alternative timeframe, or if the Director does not approve the demonstration, the owner or operator must submit to the Director a plan to continue post-injection site care until a demonstration can be made and approved by the Director.
- (c) **Demonstration of alternative post-injection site care timeframe.** At the Director's discretion, the Director may approve, in consultation with EPA, an alternative post-injection site care timeframe other than the 50 year default, if an owner or operator can demonstrate during the permitting process that an alternative post-injection site care timeframe is appropriate and ensures non-endangerment of USDWs. The demonstration must be based on significant, site-specific data and information including all data and information collected pursuant to §§ 146.82 and 146.83, and must contain substantial evidence that the geologic sequestration project will no longer pose a risk of endangerment to USDWs at the end of the alternative post-injection site care timeframe.
  - (1) A demonstration of an alternative post-injection site care timeframe must include consideration and documentation of:
    - (i) The results of computational modeling performed pursuant to delineation of the area of review under § 146.84;

- (ii) The predicted timeframe for pressure decline within the injection zone, and any other zones, such that formation fluids may not be forced into any USDWs; and/or the timeframe for pressure decline to pre-injection pressures;
  - (iii) The predicted rate of carbon dioxide plume migration within the injection zone, and the predicted timeframe for the cessation of migration;
  - (iv) A description of the site-specific processes that will result in carbon dioxide trapping including immobilization by capillary trapping, dissolution, and mineralization at the site;
  - (v) The predicted rate of carbon dioxide trapping in the immobile capillary phase, dissolved phase, and/or mineral phase;
  - (vi) The results of laboratory analyses, research studies, and/or field or site-specific studies to verify the information required in paragraphs (iv) and (v) of this section;
  - (vii) A characterization of the confining zone(s) including a demonstration that it is free of transmissive faults, fractures, and micro-fractures and of appropriate thickness, permeability, and integrity to impede fluid (e.g., carbon dioxide, formation fluids) movement;
  - (viii) The presence of potential conduits for fluid movement including planned injection wells and project monitoring wells associated with the proposed geologic sequestration project or any other projects in proximity to the predicted/modeled, final extent of the carbon dioxide plume and area of elevated pressure;
  - (ix) A description of the well construction and an assessment of the quality of plugs of all abandoned wells within the area of review;
  - (x) The distance between the injection zone and the nearest USDWs above and/or below the injection zone; and
  - (xi) Any additional site-specific factors required by the Director.
- (2) Information submitted to support the demonstration in paragraph (c)(1) of this section must meet the following criteria:
- (i) All analyses and tests performed to support the demonstration must be accurate, reproducible, and performed in accordance with the established quality assurance standards;
  - (ii) Estimation techniques must be appropriate and EPA-certified test protocols must be used where available;
  - (iii) Predictive models must be appropriate and tailored to the site conditions, composition of the carbon dioxide stream and injection and site conditions over the life of the geologic sequestration project;
  - (iv) Predictive models must be calibrated using existing information (e.g., at Class I, Class II, or Class V experimental technology well sites) where sufficient data are available;
  - (v) Reasonably conservative values and modeling assumptions must be used and disclosed to the Director whenever values are estimated on the basis of known, historical information instead of site-specific measurements;

- (vi) An analysis must be performed to identify and assess aspects of the alternative post-injection site care timeframe demonstration that contribute significantly to uncertainty. The owner or operator must conduct sensitivity analyses to determine the effect that significant uncertainty may contribute to the modeling demonstration.
  - (vii) An approved quality assurance and quality control plan must address all aspects of the demonstration; and,
  - (viii) Any additional criteria required by the Director.
- (d) **Notice of intent for site closure.** The owner or operator must notify the Director in writing at least 120 days before site closure. At this time, if any changes have been made to the original post-injection site care and site closure plan, the owner or operator must also provide the revised plan. The Director may allow for a shorter notice period.
- (e) After the Director has authorized site closure, the owner or operator must plug all monitoring wells in a manner which will not allow movement of injection or formation fluids that endangers a USDW.
- (f) The owner or operator must submit a site closure report to the Director within 90 days of site closure, which must thereafter be retained at a location designated by the Director for 10 years. The report must include:
- (1) Documentation of appropriate injection and monitoring well plugging as specified in § 146.92 and paragraph (e) of this section. The owner or operator must provide a copy of a survey plat which has been submitted to the local zoning authority designated by the Director. The plat must indicate the location of the injection well relative to permanently surveyed benchmarks. The owner or operator must also submit a copy of the plat to the Regional Administrator of the appropriate EPA Regional Office;
  - (2) Documentation of appropriate notification and information to such State, local and Tribal authorities that have authority over drilling activities to enable such State, local, and Tribal authorities to impose appropriate conditions on subsequent drilling activities that may penetrate the injection and confining zone(s); and
  - (3) Records reflecting the nature, composition, and volume of the carbon dioxide stream.
- (g) Each owner or operator of a Class VI injection well must record a notation on the deed to the facility property or any other document that is normally examined during title search that will in perpetuity provide any potential purchaser of the property the following information:
- (1) The fact that land has been used to sequester carbon dioxide;
  - (2) The name of the State agency, local authority, and/or Tribe with which the survey plat was filed, as well as the address of the Environmental Protection Agency Regional Office to which it was submitted; and
  - (3) The volume of fluid injected, the injection zone or zones into which it was injected, and the period over which injection occurred.
- (h) The owner or operator must retain for 10 years following site closure, records collected during the post-injection site care period. The owner or operator must deliver the records to the Director at the conclusion of the retention period, and the records must thereafter be retained at a location designated by the Director for that purpose.

### § 146.94 Emergency and remedial response.

- (a) As part of the permit application, the owner or operator must provide the Director with an emergency and remedial response plan that describes actions the owner or operator must take to address movement of the injection or formation fluids that may cause an endangerment to a USDW during construction, operation, and post-injection site care periods. The requirement to maintain and implement an approved plan is directly enforceable regardless of whether the requirement is a condition of the permit.
- (b) If the owner or operator obtains evidence that the injected carbon dioxide stream and associated pressure front may cause an endangerment to a USDW, the owner or operator must:
  - (1) Immediately cease injection;
  - (2) Take all steps reasonably necessary to identify and characterize any release;
  - (3) Notify the Director within 24 hours; and
  - (4) Implement the emergency and remedial response plan approved by the Director.
- (c) The Director may allow the operator to resume injection prior to remediation if the owner or operator demonstrates that the injection operation will not endanger USDWs.
- (d) The owner or operator shall periodically review the emergency and remedial response plan developed under paragraph (a) of this section. In no case shall the owner or operator review the emergency and remedial response plan less often than once every five years. Based on this review, the owner or operator shall submit an amended emergency and remedial response plan or demonstrate to the Director that no amendment to the emergency and remedial response plan is needed. Any amendments to the emergency and remedial response plan must be approved by the Director, must be incorporated into the permit, and are subject to the permit modification requirements at § 144.39 or § 144.41 of this chapter, as appropriate. Amended plans or demonstrations shall be submitted to the Director as follows:
  - (1) Within one year of an area of review reevaluation;
  - (2) Following any significant changes to the facility, such as addition of injection or monitoring wells, on a schedule determined by the Director; or
  - (3) When required by the Director.

### § 146.95 Class VI injection depth waiver requirements.

This section sets forth information which an owner or operator seeking a waiver of the Class VI injection depth requirements must submit to the Director; information the Director must consider in consultation with all affected Public Water System Supervision Directors; the procedure for Director—Regional Administrator communication and waiver issuance; and the additional requirements that apply to owners or operators of Class VI wells granted a waiver of the injection depth requirements.

- (a) In seeking a waiver of the requirement to inject below the lowermost USDW, the owner or operator must submit a supplemental report concurrent with permit application. The supplemental report must include the following:
  - (1) A demonstration that the injection zone(s) is/are laterally continuous, is not a USDW, and is not hydraulically connected to USDWs; does not outcrop; has adequate injectivity, volume, and sufficient porosity to safely contain the injected carbon dioxide and formation fluids; and has appropriate geochemistry.

- (2) A demonstration that the injection zone(s) is/are bounded by laterally continuous, impermeable confining units above and below the injection zone(s) adequate to prevent fluid movement and pressure buildup outside of the injection zone(s); and that the confining unit(s) is/are free of transmissive faults and fractures. The report shall further characterize the regional fracture properties and contain a demonstration that such fractures will not interfere with injection, serve as conduits, or endanger USDWs.
  - (3) A demonstration, using computational modeling, that USDWs above and below the injection zone will not be endangered as a result of fluid movement. This modeling should be conducted in conjunction with the area of review determination, as described in § 146.84, and is subject to requirements, as described in § 146.84(c), and periodic reevaluation, as described in § 146.84(e).
  - (4) A demonstration that well design and construction, in conjunction with the waiver, will ensure isolation of the injectate in lieu of requirements at 146.86(a)(1) and will meet well construction requirements in paragraph (f) of this section.
  - (5) A description of how the monitoring and testing and any additional plans will be tailored to the geologic sequestration project to ensure protection of USDWs above and below the injection zone(s), if a waiver is granted.
  - (6) Information on the location of all the public water supplies affected, reasonably likely to be affected, or served by USDWs in the area of review.
  - (7) Any other information requested by the Director to inform the Regional Administrator's decision to issue a waiver.
- (b) To inform the Regional Administrator's decision on whether to grant a waiver of the injection depth requirements at §§ 144.6 of this chapter, 146.5(f), and 146.86(a)(1), the Director must submit, to the Regional Administrator, documentation of the following:
- (1) An evaluation of the following information as it relates to siting, construction, and operation of a geologic sequestration project with a waiver:
    - (i) The integrity of the upper and lower confining units;
    - (ii) The suitability of the injection zone(s) (e.g., lateral continuity; lack of transmissive faults and fractures; knowledge of current or planned artificial penetrations into the injection zone(s) or formations below the injection zone);
    - (iii) The potential capacity of the geologic formation(s) to sequester carbon dioxide, accounting for the availability of alternative injection sites;
    - (iv) All other site characterization data, the proposed emergency and remedial response plan, and a demonstration of financial responsibility;
    - (v) Community needs, demands, and supply from drinking water resources;
    - (vi) Planned needs, potential and/or future use of USDWs and non-USDWs in the area;
    - (vii) Planned or permitted water, hydrocarbon, or mineral resource exploitation potential of the proposed injection formation(s) and other formations both above and below the injection zone to determine if there are any plans to drill through the formation to access resources in or beneath the proposed injection zone(s)/formation(s);

- (viii) The proposed plan for securing alternative resources or treating USDW formation waters in the event of contamination related to the Class VI injection activity; and,
  - (ix) Any other applicable considerations or information requested by the Director.
- (2) Consultation with the Public Water System Supervision Directors of all States and Tribes having jurisdiction over lands within the area of review of a well for which a waiver is sought.
- (3) Any written waiver-related information submitted by the Public Water System Supervision Director(s) to the (UIC) Director.
- (c) Pursuant to requirements at § 124.10 of this chapter and concurrent with the Class VI permit application notice process, the Director shall give public notice that a waiver application has been submitted. The notice shall clearly state:
  - (1) The depth of the proposed injection zone(s);
  - (2) The location of the injection well(s);
  - (3) The name and depth of all USDWs within the area of review;
  - (4) A map of the area of review;
  - (5) The names of any public water supplies affected, reasonably likely to be affected, or served by USDWs in the area of review; and,
  - (6) The results of UIC-Public Water System Supervision consultation required under paragraph (b)(2) of this section.
- (d) Following public notice, the Director shall provide all information received through the waiver application process to the Regional Administrator. Based on the information provided, the Regional Administrator shall provide written concurrence or non-concurrence regarding waiver issuance.
  - (1) If the Regional Administrator determines that additional information is required to support a decision, the Director shall provide the information. At his or her discretion, the Regional Administrator may require that public notice of the new information be initiated.
  - (2) In no case shall a Director of a State-approved program issue a waiver without receipt of written concurrence from the Regional Administrator.
- (e) If a waiver is issued, within 30 days of waiver issuance, EPA shall post the following information on the Office of Water's Web site:
  - (1) The depth of the proposed injection zone(s);
  - (2) The location of the injection well(s);
  - (3) The name and depth of all USDWs within the area of review;
  - (4) A map of the area of review;
  - (5) The names of any public water supplies affected, reasonably likely to be affected, or served by USDWs in the area of review; and
  - (6) The date of waiver issuance.
- (f) Upon receipt of a waiver of the requirement to inject below the lowermost USDW for geologic sequestration, the owner or operator of the Class VI well must comply with:



- (1) All requirements at §§ 146.84, 146.85, 146.87, 146.88, 146.89, 146.91, 146.92, and 146.94;
- (2) All requirements at § 146.86 with the following modified requirements:
  - (i) The owner or operator must ensure that Class VI wells with a waiver are constructed and completed to prevent movement of fluids into any unauthorized zones including USDWs, in lieu of requirements at § 146.86(a)(1).
  - (ii) The casing and cementing program must be designed to prevent the movement of fluids into any unauthorized zones including USDWs in lieu of requirements at § 146.86(b)(1).
  - (iii) The surface casing must extend through the base of the nearest USDW directly above the injection zone and be cemented to the surface; or, at the Director's discretion, another formation above the injection zone and below the nearest USDW above the injection zone.
- (3) All requirements at § 146.90 with the following modified requirements:
  - (i) The owner or operator shall monitor the groundwater quality, geochemical changes, and pressure in the first USDWs immediately above and below the injection zone(s); and in any other formations at the discretion of the Director.
  - (ii) Testing and monitoring to track the extent of the carbon dioxide plume and the presence or absence of elevated pressure (e.g., the pressure front) by using direct methods to monitor for pressure changes in the injection zone(s); and, indirect methods (e.g., seismic, electrical, gravity, or electromagnetic surveys and/or down-hole carbon dioxide detection tools), unless the Director determines, based on site-specific geology, that such methods are not appropriate.
- (4) All requirements at § 146.93 with the following, modified post-injection site care monitoring requirements:
  - (i) The owner or operator shall monitor the groundwater quality, geochemical changes and pressure in the first USDWs immediately above and below the injection zone; and in any other formations at the discretion of the Director.
  - (ii) Testing and monitoring to track the extent of the carbon dioxide plume and the presence or absence of elevated pressure (e.g., the pressure front) by using direct methods in the injection zone(s); and indirect methods (e.g., seismic, electrical, gravity, or electromagnetic surveys and/or down-hole carbon dioxide detection tools), unless the Director determines based on site-specific geology, that such methods are not appropriate;
- (5) Any additional requirements requested by the Director designed to ensure protection of USDWs above and below the injection zone(s).