



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON, D.C. 20460

JAN 11 1985

OFFICE OF
WATER

MEMORANDUM

SUBJECT: Maximum Injection Pressure Requirements for Class II
Enhanced Recovery Wells and Wells Disposing of Produced
Brines. Ground Water Program Guidance No. 37

FROM: *Victor J. Kimm*
Victor J. Kimm, Director
Office of Drinking Water

TO: Water Division Directors
Water Supply Branch Chiefs
UIC Representatives
Regions I-X

Purpose

Questions have been raised by industry and EPA Regional Staff concerning the maximum injection pressure allowable for Class II enhanced recovery injection wells and for wells disposing of produced brines.* The requirements for existing enhanced recovery injection wells are outlined in §144.28(f)(3)(ii); Alaska §147.104(a); Colorado §147.304(a); Indiana §147.754(a); Kentucky §147.904(a); Michigan §147.1154(a); Montana §147.1354(a); Nevada §147.1454(a); New York §147.1654(a); Pennsylvania §147.1954(a); and Tennessee §147.2154(a). The requirements for existing wells that dispose of produced brines are outlined in §144.28(f)(3)(ii); Alaska §147.103; California §147.253; Colorado §147.303; Indiana §147.753; Kentucky §147.903; Michigan §147.1153; Montana §147.1353; Nevada §147.1453; New York §147.1653; Pennsylvania §147.1953; and Tennessee §147.2153. This guidance is intended to address these inquiries.

* Throughout this guidance and the preamble to the May 11, 1984 rules (see, 49 FR 20138, 20152-53), we refer to those Class II injection wells which are neither enhanced recovery injection wells nor hydrocarbon storage injection wells as "salt water disposal wells" or as "wells disposing of produced brines." In fact, some Class II wells inject produced waters which are not briny or salty; such Class II wells injecting produced waters which are not briny are encompassed in the "salt water disposal" rules.

BACKGROUND

The general limitation on injection pressure applicable to all Class II wells is stated as a performance standard in 40 CFR §146.23(a)(1). This standard is:

"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."

It was envisioned that this general performance standard would be translated into specific numerical limitations on injection pressure applicable to regulated owners or operators. States with primacy generally establish such numerical limitations either in field rules or in permits.

When we turned to the task of developing the Class II regulations for direct implementation States, we realized that it was incumbent on the Agency to attempt to specify limitations on injection pressure. The reasons for this are that: (1) regulations should state as clearly as possible what the obligations of the injector are; and (2) performance standards without specific limitations are difficult to enforce effectively. These reasons are especially compelling for enhanced recovery injection wells which are authorized by rule. Salt water disposal wells will eventually be permitted and numerical limitations can be established in each permit. In an attempt to resolve this problem, the rules proposed on September 2, 1983, would have set a maximum injection pressure for each State where EPA administers the UIC program based upon a generally conservative fracture gradient value for the injection zone. A higher injection pressure limitation could have been obtained by an owner or operator by applying for a permit. In order to obtain a higher limitation, the owner or operator would have had to demonstrate that the higher injection pressure would not fracture the confining zone.

It should be noted that the maximum injection pressure was based upon the fracture gradient of the injection zone. The EPA has focused its attention on the injection zone (rather than the

confining zone) not because we wanted to change the regulatory standard, but because we wanted to base the general standards upon readily available information. Typically, the injection zone is the only formation in which tests are run and from which data is collected. Therefore the best information available is from the injection zone.

Issues related to this point raised by the petroleum industry during the public comment period and in litigation focused on six points:

- 1) The appropriate injection pressures are not a function of politically conceived State boundaries but rather are a function of the individual rock formations involved.
- 2) The formula used to determine the maximum injection pressure is too conservative and resulted in too low a value.
- 3) The specific numbers used to determine the maximum injection pressures should be withdrawn.
- 4) Basing the maximum injection pressure upon the fracture gradient of the injection zone was illogical because the regulations only protect the confining zone from fractures.
- 5) Owners or operators of existing Class II wells should not have to apply for permits in order to exceed the fracture gradient of the injection zone as long as the confining zone was not fractured.
- 6) The owners and operators of enhanced recovery injection wells have economic incentives not to fracture the confining zones.

In response to these comments, we decided to modify the proposed approach in several ways. First, it appeared that a distinction between salt water disposal and enhanced recovery injection wells is appropriate. Owners or operators of salt water disposal wells have fewer economic or technical incentives to avoid fracturing of the confining zone. Furthermore, owners or operators of salt water disposal wells must apply for permits within four years, and wells operating at higher injection pressure would likely be among the first to be called in for permits under the criteria listed in §146.09. Second, since it was the Agency's intent to relieve owners or operators of enhanced recovery injection wells of the transaction costs

associated with individual permits, it seemed appropriate to devise a mechanism for obtaining a high injection pressure limitation that was something short of the full permitting process. Finally, we agreed with the comments that safe injection pressures are a function of local geology and hydrology.

The injection pressure limitation applicable to enhanced recovery injection wells adopted in the final rule works as follows:

- 1) No numerical standard was established for enhanced recovery injection wells. For the time being, these wells must comply with the performance standard of §146.23(a)(1).
- 2) Within one year of the effective date of each Direct Implementation program, the Regional Administrator is to set numerical standards for each injection formation or field. These values are to be based on data supplied by injection well owners or operators.
- 3) If an operator believes that his operation must exceed the general "formation-specific" maximum injection pressure he may request the Regional Administrator to set an alternative maximum pressure (AMP). This AMP may allow the operator to operate at higher pressures if he can demonstrate to the Regional Administrator that the confining layer will not be fractured and that there will be no migration of fluids into a USDW.
- 4) If an operator is not satisfied with the outcome of an AMP application, he may apply for a permit under Section 144.25(c). If the operator still feels that the permit conditions are not appropriate, he may challenge the permit. Section 124.19.

For salt water disposal wells, we retained the requirements as they were proposed in the September 2, 1983, proposal. Injection pressure limitations are established in the regulations. Owners or operators must comply with them or apply for a permit.

GUIDANCE

A. Enhanced Recovery Injection Wells

Initially, owners or operators of enhanced recovery injection wells are subject to the performance standard in §146.23(a)(1). Within one year of program effectiveness, the Regional Administrator is required to specify a maximum injection pressure for each field or injection formation. The maximum injection pressure for each field or formation will be based upon specific

data supplied by injection well operators and may be established pursuant to the standards established in either §§147.104(a)(1)(i) or 147.104(a)(1)(ii) and the relevant parallel sections. The purpose of this standard is not to prohibit the fracturing of the injection zone, but rather to prevent fracturing of the confining zone and possible contamination of underground sources of drinking water. Obviously, the easiest demonstration for an operator to make and for the Agency to concur with would be a demonstration that the appropriate pressure would not fracture the injection zone. The operator usually has good data on this zone, and such a demonstration would, as a matter of course, provide protection to the confining zone.

Some enhanced recovery operations are conducted at pressures that exceed the fracture pressure of the injection zone. This is usually done in very tight formations, where it is necessary to fracture the formation in order to waterflood it. These operations can be conducted without fracturing the confining zone and, in fact, it is economically advantageous to the owner or operator not to fracture this unit. An owner or operator desiring to operate at pressures greater than the fracture initiation pressure of the injection zone may apply to the Regional Administrator for an Alternative Maximum Pressure (AMP). It should be noted that the owner or operator may apply for an AMP either before or after a maximum injection pressure has been established for a field or formation. In order to obtain an AMP, the owner or operator must show that the increased pressure will not fracture the confining zone or cause the migration of injected fluids or formation fluids into a USDW.

In providing for alternative maximum pressures, the EPA makes no presumption of any inherent danger in injection pressures which exceed the breakdown pressures of the injection zone. For example, since the confining zone that must be protected is the one adjacent to the nearest USDW, even relatively high injection pressures can be safe if there is sufficient separation between the injection zone and the USDW. However, operations which conduct injection at higher pressures should be assessed more carefully to assure that they conform with the performance standards, and the AMP should be based upon an adequate level of information.

If the owner or operator is not satisfied with the Regional Administrator's decision concerning the AMP, he may apply for a permit. Section 144.25(c). In order to receive a permit, the owner or operator must again show protection of the confining zones. The permit may be challenged by the owner or operator if he fails to receive permit conditions that he believes are appropriate. Section 124.19.

B. Salt Water Disposal Injection Wells

The maximum injection pressure for a salt water disposal well is based upon a numerical formula that uses a conservative fracture gradient for the injection zone. Of course, the general performance standard is always applicable.

Some have suggested that 1.2 psi/ft be used as the general pressure limit. Research has shown that 1.2 psi/ft is a maximum value for fracture gradients; many formations have fracture gradients much less than 1.2 psi/ft. The suggested value, therefore, does not set the conservative standard necessary in order to be protective, and will not be used as a general limitation.

Even though this EPA maximum injection pressure is a conservative limit, most salt water disposal wells already inject at pressures well below the limit.

If an operator feels it is necessary to inject at pressures greater than the fracture initiation pressure of the injection zone, he may apply to the Regional Administrator for a permit. The permit application must show to the Regional Administrator's satisfaction that the increased pressure will not fracture the confining zone or cause the migration of injected fluids or formation fluids into a USDW.

All owners or operators of Class II salt water disposal wells are required to apply for a UIC permit within four years of the implementation of the UIC program. This four year limit is a maximum, however. Section 144.31(c)(1) requires all permit applications to be made as expeditiously as possible. The Regional Administrator may require a permit application from an operator using the criteria listed in §146.09(c), if

he believes there may be a likelihood of contamination of USDWs. An injection well operating at excessive pressures can be a risk to USDWs. For these reasons, the requirement of a permit in order to operate a salt water disposal well at pressures greater than the fracture gradient constitutes no excessive burden to an owner/operator.

C. Demonstration

In reviewing a request for an AMP or a higher pressure limitation in a permit application, the Regional Administrator should consider:

- 1) Geologic descriptions of both the injection zone and the confining zone (lithologies, thicknesses, permeabilities, porosities, depths, fluid content, fluid pressures, calculated injection formation breakdown pressure, and areal extent);
- 2) Geologic disturbances known to be present (faults, folds, and fractures). The extent of hydraulic fractures that will be created as a result of stimulation should also be described;
- 3) Pre-existing wells (abandoned and producing) within the area of influence;
- 4) Intended injected fluid characteristics;
- 5) Intended injection pressures and volumes.

Applicants for higher injection pressure can provide information regarding these considerations in a variety of ways. In existing fields or wells that have previously been injecting at pressures greater than the injection zone fracture pressure, historical data can be very useful. When it is available, data should be presented to show that relatively high injection pressures will not fracture the confining zone and that fluid migration across the confining zone is not now occurring and, therefore, would not reasonably be expected to occur in the future.

Other types of evidence that could be submitted include:

- 1) Operational data demonstrating the efficiency of the flood and the degree of fluid loss;
- 2) Tracer surveys run to indicate an absence of vertical migration of the injection fluids;
- 3) Sequentially repeated time "decay" measurement logs that identify where in the vertical column the injection fluids are going;
- 4) Empirical calculations determining the fracture gradient of the specific confining zone. Any professionally accepted method of calculation which is acceptable to the Regional Administrator may be used including those based upon drilling records (mud weights, etc.), geophysical wireline logs (electric logs, formation pore pressure recorders, sonic logs, formation bulk density logs) or direct testing (instantaneous shut-in pressure, step-rate tests).
- 5) Combinations of these and other possible measurements of subsurface conditions.

To the extent possible, the Regional Administrator should request information currently available to the operator. New data should only be required from an owner or operator when the existing data are insufficient to make a responsible determination.

IMPLEMENTATION

Regional offices are instructed to use this guidance in administering UIC programs where EPA has primary enforcement responsibility. They are further instructed to make this guidance available to States working towards primacy and to advise the State director that these interpretations represent EPA policy.

FILING INSTRUCTIONS

This guidance should be filed as Ground Water Program Guidance No. ____.

ACTION RESPONSIBILITY

For further information on this guidance contact:

Daniel Sullivan
U.S. EPA
Office of Drinking Water (WH-550)
401 M Street, S.W.
Washington, D.C. 20460
(202) 382-5561