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

OFFICE OF
WATER

FEB 28 1986

MEMORANDUM

SUBJECT: Class I Permit Conditions Guidance (UICPG#46)

FROM: Michael B. Cook, Director
Office of Drinking Water

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

I. PURPOSE

The purpose of this document is to provide the Regional Offices and the States with guidance on a number of special conditions that should be included in UIC Class I permits. The addition of these conditions is particularly appropriate for hazardous waste well permits.

II. BACKGROUND

The UIC Branch in Headquarters, the Regional Offices and a contractor collected extensive information on hazardous waste wells in late 1983 and 1984. This information was used to prepare the report to Congress mandated by Section 701 of the Hazardous and Solid Waste Amendments (HSWA) of 1984. The report was submitted to Congress in May of 1985 and will be one of the components in the re-evaluation of the safety of hazardous waste injection required by §§201(f) and (g) of the HSWA.

As a result of gathering and analyzing this information for the report to Congress, we have decided to suggest the addition of several special conditions to permits, when warranted, to increase protection of underground sources of drinking water. These conditions are authorized by existing regulations. This guidance will be updated as our experience grows in the process of permitting Class I wells and will remain in effect until regulations are published on the subject. These permit conditions apply to all Class I wells and especially to those injecting hazardous waste.

These permit conditions include:

A. Installation of automatic warning and shut-off systems;
B. Increased frequency of mechanical integrity tests;
C. Limitation on the use of fluid seals;
D. Protection of the bottom of the casing and packer in wells injecting corrosive waste;
E. Precautions to prevent well blow-outs as a result of gas formation in the injection zone;
F. Consistent characterization of injected waste; and
G. Maintenance of pressures in the annulus which are greater than the injection pressure.

Some States are already including some or all of these conditions routinely when permitting Class I wells.

III. GUIDANCE

The permit writers should be aware (and if germane, inform the applicants) of several considerations. These considerations affect the permit or impose certain duties on the permittee. Some of these are widely recognized (e.g. monitoring and reporting), but others are lesser known and include:

° Certain hazardous waste injection practices may be limited or prohibited as a result of the land disposal ban determinations required under Section 201 of the Hazardous and Solid Waste Amendments of 1984. The first determinations are scheduled to be in effect by August 1988 or earlier;

° Even if a UIC permit is issued allowing the injection of waste, the permittee may be required to obtain or at least apply for other Federal, State or local permits in order to operate legally; and

° The operator is required to have adequate training for the particular mode of operation.

The permit boilerplate may already include these three considerations; however, in some cases it may be appropriate to remind the operator of these requirements.

In addition, permit writers should include several special conditions in Class I permits which will prevent endangerment of USDWs. These conditions include, but are not limited to:

A. <u>Installation of automatic warning and shut-off systems</u>

The purpose of these systems is for the operator to be instantly notified and the operation to be stopped or modified (e.g. injection of "clean" water) if a critical parameter has deviated from an acceptable and preset level, and the operator has not corrected the problem within a set time. Examples of the parameters that could trigger the shutting-off/modification process would be:

1. High injection pressure;
2. Low injection pressure;
3. High injection rate;
4. Low injection rate;
5. Significant pressure change in the annulus; and
6. Annulus/tubing pressure gradient that is negative or reaching zero.

The installation of automatic warning and modification/shut-off systems would prevent and/or indicate conditions that could damage the tubular goods and, more importantly, contaminate USDWs. If the permit does not already have a condition for the installation of such a system, it should be included at the first opportunity. Authority for this condition is found in 40 CFR 144.51(d), 144.52(a)(9) and (b)(1), 146.13(b)(2) and the equivalent in the State rules.

Example of boilerplate:

[Note: Permit writers should require a brief discussion of the system in the permit application, and this condition may be included as an appendix to the permit. In some cases, a time delay system could be used. In such a system, an alarm would sound and the operator would have a set time to make corrections before the operation shuts down or is modified.] The permittee agrees to install, continuously operate and maintain an automatic warning and shut-off system as described in appendix ___ of this permit which will stop or modify injection if: [The blanks should be filled out according to the sensitivity of the instruments and with a number which would allow for safe operation and is almost equal in magnitude to the maximum/minimum injection pressure or rate as applicable.]

[_] **Pressure in the annulus changes by ___psi;**

[_] Pressure in the annulus drops below___psig;

[_] The injection pressure reaches __ psig;

[_] The injection pressure falls below __ psig;

[_] The injection rate reaches __ gpm;

[_] The injection rate falls below __ gpm;

[_] The injection/annulus pressure difference at any point falls below __ psi. [This should be set on a case-by-case basis.]

B. Increased frequency of Mechanical Integrity Tests

The UIC regulations require continuous monitoring of the annulus for Class I wells, and §146.8 (b) provides that annulus monitoring is an approved method for determining the absence of leaks in the tubular goods. This technique can be effective for determining the absence of leaks only if:

° The operator understands the system and its operation;

° Normal losses through the packer and the casing joints are understood and quantified;

° Effects of injection and temperature of the injection fluid are understood and compensated for;

° The pressure instrument is sensitive enough to detect very small pressure changes and is routinely calibrated; and

° There is a positive pressure gradient from the annulus to the tubing (see Section "H" of this guidance).

It is very difficult for the permitting agency to assure that all of the conditions above are continuously followed by the permittee. In cases where a fluid seal is used, the operation becomes even more complex. As a result, there have been some episodes in which leaks have gone undetected even though annulus pressure monitoring was being performed. Therefore, we recommend that pressure tests be run at yearly intervals.

Another component of assuring mechanical integrity is the evaluation of the cement in the borehole above the injection zone. Adequate cementing of the borehole is imperative to assure that the injection fluid is confined to the disposal formation and that there is no movement of fluids between aquifers that can contaminate USDWs. Generally there are two types of tests that are done to determine the soundness of the cement. They are:

° Methods which rely on the injection of an indicator (e.g., radioactive) fluid into the disposal formation. A receiver (geiger counter) is then put in the hole to transverse it. A positive reading indicates that fluids are moving through the borehole out of the injection zone; and

° Methods which use sound or temperature to evaluate the density and extent of the cement throughout the length of the borehole.

Evaluation of the cement in the borehole every five years should be sufficient in all situations but one. In the case of certain Class I wells, especially hazardous waste wells which inject corrosive materials, the integrity of the cement in the borehole directly above the injection zone may have to be evaluated more often because the plug is vulnerable to physical and chemical effects of the injection operation, and rapid deterioration may occur. Therefore, for these wells, we recommend yearly radioactive tracer surveys.

In the data gathering phase of the "Report to Congress on Injection of Hazardous Waste," it was found that, in many cases, pressure tests and/or radioactive tracer surveys are done at least every other year. In general, pressure tests are done to demonstrate the integrity of the tubular goods and radioactive tracer surveys to demonstrate the integrity of the tubular goods and the cement plug at the confining zone.

Authority for this condition is found in 40 CFR 144.52(a)(9), which authorizes additional conditions to prevent contamination of USDWs, 40 CFR 144.52(b)(1) which authorizes additional conditions to provide for and assure compliance with all applicable requirements of the Act and regulations (including 144.12 and the mechanical integrity requirements) and 40 CFR 146.12(b), requiring all Class I wells to have casing and cementing that will prevent movement of fluids. Furthermore, 40 CFR 146.13(b)(3) requires MITs to be done at least every five years, meaning that they could be required more often.

Note: Boilerplate for Class I permits already includes an MIT condition for these tests to be done every five years. The boilerplate should be modified to require pressure tests and/or radioactive tracer surveys to be done annually for Class I hazardous waste wells and other Class I wells, as warranted, depending on siting, construction and operations characterization.

C. Limit the use of fluid seals in Class I wells.

There are two basic types of fluid-seal systems. The most commonly used works as follows: The annulus is filled with an immiscible fluid. Because the annulus fluid is immiscible, there is a distinct boundary marking the point where the annulus fluid meets the injection or formation fluid. The annulus fluid is kept at a pressure which keeps this boundary line at or near the bottom of the tubing. Electrodes are placed above this point to detect whether this fluid interface moves up the annulus. If the interface moves, the pressure is increased to limit its movement beyond a predetermined point. If a pressure equilibrium is not reached it may indicate problems in the well which should be investigated.

In the other system, the annulus is continuously "flushed" with a fluid. Thus, the annulus fluid has enough pressure to move through the annulus and displace formation and injection fluid. Again electrodes are used to detect any movement of formation or injection fluid up the annulus.

The first system uses both the electrodes and pressure to give an indication of the integrity of the casing and tubing. The latter system depends mostly upon the electrodes. Variations of the two generic types are also in operation, and some may be more effective than the two described above; however, their operation may be rather complex.

To be effective, both systems must be relatively simple in design. They must be monitored and tested at regular intervals, and must be operated by well trained, competent staff. Besides the parameters that should be considered in a conventional injection operation, (expansion and contraction due to temperature changes, injection pressure, operational intervals, fluid losses), there are at least two additional considerations which are critical to the proper operation of the fluid sealed annulus. First, the fluid in the annulus must not mix with either the formation fluid or the injection fluid. There must be a relatively distinct surface where the fluids meet. Thus, the fluid must be immiscible and the electrodes used to monitor movement of fluid up the annulus must be sensitive and reliable.

Accordingly, the permit writer should carefully evaluate both the injection fluids and the annulus fluid to assure that they will not mix. He should require an initial demonstration of the electrode system, and require that operators test it at frequent intervals thereafter. He should be sure that operators are trained in the use and monitoring of the system. Finally, the permit should contain provisions which assure that gauges are precise, are calibrated frequently, and perform over an appropriate range of operating conditions.

Example of boilerplate:

[To be used only when the design calls for a fluid seal which has been shown to be effective.]

[For systems in which there is an equipressure surface in the annulus directly above the end of the tubing.] The pressure in the annulus must be higher than the injection pressure at all points, except for the interval just above the bottom of the tubing. The interval just above the bottom of the tubing must be shown to be resistant to chemical and physical attack from the injection fluid.

or,

[For systems in which the annulus fluid is also injected.] The pressure in the annulus should be higher than the injection pressure at all points.

and,

The permittee will certify, at least annually and every time the operator changes, that the operator has received adequate training and understands the fluid seal system. A verification of such training and an evaluation of operator adequacy must also be submitted.

The permittee will also test the electrode system every three months and record the results. This could be done by allowing an ionic solution to enter the electrode area. Copies of these test results should be retained for three years.

D. Protection of the bottom of the casing and the packer in wells injecting corrosive waste.

The action of corrosive waste on the casing, the packer and the injection zone can have a damaging effect on the integrity of the well. One way to prevent damage to the casing is to pump an immiscible, low specific gravity fluid (diesel fuel) into the injection zone. The lower specific gravity fluid stays in the top of the cavity formed and protects the formation from dissolution and the casing and packer from corrosion. Authority for this condition is found in 40 CFR 146.12(b)(5), 144.52(a)(9) and 144.52(b)(1) or the equivalent State rules.

Example of boilerplate:

[To be used in the case of corrosive waste injection when the bottom of the casing, the packer and the injection or confining formations could be attacked by the waste.]

The permittee shall isolate the upper portion of the injection interval to prevent dissolution that may lessen the structural support of the bottom portion of the well. The permittee shall inject an immiscible fluid of a lower (with respect to other fluids present in the injection zone) specific gravity, and maintain it in a position which ensures that the corrosive fluid does not come in contact with the casing, the packer and the upper portion of the injection formation. [One such system in operation today relies on periodic injection of oil (one barrel every two months) to assure that there is sufficient protective fluid.]

E. Precautions to prevent well blow-outs.

Gases may form in the injection zone as a result of injection. The formation of carbon dioxide as the result of acid injection into carbonate formations or formations with carbonate cementing materials is a classic example of this. Under certain conditions, the gas formed could cause a negative pressure gradient and the violent return of injection fluid to the surface (well blow-out). This phenomenon has been known since injection began and, in general, precautions are taken to prevent blow-outs. A similar problem could occur when different types of wastes are injected in succession and commingle, causing violent chemical reactions with subsequent damage to the well and return of fluids to the surface. The injection of hot (near 88°F, which is the critical temperature of carbon dioxide) and/or very concentrated acid increases the possibility of volatile gas formation in the injection zone near the well bore. Authority for a condition to control such situations is found in 40 CFR 146.14(b)(6), which requires the UIC Director to consider compatibility, in 40 CFR 144.51(e), which requires proper operation of the well and 144.52(a)(9) and (b)(1), which authorize the addition of conditions on a case-by-case basis to protect USDWs or the equivalent in State rules.

The relative concentration of the acid must also be considered in permit activities. Although the temperature determines whether gas will be present and is, therefore, the parameter of greatest concern, concentrations can affect the rate and quantity of gas generation that can occur in a given instance.

Example of boilerplate:

1. A pressure which will prevent the return of the injection fluid to the surface shall be maintained in the well at all times. If there is gas formation in the injection zone near the well bore, such gas must be prevented from entering the casing or tubing, as it may cause the reduction of the specific gravity of the liquid column and a well blow-out. The well bore must be filled with a high specific gravity fluid during workovers to maintain a positive (downward) gradient and/or a plug shall be installed which can resist the pressure differential. A blowout preventer must be kept in proper operational status during workovers.

2. The permittee shall check the compatibility of the constituents of the waste streams to determine whether the commingling of these wastes would result in increased pressures in the injection zone. In the case where gas would be generated and/or pressure

increased, a non-reactive buffer shall be injected which separates the injection fluid streams.

3. Under no conditions shall hot acid (above 75°F) be injected into carbonate-containing formations, as it may cause the formation of gas with the subsequent threat of a blowout. [The critical temperature of carbon dioxide is 88°F. Above this temperature carbon dioxide is in the vapor or gas phase.]

F. Consistent characterization of injected waste

The current method of reporting the composition of the injected waste stream to the States lacks consistency and is not amenable to analysis. In order for EPA to use this information effectively, the permittee should identify the waste components of the waste-stream by their common name, chemical name, structure and concentration. The RCRA code associated with the process and type of waste should be included. Authority for this condition is found in 40 CFR 146.13(b)(1) for monitoring and 40 CFR 146.13(c)(1)(i) for reporting, and the general provisions of 144.52(a)(9) and (b)(1) or the equivalent State rules.

Example of boilerplate:

The components of the injected waste stream shall be reported in the following format: [Refer to appendix 1 of this guidance. In cases where the waste streams change often, as in commercial facilities, the condition should require that each batch be characterized and the frequency of reporting should be specified.]

G. Maintenance of pressures in the annulus which are greater than the injection pressure.

The isolation of the annulus and the monitoring of the annulus pressure provide indications of the integrity of the tubing, casing and packer. However, unless a higher pressure is maintained in the annulus relative to the injection pressure, any leak in the tubing could allow direct contact of the injection fluid with the casing. Therefore, the annulus pressure should always be higher than the injection pressure. If the operator claims that this practice is damaging to the well or causes problems, he should justify this claim. Convenience per se is not sufficient reason for failing to keep a pressure differential as specified above. Authority for this condition is found in 40 CFR 146.13(a)(3).

Example of boilerplate:

The operator must maintain a pressure in the annulus which is higher than the injection pressure throughout the whole length of the tubing.

IV. DOCUMENTATION

It is important that the permit writer be careful to document, somewhere in the public record (e.g. in a fact sheet or technical justification) why the additional permit conditions were added. The explanation need not be extremely detailed and exhaustive, but there is the need to have something in the administrative record to justify the application of conditions not specifically mandated by the regulations. Thus, for example, if the general case-by-case additional condition authority in 144.52(a)(9) and (b)(1) are relied upon, a discussion of why the conditions are useful in preventing endangerment of USDWs is needed. This will simplify permit appeals, and will ultimately provide an administrative record in case of judicial review of the permit.

V. IMPLEMENTATION

A. The Regional Offices should apply the conditions specified in this guidance, where warranted, immediately after receiving it.

B. The Regional Offices should send a copy of this guidance to the States with a strong recommendation for adoption and implementation.

VI. FILING

This guidance should be filed under Underground Injection Control guidance # 46 (UICG# 46).

VII. ACTION RESPONSIBILITY

Please contact Mario Salazar, Project Manager (202 or FTS) 382-5561) for clarification on this guidance.