



Department of Environmental Protection

Jeb Bush
Governor

Twin Towers Office Building
2600 Blair Stone Road
Tallahassee, Florida 32399-2400

David B. Struhs
Secretary

March 28, 2002

Mr. Russell Schindler
American Remediation
8666 East Traverse Highway
Traverse City, Michigan 49684

Re: **PER-PETUAL**

Dear Mr. Schindler:

The Bureau of Petroleum Storage Systems hereby accepts PER-PETUAL as a system for in situ injection-type chemical oxidation and/or bioremediation of petroleum and other suitable contaminants in groundwater and soil. As indicated in the information you provided, it is a patent-pending system, intended to be of low installation and operating costs, that can inject hydrogen peroxide in concentrations ranging from 1 to 40 percent. For chemical oxidation, the hydrogen peroxide acts as an oxidizer, and for bioremediation it acts as a source of oxygen for the indigenous microorganisms feeding on the contaminants at a remediation site.

Readers of this acceptance letter, who may be accustomed to catalyzed hydrogen peroxide reactions for site remediation via chemical oxidation, may want to note that PER-PETUAL does not use a catalyst. The bureau has no objections to the use of a catalyst, however, provided it meets all applicable and appropriate underground injection control regulations in Chapter 62-528, Florida Administrative Code (F.A.C.).

For vadose remediation where the underlying groundwater will not be affected by leaching of this product, there are no special concerns beyond those which would normally need to be addressed in preparing a Remedial Action Plan and conducting a cleanup in accordance with the petroleum cleanup requirements of Chapter 62-770, F.A.C. For ex situ groundwater treatment, where an aboveground treatment system produces effluent meeting the petroleum cleanup criteria of Chapter 62-770, F.A.C., and the drinking water standards of Chapter 62-550, F.A.C., for disposal via recharge gallery or NPDES permit, there are no special concerns. But for in situ groundwater remediation, via direct injection of PER-PETUAL into an aquifer, there are underground injection control regulations that must be observed. Since in situ aquifer remediation via injection is likely to be the most common application of this process, the bulk of the regulatory requirements discussed herein will be directed to that topic.

The bureau recognizes PER-PETUAL as a viable system for the remediation of petroleum contaminated sites in Florida. There are no objections to its use provided: (a) the considerations of this letter are taken into account; (b) a Remedial Action Plan is approved by the Department; and (c) applicable and appropriate underground injection control regulations applying to injection-type in situ aquifer remediation are observed. For PER-PETUAL, the major environmental and regulatory considerations are set forth in enclosure 1.

While the Department of Environmental Protection does not provide endorsement of specific or brand name remediation products or processes, it does recognize the need to determine their acceptability from an environmental standpoint with respect to applicable rules and regulations, and the interests of public health, safety, and welfare. Vendors must then market the products and processes on their own merits regarding performance, cost and safety in comparison to competing alternatives in the marketplace. In no way, however, shall this regulatory letter of acceptance be construed as certification of product performance. Additionally, the Department emphasizes a distinction between regulatory "acceptance" and approval: products and processes are accepted but they are not approved.

Those who prepare Remedial Action Plans may include a copy of this letter in the appendix of plans they submit, and call attention to it in the text of their document. In this way, technical reviewers throughout the state will be informed that you have contacted the Department of Environmental Protection to inquire about PER-PETUAL's environmental acceptability. To aid those reviewers, the Bureau of Petroleum Storage Systems provides supplemental information as enclosure 2. Additionally, since the chemical oxidation mode of this remediation process involves an exothermic reaction, appropriate safety topics should be considered. An in situ chemical oxidation safety advisory is included as enclosure 3.

The Department reserves the right to revoke its acceptance of a product or process if its nature or performance has been falsely represented. Additionally, Department acceptance of any product or process does not imply it has been deemed applicable for all cleanup situations, or that it is preferred over other treatment or cleanup techniques in any particular case. A site-specific evaluation of applicability and cost-effectiveness must be considered for any product or process, whether conventional or innovative, and adequate site-specific design details must be provided in Remedial Action Plans prescribing the product or process. You may contact me at 850/487-3299 if there are any questions.

Sincerely,

Rick Ruscito, P.E.
Bureau of Petroleum Storage Systems

c: T. Conrardy - FDEP/Tallahassee

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ENCLOSURE 1

ENVIRONMENTAL AND REGULATORY INFORMATION

For PER-PETUAL, the major environmental and regulatory concerns are listed below.

- a. Regulations and groundwater standards: The onus shall be on users of PER-PETUAL to ensure that all applicable groundwater standards will be met at the time of project completion, for the contaminants of concern, any residuals associated with the reagents of PER-PETUAL, and any byproducts produced as a result of chemical or biochemical reactions involving those reagents. The following chapters of the Florida Administrative Code are cited: Chapter 62-550, F.A.C., for primary and secondary water quality standards; Chapter 62-520, F.A.C. for groundwater classes and standards; Chapter 62-522, F.A.C., for groundwater permitting and monitoring requirements; Chapter 62-528, F.A.C., for underground injection control, particularly Part V, for Class V, Group 4 aquifer remediation projects; Chapter 62-770, F.A.C., for petroleum cleanup criteria; and Chapter 62-777, F.A.C., for cleanup target levels. As a convenience, these chapters are available at the Department's web site, www.dep.state.fl.us, as "rules".

A noteworthy aspect of the minimum criteria set forth in Chapter 62-520, F.A.C., is that it requires groundwater to be free from substances that are harmful to plants, animals, and organisms, and free from substances that are carcinogenic, mutagenic, teratogenic or toxic to human beings. In effect, these "free from" requirements form a catchall. They close what would otherwise be a loophole in the regulations by preventing injection of a potentially harmful product in the event that any of its ingredients is not regulated as a specific primary or secondary drinking water contaminant.

- b. Injection well permit: The issuance of a site-specific Remedial Action Plan Approval Order by either the Bureau of Petroleum Storage Systems or the Bureau of Waste Cleanup, for remediation via injection of PER-PETUAL into an aquifer, constitutes the granting of a Class V injection well permit.
- c. Groundwater injection standards: For in situ aquifer remediation, pursuant to Chapter 62-528, F.A.C., the composition of an injected fluid must meet the drinking water standards set forth in Chapter 62-550, F.A.C., and the minimum groundwater criteria described in Chapter 62-520, F.A.C. Additionally, the minimum groundwater criteria set forth in Chapter 62-777, F.A.C., apply. The pH of the hydrogen peroxide solution injected by the PER-PETUAL system does not meet the secondary drinking water standard for pH, which is an allowable range of 6.5-8.5. Therefore, in order to use PER-PETUAL for injection-type in situ aquifer remediation, rule 62-522.300(2)(c), F.A.C., must be applied to the secondary parameter pH.

Rule 62-522.300(2)(c), F.A.C., effective August 27, 2001, for aquifer remediation purposes, allows a temporary zone of discharge, within which a temporary exceedance of the primary and secondary drinking water standards associated with the prime reagents of the chemicals used to remediate an aquifer will be tolerated. In order to comply with the rule, a Department-approved site-specific remediation plan proposing PER-PETUAL must: (a) identify pH as the secondary parameter that is not met by the composition of the fluid to be injected; (b) indicate the size and

duration of the temporary zone of discharge; and (c) include groundwater monitoring of the secondary parameter pH. A discussion of Rule 62-522.300(2)(c), F.A.C., can be found in guidance document BPSS-10, "In Situ Chemical Additives", at Bureau of Petroleum Storage Systems web page www.dep.state.fl.us/waste/categories/pcp/pages/active.htm.

- d. Utilization of wells: If a remediation site happens to have an abundance of monitoring wells, then the Department has no objection to the use of some wells for the application of PER-PETUAL. However, no "designated" monitoring well, dedicated to the tracking of remediation progress (by sampling) shall be used to apply PER-PETUAL injection fluid. This will avoid premature conclusions that the entire site meets cleanup goals. By making sure that designated tracking wells are not also used for treatment, there will be more assurance that the treatment process has permeated the entire site and that it did not remain localized to the area immediately surrounding each injection well.
- e. Groundwater monitoring:
 - 1. Active remediation monitoring of petroleum: During the period of active remediation, groundwater shall be monitored for petroleum contaminants of concern in accordance with the requirements set forth in Section 62-770.700, F.A.C. For non-petroleum cleanups, the monitoring should be conducted in accordance with the provisions of an approved Remedial Action Plan.
 - 2. Post remediation monitoring of petroleum: During the period of post active remediation, groundwater monitoring for petroleum contaminants of concern shall be conducted in accordance with the requirements set forth in Section 62-770.750, F.A.C. For non-petroleum cleanups, the monitoring should be conducted in accordance with the provisions of an approved Remedial Action Plan.
 - 3. Monitoring for underground injection control purposes: For PER-PETUAL, pursuant to rule 62-522.300(2)(c), F.A.C., groundwater monitoring of the secondary drinking parameter pH must be addressed in a Department-approved Remedial Action Plan.
- f. Underground injection control inventory: Remedial Action Plans prescribing in situ aquifer injection-type remediation shall include information pursuant to Rule 62-528.630(2)(c)1 through 6, F.A.C., for the inventory purposes of underground injection control. Per Rule 62-528.630(2)(c), F.A.C., aquifer remediation projects involving injection wells may be authorized under the provisions of a Remedial Action Plan, provided the construction, operation, and monitoring requirements of Chapter 62-528, F.A.C., are met. A memorandum outlining the inventory information about injection-type aquifer remediation plans, to be transmitted by Department reviewers, to the Underground Injection Control Section is provided as enclosure 4.
- g. Avoidance of migration: For in situ injection-type aquifer remediation projects, injection of PER-PETUAL shall be performed in such a way, and at such a rate and volume, that no undesirable migration of either the injected fluid or the contaminants of concern in the aquifer results, pursuant to Rule 62-528.630(3), F.A.C.
- h. Operating parameters: Section 62-770.700, F.A.C., sets forth frequency requirements for the measurement of bioremediation operating parameters such as dissolved oxygen levels, rates of nutrient addition, temperature, etc. It also includes an option for reduction in the frequency or

discontinuation of some measurements in situations when appropriate. The measurement of these operating parameters apply when PER-PETUAL is used in its bioremediation mode.

- i. Abandonment of wells: Upon issuance of a petroleum Site Rehabilitation Completion Order, or a declaration of "No Further Action", injection wells shall be abandoned pursuant to Section 62-528.645, F.A.C. The Underground Injection Control Section of the Department shall be notified so that the injection wells can be removed from the inventory-tracking list.

ENCLOSURE 2

SUPPLEMENTAL INFORMATION

The information below, compiled from several sources, may be helpful to reviewers of Remedial Action Plans proposing the PER-PETUAL system.

- a. Nature of the system: PER-PETUAL is an in situ injection-type remediation system, for groundwater and soil, that injects hydrogen peroxide in concentrations ranging from 1 to 40 percent. For chemical oxidation, the hydrogen peroxide acts as an oxidizer, and for bioremediation it acts as a source of oxygen for the indigenous microorganisms feeding on the contaminants at a remediation site. In its chemical oxidation mode, PER-PETUAL injects hydrogen peroxide, but not a catalyst, although the bureau has no objections to a catalyst, provided it meets all applicable and appropriate underground injection control regulations in Chapter 62-528, F.A.C.

PER-PETUAL is intended to be a system of low installation and operating cost. One of its cost-saving features is the use of either compressed air or a compressed inert gas to provide the driving force for the injection of hydrogen peroxide. In this way, the cost of installing and operating a pump is eliminated.

- b. Department of Environmental Protection reviewers of injection-type in situ aquifer remediation plans, regardless of whether in Tallahassee or district offices, must fill in the blanks on the enclosure 4 memorandum, whose subject is "Proposed Injection Well(s) for In Situ Aquifer Remediation at a Petroleum Remedial Action Site". The completed form must be submitted to the Underground Injection Control Section at 2600 Blair Stone Road, Tallahassee, Florida 32399-2400.

Only the appropriate bureau chiefs and division directors within the Department and its district offices may sign in situ injection-type remediation plan approval orders that constitute the granting of a Class V injection permit. Local program staff may review such plans but are not authorized to sign the approval orders. Reason: Although an arrangement between the Environmental Protection Agency and the Department delegates underground injection control authority to the Department, it does not allow the Department to delegate that authority any further. This includes delegation to the Department's contracted remediation review agencies such as those operated by the counties and other local governments.

- c. Pilot study: For bioremediation and innovative technologies, per Section 62-770.700, F.A.C., a pilot study proposal shall be submitted for review, and a pilot test shall be performed prior to designing a treatment system. If conditions or the situation at a site do not warrant a pilot study, then a proposal explaining the rationale to forego a pilot study shall be submitted for review. The state's technical reviewers are encouraged to use judgment in balancing cost and the need for technical information to be obtained from a pilot study.
- d. Degradation products: Carbon dioxide and water are the ultimate products of both chemical oxidation and the biodegradation of hydrocarbons. When chlorinated hydrocarbons are degraded, these degradation products will also be accompanied by chloride ions as well.

- e. Dosage and application rate: The manufacturer of PER-PETUAL indicates that measurements of operating parameters are used to make adjustments in the dosage and rate of hydrogen peroxide injection, for optimal performance of the system over the life of the project. The Bureau of Petroleum Storage Systems believes this site-specific approach to optimization is cost-effective, and beneficial to the environment as well since it limits the injected amount of hydrogen peroxide to the minimum needed to accomplish a cleanup.

ENCLOSURE 3

IN SITU CHEMICAL OXIDATION SAFETY ADVISORY

The volatility of some contaminants may be sensitive to temperature and there could be a significant change in both the concentration and distribution of flammable vapors and/or toxic non-flammable vapors when using an in situ chemical oxidation method. This dynamic environment is less predictable than most other cleanup situations, where less powerful remediation methods are unable to drive the cleanup by greatly changing a site's established equilibrium of contaminants that are distributed amongst the vapor, liquid, and adsorbed phases. Therefore, both precautionary and preventative measures are appropriate.

As is the case in any petroleum or flammable solvent remediation effort, design considerations must take potential fire and explosion hazards into consideration, so that appropriate equipment and operating procedures can be specified for their prevention. For petroleum cleanups, a Remedial Action Plan Checklist recognizes the potential for a fire or explosion, so it includes reminders regarding the following items: migration via underground conduits and utilities; lower explosive level (LEL); National Electrical Code practices intended to minimize ignitions from electrical devices; explosion-proof motors; spark-resistant materials of construction for vapor blower housings and impellers; and in the case of thermal oxidizers, items to consider for the prevention of furnace explosions.

The Remedial Action Plan Checklist for petroleum cleanup sites has been revised to include a section addressing in situ chemical oxidation. The items listed below summarize a portion of the checklist and should be helpful to preparers and reviewers of in situ chemical oxidation remediation plans in identifying potential fire and explosion hazards. The suggested items to consider are, but not necessarily limited to:

- a. the potential for subsurface migration of vapors, either through pathways in the aquifer and soil itself, or via underground conduits such as sewer lines, utilities, storm drains, etc., and the destination of those pathways should migration occur;
- b. the presence of free product in the subsurface, either in underground utilities, or in the form of non-aqueous phase liquids, which could be volatilized by the heat of an exothermic chemical reaction, in concentrations which exceed the lower explosive level;
- c. the presence of underground petroleum or flammable liquid storage tanks and dispenser pipelines which may be near the source of heat generated by chemical oxidation reactions, and measures to prevent them from exposure to excessive amounts of heat;
- d. identification and control of possible ignition sources (electrical equipment, devices, and switches, vehicle exhaust sparks, mechanical sources of sparks, etc.) at potential vapor migration pathway destinations;
- e. monitoring of vapor concentrations, for comparison with lower explosive levels, at the site and/or in conduits and other potential pathways during operation of the chemical oxidation system;
- f. the chemical reactants involved and the amount of heat liberated by their reaction;

- g. monitoring of aquifer and/or vadose temperature during treatment;
- h. a maximum temperature that may be tolerated before shutting down the operation is necessary;
- i. control of reactant concentrations and/or quantities as a means of controlling temperature;
- j. the possibility of using a vacuum extraction system to collect vapors at sites where significant amounts of volatilization is expected to occur; and
- k. safety of workers involved with the actual handling of chemicals.

The foregoing list should not be applied in blanket fashion, and technical judgments should be made on a site-specific basis. For chlorinated hydrocarbon remediation via chemical oxidation methods, the risk of a fire is reduced, since those compounds are not flammable. However, caution should be exercised in order to prevent the release or migration of quantities and concentrations of chlorinated vapors that may be harmful from a toxicological or environmental standpoint.

Florida Department of Environmental Protection

Memorandum

TO: Richard Deuerling, Mail Station 3530
Division of Water Facilities
Underground Injection Control Section
Florida Department of Environmental Protection
2600 Blair Stone Road, Tallahassee, FL 32399-2400

FROM: _____ (Note 1.)

DATE: _____

SUBJ: **Proposed Injection Well(s) for In Situ Aquifer
Remediation at a Petroleum Remedial Action Site**

Pursuant to Rule 62-528.630(2)(c), F.A.C, inventory information is hereby provided regarding the proposed construction of temporary injection well(s) for the purpose of in situ aquifer remediation at a petroleum-contaminated site.

Site name: _____
Site address: _____
City/County: _____
Latitude/Longitude: _____
FDEP Facility Number: _____

Site owner's name: _____
Site owner's address: _____

Well contractor's name: _____ (Note 2.)
Well contractor's address: _____

Brief description of the in situ injection-type aquifer remediation project:

Summary of major design considerations and features of the project:

Areal extent of contamination (square feet): _____
Number of injection wells: _____
Composition of injected fluid (Note 3)
(ingredient, wt. %): _____

Injection volume per well (gallons): _____
Single or multiple injection events: _____
Injection volume total (all wells, all
events): _____

Richard Deuerling
Page Two
Date: _____

Site name: _____
FDEP facility no.: _____

A site map showing the areal extent of the groundwater contamination plume, and the location and spacing of injection wells and associated monitoring wells is attached.

The following is a summary description of the affected aquifer:

Name of aquifer: _____

Depth to groundwater (feet): _____
Aquifer thickness (feet): _____

The injection well(s) features are summarized below, and/or a schematic of the injection well(s) is attached.

Direct-push or Conventional (*circle the appropriate well type*)

Diameter of well(s) (i.e., riser pipe & screen)(inches): _____

Total depth of well(s) (feet): _____

Screened interval: _____ to _____ feet below surface

Grouted interval: _____ to _____ feet below surface

Casing diameter, if applicable (inches): _____

Cased depth, if applic.: _____ to _____ feet below surface

Casing material, if applic.: _____

The in situ injection-type aquifer remediation plan for this petroleum contaminated site is intended to meet the groundwater petroleum cleanup criteria set forth in Chapter 62-770, F.A.C. Additionally, all other groundwater standards will be met at the time of project completion for any residuals associated with the ingredients of the injected remediation products, and any by-products or intermediates produced as a result of the chemical or biochemical transformation of those ingredients or the contaminating petroleum during their use. Applicable primary and secondary drinking water standards are set forth in Chapter 62-550, F.A.C., and additional groundwater quality criteria are set forth in Chapter 62-520, F.A.C.

The remediation plan estimates that site remediation will take _____ months. We will notify you if there are any modifications to the remediation strategy which will affect the injection well design or the chemical composition and volume of the injected remediation product(s).

The proposed remediation plan was approved on _____ by an enforceable approval order. A copy is attached. The remediation system installation is expected to commence within 60 days. Please call me at _____ if you require additional information.

Note 1. Local programs are not authorized to approve underground injections into aquifers. Reason: Per agreement with EPA, the FDEP cannot delegate this authority. Local programs, after reviewing a Remedial Action Plan or an injection proposal document, should follow the instructions in a March 16, 2000 memorandum to arrange for Department headquarters' execution of an approval order, and then complete this form. This form is primarily for use by state and local program technical reviewers, but petroleum remediation contractors may fill in all blanks except those labeled "FROM", "DATE", and "approval date", and "telephone number" blanks in the last paragraph. Those blanks should be completed only by a state or local program reviewer.

Note 2. If an injection well installation contractor has not yet been selected, then indicate the name and address of the project's general remediation contractor/consultant.

Note 3. Complete chemical analysis of injected fluid is required by Chapter 62-528, Florida Administrative Code. Proprietary formulations shall make confidential disclosure. Injected fluids must meet drinking water standards of Chapter 62-550, F.A.C., unless an exemption or variance has been granted.