

Department of Environmental Protection

Jeb Bush
Governor

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

Colleen M. Castille
Secretary

April 2, 2004

Mr. Rick Gillespie
Regenesis Bioremediation Products
3104 Kimble Drive
Plano, Texas 75025

Re: **Oxygen Release Compound (ORC)**

Dear Mr. Gillespie:

The Bureau of Petroleum Storage Systems hereby reaffirms its original July 20, 1997 acceptance of Oxygen Release Compound (ORC) as a product for in situ bioremediation of petroleum and other suitable contaminants in groundwater and soil. ORC is a magnesium peroxide-based product that slowly releases oxygen when wetted, for the purpose of accelerating the growth of microorganisms that biodegrade contaminants. This letter of reaffirmation supersedes the original July 20, 1997 letter of acceptance, and provides an update and clarification regarding regulations that pertain to zones of discharge for in situ, injection type aquifer remediation.

For vadose remediation where the underlying groundwater will not be affected by leaching of this product, there are no special concerns beyond those that 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 ORC into an aquifer, there are underground injection control (UIC) regulations that must be observed. Since in situ aquifer remediation via injection is likely to be the most common application of this product, the bulk of the regulatory requirements discussed herein will be directed to that topic.

The Bureau recognizes ORC as a viable product for the bioremediation 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 are observed when the product is used for injection-type, in situ aquifer remediation. For ORC, 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

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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 ORC's environmental acceptability. To aid those reviewers, the Bureau of Petroleum Storage Systems provides supplemental information as enclosure 2.

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) 877-1133, extension 29 if there are any questions.

Sincerely,

Rick Ruscito, P.E.
Ecology and Environment, Inc.
Bureau of Petroleum Storage Systems
Petroleum Cleanup Section 6

Rebecca S. Lockenbach
FDEP Section Leader
Bureau of Petroleum Storage Systems
Petroleum Cleanup Section 6

c: T. Conrardy - FDEP/Tallahassee

History:

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7/20/97

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ENCLOSURE 1

ENVIRONMENTAL AND REGULATORY INFORMATION

For ORC, the major environmental and regulatory concerns are listed below.

- a. Groundwater cleanup standards: The onus shall be on users of ORC to ensure that all applicable groundwater contaminant standards will be met at the time of project completion, for the contaminants of concern, any residuals associated with the ingredients of ORC, and any byproducts produced as a result of chemical or biochemical reactions involving those ingredients. 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.

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 ORC 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. The minimum groundwater criteria set forth in Chapter 62-777, F.A.C., also apply. Since an ORC slurry to be injected does not meet the secondary drinking water standard of 500 milligrams (mg/L) for total dissolved solids (TDS) and the secondary drinking water range of 6.5 to 8.5 for pH, it will be necessary to establish a temporary zone of discharge (ZOD) of specific size and duration, and to monitor the TDS concentration and pH level of the groundwater at each remediation site before and after ORC injection. In the case of ORC, there are two ways to establish a zone of discharge: the first way is to make use of an existing zone of discharge variance that was granted to Regenesi Bioremediation Products by the Florida Department of Environmental Protection on January 4, 1999; the second way is to make use of rule 62-522.300(2)(c), F.A.C., in order to establish a zone of discharge.

ZOD by variance. In the case of the temporary zone of discharge variance that was granted to Regenesi Bioremediation Products by the Florida Department of Environmental Protection on January 4, 1999, the size of the zone is a 20-foot radius around each injection point, and the duration of time for which TDS and pH may temporarily exceed their respective groundwater standards is one (1) year. The terms of the

variance require monitoring of total dissolved solids and pH in the groundwater at the remediation site to show that neither of these parameters was permanently affected by the injection of ORC. Within the 1-year zone of discharge period of duration, the TDS and pH must return to their respective secondary drinking water standards or their natural-occurring background levels at the site, whichever is less stringent. The zone of discharge variance granted to Regenesi Bioremediation Products by the Department on January 4, 1999 is still valid, even though a new rule added to the Florida Administrative Code in August 2001 eliminated the need for a variance in many but not all cases when reagents are injected into a contaminated aquifer for the purpose of remediation.

ZOD by rule: Effective August 27, 2001, rule 62-522.300(2)(c), F.A.C., provided for the establishment by rule, rather than by variance, a temporary zone of discharge for aquifer remediation. The rule did not completely eliminate the need for zone of discharge variances, but rather eliminated the need in many cases. The secondary drinking water parameters of TDS and pH, which are of concern when ORC slurry is injected, are covered by this rule. If a user of ORC for a particular remediation site prefers not to use the existing zone of discharge variance, which is still valid, but rather seeks the establishment of a temporary zone of discharge by rule 62-522.300(2)(c), F.A.C., then a Department-approved site-specific remediation plan proposing the injection of ORC must: (a) identify the secondary parameters pH and total dissolved solids, whose standards are exceeded by the composition of the fluid to be injected; (b) indicate the size and duration of the temporary zone of discharge; and (c) propose groundwater monitoring of TDS and pH, which do not meet their respective secondary drinking water standards in the slurry to be injected.

Clarification: There has been some confusion as to whether or not a variance granting a temporary zone of discharge is required when reagents are injected for the purpose of in situ aquifer remediation. To eliminate some of this confusion, the Bureau of Petroleum Storage Systems would like to indicate that rule 62-522.300(2)(c), F.A.C., effective August 27, 2001, eliminated the need for a variance in many but not all cases. Whether or not a variance is needed depends on the composition of the fluid to be injected. In the case of ORC, the rule applies. But since Regenesi Bioremediation Products already holds a variance that was granted in 1997, and is still valid, **users of ORC have the option of using either the existing variance or the rule to establish a temporary ZOD for the injection of ORC at the site of their remediation project.**

- 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 ORC. However, no "designated" monitoring well, dedicated to the tracking of remediation progress (by sampling) shall be used to apply ORC. 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: In the case of ORC, the secondary drinking water parameters for pH and total dissolved solids are not met by the fluid to be injected, so the monitoring of groundwater for those two parameters is necessary. It does not matter whether the user of the ORC chose to establish the temporary zone of discharge by way of rule 62-522.300(2)(c), F.A.C., or by making use of the existing zone of discharge variance. Either way, TDS and pH of the groundwater must be monitored.
- 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 3.
- g. Avoidance of migration: For in situ, injection-type aquifer remediation projects, injection of ORC shall be performed in such a way, and at such a rate and volume, that no undesirable migration of either the product's ingredients 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.
- 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 prescribing bioremediation.

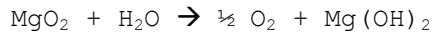
- a. Department of Environmental Protection reviewers of injection-type in situ aquifer remediation plans, regardless of whether in Tallahassee or district offices, must fill in the blanks on the enclosure 3 memorandum, whose subject is "Proposed Injection Well(s) for In situ Aquifer Remediation at a 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.

- b. Pilot study: For bioremediation, 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 at a site do not warrant a pilot study, then a proposal explaining the rationale for the decision not to perform 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.
- c. Bacteria: It is generally reported (on a total weight basis) that bacteria are approximately 70 to 80 percent water. On a dry weight basis, approximately 95 percent of the composition is represented by 5 elements: carbon, oxygen, nitrogen, hydrogen, and phosphorus. At a petroleum remediation site, it is intended that the source of carbon for the growth of bacteria will come from the petroleum hydrocarbons themselves. Natural-occurring organic carbon at a site can also serve as a carbon source for bacteria. Depending on site's specific conditions, the remaining four elements must either be available naturally, or added as macronutrients in order to stimulate bioremediation. Micronutrients must also be present for bacteria to grow.
- d. Degradation products: Carbon dioxide and water are the ultimate products of aerobic and most anaerobic biodegradations of hydrocarbons. In the case of methanogenesis, an anaerobic process, carbon dioxide and methane are produced. The intermediate products of aerobic degradation may include simple acids, alcohols, and fatty acids. Aerobic processes use oxygen as an electron acceptor to produce carbon dioxide and water.
- e. Parameters: The following parameters may be useful in determining the potential for bioremediation at a site, or whether bioremediation is already occurring. They were selected from a list that appears in the publication "In situ Treatment Technology" by E. Nyer et al., Lewis Publishers, 1996. The parameters are dissolved oxygen; redox potential; pH; temperature; specific conductance; volatile organic compounds; nitrate; nitrite; ammonia nitrogen; manganese (total and dissolved); iron

(total, dissolved, and ferrous); sulfate; sulfide; and total organic carbon. Gaseous parameters include carbon dioxide, oxygen, nitrogen, and methane. Other parameters that may be helpful are chemical oxygen demand, biochemical oxygen demand, and total organic carbon. Those who prepare bioremediation plans and their reviewers should determine which parameters, if any should be investigated on a site-specific basis.

- f. Chemical reactions: The overall chemical reaction that occurs when magnesium peroxide is mixed with water is shown below. This reaction shows that oxygen is liberated from magnesium peroxide in order to become available for the purpose of increasing the groundwater's concentration of dissolved oxygen. The notation used is as follows: magnesium peroxide, MgO_2 ; magnesium hydroxide, $\text{Mg}(\text{OH})_2$; water, H_2O ; and oxygen, O_2 .



Florida Department of
Memorandum Environmental Protection

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
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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.