



Department of Environmental Protection

Jeb Bush
Governor

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

David B. Struhs
Secretary

September 12, 2000

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

Re: **Hydrogen Release Compound (HRC)**

Dear Mr. Gillespie:

The Bureau of Petroleum Storage Systems hereby accepts Hydrogen Release Compound (HRC), as an innovative product, for the accelerated in situ bioremediation of groundwater at contaminated sites in Florida. As indicated by Regenesi, HRC is a non-toxic, food-grade polylactate ester, which upon introduction into an aquifer undergoes a transformation that produces hydrogen. In turn, the hydrogen serves as an electron donor in reductive chemical reactions involving the indigenous anaerobic microorganisms at a site. While the mission of this bureau is primarily the cleanup of groundwater and soil at sites contaminated by petroleum, rather than the cleanup of chlorinated solvents, which is expected to be the most common application of HRC, it is hereby acknowledged that HRC can play a role in reductive reactions. Such reactions include but are not limited to reductive dechlorinations, nitroaromatic reductions, and reductive dealkylations of ethers, sulfides, and amines.

There are no objections to the use of the HRC provided: (a) the considerations of this letter are taken into account; (b) a Remedial Action Plan is approved by the Department; and (c) the terms of a May 18, 1999 variance granted by the Department to Regenesi are observed. The terms of the variance -- which temporarily allows a zone of discharge where the secondary drinking water standards for pH, total dissolved solids, color, and in some cases chlorides may be exceeded -- are summarized in enclosure 1. The enclosure also includes a list of environmental and regulatory considerations.

The following chapters of the Florida Administrative Code (F.A.C.) are cited as pertinent, as portions of them are applicable to the use of HRC: 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; and Chapter 62-528, F.A.C., for underground injection control, particularly Part V, for Class V, Group 4 aquifer remediation wells. Please note that 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 also constitutes the granting of a Class V injection well permit.

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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.

Preparers of Remedial Action Plans are advised to 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 the Department of Environmental Protection has determined the environmental acceptability of this product. To aid those reviewers, supplemental information is provided in enclosure 2.

The Department reserves the right to revoke its acceptance of a product or process if the nature or composition of its ingredients, or its 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.

Questions regarding petroleum applications of HRC may be directed to Rick Ruscito in the Bureau of Petroleum Storage Systems at (850) 487-3299. Questions about non-petroleum applications may be directed to the Bureau of Waste Cleanup at (850) 488-3935.

Sincerely,

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

enclosures (3)

c: George Heuler - UIC, FDEP/Tallahassee
Tom Conrardy - BPSS, FDEP/Tallahassee

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ENCLOSURE 1

HYDROGEN RELEASE COMPOUND (HRC): ENVIRONMENTAL AND REGULATORY INFORMATION

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

- a. Groundwater cleanup standards: The onus shall be on users of HRC to ensure that all applicable groundwater contaminant standards will be met at the time of project completion. This includes the contaminants of concern, any residuals associated with the injected HRC, and any by-products produced as a result of chemical reactions. 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.
- b. Groundwater injection standards: For in situ aquifer remediation, the composition of the injected fluid must meet the drinking water standards set forth in Chapter 62-550, F.A.C., pursuant to underground injection control Rule 62-528.600(2)(d), F.A.C. Additionally, any non-regulated substances injected must meet the minimum criteria for groundwater as defined in Rule 62-520.400(1), F.A.C. If the fluid does not meet these injection requirements, then it will be necessary to obtain a variance.
- c. Variance summary: A May 18, 1999 variance granted to Regenesys is for an exemption from Rule 62-522.300(2)(a), F.A.C., in order to create a 20 foot zone of discharge in the aquifer around each injection point. Within this zone of discharge, a temporary departure from the secondary drinking water requirements set forth in Chapter 62-550, F.A.C., will be tolerated for a period of time not to exceed one (1) year for pH, total dissolved solids, color, and chloride. By the end of the 1-year period, the groundwater must meet the required values for these parameters, or the natural-occurring background value for each of them at a given remediation site, whichever is less stringent. The current secondary standards for these parameters are as follows: pH, range 6.5 to 8.5; total dissolved solids, 500 milligrams per liter (mg/L), maximum; color, 15 color units, maximum; and chloride, 250 mg/L, maximum.

The variance granted by the Department is a general variance, which may be applied to each site-specific HRC Remedial Action Plan submitted hereafter. Regenesys does not have to petition for a new variance each time HRC is proposed for the remediation of a site, provided there is no deviation from the terms of the variance.

- 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 injection of HRC. However, no "designated" monitoring well, dedicated to the tracking of remediation progress (by sampling) shall be used for injection. 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 designated tracking well.

- e. Groundwater monitoring: As in any remediation effort, the actual petroleum and/or non-petroleum contaminants of concern are to be monitored in accordance with applicable rules and regulations. Several aspects of monitoring are discussed below.
 - 1. Active remediation monitoring: 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 petroleum contaminated sites, or in accordance with the provisions of an approved Remedial Action Plan for non-petroleum sites, whichever applies. The selection of designated monitoring wells shall be of sufficient quantity to demonstrate remediation of the aquifer.
 - 2. Post active remediation monitoring: At least one (1) year of quarterly post active remediation groundwater monitoring for contaminants of concern shall be conducted at a minimum of two (2) wells, one located in the area of maximum contamination, the other downgradient of the area of maximum contamination. (For specific information about post active remediation monitoring at petroleum contaminated sites, please refer to Section 62-770.750, F.A.C.)
 - 3. Underground injection control monitoring: The Department, for underground injection control purposes, has determined that groundwater sampling, before and after injection, shall be conducted when HRC is injected into an aquifer. The variance granted May 18, 1999 requires that pH, total dissolved solids, color, and chloride in the case of chlorinated solvent cleanups, be measured before and after injection, for comparison to their secondary drinking water standards set forth in Chapter 62-550, F.A.C., or a cleanup site's natural-occurring background values, whichever is less stringent.

For the measurement of pre-injection background values, at least one (1) monitoring well located upgradient of the contamination plume, or at least one (1) non-upgradient monitoring well, located beyond the edge of the plume, shall be sampled and analyzed. If more than one well is sampled, then the average value can be used as the background value for the site.

For the post injection sampling of pH, total dissolved solids, color, and chloride in the case of chlorinated solvent cleanups, the groundwater downgradient of the injection points shall be sampled. The Bureau of Petroleum Storage Systems also suggests the sampling of one or more wells located in the central region of the injection points, where the deviation of these four parameters from their respective standards are likely to be highest. As post injection sampling indicates that the value of a parameter meets its respective drinking water standard, or natural-occurring background value, then the measurement of that parameter may be reduced in frequency or discontinued.

- 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. Operation:
1. Avoidance of migration: Injection of HRC shall be performed in such a way, and at such a rate and volume, that no undesirable migration of either the HRC or the contaminants already in the aquifer occurs, pursuant to Rule 62-528.630(3), F.A.C.
 2. Underground injection control operating permit: Although an operating permit is not required for aquifer remediation wells pursuant to Rule 62-528.640(1)(b), and 62-528.640(1)(c), F.A.C., since no movement of the contamination plume is expected to accompany HRC injection, the Department requests that the information items listed in Rule 62-528.640(1)(b), F.A.C., be considered and included in Remedial Action Plan proposals as a matter of good and thorough design practice. Briefly summarized, they are: quality of water in the aquifer; quality of the injected fluid; existing and potential uses of the affected aquifer; and well construction details. Additionally, each Remedial Action Plan should clearly indicate the total amount of HRC that will be injected.
- h. Abandonment of wells: Upon issuance of a 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 list.

ENCLOSURE 2

HYDROGEN RELEASE COMPOUND (HRC): SUPPLEMENTAL INFORMATION

The information below, compiled from various sources, may be helpful to reviewers of Remedial Action Plans prescribing HRC. It is provided as information only and should not be construed as absolute, nor should it be used as a substitute for technical judgments that should be made on a site-specific basis.

- a. UIC Notification: Department of Environmental Protection reviewers of in situ injection-type 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 Contaminated Site". The completed form must be submitted to the Underground Injection Control Section at 2600 Blair Stone Road, Tallahassee, Florida 32399-2400.

Local governments contracted by the Department to conduct technical reviews of petroleum Remedial Action Plans and Remedial Action Plan Modification proposals are instructed to follow the March 16, 2000 instructions for approval of such documents, and for submittal of the above memorandum. The March 16, 2000 instructions are included in the Bureau of Petroleum Storage Systems guidance package BPSS-10, titled "In Situ Chemical Additives for Petroleum Remediation", at web page address [/www.dep.state.fl.us/dwm/programs/pcp/geninfo/active.htm](http://www.dep.state.fl.us/dwm/programs/pcp/geninfo/active.htm).

- b. Chemical name: The Material Safety Data Sheet from the manufacturer indicates that the trade name for the polylactate ester found in HRC is glycerol tripolylactate. The chemical name for it is propanoic acid, 2-[2-[2-(2-hydroxy-1-oxopropoxy)-1-oxopropoxy]-1-oxopropoxy]-1,2,3-propanetriyl ester.
- c. Strategies: HRC can be applied in a grid-based design to remediate an entire groundwater contaminant plume, or in a barrier-based design to prevent migration of contaminants from a source area. It is anticipated that the most common use of HRC will be for in situ remediation of contaminants, although from a theoretical standpoint there appears to be no reason to define it as strictly an in situ remediation strategy.
- d. Method of application: The preferred method of application of HRC is via direct-push methods, although it is possible to pump this relatively viscous material into a well. It is reported to have a viscosity of approximately 20,000 centipoise. A comparison of its viscosity to cold honey is frequently used for visualization. The manufacturer, however, advises against dilution of HRC for the purpose of reducing its viscosity prior to application. Additionally, the manufacturer recommends that any air that is present in direct-push drive rods first be displaced by either water or glycerol before injecting HRC, in order to avoid injection of air into the aquifer.
- e. Dosage: The manufacturer provides software that assists in determining the dosage of HRC to be used at a site. The major factors taken into account are the mass of dissolved and sorbed contaminants, consumption of

HRC by competing electron acceptors, a microbial demand factor, and an additional demand (safety) factor. For information purposes, as a rule-of-thumb, the dosage per injection point typically ranges from 4 to 10 pounds per foot.

- f. Competing electron acceptors: If competing electron acceptors such as oxygen, nitrate, manganese, iron, and sulfate are present at a site to be remediated by HRC, then it will first be necessary to supply enough HRC to drive the site to anaerobic conditions. The design software provided by the manufacturer takes this into consideration.
- g. Injection spacing: As a rule-of-thumb, the horizontal spacing of HRC injection points generally ranges from 5 to 15 feet-on-center, but it is preferable to use site specific information whenever possible, taking into account groundwater velocity, permeability, and the amount of HRC required to remediate the contaminants. The vertical extent of HRC application for each injection point should be commensurate with the entire vertical contaminated saturated thickness.
- h. Pilot tests: Pursuant to Rule 62-770.700(2), F.A.C., a pilot study shall be performed when a bioremediation or innovative technology is proposed for the cleanup of a petroleum-contaminated site, 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 for the decision not to perform a pilot study shall be submitted for review, pursuant to a provision of that same rule.
- i. Density: HRC is reported to have a density of 1.3 grams per cubic centimeter, which is equivalent to approximately 11 pounds per gallon.
- j. Additional information: Regenesys' web site can be found at www.regenesys.com.

Memorandum**Florida Department of
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.