

May 4, 1999

Mr. Terry Adair
Perix Industries
100 Canterbury Circle
Niceville, Florida 32578-4412

Re: Bacto-Zyme

Dear Mr. Adair:

The Bureau of Petroleum Storage Systems hereby accepts Bacto-Zyme as a product for both in situ and ex situ bioremediation of soil and groundwater at petroleum contaminated sites in Florida. This product was originally recognized by the bureau as an innovative technology on April 23, 1997 under the name of FyreZyme, and it is also listed by the United States Environmental Protection Agency (EPA) on the National Contingency Plan product schedule. Enclosure 1 is a copy of an October 4, 1991 EPA acknowledgment regarding Bacto-Zyme. It is our understanding that the current source of the product is International Enzymes Incorporated, 1706 Industrial Road, Las Vegas, Nevada 89102.

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, Florida Administrative Code (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 injection of products 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 Bacto-Zyme 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 in situ remediation.

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. Vendor's must then market the products and processes on their own merits

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regarding performance, cost, and safety in comparison to competing alternatives in the marketplace. For Bacto-Zyme, the major environmental and regulatory considerations are set forth in enclosure 2.

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 you have contacted the Department of Environmental Protection in regard to Bacto-Zyme. To aid those reviewers, the Bureau of Petroleum Storage Systems provides supplemental information as enclosure 3.

The Department reserves the right to revoke its acceptance of any product or process if the nature or composition of either or any of its principal and proprietary 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. You may contact me at 850/487-3299 if there are any questions.

Sincerely,

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

c W. Evans - FDEP/Tallahassee
 T. Conrardy - FDEP/Tallahassee

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

OCT 4 1991

FICE OF
AND EMERGENCY RESPONSE

OF-
SOLID WASTE

Mr. Peter K. Condry
Chief Executive Officer
Global Marine Technologies, Inc.
6119 East Star Valley Street
Mesa, Arizona 82505

Dear Mr. Condry:

Thank you for your letter of October 1, 1991, in which you sought to include your product Fyre-Zyme on the National Contingency Plan (NCP) Product Schedule.

Your letter states that Fyre-Zyme is also known as Bacto-Zyme, a biological additive currently listed on the NCP Product Schedule. Also, information submitted by you and the manufacturer of Bactozyme states that these products are identical in composition. Based on this information and the original listing of Bactozyme, the Environmental Protection Agency (EPA) will not require a separate listing for your product. The NCP Product Schedule has been changed to reflect that Bactozyme may also be referred to as Fyre-Zyme. The On-Scene Coordinator may authorize the use of the biological additive on releases of oil to the navigable waters of the United States on a case-by-case basis.

As long as the composition, formulation, and handling procedures of Fyre-Zyme remain the same as Bactozyme, your product meets the data submission requirements contained in Section 300.915 of Subpart J of the NCP (40 CFR Part 300), as amended March 8, 1990. You are required to notify EPA of any changes in composition, formulation, or handling procedures for your product. Please be advised that EPA may require retesting of the product for a separate listing if any changes occur.

The listing of Fyre-Zyme on the NCP Product Schedule does not constitute approval, certification, authorization, licensing, or promotion of the product; nor does it imply compliance with any criteria or minimum standards for such agents. Therefore, to avoid possible misinterpretation or misrepresentation, any label, advertisement, or technical literature that refers to the product as being on the NCP Product Schedule must either reproduce in its entirety this letter of notification, or include the disclaimer provided in Section 300.920(e) of Subpart J.

Failure to comply with these restrictions or any improper reference to EPA in an attempt to demonstrate approval or acceptance of the product will constitute grounds for removal of the product from the Schedule.

If you have any questions concerning this letter, please contact Gail Thomas in the Emergency Response Division at (202) 260-9056.

Sincerely,

Henry L. Longest, II
Director
Office of Emergency and Remedial Response

ENCLOSURE 2

BACTO-ZYME: ENVIRONMENTAL AND REGULATORY INFORMATION

For Bacto-Zyme, the major environmental and regulatory concerns are discussed below. Please note that some references below to specific rules and sections within Chapter 62-770, F.A.C., may differ from those of the original acceptance letter dated April 23, 1997 for FyreZyme (a.k.a. Bacto-Zyme), because Chapter 62-770, F.A.C., has since been revised.

Please also note that while the format of this acceptance letter may differ from that of the original acceptance, the regulatory requirements are unchanged, with exception of the department's determination in regard to underground injection control monitoring of Bacto-Zyme pursuant to Rules 62-528.615(1)(b)1 and (2), F.A.C. The Bureau of Petroleum Storage Systems now believes that its original determination to require monitoring of nitrate, nitrite, and pH may have been too stringent and now reverses that decision. Reason: Although the Bacto-Zyme injection fluid is not processed through a permitted drinking water facility, it does meet the intent of Rule 62-528.615(1)(b)1, F.A.C., which is that an injection fluid meet the primary and secondary drinking water requirements and the minimum groundwater criteria.

And although there have been no changes to injection control regulations regarding recirculating loop-type injection systems since the original acceptance in April 1997, a discussion of the topic is now included below in response to increased interest in this remediation method during the past two years.

- a. Applicable rules and regulations: The onus shall be on International Enzymes Incorporated, Perix Industries, and users of Bacto-Zyme to observe all applicable regulations, particularly those regarding underground injection control and groundwater quality. All applicable groundwater contaminant standards shall be met at the time of project completion for the contaminants of concern, any residuals associated with the ingredients of Bacto-Zyme, 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 as applicable but should not be construed as an exhaustive list: 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; and Chapter 62-770, F.A.C., for petroleum cleanup criteria.

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 which 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 injection-type aquifer remediation constitutes the granting of a Class V injection well permit.
- c. Groundwater injection standards: For in situ aquifer remediation, the composition of an 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. For Bacto-Zyme (which is shipped in a concentrated form with pH of approximately 3.5 to 4.5, and diluted with water in volumetric ratios of approximately 20:1 and greater prior to injection) no exceedance of the primary or secondary drinking water standards, including pH, is expected. At these dilution ratios, it is expected that the pH of the resulting injection mixture will meet the secondary drinking water standard, which is an allowable range from 6.5 to 8.5. However, if there is ever a situation in which injection of a more concentrated form is desired, then it should be first ascertained that the pH of the solution meets the requirement, and that no other drinking water standard, either primary or secondary, or the minimum groundwater criteria, will be exceeded. The original April 23, 1997 acceptance of Bacto-Zyme, under the name FyreZyme, indicated that application as a 6% solution (i.e., a volumetric dilution ratio of 16:1) would not result in exceedance of drinking water standards.

If the injection of a more concentrated solution is desired, and will result in exceedance of a secondary drinking water parameter, then you should petition the department for a variance, to create a zone of discharge in which a temporary exceedance may be tolerated while the site is under remediation. If such a situation should ever arise, then a variance must be obtained prior to injection.

For injections of a more concentrated solution, in which a federal primary drinking water standard such as nitrate or nitrite could be exceeded, there is no regulatory relief available from the Florida Department of Environmental Protection to temporarily permit such an injection, even though the injection may be beneficial to an already contaminated aquifer. In this case, a federal exemption would be required.

In the event that injection of other substances such as nutrients or microorganisms into an aquifer is contemplated as part of a site remediation plan prescribing Bacto-Zyme, then they too must meet all applicable rules and regulations as discussed in paragraph (a) above.

- d. Recirculating loop-type injections: The Bureau of Petroleum Storage Systems has no objection to the use of Bacto-Zyme in any type of equipment configuration, provided all applicable and appropriate rules and regulations are observed. System configurations may include direct one-time injection of the product, or recirculating loop-type injections in which contaminated groundwater is recovered, combined with the product above ground, and either partially or totally treated above ground prior to

reinjection into the contaminated zone of a site.

In the case of Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and Resource Conservation and Recovery Act (RCRA) site cleanups, the United States Environmental Protection Agency's (EPA) Office of Solid Waste and Emergency Response, through OSWER Directive No. 9234.1-06, indicates that contaminated groundwater which has been partially treated may be reinjected under certain conditions. The conditions are as follows: (1) the injection is a CERCLA response action or RCRA corrective action; (2) the contaminated groundwater is treated to substantially reduce hazardous constituents prior to each injection; and (3) the response action or corrective action is sufficient to protect human health and the environment upon completion.

For non-CERCLA and non-RCRA cleanup sites, which typically include gasoline stations and dry cleaners, the EPA's directive does not apply. In these cases, in order to operate a recirculating loop-type injection system without violating underground injection control regulations, it will be necessary to totally treat recovered groundwater (above ground) to applicable water quality standards prior to reinjection as a mixture with Bacto-Zyme for in situ remediation. While this may not be as cost-effective as a partial treatment system, it still offers a cost-effectiveness advantage over conventional pump-and-treat systems. Nevertheless, the Bureau of Petroleum Storage Systems encourages the use of the "total treat" approach until changes in rules and regulations allow only a partial treatment prior to reinjection of groundwater at non-CERCLA and non-RCRA sites.

e. 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 Bacto-Zyme. However, no "designated" monitoring well, dedicated to the tracking of remediation progress (by sampling), shall be used to apply Bacto-Zyme. 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.

f. Groundwater monitoring:

1. Active remediation petroleum monitoring: During the period of active remediation, groundwater shall be monitored for contaminants of concern in accordance with the requirements set forth in Section 62-770.700, F.A.C. Two noteworthy rules within that section are 62-770.700(3)(i), F.A.C., for frequency of sampling, and 62-770.700(5)(f), F.A.C., which requires a sampling schedule for bioremediation. For non-petroleum cleanups, the monitoring should be conducted in accordance with the provisions of an approved Remedial Action Plan.
2. Post remediation petroleum monitoring: At least one (1) year of quarterly post remediation groundwater monitoring for contaminants of concern shall be conducted at a minimum of two (2) wells, one located in the area of maximum petroleum contamination, the other downgradient of the area of maximum petroleum contamination, pursuant to 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. Underground injection control monitoring: Since the injected Bacto-Zyme (which is diluted with water in volumetric ratios of approximately 20:1 and greater prior to injection) does not exceed

any primary or secondary drinking water standards, the department, pursuant to underground injection control Rules 62-528.615(1)(b)1 and (2), F.A.C., has determined that no monitoring of its ingredients for the purposes of underground injection control is necessary.

- g. Background samples: Prior to commencement of in situ injection-type aquifer remediation projects, the department recommends the sampling of at least one (1) monitoring well located upgradient of the petroleum contamination plume, or at least one (1) non-upgradient monitoring well, located beyond the edge of the plume, for the background concentration of selected key bioremediation parameters. If more than one well is sampled, then the average value of each parameter can be used as the background value for the site.
- h. 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.
- i. Operation:
 - 1. Avoidance of migration: For in situ injection-type aquifer remediation projects, injection of Bacto-Zyme 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.
 - 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 petroleum contamination plume is expected to accompany the Bacto-Zyme treatment process, 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 volume of fluid and the concentration of products that will be injected.
 - 3. Operating parameter measurements: Rule 62-770.700(9)(h), 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.
- j. 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 3

BACTO-ZYME: SUPPLEMENTAL INFORMATION

The information below, compiled from several sources, may be helpful to reviewers of Remedial Action Plans prescribing bioremediation.

- a. Nature of the product: Bacto-Zyme does not contain bacteria. Instead, it is a formulation which stimulates activity of indigenous bacteria already present at a petroleum or hydrocarbon contaminated site. If sufficient oxygen is not present at a site for biodegradation, then it may be added artificially, either by air sparging, magnesium peroxide, or other suitable means.
- b. 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 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 reviewers within the Department and its district offices may approve in situ injection-type remediation plans in which the approval constitutes the issuance of a Class V injection permit; local programs are not authorized to grant such approvals. Reason: The reason: although an arrangement between the US 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. Injection approval instructions to the local programs can be found in the Bureau of Petroleum Storage Systems guidance document BPSS-10 for in situ chemical additives at web page www2.dep.state.fl.us/waste/programs/pcp/remediation/index.htm.

- c. Pilot study: For bioremediation, per rule 62-770.700(2), 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 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. In some cases, only a biotreatability test may suffice. In other cases, perhaps only a sampling of the site for parameters indicative of bioremediation could serve in lieu of a pilot test, to show that some bioremediation is already occurring naturally and that the site is therefore conducive to enhanced bioremediation.
- d. 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. Naturally-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.

- e. 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.
- f. 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. Preparers of bioremediation plans and their reviewers should determine which parameters, if any, should be investigated on a site specific basis.
- g. Dosage and application: Information accompanying the submittal of Bacto-Zyme literature from Perix Industries indicates that the product is typically diluted with water in volumetric ratios of 20:1 or greater. This is roughly in keeping with the original acceptance, which indicated typical applications of a 6 percent solution (by volume) which is equivalent to a 16:1 volumetric dilution of the concentrate. The bureau therefore assumes that the amount of product needed to remediate a given volume of contaminated aquifer or soil to be roughly the same as in the original acceptance: approximately 1 gallon of concentrate per 8 cubic yards of contaminated media. This information is provided for rule-of-thumb purposes only. The actual amount applied at any given site will depend on site conditions and the mass of contaminants present.

**Florida Department of
Memorandum**

Environmental Protection

TO: Richard Deuerling
Division of Water Facilities
Bureau of Resource Protection
Underground Injection Control Section

FROM: _____ (Local programs
_____ see Note 1.)

DATE: _____

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

This is to notify you of proposed injection well(s) construction for the in situ remediation of ground-water at a petroleum contaminated site. The following is a description of the site location.

Name: _____
Address: _____
City/County: _____
Latitude/Longitude: _____
FDEP Facility Number: _____

The design of the injection-type aquifer remediation system consists of the following:

Areal extent of contamination (square feet): _____
Number of injection wells: _____
Composition of injected fluid (See note 2)
(ingredient, wt. %): _____

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

Note 1. Local programs are not authorized to approve underground injections into aquifers. Reason: The Department, per agreement with EPA, has been delegated this authority but is not allowed to delegate it any further. Local programs should arrange with either Department district offices or Department headquarters to approve such injections after reviewing the Remedial Action Plan.

Note 2. Complete chemical analysis of injected fluid is required by Chapter 62-528, Florida Administrative Code (no exceptions). 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.

Richard Deuerling
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Date:_____

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

Excerpts from the remedial action plan which describe the site lithology are attached. The following is a summary description of the affected aquifer:

Name of aquifer:_____
Depth to groundwater (feet):_____
Aquifer thickness (feet):_____

A schematic of the injection well(s) is attached. The following is a summary:

Depth of well (feet):_____
Screened interval:_____ to _____ feet below surface
Well casing diameter (inches):_____
Bore hole diameter:_____
If direct-push type well(s), describe
diameter (inches):_____ and depth (feet):_____

The in situ injection-type aquifer remediation plan for this petroleum contaminated site is a design 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 byproducts 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 remedial action plan estimates that the 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 system was approved on _____ by a Remedial Action Plan Approval Order (or other enforceable document) signed by the Director of the Division of Waste Management (copy attached). The remediation system installation is expected to commence within 60 days. Please call me at _____ if you require any additional information.