Department of
Environmental Protection

Jeb Bush
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David B. Struhs
Secretary

January 23, 2003

Mr. Dave Twaits
O_2 Tube Technology, Inc.
711 West Main Street
Batavia, Illinois 60510

Subject: O_2 Tube Technology

Dear Mr. Twaits:

The Bureau of Petroleum Storage Systems hereby accepts O_2 Tube Technology as a product for in situ remediation of petroleum and other suitable contaminants in groundwater and soil. Although this acceptance applies only to the jurisdiction of this Bureau, other Bureaus within the Department of Environmental Protection, or other state agencies and local governments may choose to recognize it if their needs and regulations are similar. This Bureau, however, is not responsible for applications beyond its jurisdiction.

The Bureau recognizes O_2 Tube Technology 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 and (b) a Remedial Action Plan is prepared in accordance with Chapter 62-770, Florida Administrative Code (F.A.C.), for approval by the Department. Please note that the use of nutrients, buffers or other augmenting substances with O_2Tube Technology must be in accordance with Chapter 62-528, F.A.C., for underground injection control, particularly Part V, for Class V, Group 4 aquifer remediation projects. The augmenting substances, depending on their chemical composition, may be subject to Rule 62-522.300(2)(c), F.A.C., and may also require the granting of a variance from Rule 62-522.300(3), F.A.C., before they can be injected. If microorganisms are to be added, these bacteria must be non-pathogenic and preferably not engineered. Please see Enclosure 1 for additional environmental and regulatory considerations.

As you indicated in your literature, O_2Tube Technology utilizes electrolytic cells placed downwell (minimum of 4" diameter well) to dissociate water into oxygen and hydrogen. The water enters the O_2Tube from the bottom passing through the O_2Tube Electrolysis Section where oxygen bubbles form on the anode plates. The O_2Tube Pneumatic draft pump re-circulates the water (moving the oxygen into solution in the groundwater). The hydrogen is off-gassed through a vent pipe. The control and air panels each require a 110-volt, single-phase outlet fed by 10 amp circuit breakers. Enclosure 2 contains additional information about the O_2Tube Technology that the Bureau would like to pass along to the readers of this letter.

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 acceptance

letter be construed as Department certification of performance. Additionally, the Department emphasizes a distinction between its regulatory "acceptance" and approval. Products and processes are accepted but they are not approved.

Also, it is not a requirement that a particular remediation product or process have an official acceptance letter in order for it to be proposed in a site-specific Remedial Action Plan. The plan, however, must contain sufficient information about the product or process to show that it meets all applicable and appropriate rules and regulations, especially those of the Florida Administrative Code.

Those who prepare 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 to inquire about the environmental acceptability of O_2 Tube Technology. 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 a Remedial Action Plan. You may contact me at 850/877-1133 ext. 29 if there are any questions.

Sincerely,

Dona J. Milinkovich, Ph.D.
Ecology and Environment, Inc.
Bureau of Petroleum Storage Systems
Petroleum Cleanup Section 6

Rebecca Marx
FDEP Section Leader
Bureau of Petroleum Storage Systems
Petroleum Cleanup Section 6

/djm

enclosures

c: R. Ruscito, P.E. - FDEP/Tallahassee
T. Conrardy, P.E. - FDEP/Tallahassee

ENCLOSURE 1

O_2TUBE TECHNOLOGY: ENVIRONMENTAL AND REGULATORY CONSIDERATIONS

For O_2Tube Technology applications, the major environmental and regulatory considerations are listed below.

1. Addition of Nutrients, Buffers, or Bacteria: This acceptance is based on use of O_2Tube Technology only. If bacteria are used to augment existing microbial populations, that bacteria must be non-pathogenic and preferably not genetically engineered. If nutrients and/or buffers, etc. are to be injected they must meet the underground injection standards of 62-528, Florida Administrative Code and a variance may be required.

2. Groundwater cleanup standards: The onus shall be on users of O_2Tube Technology to ensure that all applicable groundwater standards will be met at the time of project completion, for petroleum, other contaminants that may be present, any residuals associated with the ingredients of O_2Tube Technology, 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, and minimum criteria; 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., also for minimum groundwater 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.

3. 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 as application wells for O_2Tube Technology (provided well construction meets O_2Tube Technology requirements for application wells). However, no “designated” monitoring well, dedicated to the tracking of remediation progress (by sampling) shall be used as an application well. 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.

4. Pilot study:

   A. 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. For state funded projects, reviewers are encouraged to use judgment in balancing cost and the need for technical information to be obtained from a pilot study.

B. Parameters: The following parameters may be useful in determining the potential for bioremediation at a site, or whether bioremediation is already occurring. These parameters 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 preparing bioremediation plans and their reviewers should determine which parameters, if any, should be investigated on a site-specific basis.

5. Groundwater monitoring:

   A. Active remediation petroleum monitoring: During the period of active remediation, groundwater shall be monitored 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.
   B. Post remediation petroleum monitoring: At least one (1) year of quarterly post remediation groundwater monitoring shall be conducted at a minimum of two (2) wells, one located in the area of maximum petroleum contamination, the other down-gradient of the area of maximum petroleum contamination, pursuant to Section 62-770.750, F.A.C.

6. Operation:

   A. 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.
   B. Safety: The onus shall be on users of O_2Tube Technology to ensure that all applicable codes and regulations governing electrical and wiring safety and flammable and combustible liquids are followed.

7. Cleanup time: The Bureau of Petroleum Storage Systems suggests that users take site-specific conditions and Florida's cleanup target levels into account when estimating the amount of time needed to complete a cleanup in order to avoid an underestimate.

8. 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. If O2 Tube Technology was augmented by the injection of nutrients, buffers or microorganisms during the remediation effort, then 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

ADDITIONAL INFORMATION ABOUT O_2TUBE TECHNOLOGY

1. Configuration: The down-hole unit consists of a small draft pump and a single electrolytic cell. The unit is controlled with an aboveground controller and air pumps that operate on standard 110/220 voltages. Average energy use in one case study was 1.5 volts and 1.0 amps direct current (single unit). The use of multiple cells (units) per application well is being tested.

2. Down-hole Electrolytic Unit: The down-hole unit consists of a vertical assembly that draws in water in through the bottom of the tube with a re-circulation/draft pump that moves the water upward through an electrolytic cell that dissociates water into hydrogen (anode plates) and oxygen (cathode plates) and allows the release of the DO enriched water back into the surrounding substrate. The hydrogen is off-gassed through a vent tube. The typical 3-inch model produces 0.6 L of oxygen per approximately 2 amps each hour. The pneumatic draft pump is designed to create the low head (1.5 inches water) and high flow (50 gph) required for re-circulation in tight soils.

3. Application Wells: The application well(s) should be at least 4 inches in diameter with #10 slotted PVC or stainless screen. The well should be screened at least 5 ft. above and 15 ft. below current water tables. Sand packs and grouting should be per Florida's standards. O_2Tubes require that all application wells be properly vented to a safe location using a 1.25 inch (minimum) PC vent pipe. A draft of air at 20 PSI created by the pump evacuates any excess hydrogen safely. Testing for LEL (Lower Explosion Limit) using a combustion meter produces no greater that 20% LEL regardless of number of cells, depth of tube or lithology. The number and location of application wells is determined based on contaminant concentration, area of contamination, ground water flow, depth and lithology.

4. Controller: The control and air panels each require a 110-volt, single-phase outlet fed by 10 amp circuit breakers. The controller includes an AC to DC power converter and regulator with a built in programmable timer, voltage meter and amperage meter. Each unit is capable of operating four (4) electrolytic cells simultaneously and continuously. One air station containing 1/3 HP air pump and airflow rotometers provides for simultaneous and continuous operation of four cells. The O_2Tubes' power requirements average between 2 and 4 amps per tube depending on contaminant concentration, area of influence, and DO requirements.

5. Oxygen Generation: DO concentration was measured above 15 parts per million (ppm) in the O_2Tube application wells. Elevated concentrations (increase of 2-4 ppm) were measured in wells more than 25 feet away from the application well. One case study shows an increase in DO from 0.5 ppm to 2.0 ppm in tight clay (10^{-5} ft/day) over a 700 ft^2 horizontal groundwater area (10 ft. up-gradient, 12 ft. side-gradient and 20 ft. down-gradient) in less than 100 days.

6. Microbes: Indigenous microbial population counts increased in both the application wells and perimeter wells. In one case study using O_2Tube Technology to remediate tight clay, bacterial counts went from 10^3 #/ml to 10^7 #/ml over a six month period.

7. Water Quality Conditions: An absorption sock filled with activated carbon may be used to limit the amount of "other" materials entering the unit. In one case study the amount of dissolved road salts entering the unit was minimized thereby reducing the amount of

chlorine formed during dissociation. Groundwater should be tested for salts, iron, redox, bacterial counts, DO and pH. Salt information will determine whether a carbon filter sock is recommended. The iron, redox, DO and bacterial counts are used to estimate oxygen usage or if bacteria should be augmented into the site

8. Safety: All Electrical wiring and electrical utilization equipment shall be of a type specified by and shall be installed in accordance with NFPA 70, National Electrical Code. Outlet is Class 1, Div. 1 within 18 inches of well and Class 1, Div. 2 if 18 inches above ground level and/or within 20inches in all directions horizontally.

   Vents shall be not less than 12 ft. (3.6m) above adjacent ground level, with outlets so directed and located that flammable vapors will not accumulate or travel to an unsafe location or enter buildings. Within 3 ft. of vent opening is Class 1, Div. 1 and from 3 to 5 ft. is Class 1, Div. 2.

   With respect to the generation of pure oxygen and hydrogen by the O2 Tube electrolysis cell, the literature provided by O_2 Tube Technology recommends meeting the requirements under NFPA 30 (Flammable and Combustible Liquids Code). The O2 Tube draft pump uses air as a driving force that will sweep the space in the well above the groundwater level out a vent pipe. Note that all application wells must be vented.

   The provides a reminder that the onus shall be on the user regarding the safety precautions utilized when the O_2 Tube Technology is used at remediation sites in Florida.