

Florida Department of Environmental Protection

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Tallahassee, Florida 32399-2400

Charlie Crist
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Michael W. Sole
Secretary

May 23, 2008

Robert Moncrief
H₂O Engineering, Inc.
189 Granada Drive
San Luis Obispo, California 93401

Re: In Situ Chemical Oxidation with Ozone, Air and Oxygen (ISCO OAO)

Dear Mr. Moncrief:

The Division of Waste Management (the Division) hereby accepts In Situ Chemical Oxidation with Ozone, Air and Oxygen (ISCO OAO) by H₂O Engineering Incorporated as a system for the remediation of petroleum, chlorinated hydrocarbons and other suitable contaminants in groundwater and soil. The system components are configured such that three types of output to a subsurface sparging system are possible: (1) a mixture of ozone and air; (2) 90% oxygen; or (3) just air. The ozone/air mixture is for destruction of contaminants by chemical oxidation, while oxygen and air are for bioremediation. There are no objections to the use of ISCO OAO for the remediation of contaminated sites in Florida, provided a site-specific Remedial Action Plan is approved by the Department. Regulatory information is provided in Enclosure 1, and supplemental information is provided in Enclosure 2.

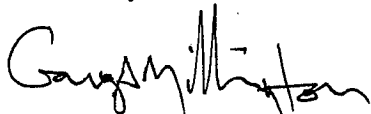
The Division of Waste Management does not provide endorsement of specific or brand name remediation products or processes, however, it does recognize the need to determine their acceptability in the context of environmental regulations, and the protection of public health and safety. In no way shall this regulatory acceptance be construed as an endorsement or certification of product performance. Additionally, the Division emphasizes a distinction between its regulatory "acceptance" letter and an approval. Products and processes are accepted but they are not approved. Vendors and environmental consulting companies must market the products and processes on their own merits regarding performance, cost, and safety in comparison to competing alternatives in the marketplace.

Remedial Action Plans that include use of an accepted product or process should include a copy of the acceptance letter in the plan's appendix, and reference it in the text of the document. 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 rules and regulations.

The Division reserves the right to revoke its acceptance of a product or process if it has been falsely or incompletely represented. Additionally, Division 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 design details must be provided in a site-specific Remedial Action Plan submitted for Department review and approval. Questions about hazardous waste cleanup applications should be directed to Gary Millington, and questions about petroleum cleanup applications should be directed to Rick Ruscito.

Sincerely,



Gary Millington, P.E.
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Rick Ruscito, P.E.
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c: T. Conrardy - DEP/Tallahassee
R. Cowdery - DEP/Tallahassee

REGULATORY INFORMATION

1. Regulations: Users of the ISCO OAO system shall comply with all applicable regulations. This includes meeting all applicable groundwater contaminant standards for the residual concentrations of chemical and biological agents used to remediate the contaminants, and any byproducts of concern produced by chemical and biological reactions induced by those agents, within the applicable regulatory timeframes. The following chapters of the Florida Administrative Code (F.A.C.) may be applicable in determining these timeframes: 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; Chapters 62-770, 62-780, 62-782, and 62-785 F.A.C., for cleanup criteria; and Chapter 62-777, F.A.C., for cleanup target levels.
2. Groundwater criteria: Florida groundwater regulations do not set concentration limits for ozone, oxygen, or air, but the absence of specific groundwater criteria for a chemical does not necessarily mean it is of no environmental or toxicological concern. The Division of Waste Management, however, in the case of these gases, does not have any concerns in regard to their residual groundwater concentrations after ISCO OAO treatment. The residual groundwater concentration of ozone is not a concern because this gas is unstable and decomposes quickly (the half-life in water at 20 deg. C is 20 minutes). The residual concentration of oxygen is not a concern because its presence is generally considered to be beneficial, and because it is relatively benign from a toxicological standpoint. Air (a mixture of oxygen and nitrogen) is not a concern, since it is generally considered benign, and the nitrogen component is inert.
3. Underground Injection Control permit: Per Rule 62-528.630(2)(c), F.A.C., Class V injection-type aquifer remediation wells are exempt from the permitting requirements of Rule 62-528.635, F.A.C., provided they are authorized under the provisions of a Remedial Action Plan or other enforceable mechanism, and the requirements of the rules governing the remediation project, as well as the construction, operation, and monitoring requirements of Chapter 62-528, F.A.C., are met. The issuance of an enforceable, site-specific Remedial Action Plan Approval Order by the Department for injection-type aquifer remediation constitutes the granting of a Class V injection well construction/clearance permit.

Underground Injection Control notification: Remedial Action Plans proposing in-situ, injection-type aquifer remediation shall include information pursuant to Rules 62-528.630(2)(c)1 through 6, F.A.C., for the inventory purposes of the underground injection control program. Reviewers of those plans, upon issuance of an enforceable Remedial Action Plan Approval Order by the Department, must submit a completed copy of the Underground Injection Control inventory notification memorandum. This notification must be submitted by the reviewer, whose name must appear in the "From: ____" area on the first page, not the name of the environmental consulting company that prepared the remediation plan.

Since the standard notification memorandum -- like most injection documents and regulations -- anticipates that the injected fluid will be a liquid, it expresses injected fluid

volumes in units that are more suited for liquids than gases. Therefore, for situations in which the notification will be for the injection of gas, it will be acceptable to modify the memorandum by crossing out the liquid units and replacing them with those commonly used for gases (e.g., volumes in cubic feet, flow rates in cubic feet per minute (cfm), and concentrations either as volume percent or parts per million by volume (ppmv)).

Alternatively, it would also be acceptable to report the amount of gas to be injected over the life of the project in pounds (on a pure basis) along with its concentration in the carrier gas mixture that is actually injected, and the injection flow rate of the mixture.

4. Temporary injection zone of discharge: Rule 62-522.300(2)(c), F.A.C., allows a temporary injection zone of discharge for closed-loop re-injection systems and for the prime constituents of the reagents used to remediate site contaminants, and for the secondary standards for ground water, as specified in a Department-approved remedial action plan that addresses the duration and size of the zone of discharge, and ground water monitoring requirements. For the injection of air and oxygen, a temporary injection zone of discharge is not needed because there are no minimum groundwater criteria. But for the injection of ozone, which is more reactive in the environment, and of toxicological concern, permission for a temporary injection zone of discharge should be sought as part of the Remedial Action Plan pursuant to paragraph 62-522.300(2)(c), F.A.C.
5. In order to obtain permission for a temporary zone of discharge via paragraph 62-522.300(2)(c), F.A.C., a site-specific Remedial Action Plan must indicate: (a) the chemical species of concern with respect to the minimum groundwater criteria of Chapter 62-520, F.A.C.; (b) the size of the zone that is needed; (c) the amount of time that the zone will be needed; and (d) a groundwater monitoring plan for the injected chemical species of concern. Ozone in water has a half-life of only 20 minutes, and there is no reason to expect that elevated residual concentrations of it will remain in the aquifer for a prolonged period of time, therefore a groundwater monitoring plan for ozone is not necessary. The size of the temporary injection zone of discharge in item (b) above will usually be just the radius of influence when the treatment system is a single injection point. For a multiple point system, the zone of discharge can usually be expressed and illustrated as the total area of a cluster formed by all the injection points, located side-by-side with overlapping radii of influence.
6. Utilization of wells: If a remediation site has an abundance of monitoring wells, then the Department has no objection to the use of some existing wells as ISCO OAO injection points for air and oxygen. It also has no objection to the use of some as ozone injection points if their materials of construction are already resistant to attack by ozone, or they are expendable if not resistant, or they are refurbished with ozone resistant materials. However, no monitoring well dedicated to the tracking of remediation progress (by sampling) shall be used as a treatment point. This will avoid a premature conclusion that the entire site meets cleanup goals. By making sure that designated monitoring wells are not used for the introduction of treatment gases, there will be more assurance that dissolved gas has permeated and treated the entire site, and that it did not remain localized to the immediate area surrounding each treatment point.

7. Avoidance of migration: Per Rule 62-528.630(3), F.A.C., in situ, injection-type aquifer remediation projects shall be conducted in such a way that there is no undesirable migration of either the remediation agents used or the contaminants of concern.
8. Abandonment of wells: Upon issuance of a Site Rehabilitation Completion Order, injection wells shall be abandoned pursuant to Section 62-528.645, F.A.C., and the Underground Injection Control Section of the Department shall be notified so that the treatment wells can be removed from the injection well inventory-tracking list.
9. Other gases: This ISCO OAO acceptance applies to ozone, oxygen and air. If a gas other than those covered by this acceptance is to be injected, then all applicable regulations must be addressed in a site-specific Remedial Action Plan and approved by the Department. If the specific gas to be used is not regulated by rule, then it will be incumbent on the submitter of the site-specific Remedial Action Plan to consider the gas flammability, reactivity, toxicity, any other properties that may warrant consideration from a safety standpoint, the minimum groundwater requirements of Chapter 62-520, F.A.C., and the procedure in Chapter 62-777, F.A.C., for the calculation of a maximum allowable residual groundwater concentration. Additionally, it may necessary to obtain permission for a temporary injection zone of discharge pursuant to rule 62-522.300(2)(c), F.A.C., or by way of variance should the gas not qualify for permission by rule.

SUPPLEMENTAL INFORMATION

1. System description[†]: Cabinet or trailer-mounted ozone, oxygen, air delivery system configured such that three types of output to a subsurface sparging system are possible:
(1) a mixture of ozone and air; (2) 90% oxygen; or (3) just air.
 - Electrical requirement[‡]: Single-phase 120- or 240-volt a.c.
 - Ozone generator output[‡]: 1.4 - 5.5 pounds per day.
 - System ozone output[‡]: 2,250 - 4,160 parts per million by volume (ppmv) ozone, after being mixed with air carrier gas. The flow rate of this mixture is 3.8 - 5.9 cubic feet per minute (cfm) at a maximum operating pressure of 50 pounds per square inch (psi).
 - System oxygen output[‡]: For oxygen-only systems, which do not include an ozone generator, the oxygen output is 1 - 2 cfm at 90% purity, at a maximum operating pressure of 50 psi. When a combination ozone/oxygen system is operated in oxygen-only mode, the oxygen is mixed with air carrier gas and the resulting oxygen content is 40%.
 - The maximum sparge well breakthrough pressure handled by the system is 100 psi.
 - Number of sparge ports[‡]: 10 - 40.
 - Mode of operation: Ozone and the air carrier gas flow continuously to a manifold, where timer-controlled solenoid valves direct the flow to only one sparge point at a time on a rotating basis.
 - Auto dialer notification of alarm conditions.
 - Automatic restart of system after power failure.

† For a complete list of features and more details, see manufacturer's publications.

‡ Varies by model number.

2. Materials of construction: As indicated by the manufacturer, selected for compatibility with ozone.
 - Ozone delivery tube (from manifold to well head): Perfluoroalkoxy (PFA)-type Teflon[®], 1/2-inch outside diameter by 3/8-inch inside diameter.
 - Sparge well head connections: 316 stainless steel.
 - Sparge well riser pipe: Schedule 80 polyvinyl chloride (PVC).
 - Sparge well disperser element: 25-micron, porous polyvinylidene fluoride (PVDF) (Kynar[®]).
 - Seals: Synthetic rubber/fluoropolymer elastomer (Viton[®])
3. Safety: All appropriate safety considerations shall be addressed in the design and construction of the portion of the ISCO OAO system that is shop-fabricated by the manufacturer, and in the design, construction and operation of the field portion of the system by environmental remediation companies and users. No attempt is made to provide a detailed, exhaustive list as part of this acceptance. There is, however, one safety feature that the Division of Waste Management would like to highlight here. The manufacturer indicates that an ambient ozone sensor will shut off the ozone reactor chamber if the ambient concentration of ozone in the equipment area exceeds 1 ppm. As for the design and operation of an ISCO OAO sparge system by environmental remediation companies for the cleanup of specific sites, the Division of Waste Management provides a reminder to determine, on a

case-by-case basis, whether a vapor recovery system will be needed to prevent fugitive emissions of ozone gas or contaminant vapors. While it is anticipated that the low flow rates produced by the ISCO OAO system will not cause undesirable levels of fugitive emissions, the situation should be evaluated for each specific cleanup site as a prudent measure.

4. Light and dense non-aqueous phase liquids (LNAPL/DNAPL): The manufacturer does not recommend ozone or oxygen sparge technology for LNAPL/DNAPL treatment.