October 6, 1998

Mr. Dan Cross
Clean Technologies Sunshine
Environmental Corporation
441 Woodbine Drive
Pensacola, Florida 32503

Re: Molecular Decomposition Process

Dear Mr. Cross:

The Bureau of Petroleum Storage Systems hereby accepts the Molecular Decomposition Process as an innovative technology for the destruction of environmental contaminants, via pyrolysis, upon immersion in an 89,000 pound molten aluminum alloy bath which is maintained at approximately 900º C. This ex situ remediation process, which is patented by Anthony S. Wagner of Bee Caves, Texas, is capable of destroying petroleum fuels and is particularly well-suited for destroying a wide range of other contaminants, both organic and inorganic; for example: petroleum hydrocarbons such as creosote, chlorinated hydrocarbons, pesticides, polychlorinated biphenyls, dioxins, and medical and industrial wastes.

By varying the composition of the molten alloy bath, the process can be tailored to efficiently and completely destroy a given contaminant. Depending upon the chemical formula of the contaminant, the process yields either gaseous decomposition products in the form of elements which exit the bath, and/or metals and alloy salts which remain in the bath. No combustion takes place.

Gaseous decomposition products exiting the bath are swept away by an oxygen-free carrier gas stream (mostly CO_2) and subsequently cooled for collection and disposal as either

precipitated solids and condensed liquids, or exhausted to the atmosphere if they do not condense or dissolve into a wet-scrubber at 100º C or less.

Metals and alloy salt products remain in the bath. When a bath reaches its capacity to absorb or react with contaminants, it is removed from the reactor pot and replaced by a fresh charge of alloy. The spent alloy, which contains metals and alloy salts, can be poured into ingots and sold to metal refiners.

The potential of the Molecular Decomposition Process to serve as a tool in the remediation of contaminated sites, and as a method for the destruction of industrial and other types of wastes in Florida, is hereby recognized. For the remediation of contaminated sites, 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 regulations are observed.

For the prevention of pollution, when using the Molecular Decomposition Process for the destruction of wastes as they are produced by manufacturing processes (or other generators of wastes), all applicable and appropriate regulations, if any, pertaining to air emissions, discharges to waters, and solid wastes should be observed when disposing of the decomposition products. Please note that the regulation of waste products from specific industries is not in the jurisdiction of either the Bureau of Petroleum Storage Systems or the Bureau of Waste Cleanup.

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 regarding performance, cost, and safety in

comparison to competing alternatives in the marketplace. For the Molecular Decomposition Process, some of the more significant environmental and regulatory considerations are discussed in enclosure 1.

Preparers of Remedial Action Plans which propose the Molecular Decomposition Process are advised to include a copy of this letter in the appendix of the 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 its environmental acceptability. For the purpose of briefing those reviewers on the technical aspects, the Bureau of Petroleum Storage Systems provides supplemental information as enclosure (2) and a copy of United States patent number 5,000,101 as enclosure 3.

The Department reserves the right to revoke its acceptance of a product or process if the nature or composition of either or any of its principal and proprietary ingredients, its performance, or any other aspect 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.

This acceptance letter shall not be construed as an exemption from the requirement that a Remedial Action Plan be prepared for the cleanup of a contaminated site, nor shall it be construed to imply automatic approval of any Remedial Action Plan prescribing the accepted product or process. 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 submitted for review and approval by the Department or one of its contracted reviewing agencies.

You may contact me at 850/487-3299 if there are any questions.

Sincerely,

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

cc: Anthony S. Wagner
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ENCLOSURE 1

ENVIRONMENTAL AND REGULATORY CONSIDERATIONS

For the remediation of contaminated sites using the Molecular Decomposition Process, some of the more significant environmental and regulatory considerations are discussed below.

a. Groundwater and soil cleanup standards: The onus shall be on users of the Molecular Decomposition Process to ensure that a remediation site is cleaned up to all applicable groundwater and soil standards for the contaminants of concern by the time of project completion. The following chapters of the Florida Administrative Code are cited: Chapter 62-520, F.A.C. for groundwater classes and standards; Chapter 62-550, F.A.C., for primary and secondary water quality standards; Chapter 62-770, F.A.C., for petroleum cleanup criteria; and Chapter 62-785, F.A.C., for brownfields cleanup criteria. Some of these regulations also provide alternative mechanisms by which a cleanup may be terminated, such as endpoints defined by a risk assessment, or natural attenuation accompanied by institutional controls such as deed restrictions or engineering controls.

b. Air emissions, and liquid and solid products disposal: Since the Molecular Decomposition Process is capable of destroying a wide variety of contaminants over a wide variety of concentrations, and therefore producing a number of chemical species as products at various concentrations, it is not possible to discuss the specifics of every conceivable situation in regard to air emissions, or the disposal of liquid and solid products. The discussion below, however, may provide some insight should there be a question as to whether or not a particular decomposition product stream from the process can be released directly to the environment, or whether it must be further treated prior to release.

1. Air emissions: Given the capability of the Molecular Decomposition Process to completely destroy contaminants, plus a design feature that recirculates a portion of its offgases, and a cyclone-type wet-scrubber for the removal of particles and dissolution of some chemical species from the bath gases, it is likely that air emissions will be minimal.

   In its application for an innovative technology evaluation, Clean Technologies Sunshine Environmental Corporation (the applicant) has indicated that offgases will be monitored using gas chromatographs and flame ionization detectors. In the event that there are air emission regulations pertaining to

the cleanup specifically at hand, then the Bureau of Petroleum Storage Systems suggests that any official samples required by the regulations for contaminants of concern at a site be incorporated into the emissions sampling schedule of the Remedial Action Plan.

2. Liquids disposal: The volume of liquid to be disposed as an effluent from the Molecular Decomposition Process will vary with the moisture content or amount of free water present in the feed material to the process. The liquid effluent stream produced by this process should be sampled for contaminants of concern at the site. In some cases, such as petroleum site cleanups, the requirements for sampling of effluent are set forth in Chapter 62-770, F.A.C. For other applications such as hazardous waste cleanups, other regulations may apply, or the approved Remedial Action Plan may set forth the effluent sampling frequency and parameters for analysis.

   Remedial Action Plans prescribing the Molecular Decomposition Process should also consider the potential for decomposition products in the recirculating carrier gas stream to combine and form compounds that may dissolve into the scrubber water, thereby changing its pH and/or composition, and thereby introducing a consideration to be taken into account when the scrubber water is eventually discarded as effluent. For example, hydrogen and chlorine atoms from the destruction of a chlorinated hydrocarbon may combine to form HCl, which could reduce the pH and raise the chloride content of the scrubber water. The foregoing may, or may not, be a major concern for a given project, depending on the condition and volume of scrubber water to be discarded upon completion of the project, and whether the method of disposal is via sanitary sewer or onsite infiltration.

   If there is uncertainty regarding the condition of the water to be disposed, then the Bureau of Petroleum Storage Systems suggests that it be sampled and analyzed for at least the appropriate <u>secondary</u> drinking water parameters listed in Chapter 62-550, F.A.C., based on knowledge of the chemical species contained in the contaminants fed to the decomposition process, and the possible compounds which could have been formed in the offgas and scrubber water by chemical reactions involving those species.

3. Solids disposal: The Molecular Decomposition Process can produce several types of solids streams of varying chemical compositions, depending on the type of contaminants fed to the process. These streams must ultimately be disposed. In the case of alloy bath disposal, the applicant has indicated that

the alloy, along with any impurities it has collected, can be poured into ingots and sold to metal refiners for recycling.

An activated carbon solid is produced when contaminants containing carbon atoms are destroyed. Elemental carbon, as a decomposition product, is emitted from the alloy bath and carried away by the recirculating gas stream. It is collected by a separator and can be sold as activated carbon.

And lastly, in the case of soil remediation, the remediated soil itself is a solids stream which exits the process. This soil must meet the cleanup criteria set forth in the appropriate and applicable regulations for the contaminants of concern at a site, as agreed upon in an approved remedial action plan. It is expected that treated soil will be clean enough to be returned to the site for reuse.

ENCLOSURE 2

MOLECULAR DECOMPOSITION PROCESS SUPPLEMENTAL INFORMATION

The information below may be useful to reviewers of Remedial Action Plans prescribing the Molecular Decomposition Process.

a. Feed condition and feed methods: Contaminants may be fed to the Molecular Decomposition Process in the form of solids, liquids, or slurries. Solids such as medical wastes are fed using cages, and soils are fed via special conveyor. An air locking door arrangement prevents excessive amounts of unwanted atmospheric oxygen from entering the process as solids are fed to the bath. Slurries and liquids are pumped into the bottom of the molten aluminum alloy vessel in order to promote contact between the contaminant and the alloy, thereby ensuring complete destruction of contaminants.

b. Chemical reactions: For the destruction of hydrocarbons and chlorinated hydrocarbons (two common types of contaminants) by pyrolysis in molten aluminum alloy, the following general chemical reactions occur.

$C_xH_y \longrightarrow xC + yH$ (hydrocarbons)

$C_xH_yCl_z \longrightarrow xC + yH + (1/3)(z)AlCl_3$ (chlorinated hydrocarbons)

It should be noted, in the case of chlorinated hydrocarbons, that the chlorine reacts chemically with the aluminum to form water soluble salts such as aluminum chloride. In the case of pure hydrocarbons, however, there is no reaction with the aluminum, so both the carbon and hydrogen decomposition products exit the bath and are swept away to a wet scrubber by a recirculating oxygen-deficient carrier gas stream. Since a variety of other types of contaminants can be destroyed by this process, there are other similar chemical reactions that can occur.

c. Behavior of soils: It has been indicated that contaminated soils, after passing through the Molecular Decomposition Process for remediation, remain as free-flowing grains of sand. The grains do not become coated with aluminum alloy, and they do not exit the process as a lump of grains bound together by solidified aluminum. A small amount of carbon, however, may remain on the soil as residue.

d. Pilot study: For innovative technologies used in the remediation of sites contaminated by petroleum fuels, Section 62-770.700, F.A.C., requires that a pilot test be conducted. A pilot test is also suggested for the use of this process in the cleanup of sites contaminated by hazardous wastes. Some judgment may be necessary in determining the extent of pilot testing that is necessary, and in some cases, whether a pilot test is necessary at all.

It may be possible to forego a pilot test when the amount of contaminated material to be processed is small, and there is little difference between the scale and cost of a pilot study and a full-scale cleanup. Another situation could be one in which the contaminants of concern, under similar conditions, have already been successfully destroyed by the Molecular Decomposition Process, or there is a high degree of confidence based on previous destruction of contaminants in the same family of chemical compounds.

e. Operating parameters: The system operates at a pressure of one (1) atmosphere and at a temperature of approximately 900º C.

f. Gas samples: A distinction is made between offgas samples to be taken for the monitoring of air emissions to the atmosphere, as described in enclosure 1, and internal gas samples to be taken for process control purposes.

The recirculating carrier gas inside the apparatus may be analyzed for volatile organic chemicals (VOC), oxygen (O_2), and carbon dioxide (CO_2). Such samples will not usually be of concern from an environmental standpoint, since

they are confined to the internal regions of the process vessels and piping. They may, however, be of some interest to technical reviewers from the standpoint of safety, since it is desirable to maintain a noncombustible atmosphere in the vapor space above the molten alloy bath. This is accomplished by keeping O_2 concentrations low and CO_2 concentrations high in the recirculating gas stream.

g. Feed rates: It is expected that petroleum contaminated soils can be processed at rates in the range of 6 to 10 cubic yards per hour. No indication of rate was given for chlorinated hydrocarbons or other types of contaminants. This, however, can be addressed in site specific remediation plans and a decision made as to whether or not the processing rate is acceptable for a given situation.

h. Performance: It has been indicated that 100 percent destruction of contaminants can be achieved by this process. In the event that a batch of treated materials exiting the process does not meet cleanup specifications, the Bureau of Petroleum Storage Systems suggests that it be fed to the process again in order to achieve the desired goal.

i. Safety: As indicated previously, to prevent combustion, it is desirable to keep the concentration of O_2 as low as possible in the recirculating CO_2 carrier gas stream above the molten alloy bath. The applicant has indicated that the equipment setup includes pressure relief valves, automatic shutdown and shutoff features, electrical system backups, dual gas systems, and monitoring for VOCs, O_2, and CO_2. Since the vessel which contains the molten aluminum is a standard furnace used to manufacture cast aluminum products, the same furnace safety considerations apply. Personal protection of workers should be appropriate for work with such an equipment item, and appropriate for the type of contaminants at a given job site.

United States Patent [19]

Wagner

[11] **Patent Number: 5,000,101**

[45] **Date of Patent: Mar. 19, 1991**

[54] **HAZARDOUS WASTE RECLAMATION PROCESS**

[76] Inventor: **Anthony S. Wagner,** 13709 Hwy. 71 W., Bee Caves, Tex. 78738-3112

[21] Appl. No.: **524,278**

[22] Filed: **May 16, 1990**

[30] **Foreign Application Priority Data**

May 25, 1989 [SE] Sweden 8901855

[51] **Int. Cl.**[5] **F23G 7/04**

[52] **U.S. Cl.** **110/346;** 110/235; 110/238; 110/250; 110/204; 422/184

[58] **Field of Search** 110/204, 250, 235, 346, 110/238; 422/184; 423/659

[56] **References Cited**

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Primary Examiner—Edward G. Favors
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[57] **ABSTRACT**

This Hazardous Waste Reclamation process pyrolyzes hazardous waste such as PCB (polychloro-biphenyl) in a closed system in a molten alloy, containing some aluminum, at a minimum of 800 degrees C. to form activated carbon that is recovered from the circulating exit gas stream and an impure alloy ingot containing unreacted metals and metal salts that are saleable to a metal processor as a high grade ore. The composition of the alloy may be varied to assure maximum reaction to nontoxic alloy salts that remain in the ingot.

19 Claims, 1 Drawing Sheet