BioSafe Systems L.L.C.
The BioSecurity Company

22 Meadow Street
East Hartford, CT 06108
toll-free: 888.273.3088
fax: 860.290.8802
www.biosafesystems.com

August 4, 2008

Robert Pooler
National Organic Program
USDA / AMS / TM / NOP
Stop 0268 – Room 4008-S
1400 Independence Avenue, SW
Washington, DC 20250-0200

RE: Peracetic Acid Petition to Amend the National List
Clarification of Required Items

Dear Mr. Pooler:

BioSafe Systems is in receipt of your letter dated July 28, 2008, in which you indicate that the above-referenced petition is incomplete, as specific items 2-13 were not comprehensively addressed in the cover letter accompanying the petition. We apologize for any inconvenience this may have caused, and below please find our response for items 2-13 of "*National Organic Program - Submission of Petitions of Substances for Inclusion on or Removal from the National List of Substances Allowed and Prohibited in Organic Production and Handling.*"

2. BioSafe Systems LLC, the Petitioner, is also the manufacturer of products containing hydrogen peroxide and peracetic acid (PAA). Contact information is as follows:

   BioSafe Systems LLC, U.S. EPA Registration #70299
   22 Meadow Street
   East Hartford, CT 06108
   Phone: 888-273-3088 (toll-free)

   The products are formulated at:
   Seeler Industries, U.S. EPA Establishment #60156-IL-001
   2000 North Broadway
   Joliet, IL 60435
   Phone: 800-336-2422

3. As explained in the cover letter dated March 28, 2008, we currently market products that are EPA registered as algaecides, bactericides, and fungicides for field and post harvest applications; OxiDate, StorOx, GreenClean Liquid, and TerraClean. With only hydrogen peroxide as the active ingredient, these products are currently compliant with the NOP regulations for organic crop production as a plant pest control and as an algaecide. There has always been peracetic acid present in these formulations, but the Biopesticide branch did not recognize PAA as an active ingredient when the products were registered.

   Recently, the EPA has determined that peracetic acid should be listed as an active ingredient, and we are currently in the process of re-registering these corresponding products. These new products will *not* be compliant with current NOP regulations for use in crop production as an algaecide/bactericide/fungicide, because peracetic acid is only approved as a plant pest control for use against fire blight, which only affects fruiting trees and ornamentals in the *Rosaceae* family, and 7 CFR §205.601 (a)(6) limits the use of peracetic acid to disinfecting equipment, seeds, and the asexual propagation of planting materials.

4. The new registrations will be the same exact formulation as the current products, and the labels will contain the same use directions and rates. Our customers rely heavily on using these products as part of their organic system plan, and under the current National List, these valuable tools will no longer be available to them, since the current scope of peracetic acid is so limited for organic crop production. We propose that the restrictions on peracetic be removed, so that it can be used for crops other than fruiting trees.

   OxiDate is currently EPA approved for use on a wide variety of crops, and our label broadly states, "Preventative treatment for seeds, growing plants, fruits, nuts and vegetables" and "A treatment for the prevention and control of plant pathogenic diseases in field grown crops, commercial greenhouses, and storage sites." Specific instructions are listed alphabetically by crop from asparagus to tropical fruits. Please refer to the OxiDate Specimen Label in Appendix C of the original petition.

   StorOx is also broadly labeled as "A treatment for the prevention and control of plant pathogenic diseases on crops after harvest" and "A treatment for the prevention and control of plant pathogenic diseases on surfaces, equipment and structures used in processing post harvest commodities." In the application directions, it is also stated, "Applicable for use on all types of post harvest commodities." The StorOx label is also included with the original petition.

   Both OxiDate and StorOx are labeled for treatment of algae, and our product GreenClean Liquid, another alternate brand name of OxiDate, is marketed as an algaecide/bactericide for the treatment of irrigation water, drainage water, and ditches. This label is included with the petition, as well.

   The mode of action for all of these applications is the same; it is oxidation. Just as hydrogen peroxide oxidizes the organisms it contacts, so does peracetic acid.

5. Peracetic acid is not manufactured. It is formed *in situ* (as a reaction between) hydrogen peroxide and acetic acid during the production of the end-use product. This information was not provided with the petition, as peracetic acid is all ready an approved substance, and we assumed that this section had been satisfied. *(Along with the crop production*

listing, PAA is also listed in 7 CFR §205.603 (a)(19) and §205.605 (b).) However, please refer to page 3 of the JACC Report for peracetic acid included in Appendix F of the petition package for confirmation of the chemistry.

6. Appendix A of the petition package includes the November 2000 TAP Reviews of peracetic acid for Crops, Livestock, and Processing applications. All three reviews recommended that peracetic acid be allowed as a synthetic input. At the time, the specific use requested for plant pathogen control was to control fire blight, as there was no other organic control.

   The following products, which contain peracetic acid, are all OMRI listed in the 2008 Product List for use in organic processing: Oxonia Active, Tsunami 100 (Eco Lab, Inc), StorOx, SaniDate 12.0 (BioSafe Systems), Blitz, Spectrum, VigorOx, VigorOx Citrus XA, and VigorOx SP-15 (FMC Corporation).

   According to the EPA stamped labels: Perasan 'A' is NSF/ANSI 60 certified for use in drinking water. BioSide HS 15%, Tsunami 100, VigorOx, and VigorOx SP-15 are all EPA approved for use in organic production.

7. Peracetic acid is exempt from a tolerance requirement by the EPA when used as an antimicrobial treatment on raw and processed agricultural commodities, as per 40 CFR §180.1196, as is hydrogen peroxide (§180.1197). Copies of these regulations can be found with this letter in Appendix 1.

   Both of the ingredients that form peracetic acid, hydrogen peroxide and acetic acid, are considered by the FDA to be "GRAS" (Generally Recognized As Safe) as per 21 CFR §582.1005 and 582.1366. Copies of these regulations can be found with this letter in Appendix 2.

   There are several products currently approved by the EPA as food contact pesticides that contain peracetic acid as an active ingredient, including Oxonia Active, EPA #1677-129; Tsunami 100, EPA #1677-164; Victory, EPA #1677-186; Perasan 'A', EPA #63838-1; BioSide HS 15%, EPA #63838-2; Peraclean, EPA #63838-3; Peraclean 15%, EPA #63838-4; VigorOx, EPA #65402-1; VigorOx SP-15, EPA #65402-3; SaniDate 5.0, EPA #70299-5 and SaniDate 12.0, EPA #70299-8. These labels can be found in Appendix 3 with this letter. *Pending with the EPA and expected registraion for Fall 2008 are TerraClean 5.0 EPA #70299-X and ZeroTol 2.0 EPA #70299-X (including the alternate brand names OxiDate 2.0, StorOx 2.0 and GreenClean Liquid 2.0)*

8. Peracetic/Peroxyacetic Acid CAS #79-21-0. Several product labels discussed in #7, with this same CAS number are included with this letter in Appendix 3.

9. The physical properties and chemical mode of action of peracetic acid are thoroughly discussed in the JACC Report for peracetic acid in Appendix F of the original petition. Basically, peracetic acid is a clear, colorless liquid that has pungent, vinegar odor. It takes on the characteristics of hydrogen peroxide and oxidizes organic matter on contact. This leaves no opportunity for mutational resistance.
   (a) Through the oxidation process, peracetic acid will actually break down harmful metals, such as copper, that persist in the environment. Hydrogen

peroxide/peracetic acid formulations are compatible and can be tank mixed with organic horticultural oils.

(b) When used according to label direction, peracetic acid poses no toxicological concern to humans, fish, birds, other wildlife, or domestic animals. It breaks down rapidly in the presence of organic matter to the original inputs of hydrogen peroxide and acetic acid. Hydrogen peroxide, which has all ready been approved for organic crop production, further decomposes into water and oxygen. Peracetic acid is only toxic in high doses and is discussed in section 6 of the JACC report, *Effects on Organisms in the Environment.*

(c) To address environmental impact, we quote the Crops TAP Review for peracetic acid, dated 6 November 2000, page 4, #5, "The substance is used *because* of its biological and chemical interactions and its physiological effects on the microorganisms, including many that are naturally found in a soil environment"

(d) When used according to label directions, peracetic acid has no effect on humans. A 1:250 dilution of our 2% peracetic acid product reduces the amount of peracetic acid so much that EPA doesn't consider it to be an active ingredient and the signal word is "caution" (See SaniDate Ready-To-Use, EPA #70299-9 label in Appendix C of the petition package). The *concentrate* is known to be an irritant to skin, eyes, mucous membranes, and respiratory tract, and our labels provide appropriate precautionary statements for handling the concentrates.

(e) Peracetic acid will oxidize any organic matter it contacts in the soil. TerraClean, our soil treatment product, is highly effective as a fungicide against soil borne pathogens, but, as established, it does not persist in the soil. Confidential efficacy studies were submitted with the petition that show no phytotoxicity issues. It is recommended that once the soil has been treated with the hydrogen peroxide/peracetic acid solution, it should be re-inoculated with beneficial bacteria, and other IPM practices should be resumed. Several confidential phytotoxicity studies have also been submitted to demonstrate the lack of phytotoxicity to a wide range of plants. Unfortunately, these proprietary studies are not available to the public.

10. Material Safety Data Sheets (MSDS) can be found at the back of the specimen labels for StorOx, GreenClean Liquid, TerraClean, and ZeroTol, submitted with the original petition. Please note that all of the MSDS recognize the presence of PAA, along with hydrogen peroxide. We are not aware of a substance report from the National Institute of Environmental Health Studies.

11. Peracetic acid was considered fur use in field applications as part of the 2000 TAP Review, but at that time, there was insufficient data to support field applications. In the past 10 years, BioSafe Systems has conducted and/or compiled extensive research that demonstrate the bactericidal, fungicidal, and algaecidal properties of peracetic acid, and several of these studies were submitted with the original petition package. Some of this data is confidential and cannot be shared with the public. Many of the studies, however, are published university and/or government research and can be founding Appendix D of the petition.

Two alternatives to hydrogen peroxide/peracetic acid solutions are copper and sulfur products. There is no environmental build-up or mutational resistance with peracetic acid, as there is with copper and other biological products. When applied at label rates, peracetic acid is not phytotoxic to plants, as sulfur can be.

12. Peracetic acid has always been present in OxiDate, StorOx, ZeroTol, GreenClean Liquid, and TerraClean; it just wasn't considered to be an active ingredient by the EPA when these agricultural products were registered. We are currently in the process of an Agency-initiated re-registration for these formulations, listing peroxyacetic acid as an active ingredient, along with hydrogen peroxide. We are very concerned that, once these new registrations are approved and PAA is listed as an active ingredient, our customers who rely on our products will suddenly find that they can no longer be used as part of a certified organic program. Removing the restrictions on the listing of peracetic acid as a synthetic substance under 7 CFR §205.601 (a)(6) & (i)(7) will ensure that organic farmers can continue to use these valuable tools.

    Nothing about efficacy or ecotox has changed between the current approved formulation and the new products. The studies conducted with the original products are still valid and applicable for the new products. The only difference is that peracetic acid will be recognized in the Confidential Statement of Formula (CSF) on file with the EPA as an active ingredient; an active ingredient that is formed between an NOP approved synthetic substance for crop production and a List 4 inert.

    Peracetic acid cannot be obtained commercially as a stand-alone product. As established, it is found in conjunction with hydrogen peroxide products. The benefits of hydrogen peroxide have already been approved by NOP, and peracetic acid should receive the same credence. It is a superior alternative to copper and sulfur-based algaecides, fungicides, and bactericides, as there is no mutational resistance to the substance, and there is no residue left behind. The oxidation process will actually help to neutralize the residues of harmful metals. It provides immediate knockdown, and it can be tank mixed with horticultural oils. Furthermore, it has all ready been established in previous TAP Reviews that it is compatible with organic farming and handling.

With this letter, we hope that we have sufficiently addressed each item. A more extensive explanation of our position can be found in the original cover letter dated March 28, 2008. BioSafe Systems wishes to thank the NOP, NOSB, and the Crops Committee in advance for their consideration. Please let me know if anything else is required to process this petition. I can be reached at phone: 860-290-8890 ext.221 or e-mail: kknox@biosafesystems.com.

Best regards,

Kristen B. Knox
Registration Manager

Appendix 1

§ 180.1192 *Bacillus thuringiensis* subspecies *tolworthi* Cry9C protein and the genetic material necessary for its production in corn; exemption from the requirement of a tolerance.

The plant-pesticide *Bacillus thuringiensis* subspecies *tolworthi* Cry9C and the genetic material necessary for its production in corn is exempted from the requirement of a tolerance for residues, only in corn used for feed; as well as in meat, poultry, milk, or eggs resulting from animals fed such feed.

[63 FR 28261, May 22, 1998]

§ 180.1193 Potassium dihydrogen phosphate; exemption from the requirement of a tolerance.

Potassium dihydrogen phosphate is exempted from the requirement of a tolerance in or on all food commodities when applied as a fungicide in accordance with good agricultural practices.

[63 FR 43085, Aug. 12, 1998]

§ 180.1195 Titanium dioxide.

Titanium dioxide is exempted from the requirement of a tolerance for residues in or on growing crops, when used as an inert ingredient (UV protectant) in microencapsulated formulations of the insecticide lambdacyhalothrin at no more than 3.0% by weight of the formulation.

[63 FR 14363, Mar. 25, 1998]

§ 180.1196 Peroxyacetic acid; exemption from the requirement of a tolerance.

(a) An exemption from the requirement of a tolerance is established for residues of peroxyacetic acid in or on raw agricultural commodities, in processed commodities, when such residues result from the use of peroxyacetic acid as an antimicrobial treatment in solutions containing a diluted end use concentration of peroxyacetic acid up to 100 ppm per application on fruits, vegetables, tree nuts, cereal grains, herbs, and spices.

(b) An exemption from the requirement of a tolerance is established for residues of peroxyacetic acid, in or on all raw and processed food commodities when used in sanitizing solutions containing a diluted end-use concentration of peroxyacetic acid up to 500 ppm, and applied to tableware, utensils, dishes, pipelines, tanks, vats, fillers, evaporators, pasteurizers, aseptic equipment, milking equipment, and other food processing equipment in food handling establishments including, but not limited to dairies, dairy barns, restaurants, food service operations, breweries, wineries, and beverage and food processing plants.

[65 FR 75173, Dec. 1, 2000]

§ 180.1197 Hydrogen peroxide; exemption from the requirement of a tolerance.

An exemption from the requirement of a tolerance is established for residues of hydrogen peroxide in or on all food commodities at the rate of ≤ 1% hydrogen peroxide per application on growing and postharvest crops.

[67 FR 41844, June 20, 2002]

§ 180.1198 *Gliocladium catenulatum* strain J1446; exemption from the requirement of a tolerance.

An exemption from the requirement of a tolerance is established for residues of the microbial pesticide, *Gliocladium catenulatum* strain J1446 when used in or on all food commodities.

[63 FR 37288, July 10, 1998]

§ 180.1199 Lysophosphatidylethanolamine (LPE); exemption from the requirement of a tolerance.

An exemption from the requirement of a tolerance is established for residues of the biochemical pesticide lysophosphatidylethanolamine in or on all food commodities.

[67 FR 17636, Apr. 11, 2002]

§ 180.1200 *Pseudomonas fluorescens* strain PRA–25; temporary exemption from the requirement of a tolerance.

A temporary exemption from the requirement of a tolerance is established for residues of the microbial pesticide, *pseudomonas fluorescens* strain PRA–25 when used on peas, snap beans and sweet corn and will expire July 31, 2001.

[63 FR 38498, July 17, 1998]

Appendix 2

Glycerol (glyceryl) tributyrate (tributyrin, butyrin).
Limonene (*d-, l-, and dl-*).
Linalool (linalol, 3,7-dimethyl-1,6-octadien-3-*ol*).
Linalyl acetate (bergamol).
l-Malic acid.
Methyl anthranilate (methyl-2-aminobenzoate).
Piperonal (3,4-methylenedioxy-benzaldehyde, heliotropin).
Vanillin.

§ 582.80 Trace minerals added to animal feeds.

These substances added to animal feeds as nutritional dietary supplements are generally recognized as safe when added at levels consistent with good feeding practice.[1]

Element	Source compounds
Cobalt	Cobalt acetate.
	Cobalt carbonate.
	Cobalt chloride.
	Cobalt oxide.
	Cobalt sulfate.
Copper	Copper carbonate.
	Copper chloride.
	Copper gluconate.
	Copper hydroxide.
	Copper orthophosphate.
	Copper oxide.
	Copper pyrophosphate.
	Copper sulfate.
Iodine	Calcium iodate.
	Calcium iodobehenate.
	Cuprous iodide.
	3,5-Diiodosalicylic acid.
	Ethylenediamine dihydroiodide.
	Potassium iodate.
	Potassium iodide.
	Sodium iodate.
	Sodium iodide.
	Thymol iodide.
Iron	Iron ammonium citrate.
	Iron carbonate.
	Iron chloride.
	Iron gluconate.
	Iron oxide.
	Iron phosphate.
	Iron pyrophosphate.
	Iron sulfate.
	Reduced iron.
Manganese	Manganese acetate.
	Manganese carbonate.
	Manganese citrate (soluble).
	Manganese chloride.
	Manganese gluconate.
	Manganese orthophosphate.
	Manganese phosphate (dibasic).
	Manganese sulfate.
	Manganous oxide.
Zinc	Zinc acetate.
	Zinc carbonate.
	Zinc chloride.
	Zinc oxide.
	Zinc sulfate.

[1] All substances listed may be in anhydrous or hydrated form.

§ 582.99 Adjuvants for pesticide chemicals.

Adjuvants, identified and used in accordance with 40 CFR 180.1001(c) and (d), which are added to pesticide use dilutions by a grower or applicator prior to application to the raw agricultural commodity, are exempt from the requirement of tolerances under section 409 of the act.

Subpart B—General Purpose Food Additives

§ 582.1005 Acetic acid.

(a) *Product.* Acetic acid.
(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1009 Adipic acid.

(a) *Product.* Adipic acid.
(b) [Reserved]
(c) *Limitations, restrictions, or explanation.* This substance is generally recognized as safe when used as a buffer and neutralizing agent in accordance with good manufacturing or feeding practice.

§ 582.1033 Citric acid.

(a) *Product.* Citric acid.
(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1057 Hydrochloric acid.

(a) *Product.* Hydrochloric acid.
(b) [Reserved]
(c) *Limitations, restrictions, or explanation.* This substance is generally recognized as safe when used as a buffer and neutralizing agent in accordance with good manufacturing or feeding practice.

§ 582.1061 Lactic acid.

(a) *Product.* Lactic acid.
(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1069 Malic acid.

(a) *Product.* Malic acid.

§ 582.1155 Bentonite.

(a) *Product.* Bentonite.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1165 Butane.

(a) *Product.* Butane.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1191 Calcium carbonate.

(a) *Product.* Calcium carbonate.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1193 Calcium chloride.

(a) *Product.* Calcium chloride.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1195 Calcium citrate.

(a) *Product.* Calcium citrate.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1199 Calcium gluconate.

(a) *Product.* Calcium gluconate.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1205 Calcium hydroxide.

(a) *Product.* Calcium hydroxide.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1207 Calcium lactate.

(a) *Product.* Calcium lactate.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1210 Calcium oxide.

(a) *Product.* Calcium oxide.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1217 Calcium phosphate.

(a) *Product.* Calcium phosphate (mono-, di-, and tribasic).

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1235 Caramel.

(a) *Product.* Caramel.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1240 Carbon dioxide.

(a) *Product.* Carbon dioxide.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1275 Dextrans.

(a) *Product.* Dextrans of average molecular weight below 100,000.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1320 Glycerin.

(a) *Product.* Glycerin.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1324 Glyceryl monostearate.

(a) *Product.* Glyceryl monostearate.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1355 Helium.

(a) *Product.* Helium.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1366 Hydrogen peroxide.

(a) *Product.* Hydrogen peroxide.

(b) [Reserved]

(c) *Limitations, restrictions, or explanation.* This substance is generally recognized as safe when used as a bleaching agent in accordance with good manufacturing or feeding practice.

§ 582.1400 Lecithin.

(a) *Product.* Lecithin.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1425 Magnesium carbonate.

(a) *Product.* Magnesium carbonate.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1428 Magnesium hydroxide.

(a) *Product.* Magnesium hydroxide.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1431 Magnesium oxide.

(a) *Product.* Magnesium oxide.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1480 Methylcellulose.

(a) *Product.* U.S.P. methylcellulose, except that the methoxy content shall not be less than 27.5 percent and not more than 31.5 percent on a dry-weight basis.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1500 Monoammonium glutamate.

(a) *Product.* Monoammonium glutamate.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1516 Monopotassium glutamate.

(a) *Product.* Monopotassium glutamate.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1540 Nitrogen.

(a) *Product.* Nitrogen.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1585 Papain.

(a) *Product.* Papain.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1613 Potassium bicarbonate.

(a) *Product.* Potassium bicarbonate.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1619 Potassium carbonate.

(a) *Product.* Potassium carbonate.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1625 Potassium citrate.

(a) *Product.* Potassium citrate.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1631 Potassium hydroxide.

(a) *Product.* Potassium hydroxide.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1643 Potassium sulfate.

(a) *Product.* Potassium sulfate.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

§ 582.1655 Propane.

(a) *Product.* Propane.

(b) *Conditions of use.* This substance is generally recognized as safe when used in accordance with good manufacturing or feeding practice.

Appendix 3

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Pesticide Programs
Antimicrobials Division (7510P)
1200 Pennsylvania Avenue NW
Washington, D.C. 20460

EPA Reg. Number:	Date of Issuance:
70299-11	NOV 15 2007

Term of Issuance:
Conditional

Name of Pesticide Product:
SaniDate® 5.0
Sanitizer

NOTICE OF PESTICIDE:
x Registration
___ Reregistration

(under FIFRA, as amended)

Name and Address of Registrant (include ZIP Code):
Donna Bishel
BioSafe Systems
22 Meadow St.
East Hartford, CT 06108

Note: Changes in labeling differing in substance from that accepted in connection with this registration must be submitted to and accepted by the Registration Division prior to use of the label in commerce. In any correspondence on this product always refer to the above EPA registration number.

On the basis of information furnished by the registrant, the above named pesticide is hereby registered/reregistered under the Federal Insecticide, Fungicide and Rodenticide Act.

Registration is in no way to be construed as an endorsement or recommendation of this product by the Agency. In order to protect health and the environment, the Administrator, on his motion, may at any time suspend or cancel the registration of a pesticide in accordance with the Act. The acceptance of any name in connection with the registration of a product under this Act is not to be construed as giving the registrant a right to exclusive use of the name or to its use if it has been covered by others.

This product is conditionally registered in accordance with FIFRA sec 3(c)(7)(a) provided that you:

1. Submit and/or cite all data required for registration of your product under FIFRA sec. 3(c)(5) when the Agency requires all registrants of similar products to submit such data; and submit acceptable responses required for re-registration of your product under FIFRA section 4.

2. Make the labeling changes listed below before you release the product for shipment:

   a. Revise the EPA Registration Number to read, "EPA Reg. No. "70299-11".

Signature of Approving Official:

Marshall Swindell
Product Manager Team-33
Regulatory Management Branch I
Antimicrobials Division (7510P)

Date: NOV 15 2007

EPA Form 8570-6

SaniDate® 5.0
Sanitizer

***(Alternate Brand Names**: SaniDate 5.0 Sanitizer/Disinfectant)*

For the sanitization and disinfection of hard, non-porous surfaces.
For use in commercial, agricultural and horticultural water treatment applications.
For the treatment of water for industrial and commercial water treatment systems.

FOR COMMERCIAL USE ONLY

ACTIVE INGREDIENT:	
Hydrogen Peroxide	23.0%
Peroxyacetic Acid	5.3%
INERT INGREDIENTS:	71.7%
TOTAL:	100.0%

DANGER - *PELIGRO*
STRONG OXIDIZING AGENT
KEEP OUT OF REACH OF CHILDREN

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle.
(If you do not understand this label, find someone to explain it to you in detail.)

FIRST AID	
If in eyes	• Hold eye open and rinse slowly and gently with water for 15 – 20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice.
If on skin or clothing	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15 – 20 minutes. • Call a poison control center or doctor for treatment advice.
If swallowed	• Call poison control center or doctor immediately for treatment advice. • Have person sip a glass of water if able to swallow. • Do not induce vomiting unless told to do so by the poison control center. • Do not give anything by mouth to an unconscious person.
If inhaled	• Move person to fresh air. • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. • Call a poison control center or doctor for treatment advice.
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-222-1222 for emergency medical treatment information.	
NOTE TO PHYSICIAN Probable mucosal damage may contraindicate the use of gastric lavage.	

Sold by: BioSafe Systems, 22 Meadow St, East Hartford, CT 06108
EPA Registration No.: 70299 -11
EPA Establishment No.: 60156-IL-001
Net Contents:

PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS AND DOMESTIC ANIMALS

DANGER: CORROSIVE. Causes irreversible eye damage. Causes skin burns. Do not get in eyes, on skin, or clothing. May be fatal if swallowed or inhaled. Do not breathe vapor or spray mist. Wear a respirator with an organic vapor removing cartridge with a prefilter approved for pesticides (MSHA/NIOSH approved prefix TC-23C), or a canister approved for pesticides (MSHA/NIOSH approval prefix TC-14G), or a NIOSH approved respirator with an organic vapor (OV) cartridge or canister with any N,R,P, or HE prefilter. Consult the MSDS for information about respirators and cartridges that have been tested and shown to be effective in removing hydrogen peroxide and peracetic acid from air. Wear chemical goggles, rubber gloves, and protective clothing when handling this product. Wash thoroughly with soap and water after handling and before eating, drinking, or using tobacco. Remove contaminated clothing and wash before reuse.

PHYSICAL AND CHEMICAL HAZARDS

Corrosive. Strong oxidizing agent. Do not use in concentrated form. Mix only with water in accordance with label instructions. Never bring concentrate in contact with other pesticides, cleaners or oxidative agents.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling. Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the state or tribal agency responsible for pesticide regulation.

SaniDate 5.0 Sanitizer works best when diluted with water containing minimal levels of organic or inorganic materials, and with water having a neutral pH. Thoroughly rinse out tank with water before mixing concentrate. This product will readily mix with clean, neutral water and does not require agitation.

SaniDate 5.0 Sanitizer concentrate should not be combined or mixed with any other pesticide concentrates.

(Note for reviewer: For labels that list medical premises and metal and/or stainless steel surfaces, one of the following statements must be used:)
This product is not to be used as a terminal sterilant/high level disinfectant on any surface or instrument that (1) is introduced directly into the human body, either into or in contact with the bloodstream or normally sterile areas of the body, or (2) contacts intact mucous membranes but which does not ordinarily penetrate the blood barrier or otherwise enter normally sterile areas of the body. This product may be used to pre-clean or decontaminate critical or semi-critical medical devices prior to sterilization or high-level disinfection.

Or

This product is not for use on Medical device surfaces.

Before use in federally inspected meat and poultry food processing plants and dairies, food products and packaging materials must be removed from room or carefully protected. A potable water rinse is not allowed (Do not rinse) following use of the product as a sanitizer on previously cleaned hard surfaces provided that the surfaces are adequately drained before contact with food so that little or no residue remains.

MOLD AND MILDEW CONTROL

SaniDate 5.0 Sanitizer may be used to effectively inhibit the growth of mold and mildew and odors caused by them at a rate of 0.5 fl. oz. in 1 gallon of water in general commercial environments such as:

- Schools, colleges, industrial facilities, dietary areas, office buildings, recreational facilities, retail and wholesale establishments.
- Animal hospitals, veterinary clinics, animal life science laboratories, farms, kennels, kennel runs, catteries, cages, feeding and watering equipment, pet shops, zoos, pet animal quarters, poultry premises, trucks, hatcheries, live stock quarters, stables, stalls, and pens.
- Packinghouses, food processing and rendering plants
- Healthcare facilities
- Commercial floral shops
- Hairdressing salons/barber shops
- Pharmaceutical/cosmetic facilities

SaniDate 5.0 Sanitizer effectively inhibits the growth of mold and mildew and odors caused by them when applied to hard non-porous surfaces (non food contact surfaces), such as floors, walkways, walls, tables, chairs, benches, countertops, cabinets, bathroom fixtures, sinks, shelves, racks, crates, carts, trailers, vehicles, conveyors, refrigerators (exterior), fan blades, drains, piping, commercial, municipal, and process water transfer and handling systems, filter housings, vats, tanks, pumps, valves and systems.

MOLD AND MILDEW CONTROL ON HARD, NON-POROUS SURFACES

Use a rate of 0.5 fl. oz. per gallon for hard, non-porous surfaces, (non food contact surfaces), that are lightly soiled or have been pre-rinsed to remove gross contamination. For heavily soiled hard non-porous surfaces use a rate of 1 fl. oz per 1 gallon of water. Apply solution with mop, cloth, sponge, brush, scrubber, or coarse spray device or by soaking so as to wet all surfaces thoroughly. Allow surface to remain wet for 10 minutes then remove solution and entrapped soil with a clean wet mop, cloth, or wet vacuum pickup. Prepare a fresh solution daily or when it becomes soiled or diluted. Repeat treatment every seven days, or more often if new growth appears.

REMEDIATION AND RESTORATION SITES

SaniDate 5.0 Sanitizer is recommended for use on hard, non-porous, environmental surfaces such as walls and other hard, nonporous surfaces such as floors, walls, tables, chairs, countertops, garbage bins/cans, bathroom fixtures, sinks, bed frames, shelves, racks, carts, refrigerators (exterior), glazed tile, and use sites listed on this label made of linoleum, vinyl, glazed porcelain, plastic polyethylene, stainless steel, or glass.

Preventative Treatment
To inhibit surface mold and mildew growth on hard, non-porous surfaces in new or renovated building construction, mix SaniDate 5.0 Sanitizer at a rate of 0.5 fl. oz. in 1 gallon of water and apply evenly by paintbrush, airless sprayer, low pressure hand wand, or backpack sprayer. Assure uniform coverage of surfaces to be protected. Surfaces should be evenly wet without runoff or pooling. Permit treated surfaces to be thoroughly dry before painting or affixing overlayment materials such as siding, wallboard or flooring. Repeat the application of this product as necessary if mold growth appears, following directions provided below for remedial treatment. Normally, infrequent application will provide effective control. If regrowth occurs, investigate to determine the causes and correct the problem prior to reapplication of SaniDate 5.0 Sanitizer. Mold may recur in conditions of persistently high humidity, standing water, or hidden water leaks.

Remedial Treatment
SaniDate 5.0 Sanitizer must be used as part of a comprehensive mold remediation or water damage restoration program, including:

- Periodic monitoring and inspection of conditions favorable to mold growth such as moisture ingress and high relative humidity
- Effective repairs as necessary to eliminate conditions favorable to mold growth
- Drying of affected areas to below 20% moisture content

Mix SaniDate 5.0 Sanitizer at a rate of 0.5 fl. oz. in 1 gallon of water and apply evenly by paintbrush, airless sprayer, low-pressure hand wand, or backpack sprayer. Assure uniform coverage of surfaces to be protected. Surfaces should be evenly wet without runoff or pooling. Permit treated surfaces to be thoroughly dry before painting or affixing overlayment materials such as siding, wallboard or flooring.

The following associations and Internet sites should be consulted for information on standards and guidelines for remedial treatment of mold and mildew:
• IAQA-Indoor Air Quality Association (www.iaqa.org)
• EPA-Environmental Protection Agency (www.epa.gov)
• DOH-New York City Department of Health
(www.ci.nyc.ny.us/html/doh/html/epi/moldrpt1.html)
• IICRC-Institute of Inspection, Cleaning and Restoration Certification
(http://www.iicrc.org/)

Small Areas-Total Surface Area Affected Less Than 10 Square Feet
Cleanup Methods*
Prior to applying SaniDate 5.0 Sanitizer, clean the affected area using one of the following or another preferred professional method.
Method 1: Wet vacuum (in the case of porous materials, some mold spores/fragments will remain in the material but will not grow if the material is completely dried).
Method 2: Damp-wipe surfaces with plain water or use a wood floor cleaner; scrub as needed.
Method 3: High-efficiency particulate air (HEPA) vacuum after the material has been thoroughly dried.
Dispose of the contents of the HEPA vacuum in well-sealed plastic bags.

*Minimum personal protective equipment to be worn during clean up includes gloves, N-95 respirator and goggles/eye protection.

Other Construction Materials
Concrete or Cinder Block
Method 1: Wet vacuum (in the case of porous materials, some mold spores/fragments will remain in the material but will not grow if the material is completely dried).
Method 2: High-efficiency air (HEPA) vacuum after the material has been thoroughly dried. Dispose of the contents of the HEPA vacuum in well-sealed plastic bags.

Special procedures and training are required for remediation of moldy areas larger than 10 square feet. Consult guidelines for remediation of large areas established by the Indoor Air Quality Association (www.iaqa.org) and the US Environmental Protection Agency (www.epa.gov). An excellent reference is the New York City Department of Health publication, "Guidelines on Assessment and Remediation of Fungi in Indoor Environments." An excellent guide for professional mold remediation is available from the Institute of Inspection, Cleaning And Restoration Certification (IICRC). Standard S520 is based upon reliable remediation and restoration techniques, and combines academic principles with practical elements of water damage restoration. Where structural members and/or contents have been exposed to water in excess of 24 hours, there is a possibility of extensive microbial growth that may be hidden. In such a case a complete assessment and remediation plan must be prepared that provides for user and occupant safety and documentation and monitoring of the remediation process. IICRC S520 contains excellent guidance for such a plan. In the context of such a plan, SaniDate 5.0 Sanitizer can be used on materials to be removed and disposed of and in other applications where mold inhibition is indicated. The Standard must be followed exactly and all growth and contaminated organic material removed prior to using SaniDate 5.0 Sanitizer. Before using SaniDate 5.0 Sanitizer in mitigation of large projects, you should be knowledgeable of these guidelines and follow their recommendations. In the absence of access to the guidance and standards identified, the user should refer to the following information taken from U.S. EPA's guide: Mold Remediation in Schools and Commercial Buildings (March 2001). These guidelines are based on the area and type of material affected by water damage and/or mold growth. Please note that these are guidelines; some professionals may prefer other cleaning methods. Use the appropriate remediation steps prior to application of SaniDate 5.0 Sanitizer.

Medium-Total Surface Area Affected Between 10 and 100 Square Feet
Cleanup Methods*
Method 1: Wet vacuum (in the case of porous materials, some mold spores/fragments will remain in the material but will not grow if the material is completely dried.
Method 2: Damp-wipe surfaces with plain water or with wood floor cleaner; scrub as needed.
Method 3: High-efficiency particulate (HEPA) vacuum after the material has been thoroughly dried.
Dispose of the contents of the HEPA vacuum in well-sealed plastic bags.

Other Construction Materials
Concrete or cinder block
Method 1: Wet vacuum (in the case of porous materials, some mold spores/fragments will remain in the material but will not grow if the material is completely dried.

Method 2: High-efficiency particulate (HEPA) vacuum after the material has been thoroughly dried.
Dispose of the contents of the HEPA vacuum in well-sealed plastic bags.

*Limited or Full personal protective equipment is recommended during cleanup. Limited personal protective equipment includes gloves, N-95 respirator or half-face respirator with HEPA filter, disposable overalls, goggles/eye protection. Full personal protective equipment includes gloves, disposable full body clothing, headgear, foot coverings, full-face respirator with HEPA filter.

Use professional judgment, consider potential for remediator exposure and size of contaminated area.

Large-Total Surface Area Affected Greater Than 100 Square Feet or Potential for Increase Occupant or Remediator Exposure During Remediation Estimated to be Significant
Cleanup Methods*
Method 1: Wet vacuum (in the case of porous materials, some mold spores/fragments will remain in the material but will not grow if the material is completely dried.
Method 2: Damp-wipe surfaces with plain water or with a wood floor cleaner; scrub as needed
Method 3: High-efficiency particulate (HEPA) vacuum after the material has been thoroughly dried.
Dispose of the contents of the HEPA vacuum in well-sealed plastic bags.
Method 4: Discard/remove water-damaged materials and seal in plastic bags while inside of containment, if present. Dispose of as normal waste. HEPA vacuum area after it is dried.

Other Construction Materials
Concrete or cinder block
Cleanup Methods*
Method 1: Wet vacuum (in the case of porous materials, some mold spores/fragments will remain in the material but will not grow if the material is completely dried.
Method 2: High-efficiency particulate (HEPA) vacuum after the material has been thoroughly dried. Dispose of the contents of the HEPA vacuum in well-sealed plastic bags.

*Gloves, disposable full body clothing, headgear, foot coverings, full-face respirator with HEPA filter are the recommended personal protective equipment.

*Select method most appropriate to situation. Since molds gradually destroy the things they grow on, if mold growth is not addressed promptly, some items may be damaged such that cleaning will not restore their original appearance. If mold growth is heavy and items are valuable or important, you may wish to consult a restoration/water damage/remediation expert. Please note that these are guidelines; other cleaning methods may be preferred by some professionals.

*Use professional judgment to determine prudent levels of Personal Protective Equipment and containment for each situation, particularly as the remediation site size increases and the potential for exposure and health effects rises. Assess the need for increased Personal Protective Equipment if, during the remediation, more extensive

contamination is encountered than was expected. These guidelines are for damage caused by clean water. If you know or suspect that the water source is contaminated with sewage, or chemical or biological pollutants, then the Occupational Safety and Health Administration (OSHA) requires PPE and containment. An experienced professional should be consulted if you and/or your remediators do not have expertise in remediating contaminated water situations.

Containment of Affected Materials
Total Surface Area Affected Between 10 and 100 Square Feet (All Surfaces)
Use polyethylene sheeting ceiling to floor around affected area with a slit entry and covering flap; maintain area under negative pressure with HEPA filtered fan unit. Block supply and return air vents within containment area.

Total Surface Area Affected Greater Than 100 Square Feet or Potential for Increased Occupant or Remediator Exposure During Remediation Estimated to be Significant
Use two layers of fire-retardant polyethylene sheeting with one airlock chamber. Maintain area under negative pressure with HEPA filtered fan exhausted outside of building. Block supply and return air vents within containment area.

SANITIZATION

SaniDate 5.0 Sanitizer is for use in circulation cleaning and institutional/industrial sanitizing of pre-cleaned, hard, non-porous food contact surfaces and equipment such as tanks, pipelines, beverage dispensing equipment, evaporators, filters, pasteurizers, and aseptic systems.

The main areas of use include:

- Dairies, wineries, breweries, and beverage plants
- Meat and meat products processing, packing, and rendering plants
- Milk and dairy processing/packing plants
- Egg processing/packing plants
- Seafood and poultry processing/packing plants
- Fruit and vegetable processing/packing plants
- Eating establishments
- Animal hospitals, laboratories, and housing facilities
- Schools, colleges, office buildings, industrial facilities
- Farms, farm equipment and harvesting equipment
- Hairdressing salons/barber shops

SaniDate 5.0 Sanitizer is an effective inanimate, hard surface sanitizer against fungus, mold, and bacteria such *as Escherichia coli, Staphylococcus aureus.* Use as a sanitizer on hard, non-porous surfaces such as floors, walkways, walls, tables, chairs, benches, countertops, cabinets, bathroom fixtures, sinks, shelves, racks, crates, carts, trailers, vehicles, conveyors, refrigerators, coolers, fan blades, drains, piping, commercial, municipal, and process water transfer and handling systems, filter housings, vats, tanks, pumps, valves and systems.

SaniDate 5.0 Sanitizer is an effective sanitizer for hard, non-porous personal equipment such as boots, gloves, hard hats, raingear, tools and equipment including but not

exclusive to buckets, pails, scrapers, squeegees, brooms, mops, shovels, rakes, hooks, wrenches, and screwdrivers.

SaniDate 5.0 Sanitizer is effective on the use sites listed which are manufactured from the following materials; linoleum, formica, vinyl, glazed porcelain, plastic, sealed fiberglass, polyethylene, CPVC, PVC, nylon, aluminum, steel, stainless steel, sealed wood, glazed tile, and glass.

SANITIZING PRE-CLEANED HARD NON-POROUS FOOD CONTACT SURFACES:

- Tanks, vats, piping systems, pumps, filters, evaporators, clean-in-place systems, pasteurizers and aseptic equipment used in dairies, breweries, wineries, beverage and food processing plants.
- Conveyors, boxing or packing equipment, peelers, corers, de-boners, scrapers, collators, slices, dicers, knives, saws, cutting boards, tabletops, trays, pans, racks, platters, and cans.

Clean equipment such as tanks immediately after use:

1. Remove all products from equipment unless treating only the return portion of a conveyor.
2. Remove gross food particulate matter and soil by a warm water flush, or pre-flush, or a pre-scrape and, when necessary, pre-soak treatment.
3. Thoroughly wash surfaces or equipment with a good detergent or compatible cleaning solution. Rinse equipment with potable water.
4. Add 1.6 to 1.7 liquid ounces SaniDate 5.0 Sanitizer to 5 gallons of potable water, and apply by wiping, mopping, or coarse spray, or by adding to closed system.
5. If applicable, fill closed systems with diluted sanitizer solution at a temperature of 5°C (41°F) to 40°C (104°F) and a
6. Allow a contact time of one (1) minute.
7. Allow items and/or surfaces to drain thoroughly before resuming operation. No potable water rinse is required.

SANITIZING GENERAL ENVIRONMENTAL SURFACES (NON-FOOD CONTACT) such as:

- Floors, walls, and other non-porous surfaces such as tables, chairs, counter tops, garbage cans/bins, bathroom fixtures, sinks, bed frames, shelves, racks, carts, refrigerators, coolers, glazed tiles, and other use sites listed on this label made of linoleum, vinyl, glazed porcelain, plastic (such as polyethylene), stainless steel, or glass.
- Packinghouses, food processing, fresh cut, food distribution and storage, beverage processing facilities, grocery food retail and wholesale stores, milking parlors, dairy production and transfer facilities and equipment.
- Schools, colleges, industrial facilities, dietary areas, office buildings, recreational facilities, retail and wholesale establishments.
- Animal hospitals, veterinary clinics, animal life science laboratories, catteries, kennels, kennel runs, cages, feeding and watering equipment, pet shops, zoos, pet animal quarters, poultry premises, trucks, hatcheries, and livestock quarters and pens.

Pre-Cleaned Surfaces:

1. Remove gross filth with a cleaner or other suitable detergent.
2. Add 1.6 to 1.7 liquid ounces SaniDate 5.0 Sanitizer to 5 gallons of potable water. Soak items in/with diluted solution using mop/wipe, coarse spray or flood techniques and
3. Allow contact for at least (5) five minutes.
4. Allow items and/or surfaces to air dry. No potable water rinse is required.

SANITIZING OF EATING ESTABLISHMENT EQUIPMENT such as plates, utensils, cups, glasses.

1. Scrape/pre-wash plates, utensils, cups, glasses, etc. whenever possible.
2. Wash all items with a detergent
3. Rinse thoroughly with potable water.
4. Add 1.6 to 1.7 liquid ounces SaniDate 5.0 Sanitizer to 5 gallons of potable water. Immerse all items for at least 1 minute or for a contact time as specified by a local governing sanitizing code.
5. Place all sanitizing items on a rack or drain board to air dry. No potable water rinse is required.

SANITIZING OF TABLEWARE IN LOW TO AMBIENT TEMPERATURE WARE WASHING MACHINES

1. Prepare solution by adding 1.6 to 1.7 liquid ounces SaniDate 5.0 Sanitizer to 5 gallons of potable water.
2. Inject solution into final rinse water. Solution must contact tableware for a minimum of 1 minute.
3. Place all sanitizing items on a rack or drain board to air dry. No potable water rinse is required.

FINAL SANITIZING BOTTLE RINSE for plastic, glass, or metal returnable and non-returnable bottles/cans.

1. Wash bottles with detergent or cleaning solution and rinse with potable water.
2. Prepare solution by adding 1.6 to 1.7 liquid ounces SaniDate 5.0 Sanitizer to 5 gallons of potable water.
3. Rinse bottles/cans with the diluted solution for a minimum of 1 minute.
4. Place all bottles/cans on a rack or drain board to air dry. No potable water rinse is required.

SANITIZING CONVEYORS FOR MEAT, POULTRY, SEAFOOD, FRUITS, AND VEGETABLES

1. Remove all products from equipment.
2. Prepare solution by adding 1.6 to 1.7 SaniDate 5.0 Sanitizer liquid ounces to 5 gallons of potable water.
3. Apply sanitizer solution to the return portion of the conveyor or to the equipment using a coarse spray or other means of wetting the surfaces for a minimum of 60 seconds contact time. Control the volume of solution so as to permit maximum drainage and to prevent puddles.
4. Allow equipment to drain dray before using. No potable water rinse is required.

DISINFECTION

SaniDate 5.0 Sanitizer may be used as a disinfectant at a rate of 0.5 fl. oz. in 1 gallon of water in general commercial environments such as:

- Schools, colleges, industrial facilities, dietary areas, office buildings, recreational facilities, retail and wholesale establishments.
- Animal hospitals, veterinary clinics, animal life science laboratories, kennels, kennel runs, catteries, cages, feeding and watering equipment, pet shops, zoos, pet animal quarters, poultry premises, trucks, hatcheries, live stock quarters, stables, stalls, and pens.
- Packinghouses, food processing and rendering plants
- Farms, farm equipment and harvesting equipment
- Healthcare facilities
- Commercial floral shops
- Hairdressing salons/barber shops
- Pharmaceutical/cosmetic facilities

SaniDate 5.0 Sanitizer disinfects as it cleans in one operation. It is effective against gram positive and negative bacteria (vegetative forms) such as *Xanthomonas axonopodis*, *Staphylococcus aureus*, *Pseudomonas aeruginosa, Salmonella enterica, Pediococcus damnosus, Lactobacillus malefermentans,* and can be used to clean, disinfect, and deodorize floors, walls and other hard, nonporous surfaces such as tables, chairs, countertops, garbage bins/cans, bathroom fixtures, sinks, bed frames, shelves, racks, carts, refrigerators, coolers, glazed tile, and use sites listed on this label made of linoleum, vinyl, glazed porcelain, plastic polyethylene, stainless steel, or glass.

When applied at recommended disinfectant rates, SaniDate 5.0 Sanitizer is also effective as a fungicide against *Trichophyton mentagrophytes.*

CLEANING OF SURFACES IN PREPARATION FOR DISINFECTION

Prepare SaniDate 5.0 Sanitizer disinfecting solution by adding 1 fl. oz. of the product to 1 gallon of potable water. Remove gross filth from surfaces to be disinfected by cleaning with SaniDate 5.0 Sanitizer solution by wiping, mopping, or as a coarse spray. Applications involving treatment of food contact surfaces require a sterile or potable water rinse following disinfection.

COMBINATION DISINFECTION AND CLEANING

Use a rate of 0.5 fl. oz. per gallon for hard, non-porous surfaces that are lightly soiled or have been pre-cleaned to remove gross contamination. For heavily soiled hard non-porous surfaces use a rate of 1 fl. oz per 1 gallon of water. Apply solution with mop, cloth, sponge, brush, scrubber, or coarse spray device or by soaking so as to wet all surfaces thoroughly. Allow surface to remain wet for ten (10) minutes then remove solution and entrapped soil with a clean wet mop, cloth, or wet vacuum pickup. Prepare a fresh solution daily or when it becomes soiled or diluted.

For treating sewer backups and for flooding remediation, prepare disinfecting solution of SaniDate 5.0 Sanitizer by adding 1 fl. oz. of the product to 1 gallon of potable water. Remove gross filth from surfaces by cleaning with SaniDate 5.0 Sanitizer solution by wiping, mopping, or as a coarse spray. Applications involving treatment of food contact surfaces, require a sterile or potable water rinse following cleaning.

DISINFECTING HOSPITALS, DENTAL OFFICES, NURSING HOMES, AND OTHER HEALTH CARE INSTITUTIONS

For disinfecting hard, non-porous surfaces such as floors, walls, countertops, bathing areas, lavatories, bed frames, tables, chairs, and garbage pails. For heavily soiled surfaces, a pre-cleaning step is required.

Add 2.5 - 5 fl. oz. of SaniDate 5.0 Sanitizer to 5 gallons of water. Treated surfaces must remain wet for ten (10) minutes. At this dilution, SaniDate 5.0 Sanitizer is an effective bactericide against: *Staphylococcus aureus, Pseudomonas aeruginosa, Salmonella enterica, Pediococcus damnosus, Lactobacillus malefermentans.*

DISINFECTING PHARMACEUTICAL AND COSMETIC SURFACES

SaniDate 5.0 Sanitizer is recommended for use on hard, non-porous, environmental surfaces such as floors, walls and processing equipment in pharmaceutical and cosmetic processing facilities. This product is effective at 0.5 fl. oz. per 1 gallon of water for pre-cleaned or lightly soiled surfaces to disinfect.

DISINFECTING HAIRDRESSING SALON/BARBER SHOP INSTRUMENTS AND TOOLS

Immerse pre-cleaned barber/salon tools (combs, brushes, razors, manicure/pedicure tools, clippers, scissors, trimmer blades) in a solution of SaniDate 5.0 Sanitizer/Disinfectant at a dilution of 1:256 or 0.5 fl. oz. per gallon of water, for at least ten (10) minutes. Rinse instruments thoroughly and dry before reuse. A fresh use-solution should be prepared daily or more often if the use solution becomes cloudy or soiled. Note: Plastics may remain immersed until ready to use. Stainless steel shears and instruments must be removed after 10 minutes, rinsed, dried and kept in a clean non-contaminated receptacle. Prolonged immersion may cause damage to stainless steel or metal instruments.

FIELD EQUIPMENT DISINFECTION

SaniDate 5.0 Sanitizer may be used to disinfect harvest equipment such as pickers, harvesters, trailers, trucks (including truck body parts and tires), bins, packing crates, ladders, power tools, hand tools, gloves, rubber boots, pruning shears or other equipment that may transfer *Xanthomonas axonopodis* (citrus canker surrogate). This product can also be used to disinfect surfaces contaminated with *Staphylococcus aureus, Pseudomonas aeruginosa, Salmonella enterica, Pediococcus damnosus, Lactobacillus malefermentans.* When applied at recommended disinfectant rates, SaniDate 5.0 Sanitizer is also effective as a fungicide against *Trichophyton mentagrophytes.*

1. Before disinfection, move the field equipment into an area with an impervious surface and with controlled drainage. Ensure that no disinfection solution will be released into the environment.
2. Remove gross contamination with a cleaner or other suitable detergent and rinse with water.
3. For *Xanthomonas axonopodis,* use SaniDate 5.0 Sanitizer at a dilution rate of 1:1,000 or 0.65 fl. oz per 5 gallons of water, as a general coarse spray. For bacteria such as *P. aeruginosa, S. enterica*, and *S. aureus*, use SaniDate 5.0 Sanitizer at a dilution rate of 1:256 (0.5 fl. oz/gal) as a general coarse spray.
4. Allow solution to contact surface for ten (10) minutes.
5. Allow to air dry, do not rinse.

ANIMAL HEALTH

SaniDate 5.0 Sanitizer is designed for use in animal hospitals, animal laboratories, kennels, pet shops, zoos, pet animal quarters, poultry premises, poultry hatcheries, livestock and dairy quarters. When used as directed, it is specifically designed to disinfect, deodorize and clean inanimate, hard, non-porous surfaces such as walls, floors, sink tops, furniture, operation tables, kennel runs, cages and feeding and watering equipment. In addition it will disinfect bins and cans, and any other hard, non-porous areas that are prone to odors caused by microorganisms.

All treated equipment that will contact feed or drinking water must be rinsed with potable water before reuse.

For heavily soiled areas, a pre-cleaning step is required. Prepare a fresh solution for each use.

Disinfection of Poultry Premises, Trucks, Coops, and Crates

1. Remove all poultry and feeds from premises, trucks, coops and crates.
2. Remove all litter and droppings from floors, walls and surfaces of facilities occupied or traversed by poultry.
3. Empty all troughs, racks and other feeding and watering appliances.
4. Thoroughly clean all surfaces with soap or detergent and rinse with water.
5. Saturate all surfaces with a solution of 0.5 fl. oz. per 1 gallon of water for a period of ten (10) minutes.
6. Immerse all types of equipment used in handling and restraining poultry, as well as forks, shovels and scrapers used for removing litter and manure.
7. Ventilate buildings, coops and other closed spaces. Do not house poultry or employ equipment until treatment has been absorbed, set or dried.
8. Thoroughly scrub all treated feed racks, mangers, troughs, automatic feeders, fountains and waterers with soap or detergent, and rinse with potable water before reuse.

Poultry Hatchery Disinfection

1. Clean out any remaining eggs and chicks. Remove all poultry and feeds from premises, trucks, coops and crates
2. Remove gross soils, such as litter, droppings, down shell fragments or other hatching related debris from floors, walls and surfaces of facilities occupied or traversed by poultry.
3. Empty all troughs, racks and other feeding and watering appliances and equipment.
4. Thoroughly clean all surfaces with soap or detergent and rinse thoroughly with water.
5. Saturate all surfaces with a solution of 0.5 fl. oz. per 1 gallon of water for period of ten (10) minutes.
6. Ventilate buildings, coops, and other closed spaces. Allow to dry before reintroducing eggs or poultry.
7. Thoroughly scrub all treated feed racks, mangers, troughs, automatic feeders, fountains and waterers with soap or detergent, and rinse with potable water before reuse.

Disinfection and Deodorizing of Animal Housing Facilities (Barns, Kennels, Hutches)

1. Remove all animals and feed from premises, vehicles and enclosures.
2. Remove all litter and manure from floors, walls and surfaces of barns, pens, stalls, chutes, and other facilities occupied or traversed by animals.
3. Empty all troughs, racks and other feeding and watering appliances.
4. Thoroughly clean all surfaces with soap or detergent and rinse with water.
5. Saturate all surfaces with a solution of 0.5 fl. oz. per 1 gallon of water for a period of ten (10) minutes.
6. Immerse all halters, ropes, and other types of equipment used in handling and restraining animals, as well as forks, shovels and scrapers used for removing litter and manure.
7. Ventilate buildings, cars, boats and other closed spaces. Do not house livestock or employ equipment until treatment has been absorbed, set or dried.
8. Thoroughly scrub all treated feed racks, mangers, troughs, automatic feeders, fountains and waterers with soap or detergent, and rinse with potable water before reuse.

Terrarium and Small Animal Cage and Cage Furniture Disinfection

1. Remove all animals and feed from enclosure to be cleaned.
2. Thoroughly clean all surfaces and objects (hot rocks, caves, cage furniture, feeding and watering dishes, and appliances) including the substrate in the terrarium or cage with soap or detergent and rinse with water.
3. Saturate all surfaces (floors, walls, cages and other washable hard, non-porous environmental surfaces) with a solution of 0.5 fl. oz. per 1 gallon of water for a period of ten (10) minutes. For smaller surfaces, use a trigger spray bottle to spray all surfaces with solution until wet. Then wipe surfaces dry.
4. Saturate gravel as above and let stand for 10 minutes. Place in bucket of clean water and swirl for 15-30 seconds. Thoroughly air dry before returning to terrarium.
5. Thoroughly scrub all treated surfaces with soap or detergent and rinse with potable water before reuse.
6. Do not return animals to the habitat until it is dry and ventilated.
7. Clean terrarium at least once weekly or more as needed.

Note: Substrates for desert terrariums (i.e. gravel) must be completely dry before returning to terrarium to avoid high humidity levels. Always replace substrate if a foul odor persists.

Foot Bath Mats, Pads, Walk Through Trays

Place foot bath mats, pads or trays at the entrances of all rooms and buildings to prevent cross contamination from area to area in animal containment areas, livestock and dairy quarters, and poultry premises.

1. Prior to use of this product, rinse or brush footwear surfaces to remove gross filth.
2. Make a solution using 0.5 – 1.0 fl. oz. of SaniDate 5.0 Sanitizer per gallon of water and add to foot bath mat, pad or tray, filling to capacity.
3. Place boots and shoes in the foot bath mat, pad or tray containing the recommended solution of SaniDate 5.0 Sanitizer. Allow surface to remain wet for ten (10) minutes prior to entering next area. Change solution daily or as needed.

For Foaming applications, add 2 - 4 fl. oz. per gallon of water mixed with foaming solution. Follow foaming directions as specified by the manufacturer of the foam generator/aerator.

DISINFECTION OF WATER FILTER MEDIA, MEMBRANES AND RELATED COMPONENTS AND SYSTEMS

SaniDate 5.0 Sanitizer is an effective disinfectant used for the reduction and removal of bio-organisms on the surfaces of the filter and membrane media, media housings, and related devices and equipment. It may be used for filter media or related system components or in Clean in Place (CIP) systems.

Disinfection and/or treatment of filter media and membrane in potable water systems should be performed when system is **NOT** in use or online.

For filter media disinfection applications, use a rate of 0.1 - 1 fl. oz. per gallon, and allow to soak for ten (10) minutes. Drain filter media and then rinse with clean water. Prior to producing product water (Permeate), test a sample of the permeate using_BioSafe Systems Test Strips to determine the level of active ingredients remaining in the permeate.

For clean in place (CIP) applications involving filters, use a rate of 2.5 to 10.25 fl. oz. per 100 gallons. Re-circulate solution for a minimum of 10 minutes. Upon completion of cleaning cycle, flush filter housings and/or assemblies with clean water. Test a sample of water being used to flush filter media with BioSafe Systems Test Strips to determine levels of active ingredients remaining in the flush water.

For direct disinfection of membranes, use a solution of 0.1 fl. oz. per 1 gallon of water, or 0.5 fl. oz. for 5 gallons of water, within a pH range of 3-7 and maximum water temperature of 80 degrees F. Allow the membranes to soak for a minimum of 10 minutes. Flush or rinse membranes with clean water after treatment. Test flush water with BioSafe Systems Test Strips to determine remaining active ingredient levels.

For membrane CIP systems, use a dilution rate of 2.5 – 10.25 fl. oz. per 100 gallons within a pH of 3-7 and a maximum water temperature of 80 Degrees F. After thorough draining of the solution, rinse the media thoroughly with clean or sterile water for a minimum of ten (10) minutes. Test sample of flush water with BioSafe Systems Test Strips to determine remaining active ingredient levels.

To calculate the amount of product to be used for CIP systems, identify total volume of all tanks, vessels and piping. Prepare dilution based on sum of all identified tank, vessel and piping volumes.

TREATMENT OF COOLING WATER SYSTEMS (such as cooling towers, evaporative condensers).

Severely fouled systems should be cleaned before treatment. Discontinue use of chlorine or bromine products prior to using this product. SaniDate 5.0 Sanitizer should be added to the system directly and not mixed with other chemicals or additives prior to dosing. Other chemicals should be added separately. Check compatibility of SaniDate 5.0 Sanitizer with any other chemicals or additives prior to use. Contamination with certain chemicals could result in lack of efficacy. Add SaniDate 5.0 Sanitizer at a point in the system where uniform mixing and even distribution will occur such as the cooling

tower basin sump. Shock doses may be applied for 1 to 2 hours, as necessary, whereas intermittent doses are applied for 5 to 60 minutes 1 to 100 times per day. For either shock, intermittent or continuous dosing, apply 3.2 fl oz to 22.5 fl. oz. of SaniDate 5.0 Sanitizer solution per 1,000 gallons of water. This will provide 25 to 175 ppm of SaniDate 5.0 Sanitizer, or 1 to 9 ppm of peroxyacetic acid. Repeat treatment as required to maintain control.

COMMERCIAL FLORIST USE DIRECTIONS *(Not for use in California)*

To clean, disinfect, and deodorize hard, non-porous surfaces, prepare use solution by adding 0.5 - 1 fl. oz. for one gallon of water.

1. Remove all leaves, petals, garbage, and refuse. Pre-clean surfaces using pressurized water where possible.
2. Apply SaniDate 5.0 Sanitizer solution to hard (inanimate) non-porous surfaces thoroughly wetting surfaces as recommended and required with a cloth, mop, brush, sponge, or sprayer.
3. Allow treated surfaces to remain wet for ten (10) minutes.
4. Ventilate treated surfaces and allow to air dry.
5. Prepare a fresh solution at least daily or sooner if use solution becomes visibly dirty.

DISINFECTION OF HARD, NON-POROUS FOOD-CONTACT SURFACES IN FOOD PROCESSING PLANTS AND FOOD SERVICE ESTABLISHMENTS

Before using this product, food products and packaging materials must be removed from area or carefully protected.

1. Prior to use of this product, remove gross soil particles from surfaces to be treated. For heavily soiled surfaces, a pre-wash is required.
2. Apply 0.5 fl. oz of SaniDate 5.0 Sanitizer per gallon of water with a mop, cloth, sponge, or hand trigger spray so as to wet all surfaces thoroughly.
3. Allow to remain wet with solution for ten (10) minutes.
4. Rinse all treated surfaces thoroughly with potable water before operations are resumed.

DISINFECTION OF NON-FOOD CONTACT PACKAGING EQUIPMENT

1. Prior to use of this product, remove gross soil particles from surfaces to be treated. For heavily soiled surfaces, a pre-wash is required.
2. For disinfection against beverage spoilage organisms that include *Pediococcus damnosus, Lactobacillus malefermentans,* and *Saccharomyces cerevisiae* apply 0.5 fl. oz. of SaniDate 5.0 Sanitizer per gallon of water to surfaces at a temperature of 25° to 45° C.
3. Allow to remain wet with solution for ten (10) minutes.
4. Rinse surfaces thoroughly with potable water before operations are resumed.

PACKINGHOUSE, FOOD PROCESSING AND RENDERING PLANT DISINFECTION

SaniDate 5.0 Sanitizer is effective against *Xanthomonas axonopodis, Staphylococcus aureus, Pseudomonas aeruginosa, Salmonella enterica, Pediococcus damnosus, Lactobacillus malefermentans.*

When applied at recommended disinfectant rates, SaniDate 5.0 Sanitizer is also effective as a fungicide against *Trichophyton mentagrophytes.*

Cover or remove all food and packaging materials before disinfection.

For Pre-Cleaned Surfaces: Use a rate of 0.5 fl. oz per gallon for hard non-porous surfaces that are lightly soiled or have been pre-cleaned to remove gross contamination.

To Fog Dairy, Beverage, and Food Processing Plants: SaniDate 5.0 Sanitizer can be used as an adjunct to acceptable manual cleaning and disinfecting to treat hard, non-porous room surfaces.

1. Remove gross filth from surfaces to be treated.
2. Prior to fogging, remove or carefully protect all food product and packaging materials.
3. Ensure room is properly ventilated. Vacate all personnel from the room during fogging and for a minimum of 1 hour after fogging, to ensure that there is no strong odor, which is characteristic of acetic acid, before having personnel return to work area.
4. Fog desired areas using 1 quart per 1,000 feet of room area with a solution of 1 fl. oz. of SaniDate 5.0 Sanitizer per gallon of potable water (0.25 fl. oz. per quart of potable water) or a dilution rate of 1:125.
5. Allow surfaces to drain thoroughly before operations are resumed. Any food contact surfaces must be rinsed with potable water prior to re-use.

Foot Bath Mats, Pads, Walk Through Trays

Place foot bath mats, pads or trays at the entrances of all rooms and buildings to prevent cross contamination from area to area in packinghouses, food processing and rendering plants.

1. Prior to use of this product, rinse or brush footwear surfaces to remove gross filth.
2. Make a solution using 0.5 – 1.0 fl. oz. of SaniDate 5.0 Sanitizer per gallon of water and add to foot bath mat, pad or tray, filling to capacity.
3. Place boots and shoes in the foot bath mat, pad or tray containing the recommended solution of SaniDate 5.0 Sanitizer. Allow surface to remain wet for ten (10) minutes prior to entering next area. Change solution daily or as needed.

For Foaming applications, add 2 - 4 fl. oz. per gallon of water mixed with foaming solution. Follow foaming directions as specified by the manufacturer of the foam generator/aerator.

POST HARVEST TREATMENTS IN PACKING HOUSES

Treatment for non-potable water systems (wash tanks, dip tanks, drench tanks, evaporators, humidification systems and/or storage tanks) –
Treat water containing plant pathogens with 0.5 fl. oz. of SaniDate 5.0 Sanitizer for every 10 gallons of water or use a dilution rate of 1:1,000.

For direct injection into spray waters used on process lines -

Treat water containing plant pathogens by injecting SaniDate 5.0 Sanitizer directly into spray system water with 0.5 fl. oz. of concentrate for every 100 gallons of water or use a dilution rate of 1:2,500. Applicable for use on all types of post-harvest commodities.

For post-harvest spray treatments on process and packing lines –
Inject SaniDate 5.0 Sanitizer directly into spray system water on process and packing lines to prevent bacterial and fungal diseases on post-harvest fruits and vegetables. Inject at a rate of 1:250 - 1:2,500 concentrate to clean water. For best results, where dump tanks are used, make post harvest spray treatment as produce is leaving dump tanks. Applicable for use on all types of post harvest commodities.

For direct injection into dump tanks, hydro coolers, spray system and process waters -
For treatment of water containing plant pathogens, inject SaniDate 5.0 Sanitizer and maintain a predetermined residual level by using metering equipment, coupled with ORP measuring probes.

1) Determine biological organic loading prior to treatment if possible.
2) For waters that contain low levels of biological and organic loading inject SaniDate 5.0 Sanitizer at 1.07 - 0.535 fl. oz. of concentrate for every 100 gallons of water or at a dilution rate of 1:5000 – 10,000.
3) For clean water, inject 0.535 - 0.2675 fl. oz. of SaniDate 5.0 Sanitizer for every 100 gallons of water or a dilution rate of 1:10,000- 1:20,000 to prevent the formation of algae, bacteria and fungi.

BACTERIOSTATIC
At 0.5 fl. oz. per 1 gallon of water, SaniDate 5.0 Sanitizer is effective at inhibiting the growth of bacteria when used in the presence of 400 ppm hard water and organic soil. This product can be used on floors, walls and other hard non-porous surfaces such as tables, chairs, countertops, bathroom fixtures, sinks, shelves, racks, carts, refrigerators, coolers, glazed tile, and use sites listed on this label made of linoleum, vinyl, glazed porcelain, plastic (such as polypropylene and polyethylene), stainless steel, or glass.

STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage or disposal.
PESTICIDE STORAGE: Store in original containers in a cool, well-vented area, away from direct sunlight. Do not allow product to become overheated in storage. This may cause increased degradation of the product, which will decrease product effectiveness. In case of spill, flood area with large quantities of water. Do not store in a manner where cross-contamination with other pesticides or fertilizers could occur.
PESTICIDE DISPOSAL: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility. Open dumping is prohibited. If wastes cannot be disposed of according to label directions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste Representative at the nearest EPA Regional Office for guidance.
CONTAINER DISPOSAL: Triple rinse (or equivalent). Then offer for recycling or dispose in a sanitary landfill, or incineration, if allowed by state and local authorities by burning. Stay out of smoke.

WARRANTY - This material conforms to the description on the label and is reasonably fit for the purposes referred to in the directions for use. Timing, method of application, incompatibility with other chemicals, pre-existing conditions and other conditions influencing the use of this product are beyond the control of the seller. Buyer assumes all risks associated with the use, storage, or handling of this material not in strict accordance with directions given herewith. NO OTHER EXPRESS OR IMPLIED WARRANTY OF FITNESS OR MERCHANTABILITY IS MADE.

Optional Label Claims for SaniDate 5.0 Sanitizer

- SaniDate 5.0 Sanitizer is a versatile cleaner, sanitizer, and broad-spectrum disinfectant for hard, non-porous surfaces.
- SaniDate 5.0 Sanitizer contains no phosphorous.
- SaniDate 5.0 Sanitizer cleans by removing dirt, grime, blood, urine, fecal matter and other common soils found in animal housing facilities, livestock, swine and poultry facilities, grooming facilities, farms, kennels, pet stores, veterinary clinics, laboratories, or other small animal facilities. It (also) eliminates odors leaving surfaces smelling clean and fresh.
- SaniDate 5.0 Sanitizer can be used to disinfect, clean, and deodorize terrarium and small animal cages, hot rocks, substrate, and cage furniture (plastic terrarium ornaments, driftwood, heat caves, and water dishes).
- SaniDate 5.0 Sanitizer is an economical concentrate that can be used with a mop and bucket, trigger spray, sponge, or by soaking.
- SaniDate 5.0 Sanitizer will not leave a grit or soap scum.
- When used as directed, this product will deodorize surfaces in restrooms and toilet areas, behind and under sinks and counters, garbage cans and garbage storage areas, and other places where bacterial growth can cause malodors.
- SaniDate 5.0 Sanitizer inhibits bacterial growth on moist surfaces and deodorizes by killing microorganisms that cause offensive odors.
- SaniDate 5.0 Sanitizer is a versatile disinfectant and sanitizer for veterinarian, animal care, animal laboratory, and agricultural and farm premises applications.
- SaniDate 5.0 Sanitizer is approved as a sanitizer in public eating places, dairy processing equipment, and food processing equipment and utensils. A potable rinse is not necessary when used as a sanitizer on food contact surfaces.
- SaniDate 5.0 Sanitizer is for use as a sanitizer on food contact surfaces, food processing equipment and utensils, and as a disinfectant on hard, non-porous surfaces. A potable water rinse is not allowed when used as a sanitizer on food contact surfaces.
- SaniDate 5.0 Sanitizer is for use as a sanitizer in bottling and beverage dispensing equipment.
- SaniDate 5.0 Sanitizer is for use as a sanitizer in sanitary filling of bottles and cans.
- SaniDate 5.0 Sanitizer is for use as a sanitizer in beer fermentation and holding tanks.
- SaniDate 5.0 Sanitizer is for use as a sanitizer in wineries for use on holding tanks, floors, and processing equipment.
- SaniDate 5.0 Sanitizer is for use as a sanitizer in dairy clean-in-place systems.
- Use SaniDate 5.0 Sanitizer to sanitize and disinfect non-porous salon/barber tools and instruments such as combs, brushes, scissors, clippers, trimmers, razors, blades, tweezers, and manicure instruments.
- Use SaniDate 5.0 Sanitizer on the multi-touch surfaces responsible for cross-contamination.
- SaniDate 5.0 Sanitizer is a concentrate formulation designed for use in commercial, institutional, and industrial operations.
- SaniDate 5.0 Sanitizer controls the growth of odor-causing and slime forming bacteria.

- SaniDate 5.0 Sanitizer is an effective anti-microbial cleaner designed for use by wholesale and retail florists, shippers, and in greenhouses.
- When used as directed, SaniDate 5.0 Sanitizer will disinfect hard, non-porous surfaces such as flower buckets, walls, floors, shippers, greenhouse packing areas, garbage pails, and other areas where obnoxious odors may develop.
- SaniDate 5.0 Sanitizer may be used as a general purpose anti-microbial detergent in florist shops, wholesale florist, shippers, greenhouse packing areas, and other commercial floriculture places for efficient cleaning and anti-microbial action against certain bacteria which cause:
    - Plugging of stems with slime, which reduces uptake of water for various flowers including roses, chrysanthemums, gladioli, and tulips.
    - Production of ethylene gas, which may injure blooms of the various sensitive flowers including carnations, snapdragons, some orchids, baby's breath, sweet peas, freesia, and alstroemeria.
- SaniDate 5.0 Sanitizer may be applied through automatic washing systems, immersion tanks, foaming apparatus, low-pressure sprayers and fogging (wet misting) systems.
- SaniDate 5.0 Sanitizer meets AOAC Germicidal and Detergent Test Standards for food contact surfaces.
- SaniDate 5.0 Sanitizer meets AOAC efficacy standards for hard surface sanitizing.
- SaniDate 5.0 Sanitizer meets AOAC efficacy standards for hard surface non-food contact sanitizing.
- SaniDate 5.0 Sanitizer is formulated to effectively eliminate offensive odors caused by mold and mildew.
- Antibacterial
- Hospital Use Disinfectant
- Institutional Use Disinfectant
- Easy to use
- For sanitizing of hard, non-porous surfaces, structures & equipment
- Ready to use Activated Peroxide Disinfectant
- Activated Peroxygen treatment
- Activated Peroxygen chemistry
- Contains no phosphates
- Sanitizes and deodorizes
- Leaves no residue
- Scent free
- Chlorine free
- Versatile Sanitizer

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

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

FEB 20 2008

BioSafe Systems
22 Meadow St.
East Hartford, CT 06108

Attention: Donna Bishel
Regulatory Manager

Subject: Sanidate 12.0 Microbiocide
EPA Reg. No. 70299-8
Amendment Dated November 7, 2006

The following amendment, submitted in connection with registration under section 3(c)(7)(A) of the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended, is acceptable pending that the following changes are incorporated:

- On page 2, under the **Direction of Use** section, after the statement "This product is not intended as treatment against any public health organism", add this following statement: Uses are intended to treat algal and odor causing bacteria.

- On page 2, under the **Direction of Use** section, delete the bullet "For use in bilge water treatment applications". An assessment has not been conducted for that use that would analyze risks to human health and the environment for hydrogen peroxide and peroxacetic acid. To add this language to the label, your company must submit the applicable data to support the use.

- On page 2, under the **Direction of Use** section, delete the entire forth bullet. This section was ambiguous. In particular, you referenced (in the beginning of the Direction of Use Section) a disclaimer stating that the product will not be used as a treatment against public health organisms. There are use sites mentioned in the bullet that are typically reserved for the removal of pathogenic organisms as sanitizers or disifectants. Moreover, consumers may not be able to distinguish the difference public or non-public health organism claims when purchasing this product. Furthermore, if your company intends to support this product as a sanitizer, efficacy data needs to be submitted to support this use. The concentrations of active ingredients the products you referenced through correspondence with EPA does not match the concentrations in your proposed amended product. Therefore, it is recommended that you delete all listed bullets to remove any uncertainty or confusion.

SaniDate® 12.0
Microbiocide

ACTIVE INGREDIENTS:
Hydrogen Peroxide. 18.5%
Peroxyacetic Acid..... 12.0%
OTHER INGREDIENTS:..... 69.5%
Total:..... 100.00

FOR COMMERCIAL USE ONLY
KEEP OUT OF REACH OF CHILDREN
DANGER-PELIGRO

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detaile. (If you do not understand this label, find someone to explain it to you in detail.)

STRONG OXIDIZING AGENT

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS - DANGER: CORROSIVE. Causes irreversible eye damage and skin burns. Do not get in eyes, on skin or clothing. May be fatal if inhaled. Harmful if swallowed. Do not breathe vapor or spray mist. Wear a respirator with an organic vapor removing cartridge with a prefilter approved for pesticides (MSHA/NIOSH approval prefix TC-23C), or a canister approved for pesticides (MSHA/NIOSH approval prefix TC-14G), or a NIOSH approved respirator with an organic vapor (OV) cartridge or canister with any N, R, P, or HE prefilter. Wear chemical goggles, rubber gloves, and protective clothing when handling this product. Wash thoroughly with soap and water after handling and before eating, drinking, or using tobacco. Remove contaminated clothing and wash before reuse.

FIRST AID	
If in eyes	• Hold eye open and rinse slowly and gently with water for 15 – 20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice.
If on skin or clothing	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15 – 20 minutes. • Call a poison control center or doctor for treatment advice.
If inhaled	• Move person to fresh air. • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. • Call poison control center or doctor for treatment advice.
If swallowed	• Call poison control center or doctor immediately for treatment advice. • Have person sip a glass of water if able to swallow. • Do not induce vomiting unless told to do so by the poison control center. • Do not give anything by mouth to an unconscious person.
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-222-1222 for emergency medical treatment information.	
NOTE TO PHYSICIAN - Probable mucosal damage may contraindicate the use of gastric lavage.	

PHYSICAL AND CHEMICAL HAZARDS

Strong oxidizing agent. Corrosive. Do not use in concentrated form. Mix only with water according to label instructions. Contact of concentrate with other sanitizers, cleaners or other material may cause fire.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

This product is not intended as treatment against any public health organism for any use on this label. Uses are intended to treat algal and odor causing bacteria.

- For use in commercial, agricultural, and horticultural irrigation water treatment applications
- Treatment of water for industrial and commercial water treatment systems
- Treatment of fruit and vegetable processing waters

The main areas of use include :

- Fruit and vegetable processing facilities
- Commercial, industrial, agricultural and horticultural facilities

SaniDate® 12.0 works best when diluted with water containing low levels of organic or inorganic materials. Thoroughly rinse out tank with water before mixing concentrate. SaniDate® 12.0 will readily mix with clean water and does not require agitation.

SaniDate® 12.0 is effective on the use sites listed which are manufactured from the following materials; linoleum, formica, vinyl, glazed porcelain, plastic, sealed fiberglass, polyethylene, CPVC, PVC, aluminum, steel, stainless steel, sealed wood, glazed tile, and glass.

FOR TREATMENT OF FRUIT AND VEGETABLE PROCESSING WATERS

Use SaniDate 12.0 for the treatment of waters used in the processing of raw fruits and vegetables. Mix SaniDate 12.0 with water either batch-wise or continuously at a rate of 25.6 to 89.6 fl. oz. of SaniDate® 12.0 solution to 1,000 gallons water. This will provide 200 to 700 ppm of SaniDate® 12.0, or 24 to 85 ppm 100% peracetic acid in the use solution. The fruits and vegetables can be sprayed or submerged in the resulting solution for a minimum contact time of 45 seconds, followed by adequate draining. At this use dilution, SaniDate 12.0 will control the growth of spoilage and decay causing non-public health organisms in process waters and on the surface of fresh cut or post harvest fruits and vegetables. This product is not intended for control of any public health organisms on fruit and vegetable surfaces.

FOR AGRICULTURAL IRRIGATION WATER AND DRAINAGE DITCHES

Use SaniDate® 12.0 to treat water to suppress / control algae, bacteria and fungi in agricultural irrigation and drainage water and ditches. For irrigation water, apply 0.6 to 1.3 fluid ounces of SaniDate® 12.0 per 1,000 gallons of water. Product can be simply added to the body of water, as the residual control will allow for even distribution throughout the water column. Apply SaniDate® 12.0 as needed to control and prevent algae growth; apply more frequently in times of higher water temperatures.

CONTROL OF ALGAL, FUNGAL, AND ODOR CAUSING BACTERIAL GROWTH IN PULP AND PAPER MILL SYSTEMS FOR FOOD AND NON-FOOD CONTACT PAPER

SaniDate® 12.0 provides an effective means to treat various process waters for slime control. Dosage rates should be increased or decreased depending on the control achieved. **Maximum usage rate must not exceed 2lbs. SaniDate® 12.0 solution per ton (2,000 lbs., dry basis) of pulp or paper produced.**

TREATMENT OF PAPER MACHINE WHITE WATER - SaniDate® 12.0 may be applied within the white water short circulation loop on the paper machine. Apply with either shock, intermittent, or continuous dosing. Shock doses may be applied for 1 to 2 hours, as necessary, whereas intermittent doses are applied 1 to 12 times per day, for a duration of 5 to 60 minutes each. For either shock or intermittent dosing, apply 2.5 to 102 fl. oz. of SaniDate® 12.0 per 1000 gallons of white water, producing a peak

concentration of 20 to 800 ppm of SaniDate® 12.0 during dosing. This is approximately equivalent to a peak dose of 2 to 100 ppm 100% peracetic acid. For continuous dosing, apply 2.5 to 25 fl. oz. of SaniDate®12.0 to 1000 gallons of process water, producing a peak concentration of 20 to 200 ppm of SaniDate® 12.0. This is approximately equivalent to 2 to 25 ppm 100% peracetic acid.

CATALASE CONTROL IN DEINKING WATER LOOPS - SaniDate® 12.0 may be applied to the inlet lines going to de-inking water storage following clarification. Apply with either shock, intermittent, or continuous dosing. Shock doses may be applied for 10 to 60 minutes as necessary. Apply 1.7 to 4.2 gallons SaniDate® 12.0 per 1000 gallons recirculation water, producing a peak concentration of 1700 to 4200 ppm SaniDate® 12.0 during dosing. This is approximately equivalent to a peak dose of 200 to 500 ppm 100% peracetic acid. For intermittent doses, apply 1 to 12 times per day, for a duration of 10 to 60 minutes. Apply 0.8 to 2.1 gallons SaniDate® 12.0 per 1000 gallons of water, producing a peak concentration of 800 to 2100 ppm of SaniDate® 12.0 during dosing. This is approximately equivalent to a peak dose of 100 to 250 ppm 100% peracetic acid. For continuous dosing, apply 0.2 to 1.4 gallons SaniDate® 12.0 to 1000 gallons of process water, producing a peak concentration of 200 to 1400 ppm of SaniDate® 12.0. This is approximately equivalent to 25 to 170 ppm 100% peracetic acid.

TREATMENT OF RAW AND PROCESS WATER - SaniDate® 12.0 may be applied to water at the inlet of the process water system or any other suitable point. Apply with either shock, intermittent, or continuous dosing. Shock dosing may be applied for a duration of 1 to 2 hours, as necessary, whereas intermittent dosing is applied for 2 to 15 minutes, 4 to 100 times per day. For either shock or intermittent dosing, apply 0.16 to 0.8 gallons SaniDate® 12.0 per 1,000 gallons of water producing a peak concentration of SaniDate® 12.0 of 160 ppm to 800 ppm during dosing. This is approximately equivalent to a peak dose of 20 to 100 ppm 100% peracetic acid. For continuous dosing applications, apply 0.01 to 0.3 gallons SaniDate® 12.0 to 1,000 gallons of water, producing a peak concentration of 10 to 300 ppm of SaniDate® 12.0. This is approximately equivalent to 1 to 36 ppm 100% peracetic acid.

CONTROL OF ALGAL, FUNGAL, AND ODOR CAUSING BACTERIAL GROWTH FOR NON-FOOD CONTACT PAPER USES

TREATMENT OF STARCH USED FOR SIZING ON THE PAPER MACHINE - Apply SaniDate® 12.0 directly to the starch storage tank or through the recirculation loop. Apply with either shock, intermittent, or continuous dosing. Shock doses may be applied for 1 to 2 hours, whereas intermittent doses may be applied for 5 to 60 minutes up to 12 times per day. For either shock or intermittent dosing, apply 0.8 to 5 gallons SaniDate® 12.0 per 1,000 gallons of starch solution to achieve 100 to 600 ppm 100% peracetic acid. For continuous dosing applications, apply 0.08 to 1.7 gallons SaniDate® 12.0 per 1,000 gallons of starch solution, producing a peak concentration of approximately 10 to 200 ppm 100% peracetic acid.

TREATMENT OF CLAYS USED AS COATINGS AND FILLERS ON THE PAPER MACHINE - Applications may be made at the recirculation loop or directly to the agitated slurry storage tank. Apply with either shock, intermittent, or continuous dosing. Shock doses may be applied for 1 to 2 hours, as necessary, whereas intermittent doses may be applied for 5 to 60 minutes, 1 to 12 times per day. For either shock or intermittent dosing, apply 51.2 to 102 fl. oz. SaniDate® 12.0 to 1,000 gallons clay slurry solution producing a peak concentration of approximately 50 to 100 ppm 100% peracetic acid. For continuous dosing applications, apply 51.2 to 102 fl. oz. SaniDate® 12.0 to 1,000 gallons of process water, producing a peak concentration of 5 to 100 ppm 100% peracetic acid.

COATINGS PRESERVATION - SaniDate® 12.0 can be used as an in-container preservative for the control of bacteria and fungi in water-based coatings such as paper coatings. Add 12.8 to 89.6 fl. oz. of SaniDate® 12.0 solution to 1,000 gallons water. This will provide 100 to 700 ppm of SaniDate® 12.0, or 12 to 85 ppm 100% peracetic acid.

TREATMENT OF DISPERSED PIGMENTS - SaniDate® 12.0 can be used in the control of bacteria and fungi in the manufacture and storage of dispersed pigments such as kaolin clay, titanium dioxide, calcium carbonate, calcium sulfate, barium sulfate, magnesium silicate and kieseguhr used in paint and paper

production. Add 0.12 to 0.6 lb. of SaniDate® 12.0 to each 1,000 lbs. of fluid. This will provide 120 to 600 ppm of SaniDate® 12.0, or 15 to 70 ppm 100% peracetic acid.

CONTROL OF ALGAL, FUNGAL, AND ODOR CAUSING BACTERIAL GROWTH IN INDOOR, CLOSED LOOP, NON-POTABLE, NON-FOOD CONTACT WATER SYSTEMS

TREATMENT OF RAW AND PROCESS WATER - (such as heat exchanger system water, boiler water, wet scrubber water) - SaniDate® 12.0 may be applied to water at the inlet of the water system or any other suitable point. Apply with either shock, intermittent, or continuous dosing. Shock dosing may be applied for a duration of 1 to 2 hours, as necessary, whereas intermittent dosing is applied for 2 to 15 minutes, 4 to 100 times per day. For either shock or intermittent dosing, apply 0.16 to 0.8 gallons SaniDate® 12.0 per 1,000 gallons of water producing a peak concentration of SaniDate® 12.0 of 160 ppm to 800 ppm during dosing. This is approximately equivalent to a peak dose of 20 to 100 ppm 100% peracetic acid. For continuous dosing applications, apply 1.3 to 38.4 fl. oz. SaniDate® 12.0 to 1,000 gallons of water, producing a peak concentration of 10 to 300 ppm SaniDate® 12.0. This is approximately equivalent to 1 to 35 ppm 100% peracetic acid.

TREATMENT OF COOLING WATER SYSTEMS - (such as cooling towers, evaporative condensers) Severely fouled systems should be cleaned before treatment. Discontinue use of chlorine or bromine products prior to using this product. SaniDate® 12.0 should be added to the system directly and not mixed with other chemicals or additives prior to dosing. Other chemicals should be added separately. Check compatibility of SaniDate® 12.0 with any other chemicals or additives prior to use. Contamination with certain chemicals could result in lack of efficacy. Add SaniDate® 12.0 at a point in the system where uniform mixing and even distribution will occur such as the cooling tower basin sump. Shock doses may be applied for 1 to 2 hours, as necessary, whereas intermittent doses are applied for 5 to 60 minutes 1 to 100 times per day. For either shock, intermittent or continuous dosing, apply 1.3 to 9.0 fl.oz. of SaniDate® 12.0 solution per 1,000 gallons of water. This will provide 10 to 70 ppm of SaniDate® 12.0, or 1 to 9 ppm of 100% peracetic acid. Repeat treatment as required to maintain control.

CONTROL OF ALGAL, FUNGAL AND ODOR CAUSING BACTERIAL GROWTH ON NON FOOD CONTACT GREENHOUSE WATERING SYSTEMS

TREATMENT OF GREENHOUSE SURFACES AND EQUIPMENT - (such as glazing, plastic, pots, flats, trays, cutting tools, benches, work areas, walkways, floors, walls, fan blades, watering systems, coolers, storage rooms, structures and equipment) – Clean surfaces before treatment. Sweep and remove all plant debris, and use power sprayer to wash all surfaces to remove loose dirt. Use a dilution of 1:600 of SaniDate® 12.0 for all non-porous surfaces that have been pre-cleaned with water. Apply solution with mop, sponge, power sprayer or fogger to thoroughly wet all surfaces. Cutting tools may be soaked to ensure complete coverage. Heavy growths of algae and fungi may have to be scrubbed off following application. Repeat treatment as required to maintain control.

TREATMENT OF GREENHOUSE EVAPORATIVE COOLERS – Treat contaminated surfaces with a dilution of 1:600 of SaniDate® 12.0. For maintenance, treat cooler water once a week with a dilution of 1:2,000 of SaniDate® 12.0 for every gallon of cooling water.

TREATMENT OF GREENHOUSE IRRIGATION SYSTEMS - (such as flooded floors, flooded benches, recycled water systems, drip trickle, capillary mats, sprinkler systems, humidification and misting systems) – Treat contaminated water with a dilution of 1:5,000 of SaniDate® 12.0. For maintenance, treat clean water with a dilution of 1:50,000 to 1:100,000 of SaniDate® 12.0 as needed.

CHEMIGATION:

General Requirements -

1) Apply this product only through a drip system or sprinkler system, including flood, and drip (trickle) irrigation systems.

2) Crop injury, lack of effectiveness, or illegal pesticide residues in the crop can result from non-uniform distribution of treated water.
3) If you have questions about calibration, you should contact State Extension Service specialists, equipment manufacturers or other experts.
4) Do not connect an irrigation system (including greenhouse systems) used for pesticide application to a public water system unless the pesticide label-prescribed safety devices for public water systems are in place.
5) A person knowledgeable of the chemigation system and responsible for its operation, or under the supervision of the responsible person, shall shut the system down and make necessary adjustments should the need arise.
6) Posting of areas to be chemigated is required when 1) any part of a treated area is within 300 feet of sensitive areas such as residential areas, labor camps, businesses, day care centers, hospitals, in-patient clinics, nursing homes or any public areas such as schools, parks, playgrounds, or other public facilities not including public roads, or 2) when the chemigated area is open to the public such as golf courses or retail greenhouses.
7) Posting must conform to the following requirements. Treated areas shall be posted with signs at all usual points of entry and along likely routes of approach from the listed sensitive areas. When there are no usual points of entry, signs must be posted in the corners of the treated areas and in any other location affording maximum visibility to sensitive areas. The printed side of the sign should face away from the treated area towards the sensitive area. The signs shall be printed in English. Signs must be posted prior to application and must remain posted until foliage has dried and soil surface water has disappeared. Signs may remain in place indefinitely as long as they are composed of materials to prevent deterioration and maintain legibility for the duration of the posting period.
8) All words shall consist of letters at least 2.5 inches tall, and all letters and the symbol shall be a color which sharply contrasts with their immediate background. At the top of the sign shall be the words KEEP OUT, followed by an octagonal stop sign symbol at least 8 inches in diameter containing the word STOP. Below the symbol shall be the words PESTICIDES IN IRRIGATION WATER.

Specific Requirements for Chemigation Systems Connected to Public Water Systems -

1) Public water system means a system for the provision to the public of piped water for human consumption if such system has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year.
2) Chemigation systems connected to public water systems must contain a functional, reduced-pressure zone, backflow preventer (RPZ) or the functional equivalent in the water supply line upstream from the point of pesticide introduction. As an option to the RPZ, the water from the public water system should be discharged into a reservoir tank prior to pesticide introduction. There shall be a complete physical break (air gap) between the outlet end of the fill pipe and the top or overflow rim of the reservoir tank of at least twice the inside diameter of the fill pipe.
3) The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump.
4) The pesticide injection pipeline must contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.
5) The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops, or in cases where there is no water pump, when the water pressure decreases to the point where pesticide distribution is adversely affected.
6) Systems must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump) effectively designed and constructed of materials that are compatible with pesticides and capable of being fitted with a system interlock.
7) Do not apply when wind speed favors drift beyond the area intended for treatment.

Specific Requirements for Sprinkler Chemigation -

1) The system must contain a functional check valve, vacuum relief valve and low-pressure drain appropriately located on the irrigation pipeline to prevent water source contamination from backflow.
2) The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump.
3) The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.
4) The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops.
5) The irrigation line or water pump must include a functional pressure switch which will stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected.
6) Systems must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump) effectively designed and constructed of materials that are compatible with pesticides and capable of being filled with a system interlock.
7) Do not apply when wind speed favors drift beyond the area intended for treatment.

Specific Requirements for Flood Chemigation -

1) Systems using a gravity flow pesticide dispensing system must meter the pesticide into the water at the head of the field and downstream of a hydraulic discontinuity such as a drop structure or weir box to decrease potential for water source contamination from backflow if water flow stops.
2) The systems utilizing a pressurized water and pesticide injection system must meet the following requirements:
   a. The system must contain a functional check valve, vacuum relief valve and low-pressure drain appropriately located on the irrigation pipeline to prevent water source contamination from backflow.
   b. The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump.
   c. The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.
   d. The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops.
   e. The irrigation line or water pump must include a functional pressure switch which will stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected.
   f. Systems must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump) effectively designed and constructed of materials that are compatible with pesticides and capable of being filled with a system interlock.

Specific Requirements for Drip (Trickle) Chemigation -

1) The system must contain a functional check valve, vacuum relief valve and low-pressure drain appropriately located on the irrigation pipeline to prevent water source contamination from backflow.
2) The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump.
3) The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.
4) The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops.

5) The irrigation line or water pump must include a functional pressure switch which will stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected.
6) Systems must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump) effectively designed and constructed of materials that are compatible with pesticides and capable of being filled with a system interlock.

Application Instructions -

1) Remove scale, pesticide residues, and other foreign matter from the chemical supply tank and entire injector system. Flush with clean water. Failure to provide a clean tank, void of scale or residues may cause product to lose effectiveness or strength.
2) Determine the treatment rates as indicated in the directions for use and make proper dilutions.
3) Prepare a solution in the chemical tank by filling the tank with the required water and then adding product as required. The product will immediately go into suspension without any required agitation.
4) Do not apply SaniDate 12.0 in conjunction with any other pesticides or fertilizers; this has the potential to cause reduced performance of the product. Avoid application in this manner.

STORAGE & DISPOSAL

DO NOT CONTAMINATE WATER, FOOD OR FEED BY STORAGE OR DISPOSAL

STORAGE: Store in original vented container in a dry location away from heat and out of direct sunlight. In case of fire involving product, use water. In case of large quantities of spilled material, dike with sand or earth. Dilute with large quantities of water.

PESTICIDE DISPOSAL: Pesticide wastes are acutely hazardous. Improper disposal of excess pesticide spray mixture or rinsate is a violation of Federal law. Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, or public waters unless the components of this product are specifically identified and addressed in a NPDES permit. Do not discharge effluent containing this product into sewer systems without previously notifying the sewage plant authority. For additional information, refer to the product Material Safety Data Sheet.

CONTAINER DISPOSAL: (Plastic Containers 30, and 55 gallon drums): Triple rinse (or equivalent) then offer for recycling or reconditioning or puncture and dispose of in a sanitary landfill or incineration or, if allowed by state and local authorities, by burning. If burned, stay out of smoke. (For 275 gallon totes) Triple rinse (or equivalent). Then dispose of in a sanitary landfill or by other approved state and local procedures.

Sold by:
BioSafe Systems
22 Meadow St.
East Hartford, CT 06108

EPA Reg. No. 70299-8
EPA Establishment No. 60156-IL-001

Lot No.: XXXX
24 Hour Emergency (281) 479-2826
For Transport Emergency call CHEMTREC (800) 424-9300

Net Contents: XX Gallons (XXlbs.)
Weight per gallon: 9.26 lbs.
Expiration: MM/DD/YY

1677-164 8/8/2007 1/4

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

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

Ecolab Inc..
370 N. Wabasha Street
St. Paul, MN 55102

AUG 08 2007

Attention: Joy A. Salverda
Regulatory Mananger

Subject: Tsumami 100
EPA Reg. No. 1677-164
Amendment Application Date: April 2, 2007
EPA Received Date: April 5, 2007

The amendment referred to above, submitted in connection with registration under the Federal Insecticide, Fungicide and Rodenticide Act, as amended, is acceptable. The Agency has no objections to the addition of the statement "For Organic Production" and also including new marketing language.

If you have any questions concerning this letter, please contact Demson Fuller at (703) 308-8062.

Sincerely,

M Swindell

Marshall Swindell
Product Manager (33)
Regulatory Management Branch 1
Antimicrobials Division (7510C)

Tsunami 100

Water Additive for Pathogen* Reduction in
Fruit and Vegetable Processing Water and Controlling the Growth of Spoilage and
Decay Causing Non-Public Health Organisms on Fruit and Vegetable Surfaces

For Organic Production.

Tsunami 100 may be used as a water additive in fruit and vegetable processing water on products labeled as organic in food processing facilities on both raw agricultural commodities and on fruits and vegetables that will be further processed.

Active Ingredients:	
Peroxyacetic acid	15.2%
Hydrogen peroxide	11.2%
Inert Ingredients:	73.6%
Total:	100.0%

KEEP OUT OF REACH OF CHILDREN

DANGER

PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS AND DOMESTIC ANIMALS
CORROSIVE: Causes severe eye damage and skin burns. Harmful or fatal if swallowed. Do not get in eyes, on skin, or on clothing. Wear chemical goggles, rubber gloves, and protective clothing if handling concentrate. Wash thoroughly with soap and water after handling and before eating, drinking, and chewing gum, or using tobacco. Remove any contaminated clothing and wash before re-use.

FIRST AID

IF ON SKIN OR CLOTHING: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15 –20 minutes. Call a poison control center or doctor for treatment advice.
IF IN EYES: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.
IF SWALLOWED: Call a poison control center or doctor immediately for treatment advice. Have a person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by the poison control center or doctor. Do not give anything by mouth to an unconscious person.
FOR EMERGENCY MEDICAL INFORMATION CALL TOLL-FREE: 1-800-328-0026
Have the product container or label with you when calling a poison control center or doctor, or going for treatment.
NOTE TO PHYSICIAN: Probable mucosal damage may contraindicate the use of gastric lavage.

PHYSICAL AND CHEMICAL HAZARDS:
Strong oxidizing agent. Corrosive. Do not use in concentrated form. Mix only with water according to label instructions. Never bring concentrate in contact with other sanitizers, cleaners or organic substances.

ENVIRONMENTAL HAZARDS: This product is toxic to birds, fish, and aquatic invertebrates. Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or other waters unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance contact your State Water Board or Regional Office of the EPA.

Used as directed, *Tsunami 100* reduces 99.9% of the pathogens *Escherichia coli* O157:H7*, *Listeria monocytogenes** and *Salmonella enterica.** in fruit and vegetable processing waters. *Tsunami 100* also provides control of spoilage and decay causing non-public health organisms present in processing waters and on the surface of post-harvest, fresh-cut and processed fruits and vegetables.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

FOR PATHOGEN* REDUCTION AND CONTROL IN FRUIT AND VEGETABLE PROCESSING WATERS:

A. Batch systems with no makeup water added:
   1. Ensure that water is mixing in the processing vessel.
   2. Add *Tsunami 100* at a rate from 2.5-6.7 fluid ounces per 100 gallons of process water. This will produce about 215-575 ppm total product and about 30-80 ppm peroxyacetic acid. At this use dilution, *Tsunami 100* will provide a 99.9% reduction against the pathogens *Escherichia coli* O157:H7*, *Listeria monocytogenes** and *Salmonella enterica.**.
   3. Measure the residual peroxyacetic acid concentration in the water using a Test Kit (consult Ecolab Representative) and adjust dose as needed. Allow a 1.5 minute mixing time.

B. Continuous systems with makeup water continuously added:

Initial dose:
   1. Ensure that water is mixing in the processing vessel and/or piping.
   2. Add *Tsunami 100* at a rate from 2.5-6.7 fluid ounces per 100 gallons of process water. This will produce about 215-575 ppm total product and about 30-80 ppm peroxyacetic acid. At this use dilution, *Tsunami 100* will provide a 99.9% reduction against the pathogens *Escherichia coli* O157:H7*, *Listeria monocytogenes** and *Salmonella enterica.**.
   3. Measure the residual peroxyacetic acid concentration in the water using a Test Kit (consult Ecolab Representative) and adjust dose as needed. Allow a 1.5 minute mixing time.

Continuous Dosing:

Meter *Tsunami 100* at a rate from 2.5-6.7 fluid ounces per 100 gallons of fresh makeup water added to the system. This will produce about 215-575 ppm total product and about 30-80 ppm peroxyacetic acid. Measure the residual peroxyacetic acid concentration in the water using a Test Kit (consult Ecolab Representative) and adjust dose as needed. Allow a 1.5 minute mixing time.

FOR TREATMENT OF FRUIT AND VEGETABLE SURFACES AND PROCESS WATERS:

Mix *Tsunami 100* with water either batchwise or continuously to produce about 36 - 575 ppm total product and about 5 - 80 ppm peroxyacetic acid in use solution. This can be accomplished by initially adding *Tsunami 100* at a rate from 0.42 - 6.7 fluid ounces per 100 gallons of process water. The fruits and vegetables can be sprayed or submerged in the resulting solution for a minimum contact time of 45 seconds, followed by adequate draining. At this use dilution, *Tsunami 100* will control the growth of spoilage and decay causing non-public health organisms in process waters and on the surface of fruits and vegetables. This product is not intended for control of any public health organisms on fruit and vegetable surfaces.

FOR TREATMENT OF SEEDS NOT INTENDED FOR HUMAN OR ANIMAL CONSUMPTION:

Apply to seeds as directed to control seedborne microorganisms that cause plant disease or spoilage and decay of developing seedlings. Only treat seeds of the crops listed on this label. Mix *Tsunami 100* with clean water either batchwise or continuously to no more than 11,500 ppm total product (1750 ppm residual peroxyacetic acid) in use solution. This can be accomplished by adding 20 fluid ounces *Tsunami 100* per 16.4 gallons of water . The volume of treatment solution should be at least two times greater than the volume of seeds to be treated. The seeds should be submerged in the treatment solution and agitated for 30 minutes. Following treatment, remove seeds from treatment solution and

ACCEPTED
AUG 8 2007
Under the Federal Insecticide, Fungicide, and Rodenticide Act as amended, for the pesticide, registered under EPA Reg. No. 1677-164
4/2/07

Tsunami 100 can be used on the following types of fresh, post harvest and further processed fruits and vegetables:

Vegetables
- Root and tuber vegetables: Carrot, potato, radish, rutabaga, sweet potato, yam, sugar beet
- Leaves of root and tuber vegetables: Turnip greens and sugar beet
- Bulb vegetables: Onion (dry bulb and green), leek, garlic, shallot
- Leafy vegetables: Lettuce (head and leaf), celery, fennel, endive, escarole, parsley, radicchio, rhubarb, spinach
- *Brassica* leafy vegetables: Broccoli, Brussel sprouts, cabbage, cauliflower, mustard greens, mustard spinach
- Legumes [succulent or dried], bean (green, kidney, lima, mung, navy, pinto, snap, wax), pea (chickpea, lentil, dwarf, garden, English, field, edible pea pod), alfalfa, and soybean
- Fruiting vegetables: Pepper (bell, pimento, hot, sweet), tomato, tomatillo, eggplant
- Cucurbits: Cucumber, melon (cantaloupe, crenshaw melon, honeydew, honey ball melon, mango melon, muskmelon, pineapple melon, watermelon), summer squash, pumpkins, winter squash

Fruits
- Citrus fruits: Sweet and sour orange, lemon, lime, tangelo, tangerine, mandarin, citrus citron, kumquats, grapefruit
- Pome fruits: Apples and pears
- Stone fruits: Sour and sweet cherry, peach, nectarine, plum, prune
- Small Fruits and berries: Blackberries, blueberries, red and black raspberries

Sprouts and seeds of: vegetables and fruits that are listed on this label including, root & tuber vegetables, bulb vegetables, leafy vegetables, *Brassica* leafy vegetables, legumes, fruiting vegetables, cucurbits, citrus fruits, pome fruits, stone fruits, small fruits and berries, mustard
Tree nuts: Almond, Brazil, filbert, cashew, pecan, walnut (black & English), macadamia, chestnut
Cereal grains: Corn, barley, oats, rice, wheat, triticale, wild rice, sweet corn
Herbs and Spices: Basil, chives, coriander, dill, lemongrass marjoram, sage, savory, tarragon, thyme
Miscellaneous: Asparagus, avocado, artichoke, banana, cranberry, fig, grape, kiwifruit, mango, mushroom, okra, peanut, persimmon, pineapple, raisins, strawberry, water chestnut, watercress

STORAGE & DISPOSAL:

DO NOT CONTAMINATE WATER, FOOD OR FEED BY STORAGE OR DISPOSAL

PESTICIDE STORAGE: Product should be kept cool and in a vented container to avoid any explosion hazard.

PESTICIDE DISPOSAL: Pesticide wastes are acutely hazardous. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal Law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.

CONTAINER DISPOSAL:

[4 gallon or 50 gallon] Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

[300 gallon tote] Verify that the tote is empty. Do not rinse or clean. Seal tote and contact Ecolab for return.

FOR COMMERCIAL OR INSTITUTIONAL USE ONLY
STRONG OXIDIZING AGENT

EPA Reg. No. 1677-164
EPA Est.: 1677-MN-1 (P), 60156-IL-1 (SI), 1677-CA-2 (R), 1677-TX-1 (D), 1677-OH-1 (H), 1677-IL-2 (J), 1677-PR-1 (B), 1677-CA-1 (S), 1677-GA-1 (M), 1677-WV-1 (V)
Superscript refers to first letter of date code.

Manufactured by:
Ecolab Inc., Food & Beverage Division
370 N. Wabasha Street

ACCEPTED
AUG 8 2007
Under the Federal Insecticide, Fungicide, and Rodenticide Act as amended, for the pesticide specified on
EPA Reg. No. 1677-164

Net Contents:
4 U.S. Gallons (15.1 liters)
50 U.S. Gallons (189 liters)
300 U.S. Gals. (1134 liters)

1677-186 05/08/2008 1/5

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

EPA United States Environmental Protection Agency **Office of Pesticide Programs**

Ecolab, Inc.
380 N. Wabasha Street
St. Paul, MN 55102

MAY - 8 2008

Attention: Rhonda K. Schulz, Associate Director
Regulatory Affairs

Subject: VICTORY
EPA Registration No. 1677-186
Your Amendment Dated April 3, 2008

The amendment, submitted in connection with registration under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), as amended, is acceptable.

-To Add an Additional Product Descriptor

A stamped copy of the "accepted" product labeling is enclosed for your records.

If you have any questions concerning this letter, please contact Martha Terry at (703) 308-6217.

Sincerely

Marshall Swindell
Product Manager 33
Regulatory Management Branch 1
Antimicrobials Division (7510P)

Enclosure

2/5

VICTORY

Water Additive for Pathogen* Reduction in Fruit and Vegetable Wash or Process Waters

Controls the Growth of Spoilage and Decay Causing Non-Public Health Organisms on Fruit and Vegetable Surfaces and in Wash or Process Waters Antimicrobial Fruit and Vegetable Wash

Active Ingredients:	
Peroxyacetic acid	15.2%
Hydrogen peroxide	11.2%
Inert Ingredients:	73.6%
Total:	100.0%

ACCEPTED
with COMMENTS
In EPA Letter Dated:
MAY - 8 2008

Under the Federal Insecticide, Fungicide, and Rodenticide Act as amended for the pesticide, registered under EPA Reg. No. 1677-186

KEEP OUT OF REACH OF CHILDREN

DANGER

PRECAUTIONARY STATEMENTS
HAZARDS TO HUMANS AND DOMESTIC ANIMALS
CORROSIVE: Causes severe eye damage and skin burns. Harmful or fatal if swallowed. Do not get in eyes, on skin, or on clothing. Wear chemical goggles, rubber gloves, and protective clothing if handling concentrate. Wash thoroughly with soap and water after handling. Remove any contaminated clothing and wash before re-use.

FIRST AID
IF ON SKIN OR CLOTHING: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15 –20 minutes. Call a poison control center or doctor for treatment advice.
IF IN EYES: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.
IF SWALLOWED: Call a poison control center or doctor immediately for treatment advice. Have a person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by the poison control center or doctor. Do not give anything by mouth to an unconscious person.
FOR EMERGENCY MEDICAL INFORMATION CALL TOLL-FREE: 1-800-328-0026
NOTE TO PHYSICIAN: Probable mucosal damage may contraindicate the use of gastric lavage.

PHYSICAL AND CHEMICAL HAZARDS:
Strong oxidizing agent. Corrosive. Do not use in concentrated form. Mix only with water according to label instructions. Never bring concentrate in contact with other sanitizers, cleaners or organic substances.

ENVIRONMENTAL HAZARDS: This product is toxic to birds, fish, and aquatic invertebrates. Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or other waters unless in accordance with the requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance contact your State Water Board or Regional Office of the EPA.

3/5

Used as directed, ***Victory*** reduces 99.9% of the pathogens *Escherichia coli* O157:H7*, *Listeria monocytogenes** and *Salmonella enterica** in fruit and vegetable wash waters. ***Victory*** also provides control of spoilage and decay causing non-public health organisms present in the wash or process waters and on the surface of fresh-cut, post-harvest and processed fruits and vegetables.

Areas of Use: Restaurants, cafeterias, food service operations, commissaries, kitchens, grocery stores, and food processing plants.

DIRECTIONS FOR USE
It is a violation of Federal Law to use this product in a manner inconsistent with its labeling.

For Pathogen* Reduction and Control in Fruit and Vegetable Wash or Process Waters:
Victory will provide a 99.9% reduction of the pathogens *Escherichia coli* O157:H7*, *Listeria monocytogenes** and *Salmonella enterica.** in fruit and vegetable wash or process waters.

Mix ***Victory*** with water either batchwise or continuously by adding 1.0 fluid ounce ***Victory*** per 16.4 gallons of water (53.3 grams or (48 mL) ***Victory*** per 100 L of water). This will produce 30-80 ppm peroxyacetic acid. Adjust dose as needed to maintain product concentration. Allow a minimum contact time of 90 seconds.

For Treatment of Fruit and Vegetable Surfaces and Wash or Process Waters:
Victory will control the growth of spoilage and decay causing non-public health organisms in wash waters and on the surface of fruits and vegetables. This product is not intended for control of any public health organisms on fruit and vegetable surfaces.

Mix ***Victory*** with water either batchwise or continuously by adding 1.0 fluid ounce ***Victory*** per 16.4 gallons of water (53.3 grams or (48 mL) ***Victory*** per 100 L of water). This will produce 30-80 ppm peroxyacetic acid. Adjust dose as needed to maintain product concentration.

The fruits and vegetables can be sprayed or submerged in the resulting solution, followed by adequate draining. Minimum contact times of a 45 second continuous spray application and 1 minute for submersion are recommended.

Refer to ***Victory*** Package Insert for the recommended list of fruits and vegetables.

ACCEPTED
with COMMENTS
EPA Letter Dated:
MAY - 8 2008

Under the Federal Insecticide, Fungicide, and Rodenticide Act as amended, for the pesticide, registered under EPA Reg. No. 1677-186

STORAGE AND DISPOSAL:
DO NOT CONTAMINATE WATER OR FOOD BY STORAGE OR DISPOSAL
PESTICIDE STORAGE: Product should be kept cool and in vented container to avoid any explosion hazard.
PESTICIDE DISPOSAL: Pesticide wastes are acutely hazardous. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal law. If these wastes cannot be disposed of by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste representative at the nearest EPA Regional Office for guidance.
CONTAINER DISPOSAL:
[Sealed containers]: Dispense product thorough the appropriate Ecolab equipment until container is empty. Dispose of empty container in a sanitary landfill, or incineration, or if allowed by state and local authorities, by burning. If burned, stay out of smoke.
[50 gallon drum] Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.
[300 gallon tote] Verify that the tote is empty. Do not rinse or clean. Seal tote and contact Ecolab for return.

Patents Pending

Net Contents:
58 oz. (1, 715 mls)
96 oz. (2,839 mls)

FOR COMMERCIAL OR INSTITUTIONAL USE ONLY
STRONG OXIDIZING AGENT

Manufactured by:
Ecolab Inc.
370 N. Wabasha Street
St. Paul, MN 55102

EPA Est.: 1677-MN-1 (P), 60156-IL-1 (SI)
1677-CA-2 (R), 1677-TX-1 (D), 1677-OH-1 (H)
1677-IL-2 (J), 1677-PR-1 (B), 1677-CA-1 (S)
1677-GA-1 (M), 1677-WV-1 (V)
Superscript refers to first letter of date code

ACCEPTED
with COMMENTS
EPA Letter Dated:

MAY - 8 2008

Under the Federal Insecticide, Fungicide, and Rodenticide Act as amended, for the pesticide, registered under EPA Reg. No. 1677-186

5/5

Package insert

VICTORY

Water Additive for Pathogen* Reduction in Fruit and Vegetable Wash Waters

Controls the Growth of Spoilage and Decay Causing Non-Public Health Organisms on Fruit and Vegetable Surfaces Antimicrobial Fruit and Vegetable Wash

EPA Reg. No. 1677-186

VICTORY can be applied to the following types of fresh, post harvest, and further processed fruits and vegetables:

Vegetables

- Root and tuber vegetables: Carrot, potato, radish, rutabaga, sweet potato, yam, sugar beet
- Leaves of root and tuber vegetables: Turnip greens and sugar beet
- Bulb vegetables: Onion (dry bulb and green), leek, garlic, shallot
- Leafy vegetables: Lettuce (head and leaf), celery, fennel, endive, escarole, parsley, radicchio, rhubarb, spinach
- *Brassica* leafy vegetables: Broccoli, Brussel sprouts, cabbage, cauliflower, mustard greens, mustard spinach
- Legumes [succulent or dried]: bean (green, kidney, lima, mung, navy, pinto, snap, wax), pea (chick, lentil, dwarf, garden, English, field, edible pea pod), alfalfa, and soybean
- Fruiting vegetables: Pepper (bell, pimento, hot, sweet), tomato, tomatillo, eggplant
- Cucurbits: Cucumber, melon (cantaloupe, crenshaw, honeydew, honey ball, mango, muskmelon, pineapple, watermelon), summer squash, pumpkins, winter squash

Fruits

- Citrus fruits: Sweet orange, sour orange, lemon, lime, tangelo, tangerine, mandarin, citrus citron, kumquats, grapefruit
- Pome fruits: Apples and pears
- Stone fruits: Sour and sweet cherry, peach, nectarine, plum, prune
- Small Fruits and berries: Blackberries, blueberries, red and black raspberries

Sprouts and seeds of: vegetables and fruits that are listed on this label including, root & tuber vegetables, bulb vegetables, leafy vegetables, *Brassica* leafy vegetables, legumes, fruiting vegetables, cucurbits, citrus fruits, pome fruits, stone fruits, small fruits and berries, mustard

Tree nuts: Almond, Brazil, filbert, cashew, pecan, walnut (black & English), macadamia, chestnut

Cereal grains: Corn, barley, oats, rice, wheat, triticale, wild rice, sweet corn

Herbs and Spices: Basil, chives, coriander, dill, lemongrass marjoram, sage, savory, tarragon, thyme

Miscellaneous: Asparagus, avocado, artichoke, banana, cranberry, fig, grape, kiwifruit, mango, mushroom, okra, peanut, persimmon, pineapple, raisins, strawberry, water chestnut, watercress

ACCEPTED
with COMMENTS
EPA Letter Dated:
MAY -8 2008

Under the Federal Insecticide, Fungicide, and Rodenticide Act as amended, for the pesticide registered under EPA Reg. No. 1677-186

Ecolab Inc.
370 N. Wabasha Street
St. Paul, MN 55102

63838-1 10/13/2005 Page 176

PERASAN® 'A' (Antimicrobial Solution)

PERASAN® 'A' is a peroxyacetic acid-based sanitizer/disinfectant developed for the following uses:

Institutional/Industrial Sanitizer and Disinfectant for Previously Cleaned Hard Non-Porous Food Contact Surfaces in: Dairies, Wineries, Breweries, Food and Beverage Plants, Poultry and Egg Facilities, and Animal Housing.

Hard, Non-Porous Surface Disinfection in: Hospitals, Schools, Industrial Facilities, Office Buildings, Veterinary Clinics.

Bacteria, Slime, Odor and Algae Control in: Recirculating Cooling Water and Evaporative Coolers, Reverse Osmosis, Nano and Ultra Filtration, and Agricultural Waters.

Active Ingredients:	
Peroxyacetic Acid	5.6%
Hydrogen Peroxide	26.5%
Inert Ingredients:	67.9%
Total:	100.0%

ACCEPTED
OCT 13 2005
Under the Federal Insecticide, Fungicide, and Rodenticide, Act as amended, for the pesticide, registered under EPA Reg. No. 63838-1

EPA Registration No. 63838-1
EPA Est. No. 69994-CA-01; 60156-IL-01

Before Using This Product, Please Read This Entire Label Carefully

KEEP OUT OF REACH OF CHILDREN

DANGER

FIRST AID

IF SWALLOWED:	Call a poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give anything by mouth to an unconscious person.
IF ON SKIN OR CLOTHING	Take off contaminated clothing and shoes. Rinse skin immediately with plenty of soap and water for 15-20 minutes. Call a poison control center or doctor for treatment advice.
IF IN EYES	Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.
IF INHALED	Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible. Call a poison control center or doctor for treatment advice.
QUESTIONS ? 1-209-581-9576	Have the product container or label with you when calling a poison control center or doctor, or going for treatment.
NOTE TO PHYSICIAN:	Probable mucosal damage may contraindicate the use of gastric lavage.

Manufactured By:

Enviro Tech Chemical Services, Inc.
500 Winmoore Way
Modesto, CA 95358

Ver 5/ 5-21-05

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PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

DANGER. CORROSIVE. Do not enter an enclosed area without proper respiratory protection. Causes irreversible eye damage and skin burns. May be fatal if inhaled or absorbed through skin. Harmful if swallowed. Do not breathe vapors or spray mist. Do not get in eyes, on skin, or on clothing. Wear goggles and face shield and rubber gloves when handling. Wash thoroughly with soap and water after handling and before eating, drinking or using tobacco. Remove contaminated clothing and wash before reuse.

Physical or Chemical Hazards

STRONG OXIDIZING AGENT. CORROSIVE. Mix only with potable water at 60-80° F. Product must be diluted in accordance with label directions prior to use. PERASAN® 'A' is not combustible; however, at temperatures exceeding 156°F, decomposition occurs releasing oxygen. The oxygen released could initiate combustion.

Environmental Hazards:

This pesticide is toxic to birds, fish and aquatic invertebrates. Caution should be used when applying indoors because pets may be at risk. Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans or other waters unless in accordance with the requirements of the National Pollution Discharge System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product into sewer systems without previously notifying the local sewage plant authority.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

SANITIZATION

PERASAN® 'A' peroxyacetic acid sanitizer is recommended for use on precleaned surfaces such as equipment, pipelines, tanks, vats, filters, evaporators, pasteurizers, and aseptic equipment in dairies, breweries, wineries, beverage and food processing/packing plants, egg processing/packing equipment surfaces, and eating establishments. This product is effective as a sanitizer when solution is prepared in water of up to 400 ppm hardness as $CaCO_3$. This product has demonstrated greater than 99.999% reduction of organisms after 60 seconds exposure period in the AOAC Germicidal and Detergent Sanitizing Action of Disinfectants study.

NOTE: FOR MECHANICAL OPERATIONS prepared use solution may not be reused for sanitizing but may be reused for other purposes such as cleaning.
FOR MANUAL OPERATIONS fresh sanitizing solutions should be prepared daily or more often if the solution becomes diluted or soiled.

SANITIZING FOOD CONTACT SURFACES:

This product can be used in Federally Inspected Meat and Poultry Facilities as a sanitizer.
Prior to sanitizing, remove gross food particles, then wash with a detergent solution, followed by a potable water rinse. Sanitize with a concentration of 1.0-2.4 oz. PERASAN® 'A' dissolved in 6 gallons of water (0.13%-.31% v/v concentration, or 82-197 ppm active peroxyacetic acid). At this dilution PERASAN® 'A' is effective against Staphylococcus aureus, Escherichia coli, Salmonella choleraesuis, and Listeria monocytogenes.
Use immersion, coarse spray or circulation techniques as appropriate to the equipment. All surfaces should be exposed to sanitizing solution for a period of at least 60 seconds or more if specified by a governing code. Drain any excess solution. Do not rinse.

SANITIZATION OF CONVEYORS AND EQUIPMENT FOR MEAT, POULTRY, SEAFOOD, FRUIT, NUTS AND VEGETABLES:

PERASAN® 'A' is effective against the gram negative and gram positive organisms Staphylococcus aureus, Salmonella choleraesius, Escherichia coli and Listeria monocytogenes.
For use in the static or continuous sanitizing, washing or rinsing of conveyors, slicers, saws, and equipment, apply a solution of this product using 1.0-2.4 oz. per 6 gallons of water (82 ppm to 197 ppm active peroxyacetic acid). Apply sanitizer solution to the return portion of the conveyor or equipment using coarse spray or similar means of wetting surfaces, so as to affect draining and prevent puddling. Allow sanitizer to thoroughly wet surface for a minimum 60 seconds contact time. No rinse is needed.

SANITIZING OF CASING, SHELL OR HATCHING EGGS:
To sanitize clean shell eggs intended for food or food products, spray with a solution of PERASAN® 'A' by diluting 1.0-2.4 oz. product with 6 gallons of potable water (providing 82-197 ppm peroxyacetic acid). The solution must be equal to or warmer than the eggs, but not to exceed 130° F. Wet eggs thoroughly and allow to drain. Eggs that have been sanitized with this product may be broken for use in the manufacture of egg products without a prior potable water rinse. Eggs must be reasonably dry before casing or breaking. The sanitizing solution must not be reused for sanitizing eggs. For hatching eggs apply the sanitizing solution as eggs are gathered or prior to setting using a coarse spray or flood so as to lightly wet egg shell surfaces. Allow to drain dry.

SANITIZING EATING, DRINKING AND FOOD PREP UTENSILS:
Remove gross food particles by a prescrape, a preflush and when necessary, a presoak treatment. Wash with a recommended detergent. Rinse with clean water.
Sanitize using a solution of 1.0 ounces PERASAN® 'A' dissolved in 6 gallons of water. Immerse for at least 60 seconds or contact time specified by a governing sanitary code. Drain excess solution.

SANITIZING TABLEWARE:
For sanitizing tableware in low temperature warewashing machines, inject PERASAN® 'A' into the final rinse water at a concentration of 1.0 ounce PERASAN® 'A' dissolved in 6 gallons of water. Do not exceed 0.13 % v/v. Air dry. To insure that PERASAN® 'A' sanitizer concentration does not fall below 0.1%, periodically test the rinse solution with a suitable test kit and adjust the dispensing rate accordingly. Consult your technical service representative for assistance and further information on sanitizing tableware in warewashing machines.

FOGGING IN FILLING, PACKAGING, AND DISPENSING ROOMS OR AREAS:
PERASAN® 'A' is used as an adjunct to acceptable manual cleaning and disinfection of room surfaces. Prior to fogging remove food products and packaging materials from the room or area or carefully protect them. Fog desired areas using one quart of a 0.3% to 1.5% solution of this product (2 oz. to 10 oz PERASAN® 'A' per 5 gallons of water) per 1000 cu. ft. of room area. Conventional corrosion resistant fogging devices are recommended. Vacate the area of all personnel prior to, during and after fogging until the hydrogen peroxide concentration is below 0.5 ppm, or there is no strong odor present, characteristic of acetic acid. Allow surfaces to drain thoroughly before operations are resumed. For food contact surfaces, concentrations above 2.4 oz. of this product per 6 gallons of water require a sterile or sanitizing rinse prior to resuming operations.

FINAL SANITIZING BOTTLE RINSE:
PERASAN® 'A' may be used as a final sanitizer rinse, followed by adequate draining, for returnable and non-returnable bottles at a 0.13%-0.31% dilution (1.0 oz.-2.4 oz PERASAN® 'A' in 6 gallons of water), which yields 82 ppm-197 ppm active peroxyacetic acid.

ANTIMICROBIAL RINSE OF PRECLEANED OR NEW RETURNABLE OR NON-RETURNABLE CONTAINERS:
To reduce the numbers of beverage spoilage organisms, including Byssochlamys fulva, Aspergillus niger, and Bacillus subtilis use a 2% to 3% v/v solution, which equals 1120-1700 ppm peroxyacetic acid (2.5-3.8 oz. to 1 gallon of water) of PERASAN® 'A' at a temperature range of 46°-60° C for 15 seconds. Higher dilutions of 1 oz. per gallon of water (0.78 fl oz/gallon) is effective against Aspergillus niger and Byssochlamys fulva at 60° C. After adequate draining, rinse interior container surfaces with sterile or potable water.

FOAM CLEANING OF FOOD AND NON-FOOD CONTACT SURFACES:
As an adjunct to cleaning and sanitizing procedures PERASAN® 'A' sanitizer/disinfectant may be added to PERAFOAM$_{TM}$ and foamed on environmental or equipment surfaces using conventional foam-generating equipment. The resultant foam blend can be used on equipment, floors, walls, ceilings, drains, etc and should be left on surface for a minimum of 1 minute or longer. On food contact surfaces do not exceed 2.4 oz of PERASAN® 'A' per 6 gallons of water. **Directions for mixing**: Manually or mechanically blend 1-2.4 fl. oz of this product and 6-12 fl. oz. of PERAFOAM$_{TM}$ (foam additive) per 6 gallons of water. The dilution water should not exceed 150° F.

NON FOOD CONTACT HARD SURFACE DISINFECTION:
Combination Disinfection and Cleaning:
PERASAN® 'A' disinfects as it cleans in one operation. PERASAN® 'A' can be used to disinfect floors, walls and other hard nonporous surfaces such as tables, chairs, countertops, bathroom fixtures, sinks, bed frames, shelves, racks, carts, refrigerators, coolers, tile, linoleum, vinyl, glazed porcelain, and use sites on this label made of plastic, stainless steel, or glass. Areas of use in hospitals use PERASAN® 'A' for surgical and obstetrical suites; housekeeping services; physical therapy departments; nursing services; autopsy facilities. Also use PERASAN® 'A'

in nursing homes, other health-care facilities, schools, colleges, veterinary clinics, animal life science laboratories, industrial facilities, dietary areas, office buildings, recreational facilities, retail and wholesale establishments.

PERASAN® 'A' is effective against Staphylococcus aureus, Salmonella choleraesuis, Pseudomonas aeruginosa, Trichophyton mentagrophytes and Escherichia coli O157:H7at 0.23%-3% v/v (1.5-20 oz./5 gal.) in hard water (400 ppm as $CaCO_3$) and 5% organic soil loading on hard nonporous surfaces. For heavily soiled areas a pre-cleaning step is required, followed by a potable water rinse. Apply solution with a mop, cloth, sponge, brush, etc... or by soaking or immersion so as to wet all surfaces thoroughly. Allow to remain wet for 10 minutes, then remove solution and entrapped soil with a clean wet mop, cloth, wet vacuum pickup, or by draining. Surfaces that may directly or indirectly contact food must be rinsed with potable water before operations resume. A rinse for non-food contact surfaces is optional. Prepare a fresh solution daily or when it becomes soiled or diluted.

DISINFECTION OF ANIMAL AND POULTRY PREMISES, TRUCKS, COOPS AND CRATES:
PERASAN® 'A' is designed for use in animal hospitals, animal laboratories, kennels, pet shops, zoos, pet animal quarters, poultry premises, poultry hatcheries, and livestock quarters. When used as directed, PERASAN® 'A' is specifically designed to disinfect, deodorize and clean inanimate, hard, surfaces such as walls, floors, sink tops, furniture, operating tables, kennel runs, cages and feeding equipment. In addition PERASAN® 'A' will deodorize those areas which are generally hard to keep smelling fresh, such as garbage storage areas, empty garbage bins and cans, and any other areas which are prone to odors caused by microorganisms.

Disinfection of Poultry Premises:
For heavily soiled areas, a pre-cleaning step is required. Prepare a fresh solution for each use.
Remove all poultry and feeds from premises, trucks, coops and crates. Remove all litter and droppings from floors, walls and surfaces of facilities occupied or traversed by poultry. Empty all troughs, racks and other feeding and watering appliances. Thoroughly clean all surfaces with a detergent and rinse with water. Saturate surfaces with a 0.31-1.25% v/v (2.0-8.0 oz./5gal.) solution of PERASAN® 'A' for a period of 10 minutes. Thoroughly scrub treated feed racks, troughs, automatic feeders, fountains and waters with a detergent and rinse with potable water before reuse. Ventilate buildings, coops and other closed spaces. Do not house poultry or employ equipment until treatment has been absorbed, set or dried.
All treated equipment that will contact food, feed, or drinking water must be rinsed with potable water before reuse. See your technical representative for specific recommendations for all cleaning and rinsing requirements.

Disinfection And Deodorizing Of Animal Housing Facilities (Barns, Kennels, Hutches, Etc.):
Remove animals and feed from premises, vehicles, and enclosures. Remove litter, waste matter from floors, walls and surfaces of barns, pens, stalls, chutes, and other facilities and fixtures occupied or traversed by animals. Empty all troughs, racks and other feeding and watering equipment. Thoroughly clean all surfaces with soap or detergent and rinse with water. Saturate surfaces by applying a 0.31% (2.0 oz./5 gal.) solution of PERASAN® 'A' with a mop, brush or coarse spray. Wet all surfaces and allow to remain wet for 10 minutes. Immerse all halters, ropes, and other types of equipment used in handling and restraining animals, as well as forks, shovels and scrapers used for removing litter and manure. Ventilate buildings and other closed spaces. Do not house livestock or employ equipment until treatment has been absorbed, set, or dried. Thoroughly scrub all treated feed racks, mangers, troughs, automatic feeders, fountains and waterers with soap or detergent, and rinse with potable water before reuse.

CONTROL OF SLIME FORMING BACTERIA IN RECIRCULATING AND COOLING WATER SYSTEMS (COOLING TOWERS, EVAPORATIVE CONDENSERS, PASTEURIZERS):
Severely fouled systems should be cleaned before adding the PERASAN® 'A' solution. PERASAN® 'A' should be added in the system directly and not mixed with any other chemicals or additives. Discontinue the use of chlorine or bromine products prior to using this product. Contamination with other chemicals could result in product decomposition. Add PERASAN® 'A' at a point in the system where uniform mixing and even distribution will occur. For slug treatment add 20 oz. of product per 1000 gallons of process water. Repeat as necessary until microbiological control is evident. Thereafter, to maintain control, use 0.3 to 1.5 lbs. (3.5-17.5 fl. oz.) of PERASAN® 'A' per 1000 gallons of process water (2-9 ppm active peroxyacetic acid) as a continuous or intermittent slug treatment. Continuous dosing methods usually require 2-5 ppm active peroxyacetic acid (4.0-10.2 fl. oz. per 1000 gal of process water) to achieve adequate control.

ACCEPTED
OCT 13 2005
Under the Federal Insecticide, Fungicide, and Rodenticide, Act as amended, for the pesticide, registered under EPA Reg. No. 6388-1

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REVERSE OSMOSIS (RO), NANO, AND ULTRA FILTRATION CLEANING-SANITIZATION:
PERASAN® 'A' may be used in the sanitization of nano filtration (NF) and ultra filtration (UF) and reverse osmosis (RO) membranes and their associated piping systems. This product may be added continuously in food, beverage, and drinking water systems for RO (reverse osmosis) systems only and in accordance with the instructions below. This product is not for use in kidney dialysis equipment. This product may not totally eliminate all vegetative microorganisms in RO or NF or UF membranes and their associated piping systems due to their construction or assembly, but can be relied upon to reduce the number of microorganisms to acceptable levels when used as directed. Prior to using this product check with membrane manufacturer to confirm compatibility of membranes with various types or concentration of peroxyacetic acid solutions.
Batch Sanitation of NF, UF and RO Systems: Isolate incompatible equipment, such as carbon filters and ion exchangers. Clean system with an appropriate cleaner and follow with RO permeate water or potable water. Remove mineral deposits if necessary with an acidic cleaner, and rinse as before. Fill entire system with water and add up to 1% of this product by volume (620 ppm peroxyacetic acid) for heavily fouled systems. The typical sanitation use solution dosing of this product is 1-2 oz per 5 gallons of water (98-195 ppm peroxyacetic acid). Recirculate the sanitizing solution through the piping and membrane system at 20° C for 10 minutes minimum, or up to 4 hours, depending on the severity of cleaning to be done. Open and close process valves and solenoids to be sure all parts are in contact with the solution. For occasional intermittent feed, do not exceed 98 ppm active peroxyacetic acid, which equals 1 oz. of this product per 5 gallons of feed water. Do not use the intermittent feed method for on-line use for potable water or direct food contact systems. Rinse the system with RO permeate or potable water until residual peroxygen concentration is below 1 ppm.
RO Continuous or Intermittent Addition: For continuous addition methods for RO systems, use 2-5 ppm active peroxyacetic acid (36-90 ppm as product), which equals 1.8-4.5 oz. PERASAN® 'A' per 430 gallons of process water. For occasional intermittent feed, do not exceed 98 ppm active peroxyacetic acid, which equals 1 oz. of this product per 5 gallons of feed water. Do not use the intermittent feed method for on-line use in potable water or direct food contact systems.

FRUIT AND VEGETABLE WATER TREATMENT:
This product may be used to help control spoilage or decay-causing bacteria and fungi in water or ice that contacts raw, unprocessed fruits and vegetables. The commodity should be continuously sprayed, using coarse spray, or submerged using a solution containing 1 oz. PERASAN® 'A' per 20 gallons of water. Adjust dose as necessary to maintain no more than 25 ppm active peroxyacetic acid. Remove excess water or allow to drain. If using the submersion method, replace with a fresh solution as necessary, or when it becomes visibly soiled. A final potable water rinse is not necessary.

AGRICULTURAL or HORTICULTURAL USES:
There is a Restricted-Entry-Interval of zero (0) hours after the use of this product. This product should never be mixed or combined with any other pesticide or fertilizer. Upon soil contact this product decomposes rapidly to oxygen, carbon dioxide and water. This product may be harmful to fish if exposed on a continuous basis at concentrations of 0.5 ppm or more of active peroxyacetic acid. Meter this product into pressurized pipes using a plastic or stainless steel injection/backflow device installed far enough upstream from the target equipment to ensure thorough mixing. For open flowing bodies of water, apply this product as far upstream as possible to allow adequate mixing prior to the flow entering any larger body of water. If open pouring of this product is required pour product as close to the surface of the water as possible to reduce odor exposure.
Treatment of Irrigation Water Systems (sand filters, humidification systems, storage tanks, ponds, reservoirs, canals): For the control of odor, sulfides, slime and algae in water systems, apply this product at 0.4-2 oz. per 100 gal of water (2-10 ppm peroxyacetic acid). This feed rate equals 0.3-1.5 gal per 10,000 gallons of water. Repeat dose as necessary to maintain control, which will vary with seasonal conditions. For prevention of algae some systems may require continuous low level dosing during warm sunny periods.
Drip Irrigation System Cleaning: To clean slime and algae from drip system tapes and emitters, meter this product upstream from pumps or filters at the rate of 1-2 oz per 50 gallons of water (10-20 ppm peroxyacetic acid). This feed rate equals 1.5-3 gal per 10,000 gallons of dilution water. When required, during normal irrigation cycles, use this product at the recommended dose for a minimum of 30 minutes. Thereafter, the irrigation cycle should be discontinued and the line should not be flushed.
NOTE: This product at its use dilution is compatible with stainless steel and aluminum surfaces. If product is intended to be used on any other surface, it is recommended that you apply product to a smaller test area to determine compatibility before proceeding with its use.

ACCEPTED
OCT 1 3 2005
Under the Federal Insecticide, Fungicide, and Rodenticide, Act as amended, for the pesticide, registered under

Storage and Disposal

Storage: Never return PERASAN® 'A' to the original container after it has been removed. Avoid all contaminants, especially dirt, caustic, reducing agents, and metals. Contamination and impurities will reduce shelf life and can induce decomposition. In case of a decomposition, isolate container, douse container with cool water and dilute PERASAN® 'A' with large volumes of water. Avoid damage to containers. Keep container closed at all times when not in use. Keep container out of direct sunlight. To maintain product quality, store at temperatures below 86°F. Do not store on wooden pallets.

Procedure for Leak or Spill: Stop leak if this can be done without risk. Shut off ignition sources: no flames, smoking, flares, or spark producing tools. Keep combustible and organic materials away. Flush spilled material with large quantities of water. Undiluted material should not enter confined spaces.

Pesticide Disposal: Pesticide wastes are acutely hazardous. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal Law. If these wastes cannot be disposed by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or Hazardous Waste representative at the nearest EPA Regional Office for guidance. If material has been spilled, an acceptable method of disposal is to dilute with at least 20 volumes of water followed by discharge into suitable treatment system in accordance with all local, state and Federal environmental laws, rules, regulations, standards, and other requirements. Because acceptable methods of disposal may vary by location, regulatory agencies should be contacted prior to disposal. PERASAN® 'A' which is to be discarded, should be disposed of as hazardous waste after contacting the appropriate local state or Federal agency to determine proper procedures.

Container Disposal: >5 gallon plastic drums: Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or, if allowed by State and local authorities, by burning. If burned, stay out of smoke.

PERASAN® 'A'

Enviro Tech Chemical Services, Inc
500 Winmoore Way
Modesto, CA 95358
209-581-9576

ACCEPTED
OCT 13 2005
Under the Federal Insecticide, Fungicide, and Rodenticide. Act as amended, for the pesticide, registered under EPA Reg. No. 6 3 8-38-1

ver5/ 5-21-05

NSF®
NSF/ANSI STD 60
DA02920

NSF REGISTERED
NSF Reg. #122279-D2

63838-2 6-3-2008 1/7

JUN 3 2008

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

EPA United States Environmental Protection Agency Office of Pesticide Programs

Enviro Tech Chemical Services, Inc.
500 Winmoore Way
Modesto, CA 95358

Attention: Michael Harvey
Regulatory Affairs Manager

Subject: BIOSIDE HS 15%
EPA Registration No. 63838-2
Amendment Dated October 24, 2007
EPA Received Date March 12, 2008

The amendment, submitted in connection with registration under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), as amended, to add the wording "Air Washers" to the claim header and to add an optional statement under "Treatment of Fruit and Vegetable Process Water Systems", is acceptable, provided that you:

1. Submit and/or cite all data required for registration/reregistration of your product under FIFRA sec. 3©(5) and sec. 4 when the Agency requires all registrants of similar products to submit such data.

2. Submit two (2) copies of final printed labeling before you release the product for shipment.

If these conditions are not complied with, the registration will be subject to cancellation in accordance with FIFRA sec. 6(e). Your release for shipment of the product constitutes acceptance of these conditions.

A stamped copy of the "accepted" product labeling is enclosed for your records.

If you have any questions concerning this letter, please contact Martha Terry at (703)
308-6217.

Sincerely

Marshall Swindell
Product Manager 33
Regulatory Management Branch 1
Antimicrobials Division (7510P)

Enclosure

3/7

BioSide™ HS 15% (Antimicrobial Solution)

For Use in Organic Production:

BioSide™ HS 15% is a peroxyacetic acid-based microbiocide developed for Equipment Sanitizing and Disinfection, and Bacteria, Fungi, Slime and Odor Control in: Pulp and Paper Mill Systems, Fruit and Vegetable Process Water Systems, and Bacterial and Algae Control in Recirculating and Agricultural Water Systems.

Active Ingredients:	
Peroxyacetic Acid	15.0%
Hydrogen Peroxide	22.0%
Inert Ingredients:	63.0%
Total:	100.0%

ACCEPTED
with COMMENTS
EPA Letter Dated:
JUN 3 2008
Under the Federal Insecticide, Fungicide, and Rodenticide Act as amended, for the pesticide, registered under EPA Reg. No.
63838-2

EPA Registration No. 63838-2
EPA Est. No. 69994-CA-01

Before Using This Product, Please Read This Entire Label Carefully

KEEP OUT OF REACH OF CHILDREN

DANGER

FIRST AID

IF SWALLOWED:	• Call a poison control center or doctor immediately for treatment advice. • Have person sip a glass of water if able to swallow. • Do not induce vomiting unless told to do so by a poison control center or doctor. • Do not give anything by mouth to an unconscious person.
IF ON SKIN OR CLOTHING	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
IF IN EYES	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice.
IF INHALED	• Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible. • Call a poison control center or doctor for treatment advice.
QUESTIONS ? 1-209-581-9576	Have the product container or label with you when calling a poison control center or doctor, or going for treatment.
NOTE TO PHYSICIAN:	Probable mucosal damage may contraindicate the use of gastric lavage.

Manufactured By:

ENVIRO TECH CHEMICAL SERVICES, Inc.
500 Winmoore Way, Modesto, CA 95358
209-581-9576 or www.envirotech.com

Ver 4a;

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PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

DANGER. CORROSIVE. Do not enter an enclosed area without proper respiratory protection Causes irreversible eye damage and skin burns. May be fatal if inhaled or absorbed through skin. Harmful if swallowed. Do not breathe vapors or spray mist. Do not get in eyes, on skin, or on clothing. Wear goggles and face shield and rubber gloves when handling. Wash thoroughly with soap and water after handling and before eating, drinking or using tobacco. Remove contaminated clothing and wash before reuse.

PHYSICAL OR CHEMICAL HAZARDS

STRONG OXIDIZING AGENT. Corrosive. Mix only with water at ambient (room) temperature. Product must be diluted in accordance with label directions prior to use. BioSide™ HS 15% is not combustible; however, at temperatures exceeding 156°F, decomposition occurs releasing oxygen. The oxygen released could initiate combustion.

Environmental Hazards:

This pesticide is toxic to birds, fish and aquatic invertebrates. Caution should be used when applying indoors because pets may be at risk. Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans or other waters unless in accordance with the requirements of the National Pollution Discharge System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product into sewer systems without previously notifying the local sewage plant authority.

ACCEPTED
With COMMENTS
EPA Letter Dated:
JUN 3 2008
Under the Federal Insecticide, Fungicide, and Rodenticide Act as amended, for the pesticide, registered under EPA Reg. No. 63838-2

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

SANITIZATION

BioSide™ HS 15% peroxyacetic acid sanitizer is recommended for use on precleaned surfaces such as equipment, pipelines, tanks, vats, filters, evaporators, pasteurizers, and aseptic equipment in dairies, breweries, wineries, beverage and food processing/packing plants, and egg processing/packing equipment surfaces. This product is effective as a sanitizer when solution is prepared in water of up to 400 ppm hardness as $CaCO_3$. This product has demonstrated greater than 99.999% reduction of Staphyloccus aureus and Escherichia coli in the AOAC Germicidal and Detergent Sanitizing Action of Disinfectants study.

Sanitizing Food Contact Surfaces

Sanitize with a concentration of 0.7 -2.0 fl.oz. BioSide™ HS 15% dissolved in 10 gallons of water (93-260 ppm active peroxyacetic acid). Use immersion, coarse spray or circulation techniques as appropriate to the equipment. All surfaces should be exposed to sanitizing solution for a period of at least 60 seconds or more if specified by a governing code. Drain thoroughly and allow to air dry. Do not rinse.

Sanitization of Conveyors and Equipment for Meat, Poultry, Seafood, Fruit, Nuts and Vegetables:

This product is effective against the gram negative and gram positive organisms Staphylococcus aureus and Escherichia coli. For use in the static or continuous sanitizing, washing or rinsing of conveyors, slicers, saws, and equipment, apply a solution of this product using a recommended 0.7-2.0 fl oz. per 10 gallons of water (93-260 ppm active peroxyacetic acid). Apply sanitizer solution to the return portion of the conveyor or equipment using coarse spray or similar means of wetting surfaces, so as to prevent puddling. Allow sanitizer to thoroughly wet surface for a minimum 60 seconds contact time. No rinse is needed.

Final Bottle or Container Rinse

BioSide™ HS 15% may be used as a final sanitizer rinse for returnable and non-returnable bottles or containers at 93-260 ppm active peroxyacetic acid (0.7-2.0 fl. oz. BioSide™ HS 15% dissolved in 10 gallons of water). The container should be drained as much as is practical prior to filling operations.

Combination Disinfection and Cleaning

BioSide™ HS 15% is effective against Staphylococcus aureus and Salmonella choleraesuis at 1.0 oz of this product per 10 gallons of water (130 ppm active peroxyacetic acid) in hard water (400 ppm as $CaCO_3$) and 5% organic soil on hard nonporous surfaces. For heavily soiled areas a pre-cleaning step is required. Apply solution with a mop, cloth, sponge, brush, or by soaking, spraying, or immersion so as to wet all surfaces thoroughly. Allow to remain

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wet for 10 minutes, then remove excess solution and entrapped soil with a clean wet mop, cloth, wet vacuum pickup or by draining. Prepare a fresh solution daily or when it becomes soiled or diluted.

REVERSE OSMOSIS (RO), NANO, AND ULTRA FILTRATION CLEANING

BioSide™ HS 15% may be used in the sanitization of nano filtration (NF) and ultra filtration (UF) and reverse osmosis (RO) membranes and their associated piping systems. This product is not for use in kidney dialysis equipment. Do not use the intermittent or continuous dosing methods for nano and ultra-filtration food or drinking water contact applications. This product may not totally eliminate all vegetative microorganisms in RO or NF or UF membranes and their associated piping systems due to their construction or assembly, but can be relied upon to reduce the number of microorganisms to acceptable levels when used as directed. Prior to using this product check with membrane manufacturer to confirm compatibility of membranes with various types or concentration of peroxyacetic acid solutions.

Batch Sanitation of NF, UF and RO Systems: Isolate incompatible equipment, such as carbon filters and ion exchangers. Clean system with an appropriate cleaner and follow with RO permeate water or potable water. Remove mineral deposits if necessary with an acidic cleaner, and rinse as before. Fill entire system with water and add up to 0.5% of this product by volume. This will equal 680 ppm peroxyacetic acid and 1000 ppm hydrogen peroxide. Recirculate the sanitizing solution through the piping and membrane system at 20° C for 10 minutes minimum, or up to 4 hours, depending on the severity of cleaning to be done. Open and close process valves and solenoids to be sure all parts are in contact with the solution. Rinse the system with RO permeate or potable water until residual peroxygen concentration is below 1 ppm.

Continuous or Intermittent Addition: For continuous addition (dosing) for RO systems, use 2-5 ppm of active peroxyacetic acid, which equals 1.5-3.7 fl. oz. BioSide™ HS 15% per 1000 gallons of process water. For occasional intermittent feed, do not exceed 93 ppm active peroxyacetic acid, which equals 0.7 fl. oz. of this product per 10 gallons of feed water. Continuous or intermittent dosing of this product is not allowed for use in NF or UF systems for on-line food or drinking water applications.

NOTE: This product at its use dilution is compatible with stainless steel and aluminum surfaces. If product is intended to be used on any other surface, it is recommended that you apply product to a smaller test area to determine compatibility before proceeding with its use.

ACCEPTED
with COMMENTS
EPA Letter Dated:
JUN 3 2008
Under the Federal Insecticide, Fungicide, and Rodenticide Act as amended, for the pesticide, registered under EPA Reg. No. 6383 8-2

BIOFOULING CONTROL IN PULP, PAPER AND PAPERBOARD MILL AND WATER SYSTEMS

For use in the manufacture of paper and paperboard intended for food or non food contact. BioSide™ HS 15% can be used to control bacteria and fungi in paper, paperboard or non-woven process water and influent water systems. Suitable dosing points include but are not limited to: stock chests, pulpers, the white water loop, white water storage systems and influent water streams.

Influent Water Systems:

BioSide™ HS 15% should be fed continuously to incoming fresh water streams (nonpotable use only) at dosages ranging from 0.11- 2.0 lbs (1.5-27 fl. oz) of this product per 1000 gallons of raw or process water (2.0-36 ppm peroxyacetic acid). Adjust dosage as necessary to maintain microbiological control.

Mill Process Waters:

Intermittent Feed - BioSide™ HS 15% may be fed intermittently (for example: 2-3 hours per 8 hour shift) at dosages ranging from 0.5 lbs to 1.2 lb (7-16 fl. oz.) of this product per ton (dry basis) of pulp or paper produced. This dosage is equivalent to 37-90 ppm peroxyacetic acid. Repeat as necessary when the peroxyacetic acid concentration reaches less than 2 ppm.

Continuous Feed - BioSide™ HS 15% should be fed continuously at dosages ranging from 0.11-1.2 lbs (1.5-16 fl. oz) of this product per ton (dry basis) of pulp or paper produced. This dosage is equivalent to 8.0-90 ppm peroxyacetic acid.

Shock (slug) Dose - BioSide™ HS 15% may be used to shock dose systems requiring a high level of biofouling control. Use rates ranging from 1-8 lbs (13.5-108 fl. oz.) of this product per ton (dry basis) of pulp or paper produced may be necessary. This dosage is equivalent to 75-600 ppm peroxyacetic acid. Shock dose every 1-3 hrs as necessary until biofouling control is evident. Thereafter, revert to continuous or intermittent feed methods.

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CONTROL OF SLIME FORMING BACTERIA AND BIOFOULING IN COOLING WATER SYSTEMS (COOLING TOWERS, EVAPORATIVE CONDENSERS, AIR WASHERS) AND ORNAMENTAL OR RECREATIONAL WATER FEATURES.

Severely fouled systems should be cleaned before adding the BioSide™ HS 15% solution. BioSide™ HS 15% should be added in the water system directly, and not mixed with any other chemicals or additives. Never add this product into any feeding device, such as shot feeders, filter housings, by-pass feeders, or miscellaneous piping of any kind, because dangerous acute decomposition can occur. Discontinue the use of chlorine or bromine products prior to using BioSide HS 15%. Contamination with other chemicals could result in product decomposition. Add BioSide™ HS 15% to only water at a point in the system where uniform mixing and even distribution will occur.

For shock (slug) treatment for moderately to severely fouled systems add 5-20 fl. oz. of this product per 1000 gallons of process water (7-27 ppm peroxyacetic acid). Repeat as necessary until microbiological control is evident.

Thereafter, to maintain control use (1.5-7.5 fl. oz.) of BioSide™ HS 15% per 1000 gallons of process water (2-10 ppm of peroxyacetic acid) as a continuous treatment method. Continuous dosing methods usually require 1.5-5 fl. oz. per 1000 gallons of water (2-7 ppm peroxyacetic acid) to achieve adequate results.

Intermittent dosing treatment usually require dose cycles of a minimum once per every other day, up to 6 times per 24 hours. Recommended rates for intermittent dose cycles are 5-10 fl. oz of BioSide HS 15% per 1000 gallons of process water (7-14 ppm peroxyacetic acid).

Air Washers: This product may be used to control bacteria and biofouling in industrial air washing/scrubbing systems. The air washer must have operational and effective mist elimination systems. Prior to use of this product, heavily fouled systems must be pre-cleaned using the appropriate cleaner. Continuous dosing methods will require 2-7 ppm and intermittent dosing methods require 7-14 ppm (as peroxyacetic acid), as described in the previous 2 paragraphs, depending on the type of system and the level of microbiological control desired.

ACCEPTED
with COMMENTS
EPA Reg. No. 63838-2
Date: JUN 3 2005

Under the Federal Insecticide, Fungicide and Rodenticide Act as amended, for the pesticide, registered under EPA Reg. No. 63838-2

TREATMENT OF FRUIT AND VEGETABLE PROCESS WATER SYSTEMS:

BioSide HS 15% can be used in water or ice that contacts raw or fresh, post-harvest or further processed fruits and vegetables for the control of bacteria and fungi.

Batch, Continuous or Spray System Processes:
Fill vessel containing fruits and vegetables with known amount of water. Ensure that water is circulating in vessel if using the submersion method. Add BioSide HS 15% to no more than 533 ppm (wt/wt) total product (80 ppm residual peroxyacetic acid) to the use solution. This can be accomplished by initially adding 53.3 grams (47.3 mls) BioSide HS 15% per 100 liters of water, or 1.0 fluid ounce per 16.4 gallons of water. The fruits and vegetables can be continuously sprayed (using coarse spray) or submerged (dipped) in the resulting solution. Periodic or continuous additions of this product to maintain the required concentration may be added as necessary. It is also recommended to apply this product during the washing, chilling, or physical cleaning processes, including the roller-spreader, washer or brush washer manifold, dip tank, or sorting processes. Contact time of 60 seconds is recommended to insure efficacy. A potable water rinse is not required. *(optional statement: this product is not intended for use in primary flumes prior to the point of the first dewatering stage)*
Fogging: For raw agricultural commodities, commercially-applied fogging methods may be used provided the dilution rates of the resultant solution does not exceed those prescribed in this section (1 fl oz per 16.4 gal of water). A potable water rinse, or subsequent antimicrobial wash using this product as prescribed above is necessary after such use. Conventional corrosion-resistant fogging devices are recommended. Vacate the area of all personnel prior to, during and after fogging until the total peroxide concentration is below 1.0 ppm, or there is no strong odor present, characteristic of acetic acid.

AGRICULTURAL or HORTICULTURAL USES:

There is a Restricted-Entry-Interval of zero (0) hours after the use of this product. This product should never be mixed or combined with any other pesticide or fertilizer. Upon soil contact this diluted product decomposes rapidly to oxygen, carbon dioxide and water. This product may be harmful to fish if exposed on a continuous basis at concentrations of 1 ppm or more of active peroxyacetic acid. Meter this product into pressurized pipes using a plastic or stainless steel injection/backflow device installed far enough upstream from the equipment to ensure thorough mixing. For open flowing bodies of water, apply this product as far upstream as possible to allow adequate mixing prior to the flow entering any larger body of water. If open pouring of this product is required pour product as close to the surface of the water as possible to reduce odor exposure.

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Treatment of Agricultural or Irrigation Water Systems (sand filters, humidification systems, storage tanks, ponds, reservoirs, canals): For the control of sulfides, odor, slime and algae in water systems, apply this product at 2-10 ppm active peroxyacetic acid. This feed rate equals 15-75 fl. oz per 10,000 gallons of water. Repeat dose as necessary to maintain control, which will vary with seasonal conditions. For prevention of algae, some systems may require continuous low level dosing during warm sunny periods (2-5 ppm peroxyacetic acid).

Drip Irrigation Systems: To clean slime and algae from drip system filters, tapes and emitters, meter this product at the rate of 7.5-15 fl. oz. per 1000 gallons of water (10-20 ppm peroxyacetic acid). When required during normal irrigation cycles, use this product at the recommended dose for a minimum of 30 minutes. Thereafter, the irrigation cycle should be discontinued and the line should not be flushed.

Storage and Disposal

Storage: Never return BioSide™ HS 15% to the original container after it has been removed. Avoid all contaminants, especially dirt, caustic, reducing agents, and metals. Contamination and impurities will reduce shelf life and can induce decomposition. In case of a decomposition, isolate container, spray container with cool water and dilute BioSide™ HS 15% with large volumes of water. Avoid damage to containers. Keep container closed at all times when not in use. Keep container out of direct sunlight. To maintain product quality, store at temperatures below 86°F.

Procedure for Leak or Spill: Stop leak if this can be done without risk. Shut off ignition sources: no flames, smoking, flares, or spark producing tools. Keep combustible and organic materials away. Flush spilled material with large quantities of water. Undiluted material should not enter confined spaces.

Pesticide Disposal: Pesticide wastes are acutely hazardous. Improper disposal of excess pesticide, spray mixture, or rinsate is a violation of Federal Law. If these wastes cannot be disposed by use according to label instructions, contact your State Pesticide or Environmental Control Agency, or Hazardous Waste representative at the nearest EPA Regional Office for guidance. If material has been spilled, an acceptable method of disposal is to dilute with at least 20 volumes of water followed by discharge into suitable treatment system in accordance with all local, state and Federal environmental laws, rules, regulations, standards, and other requirements. Because acceptable methods of disposal may vary by location, regulatory agencies should be contacted prior to disposal. BioSide™ HS 15% which is to be discarded, should be disposed of as hazardous waste after contacting the appropriate local State or Federal agency to determine proper procedures.

Container Disposal: Nonrefillable container. Do not reuse or refill this container. Clean container promptly after emptying. Offer for recycling, if available. Triple rinse as follows: Empty the remaining contents into application equipment or a mix tank. Fill the container 1/4 full with water. Replace and tighten closures. Tip container on its side and roll it back and forth, ensuring at least one complete revolution, for 30 seconds. Stand the container on its end and tip it back and forth several times. Empty the rinsate into application equipment or a mix tank or store rinsate for later use or disposal. Repeat this procedure two more times.

BioSide™ HS 15%

(Antimicrobial Solution)

Manufactured By:

ENVIRO TECH CHEMICAL SERVICES, Inc.
500 Winmoore Way
Modesto, CA 95358
209-581-9576
www.envirotech.com

Ver 5 (5-2008)

ACCEPTED
with COMMENTS
EPA Letter Dated:
JUN 3 2008
Under the Federal Insecticide, Fungicide, and Rodenticide Act as amended, for the pesticide, registered under EPA Reg. No. 63838-2

65402-1 4/2/2008 1/8

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

APR 12 2008

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

Mr. Matt Talley
Registration Agent for,
FMC Corporation
1735 Market Street
Philadelphia, PA 19103

Mail to: Attn: Matthew Talley
Keller and Heckman
1001 G Street
Suite 500 West
Washington, D.C. 20001

Subject: Vigor Ox Liquid Sanitizer and Disinfectant
EPA Registration Number 65402-1
Your Notification Dated March 5th, 2008
EPA Received Date March 6th, 2008

The amendment referred to above, submitted in connection with registration under the Federal Insecticide, Fungicide, and Rodenticide Act, FIFRA, as amended, to change use directions for the "Foam Sanitization" and "Antimicrobial Rinse of Pre-Cleaned or New Returnable or Non-Returnable Containers" section, is acceptable.

This notification has been made part of your registration file.

If you have any questions concerning this letter, please contact Karen M. Leavy-Munk at (703)-308-6237.

Sincerely,

Marshal Swindell
Product Manager 33
Regulatory Management Branch I
Antimicrobial Division(7510P)

KELLER AND HECKMAN LLP
Serving Business through Law and Science®

1001 G Street, N.W.
Suite 500 West
Washington, D.C. 20001
tel. 202.434.4100
fax 202.434.4646

Writer's Direct Access
Matthew E. Talley
(202) 434-4230
talley@khlaw.com

March 5, 2008

Via Courier

Mr. Marshall Swindell
Product Manager Team 33
U.S. Environmental Protection Agency
Document Processing Desk
Office of Pesticide Programs (7504C)
Room S-4900, One Potomac Yard
2777 South Crystal Drive
Arlington, Va. 22202-4501

Re: FMC Corporation; Notification to add Directions for Use to the label of *VigorOx®* *Liquid Sanitizer and Disinfectant* (EPA Reg. 65402-1)

Dear Mr. Swindell:

On behalf of our client, FMC Corporation (FMC), we are submitting a notification to change use directions to the label of *VigorOx® Liquid Sanitizer and Disinfectant* (EPA Reg. No. 65402-1). The directions for use occur at two different sections of the labeling and are detailed below.

1. Under the heading "Foam Sanitization" the following text has been added:

   "For foot bath application, allow foam to remain on the boot surface for one minute upon exiting the bath."

This text has been added to prevent confusion among end users who may incorrectly interpret the previous label language that workers' boots are to be submerged in the solution for one minute and removed from the bath. The revised language provides clarification that the peracetic acid solution foam should remain in contact with the boots for one minute after the boots have been removed from the antimicrobial solution.

2. Under the heading "Antimicrobial Rinse of Pre-Cleaned or New Returnable or Non-Returnable Containers" the following text has been added:

   "Apply solution, allowing a minimum contact time of 5 seconds."

This revised text removes the previous directions that users apply the solution within a 40°C to 60°C temperature range. As this use is on non-public health spoilage organisms and is not supported by efficacy data conducted within the 40°C to 60°C range, FMC wishes to remove the range so that applicators can have greater flexibility to apply the solution at higher temperatures. Since the dosage, concentration, and frequency of application do not change, we wish to remove the temperature range from the label through notification under PR notice 98-10.

This notification is consistent with the provisions of PR Notice 98-10 and EPA regulations at 40 CFR 152.46, and no other changes have been made to the labeling or the confidential statement of formula of this product. I understand that it is a violation of 18 U.S.C. Sec. 1001 to willfully make any false statement to EPA. I further understand that if this notification is not consistent with the terms of PR Notice 98-10 and 40 CFR 152.46, this product may be in violation of FIFRA and I may be subject to enforcement action and penalties under section 12 and 14 of FIFRA.

Five copies of the proposed label are attached for your review. As this is a submission under PR Notice 98-10, it is not subject to a PRIA fee or review schedule. We trust that this notification is complete. However, if any questions arise during its review, please contact me immediately at 202-434-4230.

Sincerely,

Matthew E. Talley
Pesticide Regulatory Specialist

Enclosures

VigorOx® Liquid Sanitizer and Disinfectant

EPA Registration No. 65402-1
EPA Est. No. 00279-NY-003

VigorOx® Liquid Sanitizer and Disinfectant is for Institutional/industrial sanitizing of previously cleaned non-porous food contact surfaces in:

- Dairies, Wineries, Breweries and Beverage Plants
- Meat and Poultry Processing/Packaging Plants
- Milk and Dairy Products Processing/Packing Plants
- Seafood and Produce Processing/Packing Plants
- Food Processing/Packing Plants
- Egg Processing/Packing Equipment Surfaces
- Eating Establishments

VigorOx® Liquid Sanitizer and Disinfectant is for Institutional/industrial sanitizing of previously-cleaned, hard, non-porous food-contact surfaces such as:

- Eating, Drinking, and Food Preparation Utensils
- Countertops and Food Preparation Surfaces
- Tableware
- Plastic, Glass and Metal Bottles (rinse)

For Organic Production. **VigorOx® Liquid Sanitizer and Disinfectant** may be used in rinse or wash water on products labeled as organic in food processing facilities on commodities that will be further processed. For use as a sanitizer on food contact surfaces in contact with products labeled as organic.

VigorOx® Liquid Sanitizer and Disinfectant is for sanitizing hard inanimate, non-food contact surfaces, (general environmental surfaces)

VigorOx® Liquid Sanitizer and Disinfectant is for use in the disinfection of hard, non-porous surfaces in general commercial and medical environments such as:

- Hospitals, Health Care Facilities, Veterinary Hospital/Clinics, Animal Life Science Labs, Pharmaceutical Facilities and Equipment
- Schools, Colleges, Recreational Facilities, Office Buildings
- Livestock Premises, Poultry Premises, Poultry Hatcheries, Animal Housing Facilities
- Retail and Wholesale Establishments
- Bathroom Premises

VigorOx® Liquid Sanitizer and Disinfectant is for use as a coarse spray for surfaces to be sanitized or disinfected.

VigorOx® Liquid Sanitizer and Disinfectant is for use in fogging applications as an adjunct to acceptable manual cleaning and disinfecting of room surfaces.

VigorOx® Liquid Sanitizer and Disinfectant can be used with the HRS™ and HRS™ II foaming agents. For food-contact applications, the foaming agent must be used in compliance with applicable regulations under the Federal Food, Drug and Cosmetic Act.

VigorOx® Liquid Sanitizer and Disinfectant can be used with the non-foaming agent, Peradigm™, as an antimicrobial container rinse and for hard, non-porous surface disinfection.

VigorOx® Liquid Sanitizer and Disinfectant is for use as an antimicrobial container rinse to control beverage spoilage microorganisms.

VigorOx® Liquid Sanitizer and Disinfectant is for use in the sanitization of ultra filtration and reverse osmosis (RO) membranes and their associated distribution systems.

KEEP OUT OF REACH OF CHILDREN

DANGER

[See side panel for First Aid statements]

For Industrial Use Only

Active Ingredients:	Peroxyacetic Acid	5.1%
	Hydrogen Peroxide	21.7%
Inert Ingredients:		73.2%
Total		100.0%

Precautionary Statements
Hazards to Humans and Domestic Animals

DANGER – Corrosive. Causes irreversible eye damage and skin burns. Harmful if swallowed. May be fatal if absorbed through the skin. Do not get in eyes, on skin or on clothing. Wear protective eyewear (goggles, face shield or safety glasses), chemical resistant apron or coveralls and chemical resistant gloves. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum, or using tobacco. Remove contaminated clothing and wash before reuse.

Physical or Chemical Hazards – Strong oxidizing agent. Mix only with water. VigorOx™ Liquid Sanitizer and Disinfectant is not combustible, but at temperatures exceeding 156°F, decomposition occurs releasing oxygen. The oxygen released could initiate or promote combustion of other materials.

Environmental Hazards – This pesticide is toxic to birds, mammals, fish and aquatic life. Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or other waters unless in accordance with requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance contact your State Water Board or Regional Office of the EPA.

FMC Corporation
Peroxygens Division
1735 Market Street
Philadelphia, Pennsylvania 19103

FMC

FIRST AID	
If in Eyes:	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice.
If on Skin or Clothing:	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
If inhaled:	• Move person to fresh air. • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth if possible. • Call a poison control center or doctor for further treatment advice.
If Swallowed:	• Call a poison control center or doctor immediately for treatment advice. • Have person sip a glass of water if able to swallow. • Do not induce vomiting unless told to do so by a poison control center or doctor. • Do not give anything by mouth to an unconscious person.

Note to Physician: Probable mucosal damage may contraindicate the use of gastric lavage.

This product is not to be used as a terminal sterilant/high-level disinfectant on any surface or instrument that (1) is introduced directly into the human body, either into or in contact with the bloodstream or normally sterile areas of the body, or (2) contacts intact mucous membranes but which does not ordinarily penetrate the blood barrier or otherwise enter normally sterile areas of the body. This product may be used to clean or decontaminate critical or semi-critical medical devices prior to sterilization or high-level disinfection.

Storage and Disposal

Storage

NEVER RETURN VigorOx® LIQUID SANITIZER AND DISINFECTANT TO THE ORIGINAL CONTAINER AFTER IT HAS BEEN REMOVED. Avoid all contaminants, especially dirt, caustic, reducing agents, and metals. Contamination and impurities will reduce shelf life and can induce decomposition. In case of a decomposition, isolate container, douse container with cool water and dilute with large volumes of water.

Avoid damage to containers. Keep container closed at all times when not in use. Keep container out of direct sunlight. To maintain product quality, store at temperatures below 86°F. Do not store on wooden pallets.

Procedure for Leak or Spill

Stop leak if this can be done without risk. Shut off ignition sources; no flames, smoking, flares, or spark-producing tools. Keep combustible and organic materials away. Flush spilled material with large quantities of water. Undiluted material should not enter confined spaces.

Disposal

Pesticide Disposal

If material has been spilled, an acceptable method of disposal is to dilute with at least 20 volumes of water followed by discharge into suitable treatment system in accordance with all local, state, and Federal environmental laws, rules, regulations, standards, and other requirements. Because acceptable methods of disposal may vary by location, regulatory agencies should be contacted prior to disposal.

VigorOx® Liquid Sanitizer and Disinfectant that is to be discarded should be disposed of as hazardous waste after contacting the appropriate local, state, or Federal agency to determine proper procedures.

Container Disposal

Empty drums are not returnable to FMC unless special arrangements have been made. Triple rinse drums with water. Dispose of drums in accordance with local, state, and Federal regulations. **DO NOT REUSE.** Return 200 to 300 gallon totes to FMC or Service Company without rinsing. Do not rinse totes.

Directions for Use

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

For use in circulation cleaning and institutional/industrial sanitizing of previously cleaned, hard, non-porous food-contact surfaces and equipment, such as food preparation surfaces, pipelines, tanks, vats, fillers, evaporators, pasteurizers and aseptic equipment in:

- Dairies, Wineries, Breweries and Beverage Plants
- Meat and Poultry Processing/Packaging Plants
- Milk and Dairy Products Processing/Packing Plants
- Seafood and Produce Processing/Packing Plants
- Food Processing/Packing Plants
- Egg Processing/Packing Equipment Surfaces
- Eating Establishments
- Final Sanitizing Bottle Rinse

Foam Sanitization

VigorOx® Liquid Sanitizer and Disinfectant can be applied as a foam for sanitization of previously cleaned, hard, non-porous food-contact surfaces and general environmental (non-food contact) hard, non-porous surfaces such as floors, walls, ceilings, drains and boots. Foam applications can be used where penetraton and retention of product for required times is difficult to achieve. Examples include operating conveyor belts, and vertical or uneven surfaces.

1. Prepare a dilute VigorOx® Liquid Sanitizer and Disinfectant solution by adding 1 to 1.7 fluid ounces per 4.5 gallons potable water.
2. After preparing the VigorOx® Liquid Sanitizer and Disinfectant diluted solution, add 1 to 10 fluid ounces of HRS ™ or add 2 to 20 fluid ounces of HRS II per 4.5 gallons of diluted solution. After the HRS™ or HRS™ II is added, adjust the total solution volume to 5 gallons. HRS™ and HRS ™ II are the only approved foam-generating additives for use with VigorOx® Liquid Sanitizer and Disinfectant.
3. Apply the sanitizing solution as a foam using commercially available foam generating equipment. Allow foam to contact surfaces at least one (1) minute. For foot bath application, allow foam to remain on the boot surface for one minute upon exiting the bath.
4. Drain items and/or surfaces thoroughly.

Sanitizing Hard, Non-Porous Food Contact Surfaces

VigorOx® Liquid Sanitizer and Disinfectant is an effective sanitizer against *Staphylococcus aureus, Escherichia coli, and Salmonella typhimurium.*

Clean equipment Immediately after use:

1. Remove gross particulate matter with a warm water flush.
2. Wash equipment with detergent or cleaning solution.
3. Rinse equipment with potable water.
4. Prepare VigorOx® Liquid Sanitizer and Disinfectant solution by adding 1.0 to 1.7 fluid ounces to 5 gallons potable water. This provides 87.7 to 149 ppm peroxyacetic acid and 373 to 635 ppm hydrogen peroxide.
5. Fill closed systems with diluted sanitizer solution and allow a contact time of one (1) minute. If sanitizing at temperatures of 5°C (40°F) or lower, use 1.6 fluid ounces of product to 5 gallons of potable water.
6. If sanitizing against *Listeria monocytogenes*, use 1.2 to 1.7 fluid ounces of this product to 5 gallons of potable water. This will provide 105 to 149 ppm of peroxyacetic acid and 448 to 635 ppm of hydrogen peroxide.
7. For open or not completely closed systems, use a coarse spray, mop/wipe or flood technique to apply the solution to the surface and allow a contact time of one (1) minute.
8. Allow surfaces to drain thoroughly before resuming operation.

Eating Establishment Sanitizing

VigorOx® Liquid Sanitizer and Disinfectant is an effective sanitizer against *Staphylococcus aureus, Escherichia coli, and Salmonella typhimurium.*

1. Scrape/prewash plates, utensils, cups, glasses, etc. whenever possible.
2. Wash all items with a detergent.
3. Rinse thoroughly with potable water.
4. Prepare VigorOx® Liquid Sanitizer and Disinfectant solution by adding 1.0 to 1.7 fluid ounces of the product to 5 gallons of potable water. This will provide 87.7 to 149 ppm peroxyacetic acid and 373 to 635 ppm hydrogen peroxide.
5. Immerse all items for at least 2 minutes or for a contact time as specified by the local governing sanitizing code.
6. If sanitizing against *Listeria monocytogenes*, use 1.2 to 1.7 fluid ounces of this product to 5 gallons of potable water. This will provide 105 to 149 ppm of peroxyacetic acid and 448 to 635 ppm of hydrogen peroxide.
7. Place all sanitized Items on a rack or drainboard to drain adequately. Air dry if items will not be reused immediately.

Sanitizing Tableware

For sanitizing tableware in low to ambient temperature warewashing machines, inject the diluted VigorOx® Liquid Sanitizer and Disinfectant solution (1.0 to 1.7 fluid ounces of the product to 5 gallons of potable water) into the final rinse water. Allow treated surfaces to air dry.

Final Sanitizing Bottle Rinse

VigorOx® Liquid Sanitizer and Disinfectant may be used as a final sanitizing rinse for plastic, glass or metal returnable and non-returnable bottles / cans.

1. Wash bottles with detergent or cleaning solution and rinse with potable water.
2. Rinse bottles/cans with a solution prepared by mixing 1.0 to 1.7 fluid ounces of VigorOx® Liquid Sanitizer and Disinfectant to 5 gallons of potable water.
3. Allow to drain adequately.

Sanitization of Hatching Eggs

1. Prepare a dilute solution by adding 1.0 to 1.7 fluid ounces of VigorOx® Liquid Sanitizer and Disinfectant to 5 gallons of potable water.
2. Apply dilute solution, as eggs are gathered or prior to setting, as a coarse spray or flood so as to lightly wet all egg shell surfaces.
3. Allow to drain dry.

Sanitization of Conveyors, Peelers, Slicers and Saws for Meat, Poultry, Seafood, Fruits, and Vegetables

VigorOx® Liquid Sanitizer and Disinfectant is an effective sanitizer against *Staphylococcus aureus, Escherichia coli, and Salmonella typhimurium.*

For use in the static or continuous washing, rinsing and sanitizing of conveyor equipment, peelers, collators, slicers saws etc.

1. Remove all products from equipment if during treatment the sanitizer will directly contact the items.
2. Prepare VigorOx® Liquid Sanitizer and Disinfectant solution by adding 1.0 to 1.7 fluid ounces to 5 gallons of potable water.
3. Apply sanitizer solution to the return portion of the conveyor or to the equipment using a coarse spray, foam or other means of wetting the surfaces. Treat for at least 1 minute. Control the volume of solution so as to permit maximum drainage and to prevent puddles. The conveyor still may be damp when food contact occurs.
4. If sanitizing against *Listeria monocytogenes*, use 1.2 to 1.7 fluid ounces of this product to 5 gallons of potable water.
5. Allow equipment to drain adequately before reusing; a dry surface is not required.

General Environmental Surfaces Sanitization (Non-Food Contact)

VigorOx® Liquid Sanitizer and Disinfectant is an effective inanimate, hard, non-food contact surface sanitizer against *Staphylococcus aureus*, *Klebsiella pneumoniae*, and *Saccharomyces cerevisiae*.

Sanitization of surfaces such as floors, walls, tables, chairs, benches, drains etc., can be accomplished using the following procedures:

1. Remove gross filth with a cleaner or other suitable detergent.
2. Add 1 to 11 fluid ounces of VigorOx® Liquid Sanitizer and Disinfectant to 16 gallons of potable water to prepare a solution containing 27 to 302 ppm of peroxyacetic acid and 117 to 1285 ppm of hydrogen peroxide.
3. Soak items in/with diluted solution using mop/wipe, coarse spray or flood techniques and allow contact for at least 5 minutes.
4. Allow items and/or surfaces to drain adequately or air dry.

Fogging

VigorOx® Liquid Sanitizer and Disinfectant is for sanitizing hard, non-porous room surfaces as an adjunct to acceptable manual cleaning and disinfection of room surfaces.

1. Prior to fogging, remove or carefully protect all food products and packaging materials.
2. Ensure room is properly ventilated. Vacate all personnel from the room during fogging and for a minimum of 2 hours after fogging. Ensure there is no strong odor characteristic of acetic acid before allowing personnel to return to the work area.
3. Fog areas using one quart per 1000 cu. ft. of room area with a 0.30% (3.8 fluid ounces per 10 gallons of water) VigorOx® Liquid Sanitizer and Disinfectant solution.
4. Allow surfaces to drain thoroughly before operations are resumed.

Surface Disinfection

VigorOx® Liquid Sanitizer and Disinfectant is an effective disinfectant against vegetative forms of Gram positive and Gram negative bacteria, and viruses. This product is effective against *Staphylococcus aureus, Salmonella enterica, Pseudomonas aeruginosa*, Influenza A Virus (H1N1, H3N2 and H5N1 strains), Influenza B Virus and Parainfluenza Virus Type 3. It may also be used to disinfect veterinary clinic surfaces and livestock equipment contaminated with Newcastle Disease virus, Avian Reovirus, Avian Infectious Bronchitis, Infectious Bursal Disease and Infectious Bovine Rhinotracheitis and may be used in general commercial and medical and veterinary environments to clean, disinfect, and deodorize hard, non-porous inanimate surfaces, including:

- Floors, walls, and other non-porous surfaces such as tables, chairs, counter tops, garbage cans/bins, bathroom fixtures, sinks, bed frames, shelves, racks, carts, refrigerators, coolers, glazed tile, linoleum, vinyl, glazed porcelain, plastic (such as polypropylene and polyethylene), stainless steel or glass.
- Hospitals, surgical and obstetrical suites, operating tables, housekeeping services, physical therapy departments, nursing homes, health care facilities, autopsy facilities, pharmaceutical and chemical processing facilities and equipment.
- Schools, colleges, industrial facilities, dietary areas, office buildings, recreational facilities, retail and wholesale establishments.
- Animal hospitals, veterinarly clinics, animal life science laboratories, kennels, kennel runs, cages, feeding and watering equipment, pet shops, zoos, pet animal quarters, poultry premises, trucks, hatcheries and live stock quarters.

To disinfect surfaces that may be contaminated with Gram positive or Gram negative bacteria, including *S. aureus, S. choleraesuis* or *P. aeruginosa*:

1. Prepare VigorOx® Liquid Sanitizer and Disinfectant disinfecting solution by adding 3.2 to 30 oz. of the product to 5 gallons of potable water. This will provide 280 to 2630 ppm peroxyacetic acid and 1195 to 11,200 ppm hydrogen peroxide.
2. Remove gross filth from surfaces to be disinfected by cleaning with a detergent or suitable cleaning product. Rinse with clean water.
3. Apply VigorOx® Liquid Sanitizer and Disinfectant solution by wiping, mopping, foaming, or as a coarse spray. Allow to soak for at least 10 minutes, then air dry. (Applications on food-contact surfaces require a sterile or potable water rinse following disinfection).

For surfaces contaminated with the viruses listed above:

1. Prepare VigorOx® Liquid Sanitizer and Disinfectant solution by adding 2 ⅔ fluid ounce to 5 gallons of potable water. This will provide 230 ppm peroxyacetic acid and 990 ppm hydrogen peroxide. This product is effective against viruses in up to 500 ppm hard water and on surfaces with moderate organic soil.
2. Remove gross filth from surfaces by cleaning with a detergent or suitable cleaning product. Rinse with clean water.
3. Apply VigorOx® Liquid Sanitizer and Disinfectant solution by wiping, mopping, or as a coarse spray. Allow to soak for at least 5 minutes, then air dry.

VigorOx® Liquid Sanitizer and Disinfectant may be mixed with the non-foaming agent, Peradigm™, prior to disinfection.

1. Prepare a diluted solution of VigorOx® Liquid Sanitizer and Disinfectant by adding a minimum of 2.8 fl. oz. to 4.5 gallons of water.
2. Add a maximum of 43 fl. oz. of Peradigm to the dilute solution, and bring total volume to 5 gallons.
3. Apply solution as previously described, allowing a minimum contact time of 10 minutes.

Antimicrobial Rinse of Pre-Cleaned or New Returnable or Non-Returnable Containers: To reduce the number of nonpathogenic beverage spoilage organisms such as *Aspergillus versicolor, Byssochlamys fulva, Pediococcus damnosus, Lactobacillus buchneri*, and *Saccharomyces cerevisiae*.

1. Prepare VigorOx® Liquid Sanitizer and Disinfectant by adding 7.0 to 30 fluid oz. to 5 gallons of potable water. This provides 614 to 2630 ppm peroxyacetic acid and 2614 to 11,200 ppm hydrogen peroxide.
2. Apply solution, allowing a minimum contact time of 5 seconds.
3. Allow containers to drain thoroughly, and then rinse with sterile or potable water.

VigorOx® Liquid Sanitizer and Disinfectant may be mixed with the non-foaming agent, Peradigm™, and applied at room temperature or at a minimum of 25 °C.

1. Mix a minimum of 1.5 fl. oz. VigorOx® Liquid Sanitizer and Disinfectant with Peradigm in 4.5 gallons of water.
2. Add a maximum of 43 fl. oz. of Peradigm to the dilute solution, and bring total volume to 5 gallons. This provides 132 ppm peroxyacetic acid and 560 ppm hydrogen peroxide.
3. Apply solution, allowing a minimum contact time of 30 seconds.

Disinfection and Deodorizing of Animal Housing Facilities, Poultry Premises, Coops, Trucks and Crates

1. Remove all animals / poultry from the facilities / items / areas to be disinfected.
2. Remove gross particulate, litter, droppings etc. with a warm water flush or by sweeping.
3. Empty all troughs, racks, and other feeding and watering equipment.
4. Wash all items thoroughly with detergent or cleaning solution and rinse with water.
5. Prepare a disinfecting solution by adding 3.2 fluid ounces of VigorOx™ Liquid Sanitizer and Disinfectant to 5 gallons of potable water. This provides 280 ppm of peroxyacetic acid and 1195 ppm of hydrogen peroxide which will disinfect surfaces contaminated with Gram positive and Gram negative bacteria, as well as poultry and cattle viruses listed above
6. Before starting the treatment ensure that the work area is well ventilated
7. For disinfection, saturate with the diluted product for a period of at least 10 minutes.
8. For surfaces contaminated with the viruses listed above under *Surface Disninfection*, saturate surfaces with diluted product for a period of at least 5 minutes.
9. Thoroughly scrub treated feed equipment, (i.e., feed racks, troughs, fountains etc.) with a detergent and rinse with potable water.
10. Do not return animals / poultry or use equipment until solution has been completely absorbed and air dried.

Poultry Hatchery Disinfection

1. Remove remaining eggs and chicks, and all gross particulate and other hatching-related debris.

2. Thoroughly wash all surfaces with a recommended detergent or cleaning solution and then rinse with potable water.
3. Prepare the disinfecting solution by adding 3.2 fluid ounces of VigorOx® Liquid Sanitizer and Disinfectant to 5 gallons of potable water.
4. Before starting the treatment, ensure that the work area / room and any closed spaces are well ventilated.
5. Apply the disinfecting solution with a mop, cloth, brush or coarse spray, keeping surfaces wet for 10 minutes.
6. Air dry before re-introducing eggs.

Batch Sanitization of Ultra-Filtration and Reverse Osmosis (RO) Membranes

VigorOx® Liquid Sanitizer and Disinfectant is for use in the sanitization of ultra filtration, medical and non-medical institutional/industrial reverse osmosis (RO) membranes and their associated distribution systems. This product is not for use in kidney dialysis reprocessing equipment.

This product has been shown to be an effective disinfectant when tested by AOAC and EPA methods. This product may not totally eliminate all vegetative microorganisms in reverse osmosis membranes and their associated piping systems due to their construction and/or assembly, but can be relied upon to reduce the number of microorganisms to acceptable levels when used as directed. Check with equipment manufacturer for membrane compatibility with VigorOx® Liquid Sanitizer and Disinfectant.

1. Remove biological or organic fouling from the membrane or other parts of the system with an appropriate cleaner.
2. Flush the system with RO permeate or similar quality water.
3. Remove mineral deposits with an acidic cleaner prior to sanitizing the membranes.
4. Flush the system with RO permeate or similar quality water.
5. Prepare an appropriate volume of 1% solution of the product (12 fl. oz. per 10 gallons of water). This will provide 526 ppm of peroxyacetic acid and 2338 ppm hydrogen peroxide.
6. Fill the entire water circuit to be sanitized with the dilute solution and allow the solution to reach a minimum of 20°C (69°F).
7. Recirculate the dilute solution of VigorOx® Liquid Sanitizer and Disinfectant for a minimum of 10 minutes.
8. Allow membrane elements to soak in the solution for a minimum of 20 minutes.
9. Rinse the RO system and test for residuals to ensure that there is less than 3 ppm peroxygen. Residuals can be reduced by diverting product water to drain.

Batch Sanitization of Piping Systems Associated with RO Membranes

1. Isolate incompatible equipment from piping system. This includes activated carbon filters and ion exchange equipment. Turn off power to ultraviolet light units.
2. Estimate total volume of water contained in the system (tanks, rinse stations and piping). Prepare an appropriate volume of 1.0 to 1.5% VigorOx® Liquid Sanitizer and Disinfectant solution by adding 1.0 to 1.5 gallons of the product for every 100 gallons of solution prepared. Use RO permeate or similar quality water for dilution. This will provide 561 to 842 ppm peroxyacetic acid and 2389 to 3584 ppm hydrogen peroxide.
3. Recirculate the dilute VigorOx® Liquid Sanitizer and Disinfectant solution through the system for a minimum of 4 hours. Process usage valves should be opened and closed to expose internals to the VigorOx® Liquid Sanitizer and Disinfectant solution.
4. Completely drain the system of dilute VigorOx™ Liquid Sanitizer and Disinfectant solution. Thoroughly rinse the system by filling with RO permeate or similar quality water and recirculate before drainage. Repeat the process until test for residuals indicates there is less then 3 ppm peroxygen.

Continuous/Intermittent Addition to Minimize the Accumulation of Biological Matter Between Intermittent Sanitizing Episodes in Piping Systems Associated with RO Membranes.

1. VigorOx® Liquid Sanitizer and Disinfectant, as received or diluted, may be added continuously to the feed water stream, between system sanitizing episodes, to aid In minimizing the regrowth/accumulation of biological matter. The peroxygen residual in the system that will be effective, will vary with the design and usage characteristics of the system. Adjust the addition rate of VigorOx® Liquid Sanitizer and Disinfectant or the solution and periodically monitor residual peroxygen so that the desired effect is obtained.
2. For continuous addition, do not exceed 20 ppm VigorOx® Liquid Sanitizer and Disinfectant (0.1 fl. oz. per 40 gallons of water). This will give 1 ppm peroxyacetic acid and 4.5 ppm hydrogen peroxide. For intermittent feed, do not exceed 2000 ppm VigorOx® Liquid Sanitizer and Disinfectant (10 fl. oz. per 40 gallons of water). This will give 123 ppm peroxyacetic acid and 523 ppm hydrogen peroxide.

Note: Before using VigorOx® Liquid Sanitizer and Disinfectant to sanitize metal surfaces, it is recommended that the diluted solution be tested on a small area to determine compatibility.

In all applications, always prepare a new sanitizing/disinfecting solution daily to ensure effectiveness. Do not reuse sanitizing/disinfecting solutions. Dispose of any unused sanitizing/disinfecting solution.

For more information see Material Safety Data Sheet
Label Effective Date: 3/4/2008

65402-3 8-8-2007 1/7

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

080807

OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

Ms. Luann Maloney
Manager of Regulatory Affairs for,
FMC Corporation, Peroxygens Division
1735 Market Street
Philadelphia, PA 19103

Mail to: Attn: Matt Talley
Keller and Heckman
1001 G Street, N.W.
Suite 500 West
Washington, D.C. 20001

Subject: VigorOxR SP-15 Antimicrobial Agent
EPA Registration Number 65402-3
Your Amendment Dated June 20th, 2007
EPA Received Date June 21st, 2007

The amendment referred to above, submitted in connection with registration under the Federal Insecticide, Fungicide, and Rodenticide Act, FIFRA, as amended, to add "organic language" to the product labeling as per PR Notice 2003-1, is acceptable.

A stamped copy of the labeling is enclosed for your records.

If you have any questions concerning this letter, please contact Karen M. Leavy at (703)-308-6237.

Sincerely,

Marshall Swindell
Product Manager 33
Regulatory Management Branch I
Antimicrobial Division(7510P)

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VigorOx® SP-15 Antimicrobial Agent

EPA Registration No. 65402-3
EPA Est. No. 00279-NY-003

For Industrial Use Only

Active Ingredients:	Peroxyacetic Acid	15%
	Hydrogen Peroxide	10%
Inert Ingredients:		75%
Total:		100%

KEEP OUT OF REACH OF CHILDREN
DANGER

VigorOx® SP-15 Antimicrobial Agent is for biofouling and slime control in:

- Pulp and paper mill systems
- Recirculating process and cooling water systems
- Coating preservation
- Dispersed pigment preservation

VigorOx® SP-15 Antimicrobial Agent is for institutional/industrial sanitizing of previously cleaned non-porous food contact surfaces in:

- Dairies, Wineries, Breweries and Beverage Plants
- Meat and Poultry Processing/Packaging Plants
- Milk and Dairy Products Processing/Packing Plants
- Seafood and Produce Processing/Packing Plants
- Food Processing/Packing Plants
- Egg Processing/Packing Equipment Surfaces
- Eating Establishments

VigorOx® SP-15 Antimicrobial Agent is for Institutional/ industrial sanitizing of previously cleaned non-porous food contact surfaces such as:

- Eating, Drinking, and Food Preparation Utensils
- Tableware
- Plastic, Glass and Metal Bottles (rinse)

For Organic Production. **VigorOx® SP-15 Antimicrobial Agent** may be used in rinse or wash water on products labeled as organic in food processing facilities on commodities that will be further processed. For use as a sanitizer on food contact surfaces in contact with products labeled as organic

VigorOx® SP-15 Antimicrobial Agent is for use as a coarse spray for surfaces to be sanitized.

VigorOx® SP-15 Antimicrobial Agent is for sanitizing surfaces such as packinghouse conveyers and harvesting equipment and containers. It is effective against plant pathogens such as *Xanthomonas campestris (axonopodis)* pathovars citrumelo (citrus canker surrogate).

VigorOx® SP-15 Antimicrobial Agent is for sanitization of hatching eggs

VigorOx® SP-15 Antimicrobial Agent is for use in fogging applications as an adjunct to acceptable manual cleaning and sanitizing room surfaces.

VigorOx® SP-15 Antimicrobial Agent is for porous and non-porous hard surface sterilization except aseptic packaging which is limited to hard surfaces only.

VigorOx® SP-15 Antimicrobial Agent is for use in the disinfection of hard surfaces in general commercial and medical environments and as an antimicrobial rinse of Precleaned or New *Returnable or Non-Returnable Containers*

VigorOx® SP-15 Antimicrobial Agent is for use as a dip or spray wash to control the growth of non-public health microorganisims that may cause decay and/or spoilage on raw, post-harvest and fresh cut, fruits and vegetables.

VigorOx® SP-15 Antimicrobial Agent is for use in process water that contacts raw, post-harvest, fresh-cut and processed fruits and vegetables.

VigorOx® SP-15 Antimicrobial Agent is for use in aseptic food processing on food packaging materials to achieve commercial sterility.

ACCEPTED
with COMMENTS
In EPA Letter Dated:
080807
Under the Federal Insecticide, Fungicide, and Rodenticide Act as amended, for the pesticide, registered under EPA Reg. No.
65402-3

3/7

Precautionary Statements
Hazards to Humans and Domestic Animals

DANGER
Corrosive, causes eye and skin damage. Harmful if swallowed. Do not get in eyes, on skin or on clothing. Wear goggles or face shield and rubber gloves when handling. Wash thoroughly with soap and water after handling. Do not breathe vapor or spray mist. Do not enter an enclosed area without proper respiratory protection.

Physical or Chemical Hazards
Strong oxidizing agent. Mix only with water. VigorOx® SP-15 Antimicrobial Agent is not combustible; however, at temperatures exceeding 156°F, decomposition occurs, releasing oxygen. The oxygen released could initiate or promote combustion of other materials.

Environmental Hazards
This pesticide is toxic to birds, mammals, fish and aquatic invertebrates. Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or other waters unless in accordance with requirements of a National Pollutant Discharge Elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance contact your State Water Board or Regional Office of the EPA.

Any solution released from the system should be diluted with water and tested for residuals to ensure that there is less than 3 ppm peroxygen remaining.

First Aid
Have the product container or label with you when calling a poison control center or doctor, or going for treatment.

If in eyes	• Hold eye open and rinse slowly and gently with water for 15-20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice.
If on skin or clothing	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
If inhaled	• Move person to fresh air. • If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth if possible. • Call a poison control center or doctor for further treatment advice.
If swallowed	• Call poison control center or doctor immediately for treatment advice. • Have person sip a glass of water if able to swallow. • Do not induce vomiting unless told to do so by a poison control center or doctor. • Do not give anything by mouth to an unconscious person.
Note to Physician:	Probable mucosal damage may contraindicate the use of gastric lavage.

ACCEPTED
with COMMENTS
in EPA Letter Dated:
080807
Under the Federal Insecticide, Fungicide, and Rodenticide Act as amended, for the pesticide, registered under EPA Reg. No.
65402-3

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FMC and VigorOx® are trademarks of FMC Corporation

ACCEPTED
with COMMENTS
In EPA Letter Dated:
080807
Under the Federal Insecticide, Fungicide, and Rodenticide Act as amended, for the pesticide, registered under EPA Reg. No. 65402-3

FMC Corporation
Peroxygens Division
1735 Market Street
Philadelphia Pennsylvania 19103

Storage and Disposal

Storage

NEVER RETURN VigorOx® SP-15 Antimicrobial Agent TO THE ORIGINAL CONTAINER AFTER IT HAS BEEN REMOVED. Avoid all contaminants, especially dirt, caustic, reducing agents, and metals. Contamination and impurities will reduce shelf life and can induce decomposition. In case of decomposition, isolate container, douse container with cool water and dilute with large volumes of water.

Avoid damage to containers. Keep container closed at all times when not in use. Keep container out of direct sunlight. To maintain product quality, store at temperatures below 86°F. Do not store on wooden pallets.

Procedure for Leak or Spill

Stop leak if this can be done without risk. Shut off ignition sources; no flames, smoking, flares, or spark producing tools. Keep combustible and organic materials away. Flush spilled material with large quantities of water. Undiluted material should not enter confined spaces.

Disposal

Pesticide Disposal

If material has been spilled, an acceptable method of disposal is to dilute with at least 20 volumes of water followed by discharge into suitable treatment system in accordance with all local, state, and Federal environmental laws, rules, regulations, standards, and other requirements. Because acceptable methods of disposal may vary by location, regulatory agencies should be contacted prior to disposal.

VigorOx® SP-15 Antimicrobial Agent which is to be discarded should be disposed of as hazardous waste after contacting the appropriate local, state, or Federal agency to determine proper procedures.

Container Disposal

Empty drums are not returnable to FMC unless special arrangements have been made. Triple rinse drums with water. Dispose of drums in accordance with local, state, and Federal regulations. **DO NOT REUSE.**

Directions for Use

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

Biofouling Control in Pulp and Paper Mill Systems

For use in the manufacture of paper and paperboard intended for food and non-food contact.

VigorOx® SP-15 Antimicrobial Agent can be used to control bacterial, fungal and yeast growth in pulp, paper and paperboard mills.

1. Severely fouled systems should be cleaned before initial treatment with VigorOx® SP-15 Antimicrobial Agent. Refer to the plant operations manual for directions for cleaning severely fouled systems. The product should be added directly to the system and not mixed with any other chemicals or additives. Other chemicals can be added separately. Contamination with other chemicals could result in product decomposition.
2. Add the VigorOx® SP-15 Antimicrobial Agent at a point in the system where it can be mixed uniformly with the pulp, e.g., the beater, hydropulper, fan pump, broke pump etc.
3. Intermittent feed method: Apply 0.5 lb to 1.2 lb (7 to 16 fluid ounces) of VigorOx® SP-15 Antimicrobial Agent per ton (dry basis) of pulp or paper produced for two to three hours every eight-hour shift. Maintain a concentration that provides adequate control. Daily rate could change depending on the severity of the biofouling.
4. Continuous feed method: Initially, use the intermittent feed method to achieve control. When control is accomplished, apply VigorOx® SP-15 Antimicrobial Agent continuously at the rate determined adequate for intermittent control. Then reduce the rate of addition to the lowest level sufficient to maintain control. Depending on the severity of the biofouling, control usually can be maintained using a continuous rate of 0.2 to 1.2 lb (2.6 to 16 fluid ounces) of VigorOx® SP-15 Antimicrobial Agent solution per ton (dry basis) of pulp or paper produced on a continuous basis. This will provide 15 to 90 ppm of peroxyacetic acid and 10 to 60 ppm of hydrogen peroxide.

Control of Bacteria and Fungi in Dispersed Pigments

VigorOx® SP-15 Antimicrobial Agent can be used to control bacteria and fungi in the manufacture and storage of dispersed pigments used in paint and paper production such as kaolin clay, titanium dioxide, calcium carbonate, calcium sulfate, barium sulfate, magnesium silicate and kieselguhr.

Apply 0.2 to 1.2 lb (2.6 to 16 fluid ounces) (90 to 545 grams) of VigorOx® SP-15 Antimicrobial Agent solution to each 1,000 lb (454 Kg) of fluid. This will provide 200 to 1200 ppm of product (30 to 180 ppm of peroxyacetic acid and 20 to 120 ppm of hydrogen peroxide).

Control of Slime Forming Bacteria in Recirculating Cooling Water Systems (Cooling Towers, Evaporative Condensers) and Non-Food Contact Water Systems (Pulp and Paper Mill Water Systems).

VigorOx® SP-15 Antimicrobial Agent is for use in treating raw (make-up) and process waters, closed and opened loop systems such as heat exchanges, wet scrubbers, cooling towers, evaporative condensers and recirculating industrial process waters, such as pulp and paper mill water systems.

1. Severely fouled systems should be cleaned before adding the VigorOx® SP-15 Antimicrobial Agent solution. Refer to the system operation manual for directions to clean severely fouled systems. The product should be added directly to the system and not mixed with any other chemicals or additives. Other chemicals should be added separately. Contamination with other chemicals could result in product decomposition.
2. Add the VigorOx® SP-15 Antimicrobial Agent solution at a point in the system where uniform mixing and even distribution will occur.
3. Intermittent feed method: When the system is noticeably fouled, apply 0.8 to 1.2 lb (10 to 16 fluid ounces) of VigorOx® SP-15 Antimicrobial Agent solution per 1000 gallons of water in the system. Repeat until control is achieved. When microbial control is evident, add 1.0 lb (14 fluid ounces) of the solution per 1000 gallons of water in the system every day, or as needed, to maintain control. The daily dose rate could vary depending upon the severity of the biofouling.
4. Continuous feed method: Initial dose – When the system is just noticeably fouled, apply 0.8 to 1.2 lb (10 to 16 fluid ounces) of VigorOx® SP-15 Antimicrobial Agent solution per 1000 gallons of water in the system. When microbial control is achieved, start adding VigorOx® SP-15 Antimicrobial Agent solution continuously at a rate of 1.0 lb (14 fluid ounces) per 1000 gallons of water (provides 17 ppm peroxyacetic acid and 12 ppm of hydrogen peroxide). Then reduce the rate of addition to a level sufficient to maintain control. The dose rate may have to be adjusted to account for losses due to blowdown and evaporation. Add 1.4 fluid ounces of VigorOx® SP-15 Antimicrobial Agent for every 100 gals of make-up water.

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Control of Bacteria and Fungi in Coating Preservation

Do not use for coatings preservation applications involving direct or indirect food contact.

VigorOx® SP-15 Antimicrobial Agent can be used as an in-container preservative for the control of bacteria and fungi in water-based coatings such as paper coatings.

- Add 0.2 to 1.2 lb (2.6 to 16 fluid ounces) (90 to 545 grams) of VigorOx® SP-15 Antimicrobial Agent solution to each 1,000 lbs (454 Kg) of water (provides 200 to 1200 ppm of product or 30 to 180 ppm peroxyacetic acid and 20 to 120 ppm of hydrogen peroxide).

Aseptic Food Processing Operations

This product may be used to achieve commercial sterility of food packaging prior to fill and of equipment used in aseptic food processing applications.

Food Packaging Materials

Apply VigorOx® SP-15 Antimicrobial Agent on the exterior and interior of food containers and closure systems (caps, seals, etc.) Apply 4000 ppm peroxyacetic acid at a minimum temperature of 65°C. The solution must remain in contact with the packaging surface for a minimum of 20 seconds. Rinse containers with sterile water prior to filling with processed food.

This product may be used on food packaging as an aseptic packaging antimicrobial rinse in food packaging processing operation that has a scheduled process accepted by FDA. The aseptic food processing operation must comply with all applicable FDA regulations, including but not limited to 21 CFR parts 108, 110, 113, and/or 114. Use in an aseptic food processing operation includes testing required for the process validation.

This product may be used to achieve commercial sterility of non-porous food manufacturing, packaging and filling equipment

Food Processing Equipment

VigorOx® SP-15 Antimicobial Agent may be used as a manufacturing, filling and packaging equipment.

1. Remove gross soil particles from equipment surfaces.
2. Clean surfaces thoroughly.
3. Rinse thoroughly with potable water.
4. Apply 4000 ppm peroxyacetic acid at a minimum temperature of 65 °C
5. Use immerison, coarse spray or circulation techniques to apply VigorOx® SP-15 Antimicrobial Agent
6. Allow contact time of at least 20 seconds.
7. Allow to drain dry.
8. Rinse with sterile water.

This product may be used on equipment used in aseptic packaging antimicrobial rinse in food processing operation that has a scheduled process accepted by FDA. The aseptic food processing operation must comply with all applicable FDA regulations, including but not limited to 21 CFR parts 108, 110, 113, and/or 114. Use in an aseptic food processing operation includes testing required for the process validation.

Sanitization of Non-porous Food Contact Surfaces

For use in circulation cleaning and institutional/industrial sanitizing of previously cleaned non-porous food contact surfaces and equipment, such as pipelines, tanks, vats, fillers, evaporators, pasteurizers, and aseptic equipment in:

- Dairies, Wineries, Breweries and Beverage Plants
- Meat and Poultry Processing/Packaging Plants
- Milk and Dairy Products Processing/Packing Plants
- Seafood and Produce Processing/Packing Plants
- Food Processing/Packing Plants
- Egg Processing/Packing Equipment Surfaces
- Eating Establishments, and in
- Final Sanitizing Bottle Rinse

VigorOx® SP-15 Antimicrobial Agent is an effective sanitizer against *Staphylococcus aureus, Escherichia coli, Listeria monocytogenes and Salmonella typhimurium*

Clean equipment immediately after use:

1. Remove gross particulate matter with a warm water flush.
2. Wash equipment with detergent or cleaning solution.
3. Rinse equipment with potable water.
4. Prepare VigorOx® SP-15 Antimicrobial Agent solution by adding 0.31 to 0.45 fluid ounces to 5 gallons potable water. This provides 85 to 123 ppm peroxyacetic acid and 57 to 82 ppm of hydrogen peroxide.
5. Fill closed systems with diluted sanitizer solution for a contact time of one (1) minute.
6. If sanitizing against *Listeria monocytogenes* use 0.4 to 0.45 fluid ounces (109 to 123 ppm peroxyacetic acid and 73 to 82 ppm hydrogen peroxide) of product to 5 gallons of potable water.
7. For open or not completely closed systems, use a coarse spray, mop/wipe or flood technique to apply the solution to the surface for a contact time of at least one (1) minute. Allow surfaces to drain thoroughly before resuming operation.

Eating Establishment Sanitizing

VigorOx® SP-15 Antimicrobial Agent is an effective sanitizer against *Staphylococcus aureus, Escherichia coli, Listeria monocytogenes and Salmonella typhimurium.*

1. Scrape/prewash plates, utensils, cups, glasses, etc whenever possible.
2. Wash all items with a detergent.
3. Rinse thoroughly with potable water.
4. Prepare VigorOx® SP-15 Antimicrobial Agent solution as follows: Add 0.31 to 0.45 fluid ounces of the product to 5 gallons of potable water. This will provide 85 to 123 ppm peroxyacetic acid and 57 to 82 ppm of hydrogen peroxide.
5. Immerse all items for at least one (1) minute or for a longer contact time if specified by the local governing sanitizing code.
6. If sanitizing against *Listeria monocytogenes* use 0.4 to 0.45 fluid ounces (109 to 123 ppm peroxyacetic acid and 73 to 82 ppm hydrogen peroxide) of product to 5 gallons of potable water.
7. Place all sanitized items on a rack or drainboard to drain adequately. Air dry if items will not be reused immediately.

Sanitizing Tableware

For sanitizing tableware in low to ambient temperature warewashing machines, inject the diluted VigorOx® SP-15 Antimicrobial Agent solution (0.31 to 0.45 fluid ounces of the product to 5 gallons of potable water) into the final rinse water. This provides 85 to 123 ppm peroxyacetic acid and 57 to 82 ppm of hydrogen peroxide. Allow treated materials to drain adequately. Air dry if items will not be reused immediately.

Final Sanitizing Bottle Rinse

VigorOx® SP-15 Antimicobial Agent may be used as a final sanitizing rinse for plastic, glass or metal returnable and non-returnable bottles/cans.

1. Wash bottles with detergent or cleaning solution and rinse with potable water.
2. Rinse bottles/cans with a solution prepared by mixing 0.31 to 0.45 fluid ounces of VigorOx™ SP-15 Antimicrobial Agent to 5 gallons of potable water. This provides 85 to 123 ppm peroxyacetic acid and 57 to 82 ppm of hydrogen peroxide. Allow to drain dry.

Sanitization of Hatching Eggs

1. Prepare a dilute solution by adding 0.31 to 0.45 fluid ounces of VigorOx® SP-15 Antimicrobial Agent to 5 gallons of potable water. This provides 85 to 123 ppm peroxyacetic acid and 57 to 82 ppm of hydrogen peroxide.
2. Apply dilute solution as eggs are gathered or prior to setting as a coarse spray or flood so as to lightly wet all egg shell surfaces.
3. Allow to drain dry.

ACCEPTED
with COMMENTS
In EPA Letter Dated:

080807

Under the Federal Insecticide, Fungicide, and Rodenticide Act as amended, for the pesticide, registered under EPA Reg. No. 1c5407-3

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Sanitization of Conveyors, Peelers, Slicers, and Saws for Meat, Poultry, Seafood, Fruits, and Vegetables

VigorOx® SP-15 Antimicrobial Agent is an effective sanitizer against *Staphylococcus aureus, Escherichia coli, Salmonella typhimurium,* and *Listeria monocytogenes.*

For use in the washing, rinsing and sanitizing of conveyor equipment, peelers, collators, slicers, saws etc.

1. Remove all products from equipment unless treating only the return portion of a conveyor.
2. Prepare VigorOx® SP-15 Antimicrobial Agent solution by adding 0.31 to 0.45 fluid ounces to 5 gallons of potable water. This provides 85 to 123 ppm peroxyacetic acid and 57 to 82 ppm of hydrogen peroxide.
3. Apply sanitizer solution to the return portion of the conveyor or to the equipment using a coarse spray or other means of wetting the surfaces. Control the volume of solution so as to permit maximum drainage and to prevent puddles. The conveyor suface may still be damp when food contact occurs.
4. If sanitizing against *Listeria monocytogenes* use 0.4 to 0.45 fluid ounces (109 to 123 ppm peroxyacetic acid and 73 to 82 ppm hydrogen peroxide) of product to 5 gallons of potable water.
5. Allow equipment to drain adequately before reusing; a dry surface is not required.

Surfaces Treated to Control the Spread of Citrus Canker

VigorOx® SP-15 Amtimicrobial Agent can be used to control the spread of citrus canker between inanimate surfaces and inanimate surfaces to plants. This product is for sanitizing surfaces such as packinghouse conveyers and harvesting equipment and containers. This product is not for treatment of infected plants.

Packinghouse Sanitization

VigorOx® SP-15 Amtimicrobial Agent is an effective sanitizer against microorganisms such as *Xanthomonas campestris (axonopodis)* pathovars citrumelo (citrus canker surrogate) and *Aspergillus versicolor,* as well as *Staphylococcus aureus, Escherichia coli,* and *Salmonella typhimurium.*

1. Remove gross contamination with a cleaner or other suitable detergent and rinse with potable water.
2. Use VigorOx® SP-15 Antimicrobial Agent at a dilution of 3.1 fluid oz. per 50 gallons of water (85 ppm peroxyacetic acid and 57 ppm hydrogen peroxide) as a general sanitizing coarse spray to reduce bacterial and fungal contamination of walls, floors, conveyers and harvesting containers.
3. Allow sanitizer to contact surface for at least one (1) minute.
4. Allow to air dry, do not rinse.

Field Equipment Sanitization

VigorOx® SP-15 Antimicrobial Agent may be used to sanitize harvest equipment such as pickers, trailers, trucks (including truck body parts and tires), bins, packing crates, ladders, power tools, hand tools, gloves, rubber boots, pruning shears or other equipment that may transfer *Xanthomonas campestris (axonopodis)* pathovars citrumelo (citrus canker surrogate). This product can also be used to sanitize surfaces contaminated with *E. coli, Salmonella typhimurium,* and *S. aureus.*

1. Before sanitization, move the field equipment into an area with an impervious surface and with controlled drainage. Ensure that no sanitization solution will be released into the environment.
2. Remove gross contamination with a cleaner or other suitable detergent and rinse with water.
3. Use VigorOx® SP-15 Antimicrobial Agent at a dilution of 3.1 to 5.0 fluid oz per 50 gallons of water (85 to 135 ppm peroxyacetic acid and 57 to 90 ppm hydrogen peroxide) as a general sanitizing coarse spray.
4. Allow sanitizer to contact surface for at least one (1) minute.
5. Allow to air dry, do not rinse.

ACCEPTED
with COMMENTS
In EPA Letter Dated:
080807
Under the Federal Insecticide, Fungicide, and Rodenticide Act as amended, for the pesticide, registered under EPA Reg. No.
1s5407-3

Fogging

VigorOx® SP-15 Antimicrobial Agent is for sanitizing hard room surfaces as an adjunct to acceptable manual cleaning and disinfecting of room surfaces.

1. Prior to fogging, remove or carefully protect all food products and packaging materials.
2. Ensure room is properly ventilated. Vacate all personnel from the room during fogging and for a minimum of 2 hours after fogging. Ensure there is no strong odor, characteristic of acetic acid, before having personnel return to work area.
3. Fog areas using one quart per 1000 cu. ft. of room area with a 0.1% VigorOx® SP-15 Antimicrobial Agent solution.
4. Allow surfaces to drain thoroughly before operations are resumed.

Surface Disinfection

VigorOx® SP-15 Antimicrobial Agent is an effective one-step cleaner and disinfectant against gram positive and negative bacteria (vegetative forms) such as *Staphylococcus aureus, Salmonella choleraesuis, Pseudomonas aeruginosa.* It is effective in hard water (up to 400 ppm as calcium carbonate equivalent), and in the presence of moderate organic soil. It may be used in general commercial and medical environments to clean, disinfect, and deodorize inanimate surfaces, such as:

- Floors, walls, and other non-porous surfaces such as tables, chairs, counter tops, garbage cans/bins, bathroom fixtures, sinks, bed frames, shelves, racks, carts, refrigerators, coolers, tile, linoleum, vinyl, asphalt, porcelain, plastic (such as polypropylene and polyethylene), stainless steel or glass.
- Areas of use in hospitals, surgical and obstetrical suites; operating tables, housekeeping services; physical therapy departments; nursing homes, health care facilities, autopsy facilities, pharmaceutical and chemical processing facilities and equipment.
- Schools, colleges, industrial facilities, dietary areas, office buildings, recreational facilities, retail and wholesale establishments.
- Animal hospitals, veterinary clinics, animal life science laboratories, kennels, kennel runs, cages, feeding and watering equipment, pet shops, zoos, pet animal quarters, poultry premises, trucks, hatcheries, and live stock quarters.

Prepare VigorOx® SP-15 Antimicrobial Agent disinfecting solution by adding 1.1 to 9.5 oz. of the product to 5 gallons of potable water. This will provide 300 to 2600 ppm peroxyacetic acid and 200 to 1730 ppm hydrogen peroxide. If surfaces are moderately soiled, the disinfection solution may be used without a pre-cleaning step. For grossly soiled surfaces, remove filth from surfaces to be disinfected by cleaning with a detergent or suitable cleaning product. Rinse with clean water. To disinfect, apply VigorOx® SP-15 Antimicrobial Agent by wiping, mopping, or as a coarse spray. Allow to soak for at least 10 minutes, then air dry.

Antimicrobial Rinse of Precleaned or New Returnable or Non-Returnable Containers

If non-pathogenic beverage spoilage microorganisms (for example *Byssochlamys fulva* and Aspergillus *versicolor)* are present, use up to 10 fluid oz. of product per 5 gallons of water. This provides 2700 ppm peroxyacetic acid and 1800 ppm hydrogen peroxide. After applying antimicrobial rinse, allow containers to drain thoroughly, then rinse with sterile or potable water.

For Porous and Non-porous Hard Surface Sterilization

VigorOx® SP-15 Antimicrobial Agent may be used to sterilize both porous and non-porous hard surfaces in institutions, manufacturing, food-processing or other non-medical facilities where sterilization is required. It is effective in the presence of 400 ppm hard water (measured as calcium carbonate equivalent) and moderate organic soil (tested as 5% serum).

1. Remove gross filth with a suitable detergent if present. Rinse with clean water.
2. Mix 2.5 fl. oz. of VigorOx® SP-15 Antimicrobial Agent per gallon of clean water. This provides 3400 ppm of peroxyacetic acid and 2240 ppm of hydrogen peroxide.
3. Spray, sponge or flood to wet all surfaces thoroughly. Solution must remain in contact with surface for 6 hours. Reapply solution to surfaces as necessary to maintain wet conditions.
4. Rinse food-contact surfaces with a sterile or potable water rinse, followed by application of a sanitizing solution of VigorOx® SP-15 Antimicrobial Agent.
5. Do not re-use solution; prepare new solution each time.

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This product is not to be used as a terminal sterilant/high level disinfectant on any surface or instrument that (1) is introduced directly into the human body, either into or in contact with the bloodstream or normally sterile areas of the body, or (2) contacts intact mucous membranes buth which does not ordinarily penetrate the blood barrier or otherwise enter normally sterile areas of the body. This product may not be used to preclean or decontaminate any medical device.

For Treatment of Processing Waters to Control Growth of Non-Public Health Microorganisms that Can Cause Spoilage of Fresh-Cut, Post-Harvest or Processed Fruits and Vegetables.

1. Ensure that the water is recirculating or mixing
2. Add VigorOx® SP-15 Antimicrobial Agent at a dilution of 1 fluid oz per 16 gallons of water. This provides 85 ppm peroxyacetic acid and 57 ppm hydrogen peroxide.
3. Allow the solution to circulate at least 45 seconds before adding or treating raw, fresh-cut or processed fruits and vegetables.
4. Add concentrate as needed to maintain a concentration of at least 85 ppm peroxyacetic acid and 57 ppm hydrogen peroxide.
5. Prepare fresh process water daily. Do not reuse water that is badly fouled.

For Treatment of Processed Fruit and Vegetable Surfaces to Control Growth of Non-Public Health Microorganisms that Can Cause Spoilage.

1. Add VigorOx® SP-15 Antimicrobial Agent at a dilution of 1.5 fl. oz per 25 gallons of water. Ensure that the solution is thoroughly mixed. This provides 80 ppm of peroxyacetic acid and 50 ppm of hydrogen peroxide.

Apply the prepared solution as a spray or dip. Allow a minimum contact time of 45 seconds. No rinse following application is required. This use complies with the requirements at 21 C.F.R. 173.315 (a) (5). A potable water rinse is not required following application of the diluted solution.

For Treatment of Raw, Unprocessed Fruit and Vegetable Surfaces

VigorOx® SP-15 Antimicrobial Agent can be applied as a dip or spray to control the growth of non-public health microorganisms such as *Xanthomonas campestris (exonopodis)* pathovars citrumelo (citrus canker surrogate) and *Aspergillus versicolor*, blue mold (*Penicillium* species), green mold (*Penicillium* species) and stem-end rot *(Geotrichium)* that may cause decay and/or spoilage on raw, post-harvest fruits and vegetables during the washing process. This product can be applied during physical cleaning processes, including at the roller spreader, washer manifold, dip tank, on the brushes or elsewhere in the washing process prior to, simultaneously with or after detergent wash.

1. Prepare treating solution by diluting 1 fluid oz. per 16 gallons of potable water. This will provide 85 ppm peroxyacetic acid and 57 ppm hydrogen peroxide.
2. Apply the diluted sanitizer solution using a coarse spray directed at the fruits or vegetables, or by soaking the fruits or vegetables in the solution. Allow a contact time of at least 45 seconds.
3. The treated produce can be drain dried without a potable water rinse.
4. Do not reuse solution after treatment.

VigorOx® SP-15 Antimicrobial Agent can be used on the following raw and post-harvest fruits and vegetables,

- Root and tuber vegetables such as carrots and potatoes
- Bulb vegetables such as onions, garlic and shallots
- Leafy vegetables such as lettuce and spinach
- Brassica leafy vegetables such as broccoli, cabbage and cauliflower
- Legumes such as beans, peas and lentils
- Fruiting vegetables such peppers, tomato, and eggplant
- Cucurbits such cucumbers, melons, squash, and pumpkins
- Citrus fruits such oranges, lemons, limes, and grapefruit
- Pome fruits, apples and pears
- Stone Fruits such as cherries, peaches, nectarine, and plum
- Small fruits and berries: blackberries, blueberries, red and black raspberries
- Tree nuts such almond, brazil, filbert, cashew, and pecan
- Cereal grains such corn, barley, oats, rice, and wheat
- Herbs and spices such basil, chives, coriander, and dill
- Miscellaneous fruits and vegetables such as asparagus, avocado, artichoke, banana, cranberry, fig, grapes, kiwifruit, mango, mushroom, okra, papaya, peanut, pineapple, strawberry and water chestnut

Note: May cause bleaching of treated surfaces; test commodity if unsure.

Note: Before using VigorOx® SP-15 Antimicrobial Agent to sanitize metal surfaces, it is recommended that the diluted solution be tested on a small area to determine compatibility.

In all applications always prepare a new solution daily to ensure effectiveness. Do not re-use solutions. Dispose of unused solution.

EMERGENCY TELEPHONE NUMBERS
(24 HOURS)
MEDICAL: COLLECT 303-595-9048
TRANSPORTATION: 800-424-9300
OTHER: COLLECT 716-879-0400

For more information see Material Safety Data Sheet
Label Effective Date: July 2007

ACCEPTED
with COMMENTS
In EPA Letter Dated:
080807
Under the Federal Insecticide, Fungicide, and Rodenticide Act as amended, for the pesticide, registered under EPA Reg. No.
65402-3

BioSafe Systems L.L.C.
The BioSecurity Company

22 Meadow Street
East Hartford, CT 06108
toll-free: 888.273.3088
fax: 860.290.8802
www.biosafesystems.com

March 28, 2008

CBI Redacted Copy

Mr. Robert Pooler, Agricultural Marketing Specialist
National Organic Program
USDA / AMS / TM / NOP Room 4008-So.
Ag Stop 0268
1400 Independence Ave, SW
Washington, DC 20250

RE: Petition to *Amend* the National List for Peracetic/Peroxyacetic Acid
CAS #79-21-0
Broadening the use under 7 CFR §205.601 (a)(6) and §205.601 (i)(7)

Dear Mr. Pooler:

BioSafe Systems respectfully petitions for the above-referenced peroxyacetic acid listing to be expanded so that it can be used for more applications in organic crop production. The current listing for peroxyacetic acid under §205.601 (a)(6) limits the use of peracetic acid to the disinfection of equipment, seed and asexually propagating planting material, and we propose that the restriction be removed so that it may be used as an algaecide. The current listing under §205.601 (i)(7) restricts the use to the treatment of fire blight, and we propose that this restriction be removed, as well, so that it can be used to treat a broad spectrum of plant pathogens.

BioSafe Systems manufactures several products with the active ingredient hydrogen peroxide that are currently NOP compliant and OMRI listed, including OxiDate®, U.S. EPA No. 70299-2 and the alternate brand name, StorOx®. Both of these products are widely used in the organic farming community for the treatment of plant pathogens on crops in fields, greenhouses, and packinghouses. Due to the oxidative properties, these products are valuable tools to treat crops/commodities for immediate knockdown of pathogens with no mutational resistance or residual, and our customers rely heavily on these applications.

Also under current review with OMRI is GreenClean® Broad Spectrum Algaecide /Bactericide Liquid, a second alternate brand name of OxiDate. This product is used to treat algae, bacteria and fungi in irrigation waters, as well as in stock tanks and livestock waters.

OxiDate, ZeroTol® (our original hydrogen peroxide product) U.S.EPA #70299-1, and TerraClean®, U.S. EPA #70299-5 have always contained peroxyacetic acid (PAA), which is formed *in situ* between hydrogen peroxide and acetic acid. We have never tried to hide this fact, and we have stated on our MSDS that peroxyacetic acid is present in the formulation. However, when ZeroTol, OxiDate and TerraClean were registered through the Biochemical Pesticides Branch of the EPA between 1998 and 2002, peroxyacetic acid was not recognized as an active ingredient, and BioSafe Systems was instructed to register these products with hydrogen peroxide as the sole active ingredient.

The Agency has since changed its position and has directed BioSafe Systems to re-register our agricultural hydrogen peroxide products with peroxyacetic acid listed as a second active ingredient. BioSafe Systems is pleased with this decision, and these re-registrations are currently before the EPA for review. We anticipate receiving our new registrations by October of 2008.

This presents a new obstacle, however, in that peroxyacetic acid is bound to the above-referenced conditions, whereas hydrogen peroxide is not restricted and can be used to treat a wide variety of crops and commodities for a broad spectrum of diseases. We are very concerned that, once our new registrations are approved and PAA is listed as an active ingredient, our customers who rely on our products will suddenly find that they are no longer able to be used as part of a certified organic program.

Peroxyacetic/peracetic acid is currently allowed as a synthetic on the National List under the following categories:

1. As a disinfectant for equipment, seed, and asexually propagating plant material, as previously mentioned.
2. As plant pest control for the treatment of fire blight, as previously mentioned.
3. As a sanitizer for facility and processing equipment used in livestock production as defined in 205.603 (a).
4. For use in post harvest wash/rinse waters and for sanitizing food contact surfaces in post harvest packing/processing facilities as defined in 205.605 (b).

Peroxyacetic acid was considered for use in field application as part of the TAP review dated November 6, 2000. At the time, it does not appear that there was sufficient documentation and/or data to support field applications. In the years since this review, BioSafe Systems has compiled and/or conducted many studies to support the use of our hydrogen peroxide/peroxyacetic acid products, and is submitting data for efficacy, phytotoxicity and environmental concerns as a part of this petition. Since peroxyacetic acid has always been present in the formulations, we will discuss the efficacy and attributes of our products by name. Several of the studies are being submitted under

confidential cover, and are stamped "Confidential" in the top right corner of each page that should not be posted for public view.

Despite availability of the TAP Reviews, we have been unable to obtain a copy of the NOSB Committee Recommendations for peracetic acid use in crops. Consequently, we are unable to directly address specific concerns that may have contributed to limiting the use of peracetic acid to specific applications. We will, instead, try to allay the concerns or misconceptions about peracetic acid that are addressed in the above-mentioned TAP Review. (November 2000 TAP Reviews for Peracetic Acid can be found in Appendix A) This petition will not address issues that appear to have been resolved, by the approval of certain uses of peroxyacetic acid, but will focus on the unresolved issues such as efficacy and phytotoxicity for additional crops, as well as environmental issues.

The issues and supporting data are as follows:

1. On page 2 of the November 2000 TAP Review of peracetic acid for crops, in the "Combinations" section, it is mentioned that most of the peracetic acid formulation stabilizers are List 3 Inerts. Whereas the November 2000 TAP reviews of peracetic acid for both Processing and Livestock state that "stock commercial preparations usually contain a synthetic stabilizer such as 1-hydroxyethylidene1,1-diphosphonic acid (HEDP) or 2,6-pyridinecarboxylic (dipicolinic) acid to slow the rate of oxidation or decomposition (Kurschner and Diken, 1997). According to FDA regulations, HEDP may be used with PAA at a level not to exceed 4.8 ppm in water used to wash fresh fruits and vegetables (21 CFR 173.315 (a)(5))."

   Not only do those reviews contradict each other, but any product being reviewed for organic use would have to divulge the inerts, which would have to be List 4. Why would this be mentioned in the TAP Review, or cause for concern, when it is all ready part of the criteria? Incidentally, both of the stabilizers mentioned in the Processing review *are* List 4B inerts and are approved for use in organic production. Proprietary formulations are considered trade secrets and will not be publicly revealed, but please be assured that the inerts in our hydrogen peroxide / PAA products are List 4 inerts, which can be verified by our OMRI listings for OxiDate and StorOx.

2. When the November 2000 Peracetic Acid TAP Review was written for Crops, there was no mention of an exemption from the requirement for a tolerance for PAA. In December of 2000, an exemption was posted in 40 CFR §180.1196 which reads:

   > "(a) An exemption from the requirement of a tolerance is established for residues of peroxyacetic acid in or on raw agricultural commodities, in processed commodities, when such residues result from the use of peroxyacetic acid as an antimicrobial treatment in solutions containing a

> diluted end use concentration of peroxyacetic acid up to 100 ppm per application on fruits, vegetables, tree nuts, cereal grains, herbs, and spices. (b) An exemption from the requirement of a tolerance is established for residues of peroxyacetic acid, in or on all raw and processed food commodities when used in sanitizing solutions containing a diluted end-use concentration of peroxyacetic acid up to 500 ppm, and applied to tableware, utensils, dishes, pipelines, tanks, vats, fillers, evaporators, pasteurizers, aseptic equipment, milking equipment, and other food processing equipment in food handling establishments including, but not limited to dairies, dairy barns, restaurants, food service operations, breweries, wineries, and beverage and food processing plants."

Please also note that a petition for an amendment to this peroxyacetic acid tolerance exemption has been submitted to the EPA as part of our re-registration package; a copy of which is enclosed with this submission (Appendix B). An answer is expected from the EPA by October of this year, and is requested to read:

> "(c.) An exemption from the requirement of a tolerance for residues of peroxyacetic acid in or on all agricultural commodities when used as a biochemical pesticide."

3. On page 3 of the TAP review, item #1, it is indicated that peroxyacetic acid is a strong oxidizing agent and can react violently with acetic acid anhydride, olefins, and organic matter."

   Just as with hydrogen peroxide, the only time that peroxyacetic acid will react violently is in the concentrated form. Peroxyacetic acid cannot be isolated from a hydrogen peroxide/acetic acid formulation, and this concentrated formulation must be diluted with water before use.

   Our ZeroTol and OxiDate labels give specific directions to dilute the concentrate before adding any other chemicals, in order to test for compatibility. Please see the "OxiDate Specimen Label and MSDS *Label Updates*", which is enclosed with this submission, (Appendix C) for a partial listing of field-tested chemistries that are compatible with OxiDate, a.k.a. ZeroTol, TerraClean, and other hydrogen peroxide / PAA products.

4. On page 4, item #5, the physiological effects of peroxyacetic acid on soil organisms are discussed. Peroxyacetic acid in combination with hydrogen peroxide in TerraClean, our soil treatment product, has demonstrated to be a highly effective fungicide against soil borne plant pathogens, and confidential studies are submitted to support this claim (Appendix D). These same efficacy trials also monitored for phytotoxicity, and there were no signs of phytotoxicity with the proper use of this product.

TerraClean is marketed to treat field soils that are known to harbor soil-borne plant pathogens, and BioSafe Systems recommends that TerraClean be applied as an initial treatment, so that it can be followed up with the re-introduction of beneficial bacteria and other IPM practices. Steam treatment seems to be terribly impractical for this application, whereas TerraClean can be applied via chemigation practices.

Furthermore, on page 6, Reviewer #2 indicates that for soil treatment, PAA is "prohibited by the EPA label and may be counter to the principles of sustainable agriculture." Please note that the above-referenced product, TerraClean, was EPA approved for the treatment of soil pathogens on January 25, 2002.

5. On page 5, Reviewer #1 recommends that peracetic acid should be prohibited for soil or plant applications, because of the "extremely hazardous classification with potential handling, reactivity and human exposure dangers". Please note that OxiDate, ZeroTol, and TerraClean carry a "Danger" signal word due to the corrosivity of the *concentrate*.

   Once the product is diluted, the worker exposure concerns drop considerably, and this is demonstrated by our Sanidate RTU, U.S. EPA #70299-9 label. SaniDate RTU is a 1:250 dilution of our product SaniDate, U.S. EPA#70299-7, a 27% hydrogen peroxide - 2% PAA product. SaniDate carries a "Danger" label, and SaniDate RTU carries a "Caution" label.

   With regards to the organic alternatives mentioned in this same section:

   A. Heat and steam are effective pasteurizers, but not practical for field treatments when there is a serious outbreak. TerraClean can be applied to the soil via drip or drench irrigation waters in the greenhouse *and in the field.*

   B. Copper can be used as a fungicide, but there are environmental build-up issues with copper. TerraClean, as it has been established, breaks down into acetic acid, water, and oxygen, and does not persist in the environment. Furthermore, due to the oxidizing properties of hydrogen peroxide and PAA, there is no mutational resistance, which can occur with copper and biological products.

   C. Sulfur is an oxidizer, but it is also much more phytotoxic to plants. When used at recommended label rates, there are no phytotoxicity concerns for the use of our hydrogen peroxide/peroxyacetic acid products, and phytotoxicity studies are enclosed under confidential cover which demonstrate the safety to plants, for both foliar and soil applications.

6. To alleviate environmental concerns, we are enclosing a copy of the JACC (Joint Assessment of Commodity Chemicals), titled "Peracetic Acid (CAS No. 79-21-0) and its Equilibrium Solutions", that was published in January of 2001 by the European Centre for Ecotoxicology and Toxicology of Chemicals (Appendix F). This very detailed report thoroughly discusses the properties of peracetic acid. It

addresses several of the concerns expressed in the 2000 TAP Review for peracetic acid, such as:

A. Flammability – Page 12 lists a chart of the Physical and Chemical Properties. As you will see, there is no sustained flammability at concentrations up to 15%, and we are not aware of any PAA concentrations any higher than 15% in products approved for agricultural use. Stabilizers (such as HEDP and dipic acid) are added to prevent any explosion potential, and all containers are vented.

B. Carcinogenicity – It is mentioned in the TAP review that PAA is a "possible co-carcinogen", based on an abstract dating back to 1976. This specific study is discussed in Section 8.5 Chronic Toxicity and Carcinogenicity, and on page 96, under 8.5.4 Summary and evaluation, it is stated, "In conclusion, in the only available initiation-promotion study, which suffers from a number of experimental and reporting deficiencies, the observed effects represent an effect secondary to local irritation, rather than indicating a carcinogenic potential for PAA."

C. Environmental Fate – Decomposition of PAA into water, air, soil and the atmosphere are all discussed in this report, and are summarized in section 4.2.7 Evaluation, "In conclusion PAA should be easily degraded in air, water and soil and does not persist or accumulate in the environment."

7. Numerous efficacy studies are being submitted for OxiDate, StorOx, ZeroTol and TerraClean that demonstrate the efficacy of these products against a broad spectrum of plant pathogenic diseases and algae. Some of these studies are compared against, or applied in conjunction with other organic fungicides. Many of these studies are published research, but again, some studies are proprietary, and marked as confidential in the top right corner of each page that should not be allowed for public view (Appendix D).

8. Two separate studies dedicated specifically to the potential phytotoxicity of ZeroTol and OxiDate on a wide range of plants are submitted under confidential cover (Appendix E). Neither study revealed any phytotoxicity to foliage, flowers, or fruit of target host plants at any point during these studies.

9. Specimen labels are submitted for all of BioSafe Systems' agricultural products included in the re-registration to include peroxyacetic acid as an active ingredient. As you will see, there are an enormous amount of crops and applications that will be affected by this change (Appendix C).

In conclusion of this petition, item #7 of the November 2000 TAP Review for peracetic acid states, "Peracetic acid is a synthetic pesticide. As such, it is in a category that is generally considered incompatible with sustainable agriculture, with only a few exceptions…The short period that it has had a field use label means that there is little experience with how the material fits into organic farming systems. There are a number of reasons to think that it is compatible with a system of sustainable agriculture."

Over the past eight years, BioSafe Systems has compiled significant data for our hydrogen peroxide (dioxide) and peroxyacetic (peracetic) acid products. We have provided substantial documentation regarding the efficacy, phytotoxicity and the environmental impact of using peroxyacetic acid for organic crop production, and we hope that we have demonstrated the importance of allowing its use for organic crop production applications against a variety of plant pathogens.

BioSafe Systems wishes to thank the NOP, the NOSB and the Crops Committee in advance for their consideration. If you have any questions, or require any further information, please do not hesitate to contact me at 860.290.8890.

Best regards,

Kristen B. Knox
Registration Manager

Appendix A

Peracetic Acid

Crops

Identification

Chemical Name(s):
Peroxyacetic Acid
Ethaneperoxic Acid

Other Names:
PAA, Per Acid, Periacetic acid

CAS Number:
79-21-0

Other Codes:
NIOSH Registry Number: SD8750000
UN/ID Number: UN3105

Summary Recommendation

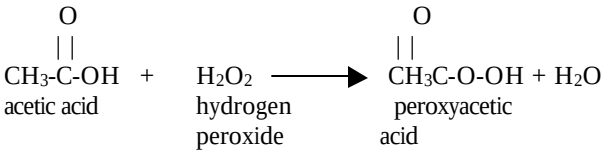
Synthetic / Non-Synthetic:	Allowed or Prohibited:	Suggested Annotation:
Synthetic (consensus)	*Allowed (consensus)*	*1.* Allowed to disinfect equipment. Prohibited for soil (field) application. Allowed to disinfect seed and asexually propagated planting material (i.e., bulb, corm, tuber) used for planting crops. From hydrogen peroxide and fermented acetic acid sources only. *(consensus)* *2.* Allowed for fireblight control with Experimental Use Permit with documentation that alternatives including biocontrols have been tried. *(1 in favor, 2 against)*

Characterization

Composition:
$C_2H_4O_3$. Peracetic acid is a mixture of acetic acid (CH_3COOH) and hydrogen peroxide (H_2O_2) in an aqueous solution. Acetic acid is the principle component of vinegar.

Properties:
Peracetic acid is a very strong oxidizing agent and has a stronger oxidation potential than chlorine or chlorine dioxide. It is a clear, colorless liquid with no foaming capability. It has a strong pungent acetic acid odor, pH is acid (2.8), specific gravity is 1.114, and weighs 9.28 pounds per gallon. Stable upon transport.

How Made:
Peracetic acid (PAA) is produced by reacting acetic acid and hydrogen peroxide. The reaction is allowed to continue for up to ten days in order to achieve high yields of product according to the following equation.



The NOSB recommended that hydrogen peroxide be added to the National List of synthetic substances allowed for crop production (Austin, 1995).

Due to reaction limitations, PAA generation can be up to 15% with residual levels of hydrogen peroxide (up to 25%) and acetic acid (up to 35%) with water up to 25%. Additional methods of preparation involve the oxidation of acetaldehyde or alternatively as an end product of the reaction of acetic anhydride, hydrogen peroxide, and sulfuric acid.

Additional methods of preparation involve the oxidation of acetaldehyde (Budavari, 1996). Another method involves the reaction of tetraacetylethylenediamine (TAED) in the presence of an alkaline hydrogen peroxide solution (Davies and Deary, 1991). These sources appear to be used more frequently in pulp, paper, and textile manufacture (Pan, Spencer, and Leary, 1999).

Specific Uses:
Its major use in the food industry is as a sanitizer. Peroxyacetic acid is used to control deposits, odor, biofilms from food contact surfaces, and as a microbial control agent for both food contact surfaces and direct contact with fruits and vegetables.

Action:
The primary mode of action is oxidation. PAA disinfects by oxidizing of the outer cell membrane of vegetative bacterial cells, endospores, yeast, and mold spores. The mechanism of oxidation is the transfer of electrons, therefore the stronger the oxidizer, the faster electrons are transferred to the microorganism and the faster the microorganism is inactiviated or killed. It has also been reported to be virucidal (Arturo-Schaan, 1996).

Combinations:
Peracetic acid usually occurs with hydrogen peroxide, acetic acid, and a stabilizer in an aqueous solution. Most stabilizers used are EPA List 3 (unknown toxicity) and are not considered in this TAP review.

Status

OFPA
Falls under Production Aid (7 USC 6517(b)(1)(C)(i)).

Regulatory
EPA regular Section 3 registration (40 CFR 152.25(a)). First registered in 1985 (US EPA, 1993). Registered for indoor use only (US EPA, 1993). Some Special Local Need registrations (40 CFR 160) may have been granted for specific crops and applications (Cal-EPA, 2000).

EPA/NIEHS/Other Appropriate Sources
OFPA 6518 (l)(1) states, "In establishing the National List or proposed amendments to the National List, the Board shall review available information from the Environmental Protection Agency, the National Institute of Environmental Health Studies, and such other sources as appropriate, concerning the potential for adverse human and environmental effects of substances considered for inclusion in the proposed National List."

EPA: It is on EPA's Extremely Hazardous Substances list (US EPA, 2000). See the Re-registration Eligibility Document for Peroxy Compunds (US EPA, 1993).

NIEHS: See attachment from the National Toxicology Program.

Other sources: See New Jersey Department of Health and Senior Services attachment.

Status Among U.S. Certifiers
None appear to explicitly allow it for crop use.

Historic Use
Peracetic acid was patented in 1950 to treat fruits and vegetables to reduce spoilage from bacteria and fungi destined for processing (Greenspan and Margulies, 1950). It has since been used in systems to disinfect recirculated wash water used to handle fresh produce (Lokkesmoe and Olson, 1995). It is used to treat bulbs (Hanks and Linfield, 1999), to disinfect potting soil, clean irrigation equipment, (Larose, 1998), and in seed treatment to inactivate fungal or other types of plant disease. While there is a long history of experimental field use as a fungicide / bactericide, efficacy has only recently been established (Hei, 2000). Peracetic acid is effective at reducing *Escherichia coli* O157:H7 on apples when used in a wash and as a chemical sanitizer (Wright et al., 2000).

International
Peracetic acid does not appear on IFOAM Appendix 2 for Plant Pest and Disease Control (IFOAM, 2000). It does not appear on EU 2092/91 Annex II. Field use of this material is not allowed under any known International Organic Standards. Post-harvest application is discussed in the processing TAP review.

OFPA 2119(m) Criteria

1. *The potential of such substances for detrimental chemical interactions with other materials used in organic farming systems.*
This material is a strong oxidizing agent. It can react violently with acetic acid anhydride, olefins (e.g., mineral oil), and organic matter (NTP, 2000).

2. *The toxicity and mode of action of the substance and of its breakdown products or any contaminants, and their persistence and areas of concentration in the environment.*
Toxicity high via oral for guinea pigs; moderate via oral and dermal routes for rats and rabbits (Sax, 1979). Skin and Eye Irritation Data: skin-rabbit 500 mg open SEV; eye-rabbit 1 mg SEV (NTP, 2000). An experimental neoplastinogen (tumor-causing agent) via dermal route (NTP, 2000). It is on EPA's Extremely Hazardous Substances list (US EPA, 2000).

   Peracetic acid is an irritant of the skin, eyes, mucous membranes, and respiratory tract (NTP, 2000; Budavari, 1996; Lenga, 1985). When heated to decomposition, it emits acrid smoke and toxic fumes of carbon monoxide and carbon dioxide. The vapor is heavier than air and can travel a considerable distance to a source of ignition and flash back (NTP, 2000). Breakdown products are acetic acid (same acid found in vinegar at 5% level) and hydrogen peroxide that breaks down to O_2 and H_2O.

   The primary mode of action is oxidation. with mechanism of oxidation is the transfer of electrons, therefore the stronger the oxidizer, the faster electrons are transferred to the microorganism and the faster the microorganism is inactivated or killed.

Table 1
Oxidation Capacity of Selected Sanitizers

Sanitizer	**eV***
Ozone	2.07
Peracetic Acid	1.81
Chlorine dioxide	1.57
Sodium hypochlorite (chlorine bleach)	1.36
*electron-Volts	

   Therefore PAA has a higher oxidation potential than chlorine sanitizers but less than ozone.

3. *The probability of environmental contamination during manufacture, use, misuse or disposal of such substance.*
Production from hydrogen peroxide and acetic acid would depend on the process used. Hydrogen peroxide is commonly produced by the electrolysis of water (Kirchner, 1981). Acetic acid may be produced by fermentation (vinegar) or distillation from plant sources. However, acetic acid may also be synthesized by hydrolysis of acetylene or oxidation of acetylaldehyde (Budavari, 1996). Acetylene and acetaldehyde are generally produced from petrochemical sources. The environmental consequences of petroleum production and refining are beyond the scope of this TAP review.

   Misuse in handling would cause a bleaching out effect on the color of fresh fruits and vegetables resulting in loss of quality that could be visually detected. Under normal use and disposal conditions, PAA decomposes into acetic acid, oxygen, and water.

4. *The effect of the substance on human health.*
Peracetic acid is an irritant of the skin, eyes, mucous membranes, and respiratory tract (NTP, 2000; Budavari, 1996; Lenga, 1985). When heated to decomposition, it emits acrid smoke and toxic fumes of carbon monoxide and carbon dioxide. The vapor is heavier than air and can travel a considerable distance to a source of ignition and flash back (NTP, 2000).

   While it is not rated as a carcinogen by itself (NTP, 2000), studies indicate that it is a possible co-carcinogen, promoting tumor production by known carcinogens (Bock, Myers, and Fox, 1976, from abstract).

5. *The effects of the substance on biological and chemical interactions in the agroecosystem, including the physiological effects of the substance on soil organisms (including the salt index and solubility of the soil), crops, and livestock.*
The substance is used *because* of its biological and chemical interactions and its physiological effects on microorganisms, including many that are naturally found in a soil environment. Among the model organisms that show significant reductions in populations after exposure to PAA are *Bacillus cereus* (Blackiston et al., 1999); *B. subtilis* (Leaper, 1984; Blackiston et al., 1999; Lindsay and von Holy, 1999); *B.. stearothermophilus* (Blackiston et al., 1999); *Clostridium botulinum* (Blackiston et al., 1999); *C. butyricum* (Blackiston et al., 1999); *C. sporogenes* (Blackiston et al., 1999); *Ditylenchus dipsaci* (Hanks and Linfield, 1999); *Enterococcus faecium* (Andrade et al., 1998); *Escherichia coli* (Arturo-Schaan et al., 1996), including *E. coli* O157:H7 (Farrell et al., 1998), *Fusarium oxysporum* (Hanks and Linfield, 1999); *Gluconobacter oxydans* (Winniczuk and Parish, 1997), *Lactobacillus plantarum* (Winniczuk and Parish, 1997), *L. thermophilus* (Langeveld and Montfort-Quasig, 1996); *Leuconostoc mesenteroides* (Winniczuk and Parish, 1997); *Listeria monocytogenes* (Mosteller and Bishop, 1993; Restaino et al., 1994); *Pseudomonas aeruginosa* (Restaino et al., 1994; Lambert et al., 1999); *P. fluorescens* (Mosteller and Bishop, 1993; Lindsay and von Holy, 1999); *Saccharomyces cerevisiae*(Winniczuk and Parish, 1997); *Salmonella typhimurium* (Restaino et al., 1994); *Staphylococcus aureus* (Restaino et al., 1994; Lambert et al., 1999); *Streptococcus delbreuckii* subsp *bulgaricus* (Langeveld and Montfort-Quasig, 1996); and
Yersinia enterocolitica (Mosteller and Bishop, 1993).

The immediate effect against soil organisms would be broad-spectrum and, if mishandled, potentially violent. The toxic effects would be short-lived, and somewhat selective, favoring acid-tolerant and aerobic bacteria. For example, experimental evidence indicates that *Bacillus* spp. would likely be less affected and would recover more quickly than *Clostridium* spp. (Blackiston et al., 1999). However, at least one study indicates no difference between the susceptibility of plasmid-containing *E. coli* strains and those strains that do not contain plasmids (Arturo-Schaan, 1996). The breakdown products--oxygen, water, and acetic acid--are all part of the agroecosystem. Acetic acid is produced in nature as a function of acetobacter species of microorganism found in soil, and is part of the natural carbon cycle (Alexander, 1991).

Salt Index: The salt index has not been calculated for this substance.

Solubility: Water: 100mg/ml at 19°C. (freely soluble). Also soluble in alcohol.

6. *The alternatives to using the substance in terms of practices or other available materials.*
Organic alternatives for post-harvest handling include hot water and steam. It is an alternative to such conventional treatments as formaldehyde and thiabendazole (Hanks and Linfield, 1999).

For fireblight control: Cultural practices such as pruning and sanitation; biological controls such as *Pseudomonas fluorescens* (non-GMO); and copper products. Antibiotics such as oxytetracycline and streptomycin are registered for fireblight. The NOSB recommended that these be added to the National List (Austin, 1995).

7. *Its compatibility with a system of sustainable agriculture.*
Peracetic acid is a synthetic pesticide. As such, it is in a category that is generally considered incompatible with sustainable agriculture, with only a few exceptions. PAA's broad-spectrum nature and its tendency to oxidize organic matter make it antagonistic to organic farming systems. The short period that it has had a field use label means that there is little experience with how the material fits into organic farming systems. There are a number of reasons to think that it is compatible with a system of sustainable agriculture. Given that the compound is made from and decomposes into acetic acid and water, it appears to have a similar compatibility to those parent substances.

TAP Reviewer Discussion

TAP Reviewer Comments

OMRI's information is enclosed in square brackets in italics. Where a reviewer corrected a technical point (e.g., the word should be "intravenous" rather than "subcutaneous"), these corrections were made in this document and are not listed here in the Reviewer Comments. The rest of the TAP Reviewer's comments are listed here minus any identifying comments and with corrections of typos.

Reviewer #1

[Organic farmer and research plant pathologist]

After reviewing the documentation on Peracetic Acid I recommend that the product should be listed as Synthetic, **Allowed** as a sanitizer for disinfecting surfaces of equipment, floors, walls, and indoor processing and packaging facilities, and as a post-harvest treatment of fruits and vegetable surfaces at the lowest effective dilution possible in the literature. All treated surfaces including vegetables and fruits should be rinsed with water following the treatment. I recommend it should be **Allowed with annotation** as a microbiocide for disinfecting seed and asexually propagated planting material (i.e., bulb, corm, tuber). I recommend that it should be **Prohibited** for soil (including soil mixes) or plant application.

Justification: Peracetic Acid appears to be an effective microbiocide for disinfecting equipment, seeds, plant materials, and as a post-harvest treatment of fruits and vegetables. However, Peracetic Acid is a hazardous substance to work with and therefore protective clothing, eye gear, and respiratory equipment is required (U.S. EPA, 2000). Peracetic acid breaks down to acetic acid, water, and oxygen that naturally occur in the agroecosystem (Alexander, 1991). It has the advantage over chlorination, which can seriously damage aquatic life and the formation of chlorinated hydrocarbons with mutagenic or carcinogenic properties (Arturo-Schaan, 1996). Additionally, the microbial activity of hypochlorite is reliant on environmental factors such as the pH, temperature, organic load, and ionic concentration of the solution and may not be an effective disinfectant if conditions are not monitored closely (Wright et al., 2000). The Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables (U.S. Dept Health and Human Services and Food and Drug Adminstration, 1998) was published as a result of President Clinton's 1997 Food Safety Initiative ("Radio Address of the President to the Nation" January 25, 1997). The guide outlines steps to decrease the probability of contaminating food and food products with food pathogens. Organic growers need to have effective microbiocides available for use in their packaging and processing operations.

Peracetic Acid should be **Allowed with annotation** as a microbiocide for disinfecting seed and asexually propagated planting materiel (i.e., bulb, corm, tuber) used for planting crops. The annotation should be that it is allowed only in cases where there are documented plant or human pathogens or pests present that can not be eliminated by hot water or temperature treatments. Such treatments should be limited to an indoor environment with ventilation systems available and proper handling procedures followed.

Peracetic Acid should be **Prohibited** for soil (including soil mixes) or plant application including use for fireblight. Its broad-spectrum, non-specific mode of action makes it incompatible to organic farming systems. Additionally, its extremely hazardous classification with potential handling, reactivity, and human exposure dangers may have greater implications in situations where the product is sprayed in an outdoor, less controlled environment. There are effective organic alternatives to disinfecting materials used in soil mixes that include heat and steam. For fireblight control cultural practices, copper products and biological control (*Pseudomonas fluorescens*) options are available. Additionally, cultivars with better resistance to the pathogen should be employed. Antibiotics such as oxytetracycline and streptomycin are registered for fireblight and were also recommended by the NOSB to be added to the National List (Austin, 1995).

I recommend that production of the product be limited to the process of obtaining hydrogen peroxide by the electrolysis of water (Kirchner, 1981), and acetic acid by fermentation or distillation from plant sources. Obtaining acetic acid synthesized by hydrolysis of acetylene or oxidation of acetyladehyde (Budavari, 1996) should be prohibited.

Reviewer #2

[Research Entomologist]

Peracetic acid is a strong, oxidizing acid that is being reviewed for possible use in organic crop production because of its antimicrobial properties. It is probably more effective as a disinfectant in aqueous solutions (Greenspan and Margulies 1950) than on biofilms (Ntsama et al. 1997) or in organic waste slurries (Bohm et al. 1983). It may be a better biocide for viruses (Quiberoni et al. 1999) and bacteria (Meyer and Meltz 1999) than

it is for fungi (Colgan and Johnson 1998). Some bacteria, such as spore formers, are more resistant (Lensing and Oei 1985).

Possible crop production uses include fireblight control (Hei 2000), bulb disinfestation (Hanks and Linfield 1999; Hanks et al. 1997), as a foliar spray to control greenhouse thrips (Gill et al. 1998), as a postharvest treatment to protect fruits against rot (Brown 1987; Mari et al. 1999; Colgan and Johnson 1998), and as a seed protectant (Wilson 1976). Since it is a synthetic, it would have to be added to the National List before it is used. Although current formulations have stabilizers added, concentrated solutions still pose a problem with fire and explosion. Exposure to aerosols can irritate skin and cause respiratory damage, as explained in the analysis.

As a postharvest treatment of apples and pears, it actually caused increased damage from fungal rots (Colgan and Johnson 1998). It might be more effective for control of brown rot (*Monilinia* sp.) on stone fruit (Mari et al. 1999). As explained below, use in soil is prohibited by the EPA label and may be counter to the principles of sustainable agriculture. Concentrated solutions would probably be needed to disinfest potting soil, and questions of human and environmental safety would have to be answered. Organic methods are already available for this purpose and for thrips control. Though it might have use as a seed protectant, bleach is more effective (Wilson 1976). Though it effectively controlled *Fusarium* sp. and nematodes in vitro, field experiments conducted with treated narcissus bulbs showed that 1-1.5% solutions did not give adequate protection unless a fungicide was added (Hanks and Linfield 1999). Presumably, this would not be possible in organic agriculture. According to Hei (2000), sprays of peracetic acid are not effective for fireblight control. However, injections into trees were effective for this purpose.

Although injections for fireblight control are promising, more data on effectiveness is needed. My recommendation is that field application of this material does not appear to be warranted at this time. Evaluation under OFPA 2119 (m) and answers to specific questions are given below.

Evaluation Under OFPA 2119 (m) Criteria

1. It is a strong oxidizing acid. It would reaction with materials such as pyrethrins if sprayed onto foliage. It would react violently with potting soil mixtures containing organic material. It might be phytotoxic in concentrated solution. Other interactions in processing and livestock production are outside the scope of this review.

2. The LD50 orally in rats is about 315 mg/kg (Busch and Werner 1974). It is a severe skin and respiratory irritant. A solution of 1.5%, which is about half that of peroxide purchased at the drugstore, when applied to the skin of pigs produced "signs of distress, rapid breathing, struggling, lacrimation and coughing." Reddening of the skin occurred, and after 40 days fissures and scaly crusts began to develop.

The material is not persistent in the environment, and breakdown products are benign. None of the breakdown products are xenobiotics.

The mode of action is oxidation. Electrons are removed from living tissue causing chemical changes, and probably disruption of membranes.

3. Industrial production of this material is probably through oxidation of acetaldehyde using a cobalt acetate catalyst. Another way to produce concentrated solutions is reaction of acetic anhydride, hydrogen peroxide, and sulfuric acid. It can also be made by oxidizing acetic acid in a special generator (Hei 2000). The spent cobalt catalyst would have to be discharged into a toxic waste dump. The other materials could possibly be reacted and diluted with water and discharged into waste water with a special permit.

In processing operations, misuse could cause excessive bleaching of fruits. Concentrations greater than 3% when used in treatment of organic wastes leads to massive amounts of foaming (Bohm et al. 1983). If used without proper protection, lungs and eyes of workers could be damaged. Peracetic acid is unstable and degrades quickly in the environment into water, oxygen and acetic acid. The oxygen can increase the chance of fire, and acetic acid is itself a respiratory irritant. Otherwise, the active ingredient seems to pose no threat. Stablizers and chelating agents present in the formulations should be separately evaluated. It is possible they are all approved inerts.

4. The material irritates eyes, skin and the respiratory tract. Concentrated solutions are a severe explosion risk. Unstabilized peracetic acid could explode from the friction of being pumped from the container (New Jersey Hazardous Substance Fact Sheet).

Postharvest disinfection vats of produce being treated with dilute solutions could expose workers to low levels that could cause respiratory problems and depress their immune systems (Heinze et al. 1981).

When solutions are heated just to warm water temperatures (40-60°C), heavier than air fumes are released that are flammable in air. There is a danger of fire that releases toxic fumes. If the fire flashes back to the container, an explosion could result (New Jersey Hazardous Substance Fact Sheet). Explosion and fire hazard are more probable with concentrated solutions. Also formulations registered with the EPA have stablizers added that make explosion less likely (Hei 2000).

As pointed out by the review, it is also a possible co-carcinogen.

5. The TAP review does a good job of analysing effects on soil microorganisms. The analysis seems reasonable. There is not enough published information to make a good judgement of its effect on crops. However, according to Hanks and Linfield (1999), it is not effective enough as a disinfectant in horticultural crops, and would have to be used with a chemical fungicide. Presumably, this would not be possible in an organic operation. As a postharvest sterilant for apples and pears, it actually caused increased damage from fungi (Colgan and Johnson 1998). This was possibly because it killed microbials on the surface that were antagonistic to the pathogens. Effects on livestock are not part of this review.

6. Organic alternatives for postharvest handling include steam, hot water, and treatment with biocontrol microbials. As mentioned in the TAP review, cultural controls, biocontrol, and copper is available for fireblight. Possibly, antibiotics will be added to the National List.

7. Broad spectrum soil sterilants generally do not fit in the concept of sustainable agriculture. Composts, manure, and various soil amendments are added to achieve the proper microbial balance. Pathogens can be selectively destroyed by solarization.

There is not enough information to evaluate effects on sustainable agriculture when used as a foliar spray, a seed treatment, or as a solution for injection into trees.

How it fits into processing and organic livestock production is outside the scope of this review.

Answers to Specific Questions

1. The fireblight label is relatively recent. Is it too early to tell if it should be sprayed on trees? Is that regular (Section 3), Experimental Use Permit (Section 5) or Special Local Need (Section 24 c) registration.

According to Hei (2000), topical application of the material is not that effective for fireblight control. He may be somewhat biased, as his patent is for injection into the cambium layer of trees.

If it is sprayed on trees, workers and those in the way of drift would be at risk. Inhalation of aerosols could damage lungs. Eyes could be damaged. Workers would have to use respiratory protection, eye protection, and protective clothing.

If a company wanted to register for fireblight control, it seems like the easiest thing to do would be to register with an experimental use permit, then conduct field trials to get the necessary data for a regular registration. I believe that Hei (2000) Larose and and Abbot (1998) and others conducted their experiments in greenhouses.

To register as a Special Local Need (24 c), I believe the State can apply to extend a registration for an additional use. To register there must be “an existing or imminent pest problem within a state for which the state lead agency, based upon satisfactory supporting information, has determined that an appropriate federally registered pesticide product is not sufficiently available.” There are antibiotics already registered for fireblight control. The state must show that these are not effective before getting a 24c for this material. Also, tolerances must have already been established before this registration can be obtained. I don't know if this has been done.

For a company to register for this application, the experimental use permit followed by a regular registration would be the way to go.

It seems like it would be much easier to get a registration for injections into the trees. Then there would be less chance of environmental and health consequences.

2. It is not EPA labeled for soil application at this time. However, the label appears to allow use in potting media. Is this a correct interpretation? What should be the organic status of this use?
The label for Tsunami™ 100 does not mention disinfection of potting soil. It is labeled for dipping or spraying fruits and vegetables to disinfect them. Although I did not look at all the labels of the 21 currently registered products (EPA 2000), it seems most of them are registered for disinfection of equipment, surfaces, etc. I think the potting soil concept is a stretch. Because compost, peat, biosolids and other organic materials are present in potting soils, concentrated solutions would have to be used to be effective. Addition to potting soil would produce a violent exothermic reaction, foaming and fumes. There would be a possibility of fire.

As far as the organic status for potting soil, other alternatives such as steam and solarization are available. To use the material at all, it would have to be added to the National List. Also, it is not true that the material leaves no residue. Peracetic acid leaves no residue, but all the formulations have other material added to reduce the chance of explosion. Most of the registered formulations have surfactants added to make them more effective. Xenobiotics such as 1-hydroxethylidene-1,1-diphosphonic acid are common additives. Approved inerts would have to be used in the formulation.

3. It is not clear what applications are used by organic farmers. While there are several references to cleaning equipment—such as greenhouse and transplant tools, and irrigation installations—data and information on the OFPA criteria for use are not readily accessible in the literature.
I believe that disinfecting equipment, if done indoors, would be consistent with the EPA label and would not violate OFPA. However, I agree the published literature on this is sparse.

4. Should peracetic acid be allowed in organic crop production? Is there a need for an annotation? If so, for what? To clean equipment and for indoor uses? What about irrigation equipment? Should field uses be allowed?
I do not know if organic farmers and farmworkers can handle concentrated solutions of peracetic acid safely. If they are dealing with a more dilute, stabilized material such that fire and explosion risks are minimized, then it could be used as a replacement for bleach as a disinfectant of equipment. I believe the EPA label does not allow it to be discharged into outside irrigation lines.

It possibly has a use as a postharvest disinfectant of fruits and vegetables, but I believe that is covered in another TAP review. Similarly, uses in the organic dairy industry would probably be covered in another review.

I do not think that sprays of this material into tree foliage is a good idea. If it turns out that injection of dilute solutions into trees can stop fireblight, then it might be worth adding it to the National List for that purpose only.

I agree that field application of this material does not appear to be warranted at this time.

5. Peracetic acid does not appear on the EPA master list of inert ingredients, and is therefore List 3 by default. Should the NOSB consider its use as an inert ingredient? What about the stabilizers? Should these be considered in a separate TAP review or are they incidental when PAA is used as an inert? What about when it is used as an active.
I do not see any justification for considering the oxidizing, corrosive, flammable, and explosive PAA as an inert. It injures living material and is a biocide. What did you have in mind? I cannot think of any approved pesticide where this could be considered an inert material. The stabilizers and other additives should be evaluated as part of the approval process for this material.

[E-mail vote on these two sentences in "Suggested Annotation:" Allowed to disinfect seed and asexually propagated planting material (i.e., bulb, corm, tuber) used for planting crops. From hydrogen peroxide and fermented acetic acid sources only.] I support the position that peracetic acid should be obtained from fermented acetic acid sources and peroxide, if this is technically possible and is overall the most environmentally friendly production method. If approved for

organic production, it should be allowed for disinfecting seeds, bulbs, etc. Those who use it in this way, however, should be advised of its efficacy.

Reviewer #3

[Organic farmer and geologist with hazardous materials experience]

Production from petrochemical sources is against one of the core values of organic production, specifically the value of producing crops without dependence or reliance on the petrochemical industry. This is a farmer reaction to both the negative environmental consequences of oil production and the economic constraints of petrochemical based agricultural production. There is a viable alternative manufacturing method. Based on this information, I support Annotation #1 "manufactured from hydrogen peroxide and acetic acid sources only."

The dangerous effects are primarily to workers and NOT to consumers or the environment. Based on this information I support Annotation #2 "All organic personnel handling this material must be informed of its possible co-carcinogenic properties." As a farmer, this is the type of information I would like to have. One of its uses would be to reinforce the importance of handling the material according to specifications. I would also like to know the level of potential danger at concentrations likely to be used when to washing apples for juice or salad mix. I suggest that peracetic acid users be provided a summary of this finding (Bock, Meyers, and Fox, 1976). Any new work is done in this area that information be made available as well. This may be a responsibility put on certification agencies and or the manufacturers of the material as well as farmers.

I suggest that the statement on *[its compatibility with a system of sustainable agriculture]* could be strengthened. Given that the compound is made from and decomposes into acetic acid and water, it appears to have a similar compatibility as the parent substances, therefore PAA should be considered compatible with an organic system of sustainable agriculture.

It too early to tell if peracetic acid should be sprayed on trees. I believe it should be annotated as allowed with Experimental Use Permit after alternatives including biocontrols have been tried. (Annotation #3). Peracetic acid is not EPA labeled for soil application at this time. However the label appears to allow use in potting media. It should be allowed for use in certified indoor nurseries if needed for production of organic starts

Commercially formulated peracetic products are relatively new on the market and organic growers are only now becoming aware of them. The NOSB should consider what current applications used in organic production would the use of peracetic acid be an improvement over existing materials and practices. One area of improvement (in the sense of being more closely aligned with OFPA criteria) to look towards is its use as a method of cleaning irrigation systems, greenhouse sanitation, tools etc. Another area of improvement to consider is its use for foreseeable problems of post harvest sanitation, esp. salad mixes, fruits and root crop washes. Sanitation problems in these areas have already damaged organic markets. Part of the problem is the reluctance of organic farmers to use common sanitizers such as chlorine and ammonia, in part due to organic regulations. While there are several references to cleaning equipment such as greenhouse and transplant tools, and irrigation installations data and information on the OFPA criteria for such uses are not readily accessible in the literature.

My general understanding of applying OFPA criteria for these sanitizers is whatever is washed with a sanitizer, needs to be double or triple washed with water. In cases where the water source is not clean (which is common for ag water) this is counterproductive. In situations where food products are involved, the residual effect of the sanitizer is often needed for preservation. This material does not appear to require a wash before the surface comes into contact with organic food.

Other crops should be applied for on a crop by crop basis based on emergency crop needs. This area may need to be under the discretion of the certification agency. Peracetic acid does not appear on the EPA master list of inert ingredients, and is therefore List 3 by default. I am not aware of peracetic acid being used as an inert ingredient in any formulation. The NOSB should not consider its use as an inert ingredient. How can a material this reactive be truly inert in anything?

The stabilizers should be considered incidental. This question should stay open to new knowledge. Specifically, if a List 4 stabilizer becomes known and works well it should be allowed and products using List 3 stabilizers should be disallowed. Disinfecting washwater is very significant for organic products. It is one of the main

reasons for allowing its use in organic production. Especially this section "5% acetic acid and peroxyacetic acid solutions were the most effective, causing reduction of 3.1 and 2.6 log units,respectively, without apparent sublethal injury (Wright et al., 2000)."

The conclusion that "PAA is effective, cheap, non-toxic to mammals and not harmful to the environment" places peracetic acid in the category or a synthetic that fits organic criteria. Any material that has these characteristics should be strongly considered for use in organic systems (Lagger, 1998).

Conclusion
While pre-planting, production aid, and post-harvest uses all appear consistent with OFPA and existing organic standards, field application of this material does not appear to be warranted at this time.

I believe the conclusion should include experimental use on fireblight after documented alternatives including biocontrols have been tried. The reasons for this include:

1) That this use is primarily on tree crops and fruit above the soil. It is likely to have some impact on the soil but not the same degree as a pre-planting soil drench or application to a field crop.
2) If it is permitted for post-harvest washing then why shouldn't it be allowed on the crop ten minutes earlier? If it is allowed ten minutes before eating a piece of fruit, then it should be allowed to be used two months earlier when it would be more effective at lower rates.
3) The main reason for not allowing field appliations is environmental damage to the soil. I am against allowing it as a field soil drench. There may be some value in allowing it as a drench for potted plants in certified nurseries. In many cases, especially in Hawaii and California, it may be necessary to pass agricultural regulations on transportation of soil bearing plant materials. Allowing its use in this situation could contribute to production of many more organic starts. Since the OFPA regulations call for growers to use organic starts when possible, this would increase the possibility of using organic starts instead of conventional ones for many large scale organic farms. The reasoning here is if organic starts can't be found then conventional ones are allowed for organic production, which may have much worse environmental consequences that allowing peracetic acid for this specific use.

Therefore I support Annotation #4 "Allowed for use in certified indoor nurseries if needed for production of organic starts."

The substance is SYNTHETIC
Summary Recommendation: ALLOWED
Suggested annotations:
1. Manufactured from hydrogen peroxide and acetic acid sources only
2. All organic personnel handling this material must be informed of its possible co-carcinogenic properties
3. Allowed for fireblight control with Experimental Use Permit with documentation that alternatives including biocontrols have been tried
4. Allowed for use in certified indoor nurseries if needed for production of organic starts.

Conclusion

While pre-planting, production aid, and post-harvest uses all appear consistent with OFPA and existing organic standards, field application of this material does not appear to be warranted at this time.

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Peracetic Acid

Livestock

Identification

Chemical Name(s):
peroxyacetic acid
ethaneperoxic acid

Other Names:
PAA, per acid, periacetic acid

CAS Number:
79-21-0

Other Codes:
NIOSH Registry Number: SD8750000
TRI Chemical ID: 000079210
UN/ID Number: UN3105

Summary Recommendation

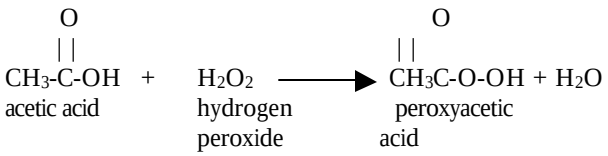
Synthetic / Non-Synthetic:	Allowed or Prohibited:	Suggested Annotation:
Synthetic (consensus)	*Allowed (consensus)*	For facility and processing equipment sanitation (barns, milking parlors, processing areas). Direct application to animals may be made only in the event of documented injuries or illnesses, under the direct supervision of a licensed veterinarian. *(consensus)* From hydrogen peroxide and fermented acetic acid sources only. *(Not discussed by livestock reviewers--see discussion of source under Crops PAA TAP review.)*

Characterization

Composition:
$C_2H_4O_3$. Peracetic acid is a mixture of acetic acid (CH_3COOH) and hydrogen peroxide (H_2O_2) in an aqueous solution. Acetic acid is the principle component of vinegar. Hydrogen peroxide has been previously recommended by the NOSB for the National List in processing (synthetic, allowed at Austin, 1995).

Properties:
It is a very strong oxidizing agent and has stronger oxidation potential than chlorine or chlorine dioxide. It is liquid, clear, and colorless with no foaming capability. It has a strong pungent acetic acid odor, pH is acid (2.8). Its specific gravity is 1.114 and weighs 9.28 pounds per gallon. Stable upon transport.

How Made:
Peracetic acid (PAA) is produced by reacting acetic acid and hydrogen peroxide. The reaction is allowed to continue for up to ten days in order to achieve high yields of product according to the following equation.



Due to reaction limitations, PAA generation can be up to 15% with residual levels of hydrogen peroxide (up to 25%) and acetic acid (up to 35%) with water up to 25%. Additional methods of preparation involve the oxidation of acetaldehyde or alternatively as an end product of the reaction of acetic anhydride, hydrogen peroxide, and sulfuric acid.

Additional methods of preparation involve the oxidation of acetaldehyde (Budavari, 1996). Another method involves the reaction of tetraacetylethylenediamine (TAED) in the presence of an alkaline hydrogen peroxide solution (Davies and Deary, 1991). These sources appear to be used more frequently in pulp, paper, and textile manufacture (Pan, Spencer, and Leary, 1999).

Specific Uses:

Peracetic acid is primarily used to clean equipment, milking parlors, barns, stalls, and veterinary facilities. It is used as a topical disinfectant on animals, for example, to treat papillomatous digital dermatitis (Hernandex, Shearer, and Elliot, 1999). Peracetic acid is also used in the handling and processing of livestock products as a dairy equipment sanitizer, as a meat and poultry disinfectant (Kurschner and Diken, 1997), and as an egg wash.

Action:
The primary mode of action is oxidation. PAA disinfects by oxidizing the outer cell membrane of vegetative bacterial cells, endospores, yeast, and mold spores. (See Question 2 under OFPA criteria for more information).

Combinations:
Peracetic acid usually occurs with hydrogen peroxide and acetic acid in an aqueous solution. Stock commercial preparations usually contain a synthetic stabilizer, such as 1-hydroxyethylidene-1,1-diphosphonic acid (HEDP) or 2,6-pyridinedicarboxylic (dipicolinic) acid to slow the rate of oxidation or decomposition (Kurschner and Diken, 1997).

Status

OFPA
Falls under Production Aid and Medication (7 USC 6517(b)(1)(C)(i)).

Regulatory
External / topical use as an antimicrobial covered under EPA regular section 3 registration (40 CFR 152.25(a)). Not included separately in 21CFR for feed use, but co-products acetic acid (21 CFR 582.1005) and hydrogen peroxide (21 CFR 582.1366) are listed as FDA GRAS in animal feeds.

EPA/NIEHS/Other Appropriate Sources
OFPA 6518 (l)(1) states, "In establishing the National List or proposed amendments to the National List, the Board shall review available information from the Environmental Protection Agency, the National Institute of Environmental Health Studies, and such other sources as appropriate, concerning the potential for adverse human and environmental effects of substances considered for inclusion in the proposed National List."

EPA: It is on EPA's Extremely Hazardous Substances list (US EPA, 2000).

NIEHS: See National Institute of Environmental Health (NIEHS) attachment.

Other sources: See New Jersey Department of Health and Senior Services attachment.

Status Among U.S. Certifiers
Variable. Some appear to allow all livestock facility cleaners, equipment disinfectants, and/or animals drugs with restrictions. Others have a list of allowed materials. No standards examined explicitly allow PAA for livestock use.

Historic Use
Acetic acid and hydrogen peroxide both have a longer history of use in livestock production than commercial preparations of peracetic acid, but the substance has, in effect, been used by farmers who combine vinegar and peroxide in a cleaning solution. Peracetic acid is a relatively recent development, but has been used to clean stalls and to disinfect livestock, particularly dairy cattle.

International
Codex Alimentarius allows chemical allopathic veterinary drugs or antibiotics to be used "under the responsibility of a veterinarian" if the use of alternative methods are "unlikely to be effective in combating illness or injury." Withholding periods are required to be double of those required by law with a minimum of 48 hours (Codex, 2000). The European Union has a similar standard (EC 1999). European Commission Regulation (EC) No. 1433/96 amended Annex II of EC 2377/90 to establish maximum residue limits of peracetic acid in foodstuffs of animal origin. IFOAM allows conventional medicines "when no other justifiable alternative is available" (IFOAM, 2000).

OFPA 2119(m) Criteria

1. *The potential of such substances for detrimental chemical interactions with other materials used in organic farming systems.*
This material is a strong oxidizing agent. It can react violently with acetic acid anhydride, olefins (e.g., mineral oil), and organic matter (NTP, 2000). PAA works synergistically with hydrogen peroxide, decreasing the amount of

hydrogen peroxide needed to reduce microorganisms (Lambert et al., 1999).

2. *The toxicity and mode of action of the substance and of its breakdown products or any contaminants, and their persistence and areas of concentration in the environment.*
Toxicity high via oral for guinea pigs; moderate via oral and dermal routes for rats and rabbits (Sax, 1979). Skin and Eye Irritation Data: skin-rabbit 500 mg open SEV; eye-rabbit 1 mg SEV (NTP, 2000). An experimental neoplastinogen (tumor-causing agent) via dermal route (NTP, 2000). It is on EPA's Extremely Hazardous Substances list (US EPA, 2000).

Peracetic acid is an irritant of the skin, eyes, mucous membranes, and respiratory tract (NTP, 2000; Budavari, 1996; Lenga, 1985). When heated to decomposition it emits acrid smoke and toxic fumes of carbon monoxide and carbon dioxide. The vapor is heavier than air and can travel a considerable distance to a source of ignition and flash back (NTP, 2000). Breakdown products are acetic acid (same acid found in vinegar at 5% level) and hydrogen peroxide that breads down to O_2 and H_2O.

The primary mode of action is oxidation. The mechanism of oxidation is the transfer of electrons, therefore the stronger the oxidizer, the faster electrons are transferred to the microorganism and the faster the microorganism is inactivated or killed.

Table 1
Oxidation Capacity of Selected Sanitizers

Sanitizer	eV*
Ozone	2.07
Peracetic Acid	1.81
Chlorine dioxide	1.57
Sodium hypochlorite (chlorine bleach)	1.36
*electron-Volts	

Therefore PAA has a higher oxidation potential than chlorine sanitizers but less than ozone.

3. *The probability of environmental contamination during manufacture, use, misuse, or disposal of such substance.*
Production from hydrogen peroxide and acetic acid would depend on the process used. Hydrogen peroxide is commonly produced by the electrolysis of water (Kirchner, 1981). Acetic acid may be produced by fermentation (vinegar) or distillation from plant sources. However, acetic acid may also be synthesized by hydrolysis of acetylene or oxidation of acetylaldehyde (Budavari, 1996). Acetylene and acetaldehyde are generally produced from petrochemical sources. The environmental consequences of petroleum production and refining are beyond the scope of this TAP review.

Misuse at the processing level would cause a bleaching out effect on the color of meat and poultry, resulting in loss of quality that could be visually detected. Under normal use and disposal conditions, PAA decomposes into acetic acid, oxygen, and water.

4. *The effect of the substance on human health.*
Peracetic acid is an irritant of the skin, eyes, mucous membranes and respiratory tract (NTP, 2000; Budavari, 1996; Lenga, 1985). When heated to decomposition it emits acrid smoke and toxic fumes of carbon monoxide and carbon dioxide. The vapor is heavier than air and can travel a considerable distance to a source of ignition and flash back (NTP, 2000).

The product is registered for use as a hospital disinfectant and to clean kidney dialysis machines (EPA, 2000).

5. *The effects of the substance on biological and chemical interactions in the agroecosystem, including the physiological effects of the substance on soil organisms (including the salt index and solubility of the soil), crops and livestock.*
The substance is used *because* of its biological and chemical interactions and its physiological effects on microorganisms, including many that are naturally found in a soil environment. Among the model organisms that show significant reductions in populations after exposure to PAA are *Bacillus cereus* (Blackiston et al., 1999); *B. subtilis* (Leaper, 1984; Blackiston et al., 1999; Lindsay and von Holy, 1999); *B. stearothermophilus* (Blackiston et al., 1999); *Clostridium botulinum* (Blackiston et al., 1999); *C. butyricum* (Blackiston et al., 1999); *C. sporogenes* (Blackiston et al., 1999); *Ditylenchus dipsaci* (Hanks and Linfield, 1999); *Enterococcus faecium* (Andrade et al., 1998); *Escherichia coli* (Arturo-Schaan et al., 1996), including *E. coli* O157:H7 (Farrell et al., 1998), *Fusarium oxysporum* (Hanks and Linfield, 1999);

Gluconobacter oxydans (Winniczuk and Parish, 1997), *Lactobacillus plantarum* (Winniczuk and Parish, 1997), *L. thermophilus* (Langeveld and Montfort-Quasig, 1996); *Leuconostoc mesenteroides* (Winniczuk and Parish, 1997); *Listeria monocytogenes* (Mosteller and Bishop, 1993; Restaino et al., 1994); *Pseudomonas aeruginosa* (Restaino et al., 1994; Lambert et al., 1999); *P. fluorescens* (Mosteller and Bishop, 1993; Lindsay and von Holy, 1999); *Saccharomyces cerevisiae*(Winniczuk and Parish, 1997); *Salmonella typhimurium* (Restaino et al., 1994); *Staphylococcus aureus* (Restaino et al., 1994; Lambert et al., 1999); *Streptococcus delbreuckii* subsp *bulgaricus* (Langeveld and Montfort-Quasig, 1996); and *Yersinia enterocolitica* (Mosteller and Bishop, 1993).

The immediate effect against soil organisms would be broad-spectrum and, if mishandled, potentially violent. The toxic effects would be short-lived, and somewhat selective, favoring acid-tolerant and aerobic bacteria. For example, experimental evidence indicates that *Bacillus* spp. would likely be less affected and would recover more quickly than *Clostridium* spp. (Blackiston et al., 1999). However, at least one study indicates no difference in the susceptibility between plasmid-containing *E. coli* strains and those strains that do not contain plasmids (Arturo-Schaan, 1996). The breakdown products--oxygen, water, and acetic acid--are all part of the agroecosystem. Acetic acid is produced in nature as a function of acetobacter species of microorganism found in soil, and is part of the natural carbon cycle (Alexander, 1991).

It may be of benefit to livestock health in certain applications (Hernandez et al., 1999).

Salt Index: The salt index has not been calculated for this substance.

Solubility: Water: 100mg/ml at 19°C. (freely soluble). Also soluble in alcohol.

6. *The alternatives to using the substance in terms of practices or other available materials.*
For teat dips and udder washes, the NOSB has recommended iodine (Orlando, 1995), glycerin, chlorhexidine, and lanolin (D.C., 1999) be on the National List for livestock uses.

For cleaning stables and stalls, there is water, hydrogen peroxide, chlorine solutions, and iodine solutions.

For topical disinfection, copper compounds, hydrated lime, and iodine-based compounds can be used. PAA itself may be an alternative to topical antibiotics (Hernandez et al., 1999).

The TAP and NOSB have reviewed a number of items for crop and/or processing that are commonly used in cleaning livestock facilities. These have not been considered for livestock facilities, including soap, hydrogen peroxide, sodium carbonate, and sodium phosphates (specifically trisodium phosphate). Detergents for crops use were tabled.

7. *Its compatibility with a system of sustainable agriculture.*
Broad-spectrum synthetic biocides are generally considered incompatible with sustainable agriculture. However, proper farm sanitation and the protection of the public health from food-borne pathogens merits special consideration. Substances are needed to clean milking machines and keep livestock facilities from harboring food-borne pathogens. While sustainable systems should minimize the use of such substances, they should not be eliminated unless and until suitable alternatives are found.

TAP Reviewer Discussion

TAP Reviewer Comments

OMRI's information is enclosed in square brackets in italics. Where a reviewer corrected a technical point (e.g., the word should be "intravenous" rather than "subcutaneous"), these corrections were made in this document and are not listed here in the Reviewer Comments. The rest of the TAP Reviewer's comments are listed here minus any identifying comments and with corrections of typos.

Reviewer #1
[Analytical chemist with animal production experience.]
What is animal drug status of PAA?
Listed uses that I've been able to find so far include all aspects of sterilizing equipment and buildings in processing for all manner of produce, dairy, hog operations, etc. and, many listings for fruit, grain and vegetable dips. There are several references to PAA as a sterilant for both processing and livestock byproducts, including manures. Uses on animals

include a variety of internal uses, mostly dealing with uterine infections. So far, I haven't seen a listing for udder wash specifically, although there are several commercial products on the market that include PAA.

EPA defines PAA as an "anti-microbial pesticide" (CFR June 24, 1998). It clearly has more uses than strictly topical, so I don't think it can be defined entirely in that manner. In fact, I can see the need for listings for equipment/barn washes, topical uses, and internal uses.

From the CFR June 24, 1998, EPA declares PAA exempt from the requirement of a tolerance up to 100ppm (EPA, 1998).

[Where do we draw the line between the farm and the processor in dairies?]
With animal operations that include "byproducts" (eggs, milk), it is difficult to define where the farm stops and the processor starts. Maybe the easiest way of doing so is to define the processing as beginning "downstream" of contact with the animal. In other words, milk collection from the cows would be considered "farm", and everything downstream of that would be considered "processing". Certainly the sanitation problems change significantly at that point.

On the farm side, one deals with excreta, feed, animal disease, the animal as pathogen incubator. Once the milk is collected and removed from the presence of the animal, sanitation problems becomes more clearly that of processing (thermophyllic bacteria, mesophyllic bacteria, machine molds, lurking spores, the microherd residing in the product being processed).

The interface in dairy is less clear than in most operations, because of the processing-type equipment used in the milking parlor. However, a pretty clear line can be drawn, if the animal-containing environment is used to define "farm."

Other situations where farm/processor lines are blurred: on-farm washing operations (i.e., dirt off of carrots, stripping cabbage or lettuce and packing for shipping). On-farm drying, cooking, or other preparing operations are far more clearly on-farm processing, and the line is pretty clear between the two.

Further, the processing-type machinery in the milking parlor should be treated as processing equipment, except where it comes in contact with the cow. For instance, cleaning solutions in the teat cups should be compatible with skin contact. Again, this is the animal interface. It would seem appropriate that the rest of the equipment be cleaned by whatever approved processing cleaners necessary.

[What is the appropriate overall approach to cleaning agents on farms?]
I think that the animal contact question might be a good yes/no for farm/livestock use. In most cases, this tends to test out. There are some situations where harsher cleansers might be appropriate (for instance, broiler/layer operations where the chickens are removed and the entire building is sterilized, or periodic cleaning of milking parlors from the bottom up), because the animals are not present. In these cases, there would need to be some certainty that there'd be no residues that would come in contact with the animals when they were returned to the facility.

Areas such as processing sheds, bunkers, storage areas, barns, that come in contact with crops and/or livestock may need periodic rigorous cleanings. It would seem that more aggressive cleaning solutions could be employed during these periodic cleanings as long as all contact with produce or livestock is avoided. However, there should be either no trace cleaner residue, or the cleaner should be listed as OK for direct contact with produce/livestock.

I would agree that the currently approved materials for crops and processors (soaps and peroxide) should generally be OK for livestock. However, anything, including currently approved crops/processing materials should be looked at individually before any specific listing for livestock, due to the possibility of residues of general cleaning or from direct applications; could at the very least cause dermatitis.

[Regarding the OFPA criteria]
1. Potential of explosive reactions with organic and basic materials. Very strong irritant, will burn to third degree on contact. However, solutions are generally sold as pretty dilute solutions. I didn't actually see strong dilutions in any of the livestock products that I perused. The strong oxidizing reaction is the desirable component of this compound; this is what fries the little buggies.

2. Concentrated solution is very toxic in terms of contact, ingestion and inhalation. Irritant and burns. This would be true of undiluted cleaning solutions. There would be some hazard during the dilution process, requiring protective clothing. However, concentrations during actual use are generally very dilute.

Mode of action is strong oxidation.

3. Byproducts are water and acetic acid. Acetic acid is a "weak" acid, and occurs naturally in a variety of situations. The product is moderately unstable, and will break down pretty quickly if a stabilizer isn't included.

Direct consequences of misuse of concentrated solutions could be catastrophic; explosions, serious burns, etc. Indirect consequences are minimal, as breakdown into acetic acid and water happens rapidly.

Proper use should have minimum consequences, due to the dilute nature of the solutions, although the possibility of irritation of mucous membranes and skin is possible. Therefore, good chemical practices should be followed when using PAA.

Manufacture: Acetic acid is a "weak" organic acid; therefore, the potential for harm is significantly lower than the inorganic acids. Fermentation and distillation seem to have low environmental impacts. Hydrogen peroxide mfr seems to be moderately low impact as well. However, acetic acid from petroleum sources may be problematic. Do we need to know from which source the acetic acid comes?

4. Direct: burns, inhalation and ingestion injuries.
Indirect: breakdown products: acetic acid is an irritant, and can cause burns as well.
Minimal secondary effects, as the breakdown products are pretty benign. EPA exempts this product from requiring a tolerance up to 100 ppm.

5. Initially, a strong oxidizer. It's what it's used for. Spills could have nasty initial consequences, until oxidation reactions are complete. All microorganisms, and many "macroorganisms" would be killed outright. Organic matter would be oxidized. After that, there would be some acidification that may need neutralizing, and that would be it.
Acetic acid does occur naturally, just not at those concentrations.

6. Facility and equipment cleaning: High-pressure water, steam, mechanical removal (brushing of residues), chlorine, detergents, TSP. PAA stacks up well in terms of environmental consequences, efficacy.

Udder wash and teat dip: It looks like there are a number of organic acid (lactic, succinic)/sodium salt/glycerine products on the market that might be considered OK for organic use. Iodine and chlorhexadine alone would also be potential irritants. I don't know how they stack up in speed of kill to PAA, but PAA seems to stack up favorably with other products on the market.

Topical sanitation: hydrated lime??? This would seem to me to be really irritating! Don't use along with PAA! Seems a good alternative here, too.

7. In places where thorough sanitation is required, PAA seems to be fairly low impact. It does its job, then breaks down into pretty harmless components. Unlike many other synthetics, it doesn't leave much in the way of footprints. Its biocidal properties are "mechanical," that is, they interfere with cell wall components, rather than metabolization. There are places where broad-spectrum biocides are required, sustainable ag or not. Therefore I think that used properly, PAA can be compatible with sustainable ag.

CONCLUSION:
Peroxyacetic acid appears to be compatible with organic agriculture livestock systems including the following uses:
1. Facility sanitation (barns, milking parlors, processing areas).
2. Processing equipment sanitation (milking machines, transfer tubing, fermentation tanks, milk tanks).
3. Topical antiseptic.
4. Udder wash.
5. As a veterinarian-prescribed uterine wash for various uterine infections.
6. As an ingredient in multiple ingredient solutions for the above purposes, assuming that all of the other ingredients are approved for organic production.

Reviewer #2
[Professor of food science.]
A review of the available literature indicates that peracetic acid is a broad-spectrum biocide that appears to have efficacy as an external parasiticide with anti microbial properties. It is capable of bacteriophage in activation on dairy equipment during processing of cheese whey. Therefore, since peracetic acid is considered as a broad-spectrum disinfectant, it may be used for a number of both on farm and process sanitation-disinfecting operations.

I feel food safety is critically important both at the farm and process level. Recent outbreaks of E. coli 0157:H7 in muscle foods as well as salmonella in milk have elevated the concern of both consumers and government regulatory agencies. Therefore one must take a holistic view of both farm and process sanitizing operations. Since peracetic acid breaks down rapidly to acetic acid, hydrogen peroxide and eventually to O_2 and H_20, overall risk to organic integrity may be minimal when compared to NOSB recommendations of iodine and chlorohexidine that do not break down readily. Therefore use and application of peracetic acid may be more compatible with sustainable agriculture. The overall approach to cleaning and sanitizing agents on farms should be no different than for processors. Risk reduction of food born illness must be a priority, with a focus on maintaining organic integrity. From a sustainability issue, chlorine, phenols, quats, and chloramines pose a much greater risk to organic integrity and to the environment. For example, it is well known that chlorine sanitizers have been shown to form trihalomethane pre-carcinogens and are not used for this reason in many municipal water treatment systems in favor of ozonation. Other sanitizers such as quats, and to a certain degree iodine compounds, are residual and do not break down or are easily removed after application.

Therefore I would like to make the following recommendations:

1. Peracetic acid be approved for on farm sanitizing operations of milking machines, pipes, pumps as well as tanker trucks that haul milk from farm to processor in accordance with CFR title 21.
2. Peracetic acid be approved for direct food contact surfaces in accordance with CFR Title 21 for dairy, livestock facilities, and poultry farms.
3. Peracetic acid should be regulated or used only under the responsibility of a veterinarian to treat external microbiological infections of animals designated for slaughter or for milk producing cows.

SUMMARY
Peracetic acid appears to offer outstanding sanitizing functionality at both the farm and process level. It appears to be compatible with sustainable agriculture and may pose less of a risk to organic integrity when compared to other available sanitizers. It may be used for all on farm and process sanitizing operations in accordance with CFR title 21. Therefore I recommend an allowed (A) status.

For direct treatment of external infections of farm animals (include cows, beef cattle, poultry) its use should be restricted (R) and used only under the direct supervision of a veterinarian as per Codex Alimentarius recommendations.

Reviewer #3
[Veterinarian with substantial ovine (sheep) experience and no direct interest in the product.]
Peracetic acid is a synthetic product, is caustic topically, but is extremely germicidal due to its oxidation action. I would call it bactericidal and virucidal rather than a parasiticide.

I recommend its use as a cleaning agent in barns and in milking facilities and equipment. It appears that this compound breaks down quickly in the environment, so shouldn't be a concern even if it is expelled outdoors in the wastewater. The food safety issue is an important and since the residue appears to be minimal, I don't think there needs to be any distinction with this product whether it is used in barns or on milking equipment; whether these uses are considered farm use or processing use.

I have more of a problem with it as an animal antimicrobial. I am not sure of effectiveness, based on some of the research given. Also, if peracetic acid were to be used at a stronger level than these articles state, the irritation might be greater than the benefits of using it. NOSB has recommended several compounds for teat dips and udder washes that there is more known regarding level of irritation and toxicity. Since there isn't as much known about peracetic acid's use on animals, I have a much harder time recommending it be allowed for use on animals. If there were fewer products recommended, I would be willing to consider its use. Until there is more information about the amount of irritation when being used in farm animals, I'd recommend that it be prohibited.

[OMRI e-mailed this reviewer to ask if there is agreement on the second sentence in the suggested annotation: "Direct application to animals may be made only in the event of documented injuries or illnesses, under the direct supervision of a licensed veterinarian."] This is a GREAT annotation. I felt that to say prohibited was too strong, but wasn't sure what else I could say.

Conclusion

While organic farming is not a food safety claim, it must meet laws and standards to protect the public from risks arising from both microbiological and chemical exposures. The OFPA recognizes the need to exempt synthetic substances to clean equipment. This is an undefined area between production and handling, but is usually thought of as part of the farm by farmers, certifiers, and inspectors. As such, it would fall under the livestock standards. The NOSB has reviewed

few materials for use in barns, stalls, stables, and milking parlors, leaving relatively few options for producers. While these are synthetic biocides, there are public health and safety benefits from their use that need tobe considered. Physical methods, such as steam and heat, might be more appropriate, but have their disadvantages. Peracetic acid, while synthetic, might serve a role in cleaning and disinfecting livestock facilities and equipment.

While its use as a topical disinfectant is relatively new, external use appears to have promise to alleviate animal suffering.

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Peracetic Acid

Processing

Identification

Chemical Name(s):
peroxyacetic acid, ethaneperoxic acid

CAS Number:
79-21-0

Other Names:
per acid, periacetic acid, PAA

Other Codes:
NIOSH Registry Number: SD8750000
TRI Chemical ID: 000079210
UN/ID Number: UN3105

Summary Recommendation

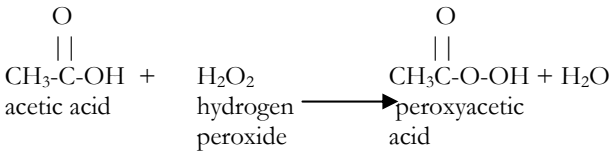
Synthetic / Non-Synthetic:	Allowed or Prohibited:	Suggested Annotation:
Synthetic (consensus)	*Allowed (consensus)*	Allowed only for direct food contact for use in wash water. Allowed as a sanitizer on surfaces in contact with organic food. *(consensus)* From hydrogen peroxide and fermented acetic acid sources only. *(Not discussed by processing reviewers--see discussion of source under Crops PAA TAP review.)*

Characterization

Composition:
$C_2H_4O_3$. Peracetic acid is a mixture of acetic acid (CH_3COOH) and hydrogen peroxide (H_2O_2) in an aqueous solution. Acetic acid is the principle component of vinegar. Hydrogen peroxide has been previously recommended by the NOSB for the National List in processing (synthetic, allowed at Austin, 1995).

Properties:
It is a very strong oxidizing agent and has stronger oxidation potential than chlorine or chlorine dioxide. Liquid, clear, and colorless with no foaming capability. It has a strong pungent acetic acid odor, and the pH is acid (2.8). Specific gravity is 1.114 and weighs 9.28 pounds per gallon. Stable upon transport.

How Made:
Peracetic acid (PAA) is produced by reacting acetic acid and hydrogen peroxide. The reaction is allowed to continue for up to ten days in order to achieve high yields of product according to the following equation.



Due to reaction limitations, PAA generation can be up to 15% with residual levels of hydrogen peroxide (up to 25%) and acetic acid (up to 35%) with water up to 25%. Additional methods of preparation involve the oxidation of acetaldehyde or alternatively as an end product of the reaction of acetic anhydride, hydrogen peroxide, and sulfuric acid.

Additional methods of preparation involve the oxidation of acetaldehyde (Budavari, 1996). Another method involves the reaction of tetraacetylethylenediamine (TAED) in the presence of an alkaline hydrogen peroxide solution (Davies and Deary, 1991). These sources appear to be used more frequently in pulp, paper, and textile manufacture (Pan, Spencer, and Leary, 1999).

Specific Uses:
Peracetic acid's primary use in food processing and handling is as a sanitizer for food contact surfaces and as a disinfectant for fruits, vegetables, meat, and eggs (Evans, 2000). PAA can also be used to disinfect recirculated flume water (Lokkesmoe and Olson, 1993). Other uses of PAA include removing deposits, suppressing odor, and stripping biofilms from food contact surfaces (Block, 1991; Mosteller and Bishop. 1993; Marriot, 1999; Fatemi and Frank 1999). It is also

used to modify food starch by mild oxidation and is used as a bleach (Food Chemicals Codex, 1996).

Action:
The primary mode of action is oxidation. PAA disinfects by oxidizing of the outer cell membrane of vegetative bacterial cells, endospores, yeast, and mold spores. The mechanism of oxidation is the transfer of electrons, therefore the stronger the oxidizer, the faster electrons are transferred to the microorganism and the faster the microorganism is inactivated or killed.

Table 1
Oxidation Capacity of Selected Sanitizers

Sanitizer	eV*
Ozone	2.07
Peracetic Acid	1.81
Chlorine dioxide	1.57
Sodium hypochlorite (chlorine bleach)	1.36
*electron-Volts	

Therefore PAA has a higher oxidation potential than chlorine sanitizers but less than ozone.

PAA also inactivates enzymes that are responsible for discoloration and degradation, such as peroxidase in the browning of potatoes (Greenspan and Margulies, 1950).

Combinations:
Peracetic acid usually occurs with hydrogen peroxide and acetic acid in an aqueous solution. Stock commercial preparations usually contain a synthetic stabilizer such as 1-hydroxyethylidene-1,1-diphosphonic acid (HEDP) or 2,6-pyridinedicarboxylic (dipicolinic) acid to slow the rate of oxidation or decomposition (Kurschner and Diken, 1997). According to FDA regulations, HEDP may be used with PAA at a level not to exceed 4.8 ppm in water used to wash fresh fruits and vegetables (21 CFR 173.315(a)(5)).

Sanitizing combinations approved by 21CFR 178.1010 to be used with PAA under (b)(38) include: hydrogen peroxide; acetic acid; sulfuric acid; and 2,6-pyridinedicarboxylic (dipicolinic) acid. Under (b)(45) they include: hydrogen peroxide; acetic acid; octanoic acid; peroxyoctanoic acid; sodium 1-octanesulfonate; and 1-hydroxyethylidene-1,1-diphosphonic acid.

These stabilizers, surfactants, and synergists are not evaluated in this TAP review. Some are specifically mentioned in the context of the OFPA criteria.

Status

OFPA 7 USC 6517(b)(1)(C)(i) is listed as an equipment cleaner.

Regulatory
FDA approved it for direct food contact for use in wash water or to assist in the peeling of fruits and vegetables (21CFR 173.315). Also approved as sanitizer on food contact surfaces (21 CFR 178.1010). Registered as an EPA Section 3 pesticide (40 CFR 152.25(a)--regular registration).

Status among U.S. Certifiers
Variable. Most allow it with a fresh water rinse. Some may require continuous testing of rinse water by on-line meter. Some may allow direct food contact use at present, but many will not allow for direct food contact unless the NOSB recommends that it be included on the National List.

Historic Use
Peracetic acid was patented in 1950 to treat fruits and vegetables to reduce spoilage from bacteria and fungi destined for processing (Greenspan and Margulies, 1950). It has since been used in systems to disinfect recirculated wash water used to handle fresh produce (Lokkesmoe and Olson, 1995). Research as an alternative to chlorine and irradiation as a disinfectant for meat and poultry is relatively recent.

International
Does not appear on the IFOAM Basic Standards Appendix IV or EU 2092/91 Annex VI. It is not clear if those standards require that disinfectants need to apper; these lists are "positive" lists.

Criteria from the February 10, 1999 NOSB Meeting

A PROCESSING AID OR ADJUVANT may be used if;

1. *It cannot be produced from a natural source and has no organic ingredients as substitutes.*
   Alternatives include: fresh, clean water; rapid cooling; and reducing the time between harvest and consumption. Physical methods such as heat and steam can also be used in some situations. Other alternatives previously reviewed by the NOSB include hydrogen peroxide (synthetic, allowed at Austin 1995), chlorine bleach (synthetic, allowed at Austin 1995 and includes calcium hypochlorite, sodium hypochlorite, and chlorine dioxide), phosphoric acid (synthetic and allowed with annotation "for cleaning food contact surfaces and equipment" at D.C. 1999), and sodium hydroxide (synthetic and allowed with annotation "Prohibited for use in lye peeling of fruits and vegetables and where natural sodium bicarbonate is an acceptable substitute" at Orlando 1995). Peracetic acid is superior to hydrogen peroxide in antimicrobial activity (Evans, 2000).

2. *Its manufacture, use, and disposal do not have adverse effects on the environment and are done in a manner compatible with organic handling as described in section 6513 of the OFPA.*
   Impacts of manufacture depends on processes used. Various methods of manufacturing involve the use of acetaldehyde. Breakdown products are acetic acid (same acid found in vinegar at 5% level) and hydrogen peroxide that breads down to O_2 and H_2O. Disposal in municipal sewer system may have a positive effect due to oxidation capabilities (Arturo-Schaan et al., 1996). It is more persistant than chlorine-based disinfectants, but less so than quaternary ammonium compounds (Evans, 2000). It can have a longer residual activity than chlorine (Gruetzmacher and Bradley, 1999).

3. *If the nutritional quality of the food is maintained and the material itself or its breakdown products do not have adverse effects on human health as defined by applicable Federal regulations.*
   Limited studies have shown no significant loss of water soluble vitamins as a function of direct food contact (asserted, but not backed up by any reference journal studies). It may inhibit various dairy cultures, but this effect is short-lived (Langeveld and van Montfort-Quasig, 1996). Peracetic acid is an irritant of the skin, eyes, mucous membranes, and respiratory tract (NTP, 2000; Budavari, 1996; Lenga, 1985). When heated to decomposition it emits acrid smoke and toxic fumes of carbon monoxide and carbon dioxide. The vapor is heavier than air and can travel a considerable distance to a source of ignition and flash back (NTP, 2000).

4. *Its primary purpose is not as a preservative or used only to recreate/improve flavors, colors, textures, or nutritive value lost during processing except in the latter case as required by law.*
   Peracetic acid is approved by the FDA for sanitizing and disinfection (21 CFR 178.1005-1010). Proper disinfection of equipment and facilities can reduce the need for synthetic preservatives contained in food products (Bundgaard-Nielsen and Nielsen, 1995).

   Peracetic acid may be used with hydrogen peroxide as a bleach and to produce artificial flavors (Pan, Spencer, and Leary, 1999). For example, when used to disinfect chicken chillwater, some bleaching is observed (Kurschner and Diken, 1997). PAA is also used to modify food starch through mild oxidation (21 CFR 172.892 and Food Chemicals Codex, 1996).

5. *Is Generally Recognized as Safe (GRAS) by FDA when used in accordance with Good Manufacturing Practices (GMP), and contains no residues of heavy metals or other contaminants in excess of FDA tolerances.*
   Peracetic acid is not explicitly listed as GRAS by FDA. However, PAA arguably benefits human health by controlling food-borne pathogens (Cherry, 1999). The maximum residues for washwater used for fruits and vegetables is 80 ppm (21 CFR 173.315). The maximum residues allowed on a food contact surface are 200 ppm (21 CFR 178.1010).

6. *Its use is compatible with the principles of organic handling.*
   In comparison to other most-used sanitizers in the food industry, peracetic acid may be more compatible with organic handling than the use of halogen-based sanitizers and disinfectants such as chlorine bleach, iodine-phosphorous (iodophors), or quaternary ammonia products (quats). For example, chlorination can seriously damage aquatic life and form chlorinated hydrocarbons with carcinogenic and mutagenic properties (Arturo-Schaan et al., 1996). Quats have the longest residual activity (Block, 1991). PAA degrades rapidly, leaves little residue, and decomposes into relatively harmless naturally-occurring substances (Evans, 2000).

7. *There is no other way to produce a similar product without its use and it is used in the minimum quantity required to achieve the process.*

While there are other disinfectants and sanitizers, these are also synthetic. The efficient (minimal) use of peracetic acid as a disinfectant in a HACCP program requires constant monitoring but is technically feasible (Schultz, 1992). Minimum levels for allowed for sanitizing food contacts surfaces are established by FDA (21 CFR 178.1010(c)).

TAP Reviewer Discussion

TAP Reviewer Comments

OMRI's information is enclosed in square brackets in italics. Where a reviewer corrected a technical point (e.g., the word should be "intravenous" rather than "subcutaneous"), these corrections were made in this document and are not listed here in the Reviewer Comments. The rest of the TAP Reviewer's comments are listed here minus any identifying comments and with corrections of typos.

Reviewer #1
[Food Scientist in a research laboratory.]
Synthetic/Non: It is synthetic.

Allow or prohibit: Allowed with annotations.

Annotations:
Allow as an equipment sanitizer where organic food contacts the equipment.

Allow for direct food contact use in wash water (with a concentration limitation of maybe 100 ppm). Must be followed by a fresh water rinse.

Notes: the only concern that I have is with the added stabilizers. Are we approving peracetic acid ONLY if it doesn't contain any stabilizers? Do we need to evaluate the potential stabilizers? I was unable to find any pertinent information about the various stabilizers listed in the packet.

Annotations should be written to NOT allow use for peeling or starch modification if these are not implicitly prohibited. The notes about rinsing (when used as an equipment sanitizer) or not are still up for debate. I tend to NOT want to see sanitizer rinsed off (preferring to allow time for it to volatilize off), but I know that *[other experts want]* to see them rinsed off. I can go either way on this.

Reviewer #2
[Facility pest management expert]
Thank-you for the opportunity to participate in the Technical Advisory Panel (TAP) Review of peracetic acid. This subject is especially important because in my fieldwork in both food safety and organic certification of food products; the area of sanitizers and disinfectants is a difficult issue. Organic consumers, producers, and handlers are not only faced with concerns of appropriate materials selection for the handling and processing of organic commodities, but are responsible for controlling the incidence of potentially harmful pathogens in food products.

Opinions:
1. In the assessment of the resource materials provided and based upon personal experience in the food industry, it is the opinion of this reviewer that peracetic acid (PAA) is [by definition of the Organic Foods Production Act of 1990] a *synthetic* substance.
2. Under provision of the Organic Food Production Act of 1990, it is the opinion of this reviewer that the material PAA should be listed as an *allowed synthetic* substance with the following annotations:
    a. From hydrogen peroxide and acetic acid sources only.
    b. Allowed only for direct food contact for use in wash water. (Which should be understood to mean for use in recirculating flume water.)
    c. Allowed as a sanitizer on food contact surfaces (not requiring a rinse step after application).
3. Without additional background materials and discussions on the use of PAA in the assistance in the peeling of fruits and vegetables, this reviewer believes that this use pattern should be prohibited in organic handling practices.
4. This reviewer does not believe that the use of PAA for bleaching of food is consistent with organic handling practices.
5. Without additional background and discussion, this reviewer believes that the modification of starches with PAA should at least be temporarily prohibited.
6. This reviewer found no additional information regarding the use of PAA for the bleaching of organic cotton and has no comments on the topic at this time.

Discussion

With the implementation of the OFPA, the organic certification industry will be in an increasingly difficult position with regard to acceptable materials for food borne pathogen control. The organic industry has traditionally prohibited synthetic materials for the handling and processing of certified organic products, but has made certain allowances depending on circumstances. Under a strict rule, the available options for sanitizing are narrow and can be costly.

As stated in the materials provided by OMRI for this TAP review, there has traditionally been a mixed view amongst organic certifiers in the use of various sanitizers and disinfectants. The range of materials available does not provide a completely "perfect" organic solution. We are faced with the dilemma of allowing potential residues of synthetic sanitizers on organic products, or the use of fresh water rinses after sanitizing—which is problematic because potentially harmful pathogens can be reintroduced to food or food preparation surfaces during this step.

The use of Hazard Analysis and Critical Control Points (HACCP) as a food hazard identification and control tool requires that certain steps routinely occur to control potentially harmful conditions from occurring. Chemical sanitizers and disinfectants are critical to this management program.

It is the opinion of this reviewer that while this material is synthetic under definition of the OFPA, a reasonable and responsible position can be taken by allowing PAA in the handling and processing of certified organic commodities. This allowance is justifiable and should be provided under the auspices of food safety.

Please be advised that the original conflict of interest statement provided by this reviewer to OMRI is still applicable in all respects for this review process. I have no commercial alliances or monetary affiliations that have influenced this position.

Reviewer #3

[Consultant to organic food processors]

I agree with the summary recommendation put together by OMRI. The product is Synthetic, should be Allowed and the suggested annotations are as follows: from hydrogen peroxide and acetic acid sources only. Allowed for direct food contact for use in wash water. Allowed on surfaces in contact with organic food.

Peracetic acid seems to be a much more acceptable sanitizer than chlorine, in that it is a stronger oxidizing agent, but is less detrimental to the environment. It is an irritant in concentrated form, but appears to be relatively easy to handle in its diluted state.

A search of the literature did not turn up any information on the impact of peracetic acid on nutritional quality. I found only one reference to treatment of rice straw (Tamiguchi et al 1982).

My recommendation would be not to approve for peeling of fruits and vegetables or for bleaching of organic cotton. Those uses should be petitioned separately as this review is primarily for its disinfectant properties in food establishments and I believe we need more complete analysis of the literature and feasibility of its use for these purposes.

One concern is a reference to it ability to corrode steel, unless anti-corrosive agents are present (Boulange-Peterman et al, 1997). Would these be included in the inert ingredients in *[brand name products]*? I did not see a reference to anti-corrosion in *[a company's]* literature.

In conclusion, I agree with most of the analysis contained in the current TAP review document.

Conclusion

Organic farmers, handlers, and consumers face a dilemma with the disinfection of wash water used to handle organic food as well as to clean food contact surfaces. On the one hand, organic standards prohibit the use of synthetic biocides. On the other hand, the presence of food-borne pathogens is a concern. While organic farmers and handlers have a number of materials and methods that they can use instead of peracetic acid, these are limited in their ability to disinfect and sanitize certain types of food, equipment, and surfaces. Both acetic acid and hydrogen peroxide are produced in nature as a function of natural processes.

PAA has broad-spectrum impacts on microorganisms, is an irritant, and may cause other health problems if handled improperly. However, if proper safety precautions are taken, then PAA is no worse than the principle alternative chemical sanitizers and disinfectants previously recommended to be included on the National List.

Some bleaching or discoloration may occur as a part of the normal disinfection application. However, the use of PAA to intentionally bleach food would not be compatible with organic principles.

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Appendix B

Petition for an <u>amendment</u> to the exemption from the requirement of a tolerance for residues of products containing the active ingredient PEROXYACETIC ACID (40 CFR Part 180.1196)

September 20, 2007

<u>Submitted by</u>: **BioSafe Systems (EPA Company No. 70299)**
22 Meadow Street
East Hartford, CT 06108

SUMMARY:

This petition is for an amendment to the existing tolerance exemption to **include** a section as follows:

“(c) an exemption from the requirement of a tolerance for residues of peroxyacetic acid in or on all agricultural commodities when used as a biochemical pesticide.”

The addition of all agricultural commodities is consistent with the use pattern of the active ingredient when used as a biochemical pesticide and does not pose a risk to human health or the environment, as is supported by the data referenced in this petition.

SECTION A - SUMMARY OF PRODUCT CHEMISTRY

Product Name: ZeroTol 2.0
[2.0% Peroxyacetic acid (Peracetic acid)]
[EPA Reg. No. 70299-XX]

TerraClean 5.0
[5.0% Peroxyacetic acid (Peracetic acid)]
[EPA Reg. No. 70299-XX]

Active Ingredient: Peroxyacetic acid (Peracetic Acid)
CAS Number: 79-21-0
Molecular Formula: $C_2H_4O_3$
Molecular Weight: 76.02D

General Information:
Peroxyacetic acid (peracetic acid) is found in the presence of hydrogen peroxide and acetic acid. Peroxyacetic acid is not an intentionally added active ingredient, but is formed *in situ* as the result of a reaction between hydrogen peroxide and acetic acid in the manufacturing process. The levels of peroxyacetic acid continue to increase until the product reaches a state of equilibrium, which occurs approximately one week after initial formulation. Peroxyacetic acid cannot be manufactured and isolated as a 100% pure technical grade active ingredient.

Mode of Action:
Peroxyacetic acid acts to control plant diseases through oxidation and disruption of the cell membrane, via the hydroxyl radical (OH·). As diffusion is slower than the half-life of the radical, it will react with any oxidizable compound in its vicinity. It can damage virtually all types of macromolecules associated with a microorganism: carbohydrates, nucleic acids, lipids and amino acids. The organic tail of the peroxyacetic acid molecule penetrates the cell, oxidizing cell structures containing sulfhydril bonds, leading to cell lysis and death.Peroxyacetic acid reacts on contact with a surface on which it is applied, and rapidly degrades to rapidly degrades into acetic acid, oxygen and water, none of which are of toxicological concern.

Analytical Method:
Due to the fact an exemption from the requirement of a tolerance without numerical limitation on residue levels is granted for peroxyacetic acid, an enforcement analytical method is not needed. Peroxyacetic acid is used in low concentrations and rapidly degrades into acetic acid, oxygen and water.

History of Use:
Peroxyacetic acid is currently EPA registered as a pesticide for antimicrobial use against viruses, bacteria, and fungi. In 1985, the EPA first registered peroxyacetic acid as an antimicrobial for indoor use on hard surfaces. Use sites include agricultural premises, food establishments, medical facilities, and bathrooms. Peroxyacetic acid is also registered for use in dairy/cheese processing plants, on food processing equipment and in pasteurizers in breweries, wineries, and beverage plants. It is also applied for the disinfection of medical supplies, to prevent bio film formation in pulp industries, and as a water purifier and disinfectant.

Peroxyacetic acid is an ideal antimicrobial agent and biochemical pesticide due to its high oxidizing potential. It is broadly effective against microorganisms and plant diseases, and is not deactivated by catalase and peroxidase, the enzymes which break down hydrogen peroxide. It also breaks down to food-safe and environmentally friendly residues (acetic acid and hydrogen peroxide) that are not of toxicological concern.

SECTION B - PROPOSED USE PRACTICE

For use to control plant pathogenic and horticultural diseases in soil, on plants, turf, seeds, food crops and commodities, post harvest commodities, greenhouse surfaces and other agricultural, horticultural and commercial use sites. For use as a bactericide/fungicide/algaecide on hard, non-porous surfaces, tools, equipment, and structures in agricultural settings, greenhouses and post harvest packinghouse applications. For use in treatment of agricultural spray water, livestock water, irrigation water, and water treatment in packinghouse applications.

SECTION C - TOXICOLOGICAL PROFILE

Peroxyacetic acid at a concentration of 2.0% has a pH of 0.82, and at 5.0% has a pH of 0.74, at which concentration the Agency assumes a Toxicity Category I for eye and skin irritation. BioSafe Systems has submitted toxicology information for aqueous solutions containing peroxyacetic acid concentrations between 0.15% and 15%. The 2.0% peroxyacetic acid concentrate is diluted prior to use according to label directions, a minimum of 1:32 (12 ounces to 3 gallons, or 384 oz) with water The 5.0% peroxyacetic acid concentrate is diluted prior to use according to label directions, a minimum of 1:500 (3 gallons to 1500 gallons) with water. Thus, the greatest concentration of peroxyacetic acid in the 2.0% product at the time of application would contain a maximum of approximately 0.07% peroxyacetic acid, and the greatest concentration of peroxyacetic acid in the 5.0% product at the time of application would contain a maximum of approximately 0.01% peroxyacetic acid.

Information reported by The European Centre for Ecotoxicology and Toxicology of Chemicals (ECETOC) demonstrated that a solution of 5.6 % peroxyacetic acid has an acute oral LD50 of 3,622 mg/kg, in female and male rats together (toxicity category III), a solution of 4.89% peroxyacetic acid has an acute dermal LD50 of 1,040 mg/kg in rabbits (toxicity category II), and a solution of 4.5% peroxyacetic acid has an LC50 of > 5,350 mg/m^3 (5.35 mg/L) in rats (toxicity category IV). The ECETOC Task Force determined that solutions containing peroxyacetic acid at concentrations of 0.2% and higher were severely irritating or corrosive to the eye. A solution containing 0.15 % peroxyacetic acid caused mild irritation in the rabbit eye study, and a concentration of 0.034 resulted in very slight irritation.

Peroxyacetic acid is currently EPA registered as a pesticide for antimicrobial use against viruses, bacteria, and fungi. Peroxyacetic acid is also EPA registered for use in dairy/cheese processing plants, agricultural premises, and food establishments, on food processing equipment and in pasteurizers in breweries, wineries, and beverage plants. Per the Final Rule published for the current peroxyacetic acid tolerance exemption at 40 CFR Part 180.1196 (FR Volume 65, Number 232, Pages 75168 -75173, December 1, 2000) that covers those uses, there are acceptable acute generic data referenced in the Reregistration Eligibility Document (RED) for Peroxy Compounds (December 1993, Case 4072, EPA 738-R-93-030). Peroxyacetic acid was found to be corrosive and severely irritating to the eyes, skin, and mucous membranes but only when high concentrations were used. The proposed use patterns involve low concentrations and are expected to result in a lack of any residues of toxicological concern. The RED document waived all other non-acute toxicology data requirements for peroxyacetic acid.

Per the December 2000 Final Rule, no data exists for the subchronic, chronic, carcinogenicity, mutagenicity, developmental and reproductive toxicity of peroxyacetic acid. However, peroxyacetic acid shares similar chemical characteristics with hydrogen peroxide which has a more extensive toxicology data base. For example, peroxyacetic acid and

hydrogen peroxide both decompose into two identical degradates that do not pose any toxicological concern. These two degradates are oxygen and water. Acetic acid is also a degradate of peroxyacetic acid and does not pose any toxicological concern.

Peroxyacetic acid and hydrogen peroxide also show similar chemical characteristics for corrosivity, pH, rapid peroxide bond dissociation, and production of oxygen molecules. Because of these similar chemical characteristics, and low expected exposures with the proposed uses, the dose-response toxicology relationships (i.e. adverse effects experienced only at very high doses) shown by the data for hydrogen peroxide, can also be expected with peroxyacetic acid. The remaining toxicology testing requirements for peroxyacetic acid were waived in the RED because of the similar chemical characteristics, similar expected dose- response relationships with hydrogen peroxide, low exposure levels under the proposed uses, and for the reasons given above.

As stated, residues of peroxyacetic acid are not expected because peroxyacetic acid reacts immediately on contact with materials such as food, reducing agents and catalysts, and is degraded to moieties which present no toxicological concern (Reregistration Eligibility Decision, Peroxy Compounds, U.S. EPA 738-R-93-030). The ultimate degradation products of peroxyacetic acid are acetic acid (which is generally regarded as safe in food up 0.15 %, 21 CFR 184.1,005), water and oxygen. The degradation products of peroxyacetic acid are not of toxicological concern.

Finally, it is noted that the Food and Drug Administration (FDA) has approved peroxyacetic acid for direct food contact for use in wash water or to assist in the peeling of fruits and vegetables (21 CFR 173.315), and is also approved as a sanitizer on food contact surfaces (21CFR 178-1010). Co-products hydrogen peroxide (21 CFR 582.1366) and acetic acid (21 CFR 582.1005) are listed as FDA GRAS in animal feeds.

SECTION D - AGGREGATE EXPOSURE

1) Dietary Exposure:

U.S. EPA has previously established an exemption from the requirement of a tolerance for residues of peroxyacetic acid as an antimicrobial pesticide, in or on raw agricultural commodities, in processed commodities, when such residues result from the lawful use of peroxyacetic acid as an antimicrobial agent on fruits, vegetables, tree nuts, cereal grains, herbs, and spices up to 100 ppm.

According to the 1993 RED, peroxyacetic acid is used in dairy/cheese processing plants, on food-processing equipment and in pasteurizers in breweries, wineries and beverage plants. While some contact may occur between treated equipment and food, no residues are expected since only trace amounts would come in contact with food having contacted treated equipment and the compound degrades rapidly in air and in contact with organic materials to acetic acid (which is generally regarded as safe in food up 0.15 %, see 21 CFR 184.1005), oxygen and water. In addition, peroxyacetic acid may be safely used on food-processing equipment, utensils, and other food-contact articles according to the Food and Drug Administration (FDA) (21 CFR 178.1010, Sanitizing Solutions).

This petition proposes including use of peroxyacetic acid as a biochemical pesticide to control plant diseases in horticultural, commercial and agricultural areas. The ingredient would be applied to soil, plants, turf, seeds, food crops and commodities, post harvest commodities, surfaces, tools, equipment and structures in agricultural settings, agricultural spray water, livestock water, and irrigation water. Dietary exposure from these uses is possible; however, peroxyacetic acid reacts immediately upon contact with materials such as food and degrades to moieties which present no toxicological concern. The addition to dietary aggregate exposure of peroxyacetic acid as described in this petition is expected to be zero.

2) Drinking Water Exposure:

At the proposed application rates, the use of peroxyacetic acid to treat agricultural food commodities will result in minimal transfer of residues to potential drinking water supplies. This is due to the low application rate and rapid degradation of peroxyacetic acid into acetic acid, oxygen and water, none of which are of toxicological concern.

In addition, the degradation products of peroxyacetic acid in aqueous solutions are acetic acid (which is generally regarded as safe in food up 0.15%, see 21 CFR 184.1005), water and oxygen. These degradation products are not of toxicological concern.

3) Non-Dietary Exposure:

According to the 1993 RED, the compound, in the form of a soluble concentrate/liquid, is used in industrial and commercial settings. Peroxyacetic acid is highly reactive and short-lived because of the inherent instability of the peroxide bond (O-O bond) and, because the peroxide bond is weak, transformation to acetic acid, water and oxygen is very highly favored thermodynamically (1993 RED). The degradation products of peroxyacetic acid in aqueous solutions are acetic acid (which is generally regarded as safe in food up 0.15%, see 21 CFR 184.1005), water and oxygen. The degradation products of peroxyacetic acid are not of toxicological concern.

The potential for any non-occupational exposure under the use proposed in this petition to the general population (including children) is unlikely. Peroxyacetic acid is proposed in this petition to be used only at horticultural, commercial and agricultural establishments (including farms) and is not proposed for use in or around the home.

SECTION E - CUMULATIVE EFFECTS

When used as proposed, peroxyacetic acid decomposes quickly; there is no reasonable expectation that residues of these compounds will remain in human food items in accordance with 40 CFR 180.3. The mode of action of this pesticide is oxidation. Other chemicals that may share a similar mode of action are hydrogen peroxide and potassium peroxymonosulfate sulfate as listed in the 1993 RED. Combining exposures to these compounds could be appropriate; however, each degrades rapidly (due to the peroxy bond, the O-O bond) into compounds that are not toxicologically significant (including water, oxygen, and carbon dioxide).

SECTION F - SAFETY DETERMINATION

1) **U.S. Population.** Peroxyacetic acid naturally degrades to acetic acid (which is generally regarded as safe in food up 0.15%, see 21 CFR 184.1005), water and oxygen which would not pose a health risk to the U.S. general population. These degradation products are not of toxicological concern.

2) **Infants and children.** Peroxyacetic acid naturally degrades to acetic acid (which is generally regarded as safe in food up 0.15%, see 21 CFR 184.1005), water and oxygen which would not pose a health risk to the U.S. population subgroup of infants and children. These degradation products are not of toxicological concern. Residues of peroxyacetic acid are not expected on food from use of peroxyacetic acid as a biochemical pesticide on agricultural commodities. Therefore, exposure of the pesticide chemical (from the use proposed in this petition) to the U.S. general population should not occur. There is a reasonable certainty of no harm to consumers, including infants and children, from aggregate exposure to peroxyacetic acid.

SECTION G - EXISTING TOLERANCES

US EPA Tolerance –

40 CFR Part 180.1196 - Peroxyacetic acid; exemption from the requirement of a tolerance.

(a) An exemption from the requirement of a tolerance is established for residues of peroxyacetic acid in or on raw agricultural commodities, in processed commodities, when such residues result from the use of peroxyacetic acid as an antimicrobial treatment in solutions containing a diluted end use concentration of peroxyacetic acid up to 100 ppm per application on fruits, vegetables, tree nuts, cereal grains, herbs, and spices.

(b) An exemption from the requirement of a tolerance is established for residues of peroxyacetic acid, in or on all raw and processed food commodities when used in sanitizing solutions containing a diluted end- use concentration of peroxyacetic acid up to 500 ppm, and applied to tableware, utensils, dishes, pipelines, tanks, vats, fillers, evaporators, pasteurizers, aseptic equipment, milking equipment, and other food processing equipment in food handling establishments including, but not limited to dairies, dairy barns, restaurants, food service operations, breweries, wineries, and beverage and food processing plants.

International –

There is no Codex Alimentarium Commission Maximum Residue Level (MRL) for peroxyacetic acid.

SECTION H - INFORMATION ON ENDOCRINE EFFECTS

Peroxyacetic acid is not structurally similar to any known chemical capable of producing adverse effects on the endocrine system. Per the Final Rule published for the current peroxyacetic acid tolerance exemption at 40 CFR Part 180.1196 (FR Volume 65, Number 232, Pages 75168 -75173, December 1, 2000), the currently available animal data suggest no significant endocrine effects from exposure to peroxyacetic acid.

Appendix C

OxiDate®

Broad Spectrum Bactericide/Fungicide

SPECIMEN LABEL

PREVENTATIVE TREATMENT FOR SEEDS, GROWING PLANTS, FRUITS, NUTS AND VEGETABLES.

A treatment for the prevention and control of plant pathogenic diseases in field grown crops, commercial greenhouses, and storage sites.

FOR AGRICULTURAL AND COMMERCIAL USE ONLY

ACTIVE INGREDIENT:

Hydrogen Dioxide:	27%
OTHER INGREDIENTS:	73%
TOTAL:	100%

KEEP OUT OF REACH OF CHILDREN
DANGER - *PELIGRO*

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. *(If you do not understand this label, find someone to explain it to you in detail.)*

FIRST AID
If in eyes:

- Hold eye open and rinse slowly and gently with water for 15 - 20 minutes.
- Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.
- Call a poison control center or doctor for treatment advice.

If on skin or clothing:

- Take off contaminated clothing.
- Rinse skin immediately with plenty of water for 15 - 20 minutes.
- Call a poison control center or doctor for treatment advice.

If swallowed:

- Call poison control center or doctor immediately for treatment advice.
- Have person sip a glass of water if able to swallow.
- Do not induce vomiting unless told to do so by a poison control center or doctor.
- Do not give anything by mouth to an unconscious person.

If inhaled:

- Move person to fresh air.
- If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible.
- Call poison control center or doctor for treatment advice.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-222-1222 for emergency medical treatment information.

NOTE TO PHYSICIAN: Probable mucosal damage may contraindicate the use of gastric lavage.

SOLD BY: BioSafe Systems LLC
22 Meadow Street
East Hartford, CT 06108
EPA Registration No. 70299-2
EPA Establishment No. 60156-IL-001

PRECAUTIONARY STATEMENTS
HAZARDS TO HUMAN AND DOMESTIC ANIMALS – DANGER: Corrosive. Concentrate causes irreversible eye damage. Concentrate may be fatal if swallowed or absorbed through skin. Concentrate causes skin burns or temporary discoloration on exposed skin. Do not breathe vapor of concentrate. Do not get concentrate in eyes, on skin or on clothing. Wear protective eyewear such as goggles or face shield. Wash thoroughly with soap and water after handling. Remove and wash contaminated clothing before reuse.

PERSONAL PROTECTIVE EQUIPMENT (PPE): When handling concentrate wear protective eyewear (goggles or face shield) and rubber gloves. Applicators and handlers must wear coveralls over long-sleeved shirt, long pants, and chemical resistant footwear plus socks. Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions exist for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

USER SAFETY RECOMMENDATIONS
Users should wash hands thoroughly with soap and water before eating, drinking, chewing gum, using tobacco or using the toilet. Users should remove clothing immediately if pesticide gets inside, then wash thoroughly and put on clean clothing. Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

ENVIRONMENTAL HAZARDS
This pesticide is toxic to birds and fish. Do not contaminate water when disposing of equipment washwaters or rinsate. Exposed treated seed may be hazardous to birds and other wildlife. Dispose of all excess treated seed and seed packaging by burial away from bodies of water.

This product is highly toxic to bees and other beneficial insects exposed to direct contact on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds while bees are actively visiting the treatment area. Do not apply this product or allow it to drift to crops where beneficials are part of an Integrated Pest Management strategy.

PHYSICAL AND CHEMICAL HAZARDS
Corrosive. Strong oxidizing agent. Do not use in concentrated form. Mix only with water in accordance with label instructions. Never bring concentrate in contact with other pesticides, cleaners or oxidative agents.

DIRECTIONS FOR USE
It is a violation of Federal law to use this product in a manner inconsistent with its labeling. Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation.

AGRICULTURAL USE REQUIREMENTS
Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR Part 170. This standard contains requirements for the protection of agricultural workers on farms, forests, nurseries and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about Personal Protective Equipment (PPE), notification to workers, and Restricted-Entry Interval (REI). The requirements in this box only apply to the uses of this product that are covered by the Worker Protection Standard.

For enclosed environments:
There is a restricted entry of one (1) hour for this product when applied via fogging or spraying to growing plants, surfaces, equipment, structures and non-porous surfaces in enclosed environments such as glasshouses and greenhouses. PPE requirement for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil or water, is coveralls worn over long-sleeved shirt and pants, waterproof gloves and shoes plus socks.

There is a restricted entry of zero (0) hours for pre-plant dip, seed treatment, soil drench, mop, sponge, dip, soak, rinse or other non-spraying or fogging application methods when used in enclosed environments such as glasshouses and greenhouses.

For field applications:
Keep unprotected persons out of treated areas until sprays have dried.

NON-AGRICULTURAL USE REQUIREMENTS
The requirements in this box apply to uses of this product that are **not** within the scope of the Worker Protection Standard for agricultural pesticides (40 CFR Part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries or greenhouses.

Keep unprotected persons out of treated areas until sprays have dried.

DIRECTIONS FOR USE

- OxiDate works best when diluted with water containing low levels of organic or inorganic materials, and with water having a neutral pH. Thoroughly rinse out tank with water before mixing concentrate. OxiDate will readily mix with clean, neutral water and does not require agitation.
- Before tank mixing with fertilizers, fungicides, or bactericides, conduct a compatibility test for each combination. Make a test solution and shake or stir vigorously. Excessive bubbling and/or pressure are indications of incompatibility.
- OxiDate is formulated with a minimal amount of surfactant for plants having waxy or hairy surfaces. The use of additional surfactant is acceptable.
- OxiDate works by surface contact with the plants and materials being treated. It is important to ensure that all surfaces are thoroughly wetted. OxiDate does not produce any visible residue, distinct odor or deleterious effects to plants or to post harvest commodities when used in accordance with label directions. Do not use at stronger than suggested dilution rates as leaf burn may result.
- OxiDate may be applied up to and including the day of harvest.

Do not apply this product through any irrigation system unless directed by the label; refer to Chemigation Directions for Use.

APPLICATION DIRECTIONS

Pre-Plant Dip Treatment:
Use OxiDate for the control of damping-off, root disease and stem rot disease caused by *Pythium, Phytophthora, Rhizoctonia, Fusarium* or *Thielaviopsis*, on seeds, seedlings, bulbs, or cuttings.

1) Mix 64-fl. oz. OxiDate per 50 gallons of water.
2) Immerse plants or cuttings; remove and allow to drain. Do not rinse.

Seed Treatment:
Use OxiDate for the control of damping-off, root disease and stem rot disease caused by *Pythium, Phytophthora, Rhizoctonia, Fusarium* or *Thielaviopsis*, on seeds of seed sprout crops such as mung bean, red clover, soybeans and alfalfa, and on crops grown exclusively for seed for planting.

1) Mix 64-fl. oz. OxiDate per 50 gallons of water.
2) Immerse seeds and let soak for two minutes; remove and allow to drain. Do not rinse.

Do not use treated seed for food or feed purposes or process for oil. Treat only those seeds needed for immediate use, minimizing the interval between treatments at planting. Do not store excess treated seeds beyond planting time.

Seed treatment on agricultural establishments in hopper-box, planter-box or other seed treatment application at or immediately before planting is within the scope of WPS, while commercial treatment of seeds is not within the scope.

Soil Drench:
OxiDate is effective for the control of soil-borne plant diseases such as *Pythium, Phytophthora, Rhizoctonia, Thielaviopsis* or *Fusarium*. Use as a soil drench at the time of seeding or transplanting, as well as a periodic drench throughout the plant's life. Use OxiDate on potting soil and growing mediums prior to planting.

1) Mix 1-1/4 fl. oz. OxiDate per gallon of clean water.
2) Apply to soil or growing media to the point of saturation.
3) Wait fifteen minutes before planting or watering.

Foliar Spray Treatments for field grown crops, crops grown in commercial greenhouses or crops grown in other similar sites:
OxiDate works immediately on contact with any plant surface for control of plant diseases – see Application Instructions chart. Good coverage and wetting of the foliage is required.

FOLIAR APPLICATIONS

Plant Sensitivity Testing:
For foliar applications, be sure to use OxiDate at labeled dilutions as solutions more concentrated can result in leaf necrosis for some crops (i.e., do not use dilutions stronger than 1:100 for foliar treatments). OxiDate has been designed to provide a balanced source of the active ingredient directly to the plant surface. OxiDate has been used and tested on many varieties of plant material; however, the nature of the target plant, environmental conditions, plant vigor and the use of other pesticides can all affect plant sensitivity to OxiDate. Therefore, before treating large numbers of plants, test OxiDate on a few plants for sensitivity.

Application of OxiDate for curative control of obligate organisms living in the plant tissue (such as Downy and Powdery Mildew) can result in lesions on plant tissue. OxiDate will oxidize parasitic organisms living in plant tissue that are not always visible to the naked eye. Resulting oxidative effects can include spotting, or drying of the plant tissue where organisms inhabited tissue.

FOR CLEAN, NON-POROUS SURFACES

Pots, Flats, Trays:
Use a dilution of 1:100 - 1:300 or 1-1/4 fl oz. - 1/2 fl. oz. of OxiDate per gallon of clean water. Spray until runoff. The use of additional surfactant is acceptable.

Cutting Tools:
Use a dilution of 1:100 - 1:300 or 1-1/4 fl oz. - 1/2 fl. oz. of OxiDate per gallon of clean water. Soak tools to ensure complete coverage. The use of additional surfactant is acceptable.

Benches and Work Areas:
Sweep and remove all plant debris. Use power sprayer to wash all surfaces to remove loose dirt. Use a dilution of 1:100 - 1:300 or 1-1/4 fl oz. - 1/2 fl. oz. of OxiDate per gallon of clean water. Use a dilution of 1:50 or 2-1/2 fl. oz. of OxiDate per gallon of clean water if surfaces that are to be treated have not been pre-cleaned with water to remove organic deposits. The use of additional surfactant is acceptable.

For surfaces, equipment and structures:
Use OxiDate to suppress / control bacteria, fungi and slime forming algae on surfaces, equipment, and structures such as: plastic, benches, walkways, floors, walls, fan blades, watering systems, vats, tanks, coolers, storage rooms, bins, elevators, storage areas, spray equipment, conveyors, irrigation systems, process equipment, process water systems, trucks, structures and related equipment. Follow treatment of any food contact surfaces, equipment or structures with a potable water rinse.

1) Sweep and remove all plant debris. Use power sprayer to wash all surfaces to remove loose dirt and/or organic material.
2) Use a dilution of 1:100 - 1:300, or 1-1/4 fl oz. - 1/2 fl. oz., of OxiDate per gallon of clean water. Use a dilution of 1:50 or 2-1/2 fl. oz. of OxiDate per gallon of clean water if surfaces that are to be treated have not been pre-cleaned with water to remove organic deposits. The use of additional surfactant is acceptable.
3) Apply solution with mop, sponge, power sprayer or fogger to thoroughly wet all surfaces.

Fog enclosed areas as an adjunct to manual surface application. Wear protective eyewear (goggles or face shield) when fogging. Prior to fogging, pre-clean surfaces with water to remove any organic deposits. Fog the desired areas using dilution rates of 1:100 - 1:300, or 1-1/4 fl oz. - 1/2 fl. oz., of OxiDate using any type of fogging equipment including but not limited to cold foggers, thermal foggers, low pressure air assisted and high pressure fog systems. Solutions are corrosive to materials that are easily oxidized such as natural rubber, copper, galvanized and black iron pipe. Test solutions on surfaces prior to use.

4) Follow treatment of any food contact surfaces, equipment or structures with a potable water rinse.
5) Scrub off heavy growths of algae and fungi following application. Use a solution of OxiDate to wash away dead growth.
6) Reapply often for control.

For foot bath mats:
Make a solution using 3/4 fl. oz. of OxiDate per gallon of water and fill foot bath mat to capacity. Change solution as needed.

FOAMING APPLICATIONS
Apply OxiDate as a foam treatment to enhance contact on porous surfaces, vertical surfaces and irregular surfaces such as metal grating and structural steel where contact is difficult to maintain with coarse spray treatments. Add a foaming agent to the spray tank that contains the diluted OxiDate solution. Apply foam until the surface treated is completely covered. Allow foam treated surface to air dry. Do not rinse.

For stock tanks and livestock water:
Use OxiDate to suppress / control algae, bacteria and fungi in stock tanks, stock watering ponds, tanks and troughs, and livestock water. Apply 2 fluid ounces of OxiDate per 250 gallons of water for algae control. Product can be simply added to the body of waters as the residual control will allow for even distribution throughout the water column. Where existing algae mats are present at time of treatment, the most effective control will be obtained by breaking up mats and/or evenly dispersing diluted OxiDate over the algae mats. Apply OxiDate as needed to control and prevent algae growth; apply more frequently applications in times of higher water temperatures.

Drip system application for livestock watering tanks: Tanks fed by a continuous flow of spring or well water can be equipped with a chemical drip system designed to meter-in OxiDate based upon water flow rates. Pre-dilute OxiDate at a 100:1 rate or 4-mL/minute water flow rate. Treat continuously or as needed to control and prevent algae regrowth.

APPLICATION INSTRUCTIONS (ALPHABETICAL BY CROP)

CROP	DISEASE	DILUTION RATE	APPLICATION RATE	DIRECTIONS
Asparagus	Phytophthora	1:100	128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre.	**Curative:** Spray diseased plants using 128 fl. oz. of OxiDate per 100 gallons of water for one to three consecutive days and continue treatments on five to seven day intervals.
		1:100 - 1:300	40-128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre.	**Preventative:** Begin when plants are small. Apply first three treatments using the curative rate at five-day intervals. Reduce rate to 40 fl. oz. of OxiDate per 100 gallons of water after the completion of third treatment and maintain five-day interval spray cycle until harvest.
Bananas Plantains	Sigatoka	1:100	128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre.	**Curative:** Spray diseased plants using 128 fl. oz. of OxiDate per 100 gallons of water for one to three consecutive days and continue treatments on five to seven day intervals.
		1:100 - 1:300	40-128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre.	**Preventative:** Begin when plants are small. Apply first three treatments using the curative rate at five-day intervals. Reduce rate to 40 fl. oz. of OxiDate per 100 gallons of water after the completion of third treatment and maintain five-day interval spray cycle until harvest.
Beans Lima Beans Peas Snap & Dry Soybeans	Anthracnose Botrytis Downy Mildew Early Blight Fusarium Late Blight Phytophthora Powdery Mildew Pythium Rhizoctonia Sclerotinia Rust White Mold	1:100 - 1:2000	(See Beans – Snap and Dry Application Instructions)	For specific application instructions, see Beans – Snap and Dry Application Instructions in previous section.
Berries, including but not limited to: Blackberry Blueberry Cranberry Raspberry Strawberry (see Strawberry Application Instructions)	Alternaria Angular Leaf Spot Botrytis Crown Rot Downy Mildew Fruit Rot Leaf Blight Powdery Mildew	1:100	128 fl. oz. of OxiDate per 100 gallons of water; apply 25-100 gallons of spray solution per treated acre.	**Curative:** Spray diseased plants using 128 fl. oz. of OxiDate per 100 gallons of water for one to three consecutive days and continue treatments on five to seven day intervals.
		1:100 - 1:300	40-128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre.	**Preventative:** Begin when plants are small. Apply first three treatments using the curative rate at five-day intervals. Reduce rate to 40 fl. oz. of OxiDate per 100 gallons of water after the completion of third treatment and maintain five-day interval spray cycle until harvest.
Celery	Early Blight Late Blight	1:100	128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre.	**Curative:** Spray diseased plants using 128 fl. oz. of OxiDate per 100 gallons of water for one to three consecutive days and continue treatments on five to seven day intervals.
		1:100 - 1:300	40-128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre.	**Preventative:** Begin when plants are small. Apply first three treatments using the curative rate at five-day intervals. Reduce rate to 40 fl. oz. of OxiDate per 100 gallons of water after the completion of third treatment and maintain five-day interval spray cycle until harvest.

APPLICATION INSTRUCTIONS (ALPHABETICAL BY CROP) CONTINUED

CROP	DISEASE	DILUTION RATE	APPLICATION RATE	DIRECTIONS
Citrus Crops, including but not limited to: Grapefruit Kumquat Lemon Orange Tangerine	Alternaria Anthracnose Brown Rot Phytophthora Powdery Mildew Rust Scab	1:100 1:100 - 1:300	128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre. 40-128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre.	**Curative:** Spray diseased plants using 128 fl. oz. of OxiDate per 100 gallons of water for one to three consecutive days and continue treatments on five to seven day intervals. **Preventative:** Begin when plants are small. Apply first three treatments using the curative rate at five-day intervals. Reduce rate to 40 fl. oz. of OxiDate per 100 gallons of water after the completion of third treatment and maintain five-day interval spray cycle until harvest.
	Citrus Canker	1:100 - 1:600	*See Citrus Canker Application Instructions*	***For specific application instructions, see Citrus Canker Treatment Application Instructions.***
Cole Crops, including but not limited to: Broccoli Brussel Sprouts Cabbage Cauliflower Collards	Alternaria Leaf Spot Downy Mildew Early Blight Late Blight Powdery Mildew	1:100 1:100 - 1:300	128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre. 40-128 fl oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre.	**Curative:** Spray diseased plants using 128 fl. oz. of OxiDate per 100 gallons of water for one to three consecutive days and continue treatments on five to seven day intervals. **Preventative:** Begin when plants are small. Apply first three treatments using the curative rate at five-day intervals. Reduce rate to 40 fl. oz. of OxiDate per 100 gallons of water after the completion of third treatment and maintain five-day interval spray cycle until harvest.
Cucurbit Crops, including but not limited to: Cucumber Melons Pumpkins Squash	Alternaria Anthracnose Belly Rot Downy Mildew Fusarium Wilt Gummy Stem Blight Leaf Spot Phytophthora Powdery Mildew Pythium Rot Rhizoctonia Root Rots	1:100 - 1:2000	*(See Cucurbit Application Instructions)*	**For specific application instructions, see Cucurbit Application Instructions in previous section.**
Filberts **Almonds**	Alternaria Brown Rot Bacterial Blight Bacterial Canker E. Filbert Blight Jacket Rot	1:100	128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre.	**Pre-Bloom:** Begin applications at ¼-½ inch green tip and continue on a five to seven day schedule through bloom. **Curative:** Spray diseased trees for three consecutive days and continue treatments on five to seven day intervals.
Garlics **Leeks** **Onions** **Green Onions** **Scallions** **Shallots**	Botrytis Downy Mildew Powdery Mildew	1:100 1:100 - 1:300	128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre. 40-128 fl. of oz. OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre.	**Curative:** Spray diseased plants using 128 fl. oz. of OxiDate per 100 gallons of water for one to three consecutive days and continue treatments on five to seven day intervals. **Preventative:** Begin when plants are small. Apply first three treatments using the curative rate at five-day intervals. Reduce rate to 40 fl. oz. of OxiDate per 100 gallons of water after the completion of third treatment and maintain five-day interval spray cycle until harvest.

APPLICATION INSTRUCTIONS (ALPHABETICAL BY CROP) CONTINUED

CROP	DISEASE	DILUTION RATE	APPLICATION RATE	DIRECTIONS
Grapes	Black Rot Botrytis Downy Mildew Powdery Mildew Sour Rot	1:100 1:100 - 1:300	128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre. 40-128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre.	**Curative:** Spray diseased plants using 128 fl. oz. of OxiDate per 100 gallons of water for one to three consecutive days and continue treatments on five to seven day intervals. **Preventative:** Begin when plants are small. Apply first three treatments using the curative rate at five-day intervals. Reduce rate to 40 fl. oz. of OxiDate per 100 gallons of water after the completion of third treatment and maintain five-day interval spray cycle until harvest.
Grasses grown for seed or sod	Gray Leaf Spot Stem Rust Leaf Rust Leaf Spot	1:100 - 1:300	40-128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre.	Use sufficient water to achieve good coverage. Begin applications during stem elongations. Repeat weekly or as needed. Livestock can graze treated areas.
Herbs and Spices, including but not limited to: Basil Chives Cilantro Coriander Dill Mint Rosemary Sage	Anthracnose Downy Mildew Powdery Mildew Pythium Rot	1:100 1:100 - 1:300 1:500 - 1:1000	128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre. 40-128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre. Direct inject at a dilution ratio of 1:500-1:1000.	**Curative:** Spray diseased plants using 128 fl. oz. of OxiDate per 100 gallons of water for one to three consecutive days and continue treatments on five to seven day intervals. **Preventative:** Begin when plants are small. Apply first three treatments using the curative rate at five-day intervals. Reduce rate to 40 fl. oz. of OxiDate per 100 gallons of water after the completion of third treatment and maintain five-day interval spray cycle until harvest. **Direct Injection:** Inject directly into misting systems for continual treatment during propagation.
Leafy Vegetables	Brown Rot Botrytis Downy Mildew Early Blight Late Blight Phytophthora Powdery Mildew Rust	1:100 1:100 - 1:300	128 fl oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre. 40-128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre.	**Curative:** Spray diseased plants using 128 fl. oz. of OxiDate per 100 gallons of water for one to three consecutive days and continue treatments on five to seven day intervals. **Preventative:** Begin when plants are small. Apply first three treatments using the curative rate at five-day intervals. Reduce rate to 40 fl. oz. of OxiDate per 100 gallons of water after the completion of third treatment and maintain five-day interval spray cycle until harvest.
Mushrooms	Verticillium Spot Trichoderma Bacterial Blotch Mycogene Necrotic Spot	1:100 1:300	1¼ fl. oz. of OxiDate per gallon of water; apply 6 gallons of solution per 1000 sq. ft. ½ fl. oz. of OxiDate per gallon of water; apply 6 gallons of solution per 1000 sq. ft.	**Curative:** Spray diseased mushrooms using 1¼ fl. oz. of OxiDate per gallon of water for one to three consecutive days. **Preventative:** Spray mushrooms using ½ fl. oz. of OxiDate per gallon of water on five to seven day intervals. Begin at pinning stage and continue through harvest.
Peanuts	Early Blight Late Blight Rust	1:100 1:100 - 1:300	128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre. 40-128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre.	**Curative:** Spray diseased plants using 128 fl. oz. of OxiDate per 100 gallons of water for one to three consecutive days and continue treatments on five to seven day intervals. **Preventative:** Begin when plants are small. Apply first three treatments using the curative rate at five-day intervals. Reduce rate to 40 fl. oz. of OxiDate per 100 gallons of water after the completion of third treatment and maintain five-day interval spray cycle until harvest.

APPLICATION INSTRUCTIONS (ALPHABETICAL BY CROP) CONTINUED

CROP	DISEASE	DILUTION RATE	APPLICATION RATE	DIRECTIONS
Peppers & Tomatoes	Alternaria Anthracnose Bacterial Speck Bacterial Spot Botrytis Cladosporium Mold Early Blight Late Blight Leaf Spot Phytophthora Powdery Mildew Pythium Rhizoctonia	1:100 - 1:2000	*(See Tomato and Pepper Application Instructions)*	**For specific application instructions, see Tomato and Pepper Application Instructions in previous section.**
Pome Fruits, including but not limited to: Apples Pears	Powdery Mildew Rusts Scabs	1:100 1:100 - 1:300	128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre. 40-128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre.	**Curative:** Spray diseased plants using 128 fl. oz. of OxiDate per 100 gallons of water for one to three consecutive days and continue treatments on five to seven day intervals. **Preventative:** Begin when plants are small. Apply first three treatments using the curative rate at five-day intervals. Reduce rate to 40 fl. oz. of OxiDate per 100 gallons of water after the completion of third treatment and maintain five-day interval spray cycle until harvest.
Potatoes	Early Blight Late Blight	1:100 1:100 - 1:300	128 fl oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre. 40-128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre.	**Curative:** Spray diseased plants using 128 fl. oz. of OxiDate per 100 gallons of water for one to three consecutive days and continue treatments on five to seven day intervals. **Preventative:** Begin when plants are small. Apply first three treatments using the curative rate at five-day intervals. Reduce rate to 40 fl. oz. of OxiDate per 100 gallons of water after the completion of third treatment and maintain five-day interval spray cycle until harvest.
Potatoes (Seed)	Fusarium	1:50	2½ fl. oz. of OxiDate per gallon of water.	Dip whole or cut tubers into tank of working solution. Let soak for a period of five minutes before removing seed pieces.
Root Crops, including but not limited to: Beets Carrots Ginseng Horseradish Sweet Potato Yams	Alternaria Crown Rot Early Blight Late Blight	1:100 1:100 - 1:300	128 fl oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre. 40-128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre.	**Curative:** Spray diseased plants using 128 fl. oz. of OxiDate per 100 gallons of water for one to three consecutive days and continue treatments on five to seven day intervals. **Preventative:** Begin when plants are small. Apply first three treatments using the curative rate at five-day intervals. Reduce rate to 40 fl. oz. of OxiDate per 100 gallons of water after the completion of third treatment and maintain five-day interval spray cycle until harvest.
Stone Fruits, including but not limited to: Cherries Nectarines Peaches Plums Prunes	Brown Rot Downy Mildew Powdery Mildew	1:100	128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre.	**Pre-Bloom:** Begin applications at ¼-½ inch green tip and continue on a five to seven day schedule through bloom. **Curative:** Spray diseased trees for three consecutive days and continue treatments on five to seven day intervals.

APPLICATION INSTRUCTIONS (ALPHABETICAL BY CROP) CONTINUED

CROP	DISEASE	DILUTION RATE	APPLICATION RATE	DIRECTIONS
Sugar Beets	Alternaria Bacterial Leaf Spot Crown Rot Leaf Blight Leaf Spot Powdery Mildew Rhizoctonia	1:100 1:100 - 1:300	128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre. 40-128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre.	**Curative:** Spray diseased plants using 128 fl. oz. of OxiDate per 100 gallons of water for one to three consecutive days and continue treatments on five to seven day intervals. **Preventative:** Begin when plants are small. Apply first three treatments using the curative rate at five-day intervals. Reduce rate to 40 fl. oz. of OxiDate per 100 gallons of water after the completion of third treatment and maintain five-day interval spray cycle until harvest.
Tobacco Field	Blue Mold	1:100 1:100 - 1:300	128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre. 40-128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre.	**Curative:** Spray diseased plants using 128 fl. oz. of OxiDate per 100 gallons of water for one to three consecutive days and continue treatments on five to seven day intervals. **Preventative:** Begin when plants are small. Apply first three treatments using the curative rate at five-day intervals. Reduce rate to 40 fl. oz. of OxiDate per 100 gallons of water after the completion of third treatment and maintain five-day interval spray cycle until harvest.
Tobacco Float Beds	Blue Mold Fusarium Phytophthora Pythium	1:500 - 1:1000 1:5000 - 1:10,000	1¼-2½ fl. oz. of OxiDate per 10 gallons. 6-24 fl. oz. of OxiDate per 1000 gallons.	**Curative:** Initial treatment of float bed water. **Preventative:** Treat water on a regular basis or maintain a residual 100 ppm concentration.
Tomatoes	*(See Peppers section)*			
Tropical Fruits, including but not limited to: Casaba Coconut Dates Guava Kivi Mango Passion Fruit Pineapple Poi Star Fruit	Alternaria Anthracnose Leaf Blight Powdery Mildew Rhizoctonia Sooty Mold Stem Rot	1:100 1:100 - 1:300	128 fl oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre. 40-128 fl. oz. of OxiDate per 100 gallons of water; apply 30-100 gallons of spray solution per treated acre.	**Curative:** Spray diseased plants using 128 fl. oz. of OxiDate per 100 gallons of water for one to three consecutive days and continue treatments on five to seven day intervals. **Preventative:** Begin when plants are small. Apply first three treatments using the curative rate at five-day intervals. Reduce rate to 40 fl. oz. of OxiDate per 100 gallons of water after the completion of third treatment and maintain five-day interval spray cycle until harvest.

DIRECTIONS, RATES, AND USAGE

BEANS – SNAP AND DRY APPLICATION INSTRUCTIONS

At-Planting Application

For control of Early Blight, Late Blight, Phytophthora, Pythium, Rhizoctonia, Fusarium Root-Rot, and Sclerotinia.

RATE	APPLICATION	NOTES
½ to 1 gallon of OxiDate per treated acre in 50 to 200 gallons of water.	Add OxiDate to setting water or starter fertilizer and make in-furrow application just prior to seed drop.	• In fields with a history of disease pressure, use stronger rates. • Before tank mixing OxiDate with other fertilizers, fungicides or bactericides, conduct a compatibility test for each combination. Make a test solution and shake or stir vigorously. Excessive bubbling and/or pressure are an indication of incompatibility.

Surface Application
For control of Early Blight, Late Blight, Phytophthora, Pythium, Rhizoctonia, Fusarium Root-Rot and Sclerotinia.

RATE – SPRAY APPLICATION	APPLICATION	NOTES
1/3 to 1 gallon of OxiDate per 100 gallons of water.	• Apply OxiDate as a foliar spray with sufficient water to achieve runoff to soil. • Repeat every seven days through infectious season.	• Typical applications use 30 to 100 gallons of spray per treated acre. During periods of wet, cloudy, or rainy weather, use stronger rates and volumes, and reduce spray intervals. • Before tank mixing OxiDate with other fertilizers, fungicides or bactericides, conduct a compatibility test for each combination. Make a test solution and shake or stir vigorously. Excessive bubbling and/or pressure are an indication of incompatibility.
RATE – IRRIGATION APPLICATION	**APPLICATION**	**NOTES**
1/2 to 1 gallon of OxiDate per treated acre in 500 to 1000 gallons of water.	Apply through drip trickle, center pivot, lateral move, end tow, side wheel roll, traveler, solid set, hand move, or flood basin irrigation systems.	

Foliar Application
For control of Anthracnose, Bacterial Blights, Botrytis, Powdery Mildew, Rhizoctonia, Rust and White Mold.

RATE – SPRAY APPLICATION	APPLICATION	NOTES
1/3 to 1 gallon of OxiDate per 100 gallons of water. Complete coverage is essential.	• Begin applications of OxiDate prior to or in early stages of disease development and continue throughout the season. • Spray at first appearance or when conditions are favorable for disease development. • Repeat applications at 7-day intervals.	• Under severe disease conditions and during periods of rainy weather, apply immediately after each rain, reduce spray intervals, and use stronger dilution rates. • Use sufficient water to obtain complete coverage. • Before tank mixing OxiDate with other fertilizers, fungicides or bactericides, conduct a compatibility test for each combination. Make a test solution and shake or stir vigorously. Excessive bubbling and/or pressure are an indication of incompatibility.
RATE – IRRIGATION APPLICATION	**APPLICATION**	**NOTES**
1/2 to 1 gallon of OxiDate per treated acre in 500 to 1000 gallons of water.	Apply through center pivot, lateral move, end tow, side wheel roll, traveler, solid set or hand move irrigation systems.	• Do not spray OxiDate during conditions of intense heat, drought or poor vine canopy.

CITRUS CANKER APPLICATION INSTRUCTIONS

For vehicles, field equipment, tools, personnel clothing – Surface Treatment: For Citrus Canker.

RATE - FOLIAR SPRAY	APPLICATION	NOTES
16.0 – 21.3 fl. oz. of Oxidate per 100 gallons of water. Complete coverage is essential.	• Apply to field equipment such as pickers, trailers, trucks (including truck body parts and tires), bins, packing crates, ladders, power tools, pruning shears, gloves, rubber boots, Tyvek suits or other equipment that can transfer Xanthomonas bacterial species including citrus canker. • Apply to equipment and surfaces found in commercial packing houses including dump tanks, drenches, crates, containers, conveyors, storages, walls, floors, and process lines.	• Remove loose soil or organic matter with clean water or detergent/rinse. Use a power sprayer to remove loose dirt and organic matter. • Apply solution as a coarse spray or by mop, sponge, power sprayer, portable sprayer or fogger. Apply until run off. • Allow treated surfaces to air dry, do not rinse.

Existing Plantings
Foliar and Tree Treatment: For control of Citrus Canker on Citrus Crops including but not limited to grapefruit, kumquat, lemons, limes, oranges and tangerines:

RATE – FOLIAR SPRAY	APPLICATION	NOTES
20 – 128 fl. oz. of OxiDate per 100 gallons of water. Complete coverage is essential..	• Begin applications of OxiDate prior to or in the early stages of disease development and continue throughout the season. • Spray at first appearance or when conditions are favorable for disease development. • Repeat applications at 7-day intervals.	• Spray diseased plants using OxiDate treatment solution for one to three consecutive days and continue treatments on five to seven day intervals. • Spray entire tree including trunk, branches, and leaf canopy. • Spray all areas where branches have been pruned, grafted or have become damaged or have apparent lesions or breaks in bark. • In groves with a history of disease pressure, use the stronger rate. • Typical applications use 30 to 100 gallons of spray solution per treated acre. • Before tank mixing OxiDate with other fertilizers, fungicides or bactericides, conduct a compatibility test for each combination. Make a test solution and shake or stir vigorously. Excessive bubbling and /or pressure are an indication of incompatibility. • Under severe disease conditions and during periods of wet, cloudy or rainy weather, apply immediately following each rain, reduce spray intervals and use stronger dilution rate. • Use sufficient water to obtain complete coverage. • OxiDate may be applied up to and including the day of harvest.

CUCURBIT APPLICATION INSTRUCTIONS

At-Planting Application
For control of Belly Rot, Root Rots, Fusarium Wilt, Pythium, Phytophthora and Rhizoctonia.

RATE	APPLICATION	NOTES
1/2 to 1 gallon of OxiDate per treated acre in 50 to 200 gallons of water.	• Make in-furrow applications just before seed is covered. • Make band applications to soil surface after seed is covered.	In fields with a history of disease pressure, use stronger rates.

Banded Application
For control of Belly Rot, Root Rots, Fusarium Wilt, Pythium, Phytophthora and Rhizoctonia.

RATE – SPRAY APPLICATION	APPLICATION	NOTES
1/3 to 1 gallon of OxiDate per 100 gallons of water.	• Apply OxiDate as a foliar spray with sufficient water to achieve runoff to soil when vines begin to run. • Repeat every seven days through infectious season.	• Typical applications use 30 to 100 gallons of spray per treated acre. During periods of wet, cloudy or rainy weather, use stronger rates and volumes, and reduce spray intervals. • Before tank mixing OxiDate with other fertilizers, fungicides or bactericides, conduct a compatibility test for each combination. Make a test solution and shake or stir vigorously. Excessive bubbling and/or pressure are an indication of incompatibility.
RATE – IRRIGATION APPLICATION	**APPLICATION**	**NOTES**
1/2 to 1 gallon of OxiDate per treated acre in 500 to 1000 gallons of water.	Apply through drip trickle, center pivot, lateral move, end tow, side wheel roll, traveler, solid set, hand move, or flood basin irrigation systems.	

Foliar Application
For control of Alternaria, Anthracnose, Downy Mildew, Gummy Stem Blight, Leaf Spot and Powdery Mildew.

RATE – SPRAY APPLICATION	APPLICATION	NOTES
1/3 to 1 gallon of OxiDate per 100 gallons of water. Complete coverage is essential.	• Begin applications of OxiDate prior to or in early stages of disease development and continue throughout the season. • Spray at first appearance or when conditions are favorable for disease development. • Repeat at 7-day intervals using sufficient water to obtain complete coverage.	• Before tank mixing OxiDate with other fertilizers, fungicides or bactericides, conduct a compatibility test for each combination. Make a test solution and shake or stir vigorously. Excessive bubbling and/or pressure are an indication of incompatibility. • Under severe disease conditions and during periods of rainy weather, apply immediately after each rain, reduce spray intervals, and use stronger dilution rates. • Do not spray OxiDate during conditions of intense heat, drought or poor vine canopy.
RATE – IRRIGATION APPLICATION	**APPLICATION**	**NOTES**
1/2 to 1 gallon of OxiDate per treated acre in 500 to 1000 gallons of water.	Apply through center pivot, lateral move, end tow, side wheel roll, traveler, solid set or hand move irrigation systems.	• Before tank mixing OxiDate with other fertilizers, fungicides or bactericides, conduct a compatibility test for each combination. Make a test solution and shake or stir vigorously. Excessive bubbling and/or pressure are an indication of incompatibility. • Do not spray OxiDate during conditions of intense heat, drought or poor vine canopy.

STRAWBERRY APPLICATION INSTRUCTIONS

Pre-Plant Dip or Spray Application
For control of Botrytis, Crown Rot and Powdery Mildew.

RATE	APPLICATION	NOTES
64 fl. oz. of OxiDate per 100 gallons of water.	Thoroughly wet transplants by dipping or spraying prior to planting.	• Excessive foaming or bubbling during the dipping process may be an indication of high levels of disease contamination. • Removal of dead or dying foliage prior to dipping is suggested. • Before tank mixing OxiDate with other fertilizers, fungicides or bactericides, conduct a compatibility test for each combination. Make a test solution and shake or stir vigorously. Excessive bubbling and/or pressure are an indication of incompatibility.

Setting Water Application
For control of Botrytis.

RATE	APPLICATION	NOTES
½ to 1 gallon of OxiDate in 50 to 200 gallons of water per treated acre.	Add OxiDate to transplant water or starter fertilizer and make in-furrow or dibble application at the time of plant set.	• OxiDate is chemically compatible with most water soluble fertilizers. • Before tank mixing OxiDate with other fertilizers, fungicides or bactericides, conduct a compatibility test for each combination. Make a test solution and shake or stir vigorously. Excessive bubbling and/or pressure are an indication of incompatibility.

At-Planting Foliar Application
For control of Powdery Mildew, Leaf Blight, Angular Leaf Spot, Crown Rot, and Botrytis.

RATE	APPLICATION	NOTES
40 to 128 fl. oz. of OxiDate per 100 gallons of water. Complete coverage is essential.	Immediately following planting, apply OxiDate as a foliar spray with sufficient water to achieve runoff to soil or plastic.	• Typical applications use 30 to 100 gallons of spray solution per treated acre. In fields with a history of disease pressure, use the high rate. • Before tank mixing OxiDate with other fertilizers, fungicides or bactericides, conduct a compatibility test for each combination. Make a test solution and shake or stir vigorously. Excessive bubbling and/or pressure are an indication of incompatibility.

Existing Plantings – Foliar and Crown Disease Control
For control of Powdery Mildew, Leaf Blight, Angular Leaf Spot, Crown Rot, and Botrytis.

RATE – FOLIAR SPRAY	APPLICATION	NOTES
40 to 128 fl. oz. of OxiDate per 100 gallons of water. Complete coverage is essential.	• Begin applications of OxiDate prior to or in the early stages of disease development and continue throughout the season. • Spray at first appearance or when conditions are favorable for disease development. • Repeat applications at seven-day intervals.	• Typical applications use 30 to 100 gallons of spray solution per treated acre. • Before tank mixing OxiDate with other fertilizers, fungicides or bactericides, conduct a compatibility test for each combination. Make a test solution and shake or stir vigorously. Excessive bubbling and/or pressure are an indication of incompatibility. • Under severe disease conditions, and during periods of rainy weather, apply immediately following each rain, reduce spray intervals, and use the stronger dilution rate. • Use sufficient water to obtain complete coverage. • OxiDate may be applied up to and including the day of harvest.

Botrytis Control on Existing Plantings

RATE – FOLIAR SPRAY	APPLICATION	NOTES
40 to 128 fl. oz. of OxiDate per 100 gallons of water. Complete coverage is essential.	• Apply OxiDate at the first growth flush. Repeat applications at 10% bloom, full bloom and at late or extended bloom. • Use additional sprays in late winter just after plant bed cleaning.	• Typical applications use 30 to 100 gallons of spray solution per treated acre. • Use sufficient water to obtain complete coverage. • Remove dead plant growth from the beds immediately prior to making OxiDate application. • Before tank mixing OxiDate with other fertilizers, fungicides or bactericides, conduct a compatibility test for each combination. Make a test solution and shake or stir vigorously. Excessive bubbling and/or pressure are an indication of incompatibility.

TOMATO AND PEPPER APPLICATION INSTRUCTIONS

Seed Treatment
For control of Bacterial Speck and Bacterial Spot.

RATE	APPLICATION	NOTES
1:100 or 1 gallon of OxiDate to 100 gallons of water.	If seed has not been treated by the seed company, immerse seed in the OxiDate solution for one minute, remove seed and allow to drain.	Rinsing of the seed after application is not required.

Seedling Production Treatment
For control of Bacterial Speck, Bacterial Spot, Damping-Off Pythium, Early Blight, Late Blight, and Phytophthora.

RATE AT SEEDING	APPLICATION	NOTES
½ to 1¼ fl. oz. of OxiDate per gallon of water.	Apply one application of OxiDate to the point of saturation.	Apply on newly seeded plug trays, seed flats, or beds with the initial watering.
RATE FOR POST-EMERGENCE	**APPLICATION**	**NOTES**
½ fl. oz. of OxiDate per gallon of water.	Apply OxiDate at the 2 to 4 true leaf stage as a foliar spray with sufficient water to achieve complete coverage.	Repeat at seven-day intervals.

At-Planting Application
For control of Early Blight, Late Blight, Phytophthora, and Pythium.

RATE	APPLICATION	NOTES
½ to 1 gallon of OxiDate per treated acre in 50 to 200 gallons of water.	Add OxiDate to transplant water or starter fertilizer and make in-furrow or dibble application just prior to plant set.	• In fields with a history of disease pressure, use the high rate. • Before tank mixing OxiDate with other fertilizers, fungicides, or bactericides, conduct a compatibility test for each combination. Make a test solution and shake or stir vigorously. Excessive bubbling and/or pressure are an indication of incompatibility.

Surface Application
For control of Early Blight, Late Blight, Phytophthora, and Pythium.

RATE – SPRAY APPLICATION	APPLICATION	NOTES
⅓ to 1 gallon of OxiDate per 100 gallons of water.	• Apply OxiDate as a foliar spray with sufficient water to achieve runoff to soil. • Repeat applications every seven days through infectious season.	• Typical applications use 30 to 100 gallons of spray solution per treated acre. • During periods of wet, cloudy, or rainy weather, use stronger rates and volumes and reduce spray intervals.
RATE – IRRIGATION APPLICATION	**APPLICATION**	**NOTES**
½ to 1 gallon of OxiDate per treated acre in 500 to 1000 gallons of water.	Apply through drip trickle, center pivot, lateral move, end tow, side wheel roll, traveler, solid set, hand move, or flood irrigation systems.	

Foliar Application
For control of Anthracnose, Bacterial Speck and Spot, Botrytis, Early Blight, Late Blight, Powdery Mildew, and Rhizoctonia Fruit Rot.

RATE – SPRAY APPLICATION	APPLICATION	NOTES
⅓ to 1 gallon of OxiDate per 100 gallons of water. Complete coverage is essential.	• Begin applications of OxiDate prior to or in early stages of disease development and continue throughout the season. • Spray at first appearance or when conditions are favorable for disease development. • Repeat applications at seven-day intervals.	• Under severe disease conditions and during periods of rainy weather, apply immediately after each rain, reduce spray intervals, and use the stronger dilution rate. • Use sufficient water to obtain complete coverage. • Before tank mixing OxiDate with other fertilizers, fungicides or bactericides, conduct a compatibility test for each combination. Make a test solution and shake or stir vigorously. Excessive bubbling and/or pressure are an indication of incompatibility.
RATE – IRRIGATION APPLICATION	**APPLICATION**	**NOTES**
½ to 1 gallon of OxiDate per treated acre in 500 to 1000 gallons of water.	Apply through center pivot, lateral move, end tow, side wheel roll, traveler, solid set, or hand move irrigation systems.	• Do not spray OxiDate during conditions of intense heat, drought, or poor vine canopy.

CHEMIGATION
General Requirements:

1) Apply this product only through a drip system or sprinkler including center pivot, lateral move, end tow, side (wheel) roll, traveler, big gun, solid set, hand move, flood (basin), furrow, border, or drip (trickle) irrigation systems. Do not apply this product through any other type of irrigation system.
2) Crop injury, lack of effectiveness, or illegal pesticide residues in the crop can result from non-uniform distribution of treated water.
3) If you have questions about calibration, you should contact State Extension Service specialists, equipment manufacturers or other experts.
4) Do not connect an irrigation system (including greenhouse systems) used for pesticide application to a public water system unless the pesticide label-prescribed safety devices for public water systems are in place.
5) A person knowledgeable of the chemigation system and responsible for its operation, or under the supervision of the responsible person, shall shut the system down and make necessary adjustments should the need arise.
6) Posting of areas to be chemigated is required when 1) any part of a treated area is within 300 feet of sensitive areas such as residential areas, labor camps, businesses, day care centers, hospitals, in-patient clinics, nursing homes or any public areas such as schools, parks, playgrounds, or other public facilities not including public roads, or 2) when the chemigated area is open to the public such as golf courses or retail greenhouses.
7) Posting must conform to the following requirements. Treated areas shall be posted with signs at all usual points of entry and along likely routes of approach from the listed sensitive areas. When there are no usual points of entry, signs must be posted in the corners of the treated areas and in any other location affording maximum visibility to sensitive areas. The printed side of the sign should face away from the treated area towards the sensitive area. The signs shall be printed in English. Signs must be posted prior to application and must remain posted until foliage has dried and soil surface water has disappeared. Signs may remain in place indefinitely as long as they are composed of materials to prevent deterioration and maintain legibility for the duration of the posting period.
8) All words shall consist of letters at least 2.5 inches tall, and all letters and the symbol shall be a color which sharply contrasts with their immediate background. At the top of the sign shall be the words KEEP OUT, followed by an octagonal stop sign symbol at least 8 inches in diameter containing the word STOP. Below the symbol shall be the words PESTICIDES IN IRRIGATION WATER.

Specific Requirements for Chemigation Systems Connected to Public Water Systems:

1) Public water system means a system for the provision to the public of piped water for human consumption if such system has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year.
2) Chemigation systems connected to public water systems must contain a functional, reduced-pressure zone, backflow preventer (RPZ) or the functional equivalent in the water

supply line upstream from the point of pesticide introduction. As an option to the RPZ, the water from the public water system should be discharged into a reservoir tank prior to pesticide introduction. There shall be a complete physical break (air gap) between the outlet end of the fill pipe and the top or overflow rim of the reservoir tank of at least twice the inside diameter of the fill pipe.

3) The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump.
4) The pesticide injection pipeline must contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.
5) The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops, or in cases where there is no water distribution is adversely affected.
6) Systems must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump) effectively designed and constructed of materials that are compatible with pesticides and capable of being fitted with a system interlock.
7) Do not apply when wind speed favors drift beyond the area intended for treatment.

Specific Requirements for Sprinkler Chemigation:

1) The system must contain a functional check valve, vacuum relief valve and low-pressure drain appropriately located on the irrigation pipeline to prevent water source contamination from backflow.
2) The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump.
3) The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.
4) The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops.
5) The irrigation line or water pump must include a functional pressure switch which will stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected.
6) Systems must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump) effectively designed and constructed of materials that are compatible with pesticides and capable of being filled with a system interlock.
7) Do not apply when wind speed favors drift beyond the area intended for treatment.

Specific Requirements for Flood (Basin), Furrow, and Border Chemigation:

1) Systems using a gravity flow pesticide dispensing system must meter the pesticide into the water at the head of the field and downstream of a hydraulic discontinuity such as a drop structure or weir box to decrease potential for water source contamination from backflow if water flow stops.
2) The systems utilizing a pressurized water and pesticide injection system must meet the following requirements:

a. The system must contain a functional check valve, vacuum relief valve, and low-pressure drain appropriately located on the irrigation pipeline to prevent water source contamination from backflow.
b. The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump.
c. The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.
d. The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops.
e. The irrigation line or water pump must include a functional pressure switch which will stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected.
f. Systems must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump) effectively designed and constructed of materials that are compatible with pesticides and capable of being filled with a system interlock.

Specific Requirements for Drip (Trickle) Chemigation:

1) The system must contain a functional check valve, vacuum relief valve, and low-pressure drain appropriately located on the irrigation pipeline to prevent water source contamination from backflow.
2) The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump.
3) The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.
4) The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops.
5) The irrigation line or water pump must include a functional pressure switch which will stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected.
6) Systems must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump) effectively designed and constructed of materials that are compatible with pesticides and capable of being filled with a system interlock.

Application Instructions:

1) Remove scale, pesticide residues, and other foreign matter from the chemical supply tank and entire injector system. Flush with clean water. Failure to provide a clean tank, void of scale or residues may cause product to lose effectiveness or strength.
2) Determine the treatment rates as indicated in the directions for use and make proper dilutions.
3) Prepare a solution in the chemical tank by filling the tank with the required water and then adding product as required. The product will immediately go into suspension without any required agitation.
4) Do not apply OxiDate in conjunction with any other pesticides or fertilizers; this has the potential to cause reduced performance of the product. Avoid application in this manner.

STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage or disposal.

PESTICIDE STORAGE: Store in original containers in a cool, well-vented area, away from direct sunlight. Do not allow product to become overheated in storage. This may cause increased degradation of the product, which will decrease product effectiveness. In case of spill, flood area with large quantities of water. Do not store in a manner where cross-contamination with other pesticides or fertilizers could occur.

PESTICIDE DISPOSAL: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility. Open dumping is prohibited. If wastes cannot be disposed of according to label directions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste Representative at the nearest EPA Regional Office for guidance.

CONTAINER DISPOSAL: Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

WARRANTY: This material conforms to the description on the label and is reasonably fit for the purposes referred to in the directions for use. Timing, method of application, weather, watering practices, nature of soil, potting medium, disease problem, condition of crop, incompatibility with other chemicals, pre-existing conditions and other conditions influencing the use of this product are beyond the control of the seller. Buyer assumes all risks associated with the use, storage, or handling of this material not in strict accordance with directions given herewith. NO OTHER EXPRESS OR IMPLIED WARRANTY OF FITNESS OR MERCHANTABILITY IS MADE.

NOTES:

BioSafe Systems L.L.C.

For additional information on OxiDate® Broad Spectrum Bactericide/Fungicide
call us toll-free at 1.888.273.3088 or visit www.biosafesystems.com

OxiDate®

Broad Spectrum Bactericide/Fungicide

MATERIAL SAFETY DATA SHEET

1. IDENTIFICATION

Product Name: OxiDate®
Product Type: Bactericide/Fungicide
Manufacturer:
BioSafe Systems LLC
36 Commerce St, Glastonbury, CT 06033
Creation Date: 09/05
NOTE: Not valid two years after creation date.

EPA Registration No. 70299-2
EPA Establishment No. 60156-IL-001
Patent # 5723406

2. HAZARDOUS COMPONENTS

Peroxyacetic Acid 79-21-0
Hydrogen Dioxide 7722-84-1

3. HEALTH HAZARDS DATA

Health effects to over exposure to CONCENTRATE:

- Corrosive to mucous membranes, eyes and skin.
- The seriousness of the lesions and the prognosis of intoxication depend directly on the concentration and duration of exposure.

Skin: May cause TEMPORARY skin discoloration and irritation.
Eyes: May cause severe eye damage.
If swallowed: HARMFUL OR FATAL: Causes chemical burns of mouth, throat and stomach.

- Corrosive to gastrointestinal tract
- Paleness and cyanosis of the face
- Excessive fluid in the mouth and nose
- Bloating of stomach and belching
- Nausea and vomiting
- Risk of chemical pneumonitis and pulmonary edema

If inhaled: Vapors or mist can cause irritation. People with asthma or other lung problems may be more affected.

4. FIRST AID

General recommendations:

- In case of product splashing in eyes, treat eyes first
- Submerge soiled clothing in water
- Contact physician in all cases

Eyes: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.
Skin: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.
If swallowed: Call poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by the poison control center or doctor. Do not give anything by mouth to an unconscious person.
If inhaled: Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. Call poison control center or doctor for treatment advice.
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1.800.222.1222 for emergency treatment information.

NOTE TO PHYSICIAN: Probable mucosal damage may contraindicate the use of gastric lavage.

5. FIRE AND EXPLOSION DATA

Special fire hazards: Product (concentrate) can decompose and will release oxygen thereby adding to the fire hazard.
Fire fighting methods: Product is not flammable and can be quickly diluted with clean water.
Oxidizing Agent may cause spontaneous ignition with oxidizing agents.

6. SPILL OR LEAK PROCEDURES

Cleanup: Rinse small amounts to drain when possible. Dike or dam large spills, pump to containers or soak in inert absorbent. Flush residue to sanitary sewer, rinse area thoroughly with clean water.
Avoid materials that are incompatible with concentrate.
Waste Disposal: Consult state and local authorities for restrictions on disposal of chemical wastes. Unused product (concentrate) is classified as a (D002) by RCRA criteria.

7. HANDLING AND STORAGE

- Never return product back to the original container
- Keep concentrate away from reactive substances
- Prevent contact with organic materials
- Keep product in original container
- Store in cool, ventilated area
- Keep out of direct sunlight
- Never use metal containers or spigots
- Use vented container
- Warn personnel of dangers of concentrated product

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Respiratory: Avoid breathing mists or vapors of concentrate.
Eyes: Use chemical splash goggles when handling concentrate. For continued severe exposure, wear a face shield over the goggles.
Skin: Rubber gloves - protective or gauntlet type preferred when handling concentrate. Use aprons.
ACGIH TLV: 1 PPM 8 HOUR TWA
1.4 mg/m^3 TWA
OSHA PEL: 1 PPM 8 HOURS TWA
1.4 mg/m^3 TWA
Respiratory protection:

- NIOSH approved full-face respirator for excessive conditions
- Hand gloves for handling concentrate = butyl rubber
- Eye protection - chemical proof goggles/face shield for splash risk
- Skin protection - coveralls when handling concentrate

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance: Clear, colorless liquid
Odor: Pungent
Freezing Point: -30°C (-22°F)
Boiling Point: Not applicable, product decomposes
Specific gravity: 1.09
pH: 1.33
Solubility: Complete
Decomposition temperature: self-accelerating decomposition temperature > 55°C

10. STABILITY AND REACTIVITY

Stability: Stable under normal conditions, with slow oxygen release
Conditions to avoid: Heat / Direct Sunlight
Materials to avoid: · Acids · Bases · Reducing Agents · Organic Materials · Metals · Salts of Metals

11. TOXICOLOGICAL INFORMATION

Acute Toxicology:

- Oral route, LD50, rat 330 mg/kg. Test substance: 7% solution
- Dermal route, LD50 rabbit, 1410 mg/kg. Test substance: 10% solution
- Inhalation, LD50, four hours, rat 4080 mg/kg. Test substance: 5% solution

Irritation:

- Rabbit, corrosive (eyes). Test substance: 4% solution
- Rabbit, corrosive (skin). Test substance: 5% solution
- Rat, irritant (respiratory tract)

Chronic Toxicity:

- Dermal = >0.12% solution, irritating effect
- Inhalation = > 5 mg/m^3, irritant

OxiDate®
Broad Spectrum Bactericide/Fungicide

MATERIAL SAFETY DATA SHEET

- Route of entry = Inhalation / ingestion

12. ECOLOGICAL INFORMATION

Toxic to simple cell and aquatic organisms.
Danger to the environment limited due to product properties.

- No bioaccumulation
- Soil degradation = 99% in 20 minutes
- Considerable abiotic and biotic degradability
- Sediments = Non-significant adsorption
- Weak persistence of degradation products
- Degradation products = water & oxygen

Acute Ecotoxicity:

- Fish, Rainbow trout LC50, 48 hours > 40 mg/L
- Crustaceans, EC 50,48 hours 126.8 mg/L 1 mg/ L
- Bacteria, Pseudomonas aeruginosa, EC 100, 5 minutes, 5mg/L

13. DISPOSAL CONSIDERATIONS

- Store in original containers in a cool, well-vented area, away from direct sunlight. Do not allow product to become overheated in storage. This may cause increased degradation of the product, which will decrease product effectiveness. In case of spill, flood area with large quantities of water. Do not store in a manner where cross-contamination with other pesticides or fertilizers could occur.
- Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility. Open dumping is prohibited. If wastes cannot be disposed of according to label directions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste Representative at the nearest EPA Regional Office for guidance.
- Triple rinse (or equivalent). Then offer for recycling or dispose in a sanitary landfill, or incineration, if allowed by state and local authorities by burning. Stay out of smoke.

14. TRANSPORT INFORMATION

DOT Shipping Name: Hydrogen Peroxide and peroxyacetic acid mixture, stabilized, not more than 5% Peroxyacetic acid.
UN Number: 3149
Hazard Class: 5.1
Primary Hazard Label: Oxidizer
Subsidiary Risk Label: Corrosive
Packing Group: II
Shipping Container: UN Certified vented polyethylene. 2.5, 5, 30, 55 and 275 gallon polyethylene drums

Regulatory Information

TSCA Inventory List: YES
CERCLA Hazardous Substance (40 CFR 302)
Listed substance: NO
Unlisted Substance: YES
Characteristic: Corrosive
Reportable Quantity: 100 pounds
NFPA Rating Health – 2 Flammability – 0 Reactivity – 3 Special – OXY
HMIS Rating Health – 2 Flammability – 0 Reactivity – 2 PPE - Required
Canadian WHMIS Classification
C – Oxidizing E – Corrosive F – Dangerously Reactive

BioSafe Systems L.L.C.
1.888.273.3088
www.biosafesystems.com

OxiDate®
Broad Spectrum Bactericide/Fungicide

Specimen Label and MSDS: *Label Updates*

Tank Mixing with OxiDate
Before tank mixing with fertilizers, fungicides, or bactericides, conduct a compatibility test for each combination. Make a test solution and shake or stir vigorously. Excessive bubbling and or pressure are indications of incompatibility.

Mixing Instructions

1. Fill spray tank half way with water
2. Add OxiDate
3. Continue filling and add other chemistries

Reduced Spray Volumes
Now 30 to 100 Gallons per Acre

Crops Added

- Lima Beans
- Peas
- Soy Bean
- Green Onions
- Shallots
- Horseradish

Diseases Added
Grey Leaf Spot on Grasses
Powdery Mildew on Sugar Beets

For foot bath mats: make a solution using 3/4 fl. oz. of OxiDate per gallon of water and fill foot bath mat to capacity. Change solution as needed.

For contained waters: To suppress, control and prevent algae and cyanobacteria in contained waters such as Ponds, Lakes, Lagoons, Irrigation Ponds, Golf Course Ponds, Farm Ponds, Fish Ponds, Fish Hatcheries, Impounded Waters, Bilge Water, Reservoirs, Waterways, Conveyance Ditches, Canals, Laterals, Drainage Systems, Watering Tanks, Storage Tanks. Waters treated with OxiDate are permissible to be used without interruption.

For agricultural spray irrigation and drainage water and ditches: Use OxiDate to suppress/control algae, bacteria and fungi in agricultural irrigation and drainage water and ditches.

For water filter, water filter media, membranes and related components and systems treatment: To suppress, control and prevent clogging of filters from growth of plant pathogenic algae, bacteria or fungi, as well as the oxidation of iron deposits. For reduction and removal of bio-organisms on the surfaces of filter and membrane media, media housings, related devices and equipment, or for Clean in Place (CIP) systems.

Partial List of Field-Tested Chemistries that can be Tank-Mixed with OxiDate:

• Bravo	• Co-Ron	• Kumulas Sulfur	• Mankocide	• Procure	• Vydate
• Cal-Bor	• Cuprofix	• Kocide	• Microplex	• Switch	• Xentari
• Captec	• Dithane	• Lannate	• Penncozeb	• Topsin	
• Champ	• Elevate	• Manex	• Prev-Am	• TriBasic	

Always refer to container labels. This is intended as a guide, not a complete listing of compatible products. Please call BioSafe Systems with any questions before beginning. Be sure to test for compatibility before using. (We have not tested all insecticides for their compatibility with OxiDate.)

OxiDate®

Broad Spectrum Bactericide/Fungicide

FEATURES AND BENEFITS

- Zero Days to Harvest
- Exempt from Pesticide Residue
- OMRI Listed for Use in Organic Production
- No Mutational Resistance
- Zero-Hour Restricted Entry Interval (Four-Hour REI in California)

WHAT IS OXIDATE?

OxiDate is a broad-spectrum bactericide/fungicide treatment for the prevention and control of plant pathogenic diseases in field-grown crops and commercial greenhouses.

WHAT IS THE ACTIVE INGREDIENT?

27% Hydrogen Dioxide

WHAT IS HYDROGEN DIOXIDE?

The Hydrogen dioxide in OxiDate, is an engineered molecule, which combines peroxide with a per-acid (an acid with extra Oxygen on it) to form a dioxide. Dioxides are extremely effective anti-microbials because they are highly reactive oxidizers. The inherent problem is that without proper stabilization, dioxides tend to break down immediately upon formulation. OxiDate is formulated with proprietary stabilizers and buffers, which slow down and focus the chemical reaction to be most reactive with proteins and enzymes.

HOW TO USE OXIDATE:

OxiDate kills fungus and bacteria on contact, stopping an infection in its tracks.

- *Quick knock down*
- *Population control*
- *Resistance management tool*
- *Ideal tank mix partner for residual chemistries (See label for mixing instructions)*

MODE OF ACTION:

OxiDate uses an oxidation chemical reaction to kill bacteria and fungus. More specifically, OxiDate reacts with the enzymes and proteins that make up simple cell organisms on contact.

APPLICATION:

Foliar spray. Sufficient volume and pressure should be used to ensure full coverage.

WHAT IS THE RATE FOR OXIDATE?

The rates for OxiDate are expressed in dilution ratios. The reason for this is tied to the mode of action, which requires contact with the plant surface being treated. The strength of the chemical reaction is critical to assuring effectiveness. Experience has shown that if spray volumes are less than 50 gallons per acre, the concentrate should be at the stronger end of the range (1 gallon per 100 gallons). Spray volumes of 50 gallons or more can be applied using the 1/3 to 1 gallon per 100 gallons range. If disease pressure is high, you should be at the higher end of the range. Be careful giving a rate per acre unless you know the spray volume per acre ahead of time. *(See OxiDate Application Instructions)*

CAN I TANK MIX OXIDATE?

OxiDate has been shown to be chemically compatible with a number of chemicals. However, do not mix OxiDate concentrate with undiluted fertilizers or pesticides. Dilute OxiDate with water then add liquid fertilizers and pesticides. Before tank mixing OxiDate with fertilizers, fungicides or bactericides, conduct a compatibility test of each combination. Make a test solution per manufacturer's label in a container, close the lid and shake or stir vigorously. Excessive bubbling and/or increased pressure are an indication of incompatibility. *NOTE: OxiDate should not be tank mixed or applied in a spray solution with metal-based chemistries having a pH less than 7.0. (See OxiDate Directions for Use)*

(Continued on back)

HOW "SAFE" IS OXIDATE:

OxiDate is OMRI listed for use in organic production, has a zero-hour REI (four-hour REI in California), and there is no bioaccumulation in tissue or the environment. The dilute working solution of OxiDate does not require the use of eye protection or respirator by applicators or handlers.

OxiDate concentrate carries a "Danger" signal word. The dangers associated with OxiDate relate to the concentrated solution. The concentrate is corrosive and a strong oxidizer. These dangers can be minimized by the proper use of protective eyewear, gloves, and coveralls. Skin contact with the concentrate may cause temporary discoloration and irritation. Eye contact with the concentrate may cause severe eye damage. When handling the concentrate wear protective eyewear (goggles or face shield) and rubber gloves. *(See OxiDate Supplemental Label)*

PHYSICAL PROPERTIES:

Clear Colorless Liquid

WHAT SIZES DOES OXIDATE COME IN AND HOW MANY ARE ON A PALLET?

2.5 gallon:	75 per pallet
5 gallon:	32 per pallet
30 gallon:	5 per pallet
55 gallon:	4 per pallet
275 gallon:	1 per pallet

Freight is included on all pallet quantity orders shipped to locations in the continental USA.

WHAT CROPS ARE ON THE OXIDATE LABEL?

- Asparagus
- Bananas
- Plantains
- Beans
  - Snap & Dry
- Berries
  including but not limited to:
  - Blackberry
  - Blueberry
  - Cranberry
  - Raspberry
  - Strawberry
- Celery
- Citrus Crops
  including but not limited to:
  - Grapefruit
  - Kumquat
  - Lemon
  - Orange
  - Tangerine
- Cole Crops
  including but not limited to:
  - Broccoli
  - Brussels Sprouts
  - Cabbage
  - Cauliflower
  - Collards
- Cucurbit Crops
  including but not limited to:
  - Cucumber
  - Melons
  - Pumpkin
  - Squash
- Filberts
- Garlic
- Leeks
- Onions
- Shallots
- Grapes
- Grasses Grown for Seed or Sod
- Herbs and Spices
  including but not limited to:
  - Basil
  - Chives
  - Cilantro
  - Coriander
  - Dill
  - Mint
  - Rosemary
  - Sage
- Leafy Vegetables
- Mushrooms
- Peanuts
- Peppers
- Pome Fruits
  including but not limited to:
  - Apples
  - Pears
- Potatoes
- Potatoes (Seed)
- Root Crops
  including but not limited to:
  - Beets
  - Carrots
  - Ginseng
  - Sweet Potato
  - Yams
- Stone Fruits
  including but not limited to:
  - Cherries
  - Nectarines
  - Peaches
  - Plums
  - Prunes
- Tobacco (Field)
- Tobacco (Float Beds)
- Tomatoes
- Tropical Fruits
  including but not limited to:
  - Casaba
  - Coconut
  - Dates
  - Guava
  - Kiwi
  - Mango
  - Passion Fruit
  - Pineapple
  - Poi
  - Star Fruit

OMRI™ Listed
Organic Materials Review Institute

For more information, contact:

BioSafe Systems L.L.C. 1.888.273.3088 (toll free) • www.biosafesystems.com

OxiDate For Disease Control

Proven to be Fast and Effective on Grapes & Vines.



OxiDate®

Broad Spectrum Bactericide/Fungicide

- Sulfur Alternative, No Residues
- Works On Contact
- Zero Days to Harvest
- Zero-Hour REI (4-Hours in California)
- Exempt From Pesticide Tolerances
- Will Not Affect Fruit or Sugar Content
- No Mutational Resistance

OMRI Listed
Organic Materials Review Institute

"What I like most about OxiDate is that I can apply it right up to the day of harvest. Late in the season I'm limited to what I can spray, especially in wet conditions.

I can spray OxiDate right on the fruit clusters to kill any disease and then continue harvesting. In an area where pesticides and water run-off are very regulated, OxiDate is a perfect fit."

Tom Stevenson, Vineyard Manager,
Osprey's Dominion Vineyards

Call your Local Distributor to Place your Order.

1.888.273.3088 toll-free www.biosafesystems.com

StorOx®

Broad Spectrum Bactericide/Fungicide

SPECIMEN LABEL AND MSDS

A treatment for the prevention and control of plant pathogenic diseases on crops after harvest.

A treatment for the prevention and control of plant pathogenic diseases on surfaces, equipment and structures used in processing postharvest commodities.

FOR AGRICULTURAL
AND COMMERCIAL USE ONLY

ACTIVE INGREDIENT:

Hydrogen Dioxide: 27%
INERT INGREDIENTS: 73%
TOTAL: 100%

KEEP OUT OF REACH OF CHILDREN
DANGER – PELIGRO
Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle.

(If you do not understand this label, find someone to explain it to you in detail.)

FIRST AID

IF IN EYES: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.

IF ON SKIN OR CLOTHING: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

IF SWALLOWED: Call poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by the poison control center or doctor. Do not give anything by mouth to an unconscious person.

IF INHALED: Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. Call poison control center or doctor for treatment advice.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment.

NOTE TO PHYSICIAN: Probable mucosal damage may contraindicate the use of gastric lavage.

Sold by: BioSafe Systems LLC
22 Meadow Street
East Hartford, CT 06108
1.888.273.3088
www.biosafesystems.com
EPA Registration No. 70299-2
EPA Establishment No. 60156-IL-001
Net Contents: 5, 30, 55 and 275 gallons

PRECAUTIONARY STATEMENTS
HAZARDS TO HUMAN AND DOMESTIC ANIMALS – DANGER:
CORROSIVE. Concentrate causes irreversible eye damage. Concentrate may be fatal if swallowed or absorbed through skin. Concentrate causes skin burns or temporary discoloration on exposed skin. Do not breathe vapor of concentrate. Do not get concentrate in eyes, on skin or on clothing. Wear protective eyewear such as goggles or face shield. Wash thoroughly with soap and water after handling. Remove and wash contaminated clothing before reuse.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

When handling concentrate wear protective eyewear (goggles or face shield) and rubber gloves. Applicators and handlers must wear coveralls over long-sleeved shirt, long pants, and chemical resistant footwear plus socks. Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions exist for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

USER SAFETY RECOMMENDATIONS

Users should wash hands thoroughly with soap and water before eating, drinking, chewing gum, using tobacco or using the toilet. Users should remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing. Remove PPE immediately after

handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

ENVIRONMENTAL HAZARDS

This pesticide is toxic to birds and fish. Do not contaminate water when disposing of equipment washwaters or rinsate. Exposed treated seed may be hazardous to birds and other wildlife. Dispose of all excess treated seed and seed packaging by burial away from bodies of water.

This product is highly toxic to bees and other beneficial insects exposed to direct contact on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds while bees are actively visiting the treatment area. Do not apply this product or allow it to drift to crops where beneficials are part of an Integrated Pest Management strategy.

PHYSICAL AND CHEMICAL HAZARDS

Corrosive. Strong oxidizing agent. Do not use in concentrated form. Mix only with water in accordance with label instructions. Never bring concentrate in contact with other pesticides, cleaners or oxidative agents.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling. Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation.

AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR Part 170. This standard contains requirements for the protection of agricultural workers on farms, forests, nurseries and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about Personal Protective Equipment (PPE) and Restricted-Entry Interval (REI). The requirements in this box only apply to the uses of this product that are covered by the Worker Protection Standard.

For enclosed environments: There is a restricted entry of one (1) hour for this product when applied via fogging or spraying to growing plants, surfaces, equipment, structures and non-porous surfaces in enclosed environments such as glasshouses and greenhouses. PPE requirement for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil or water, is coveralls, waterproof gloves and shoes plus socks.

There is a restricted entry of zero (0) hours for pre-plant dip, soil drench, mop, sponge, dip, soak, rinse or other non-spraying or fogging application methods when used in enclosed environments such as glasshouses or greenhouses.

For field applications: Keep unprotected persons out of treated areas until sprays have dried.

Non-Agricultural Use Requirements

The requirements in this box apply to uses of this product that are **not** within the scope of the Worker Protection Act Standard for agricultural pesticides (40 CFR Part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries or greenhouses.

Keep unprotected persons out of treated areas until sprays have dried.

STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage or disposal.

PESTICIDE STORAGE: Store in original containers in a cool, well-vented area, away from direct sunlight. Do not allow product to become overheated in storage. This may cause increased degradation of the product, which will decrease product effectiveness. In case of spill, flood area with large quantities of water. Do not store in a manner where cross-contamination with other pesticides or fertilizers could occur.

PESTICIDE DISPOSAL: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility. Open dumping is prohibited. If wastes cannot be disposed of according to label directions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste Representative at the nearest EPA Regional Office for guidance.

CONTAINER DISPOSAL: Triple rinse (or equivalent). Then offer for recycling or dispose in a sanitary

landfill, or incineration, if allowed by state and local authorities by burning. Stay out of smoke.

DIRECTIONS FOR USE:
StorOx works best when diluted with water containing low levels of organic or inorganic materials, a nd with water having a neutral pH. Thoroughly rinse out tank with water before mixing concentrate. StorOx will readily mix with clean, neutral water and does not require agitation.

StorOx works by surface contact with the plants and materials being treated. It is important to ensure that all surfaces are thoroughly wetted. StorOx does not produce any visible residue, distinct odor or deleterious effects to plants or to postharvest commodities when used in accordance with label directions. Do not use at stronger than suggested dilution rates as leaf burn may result.

Do not apply this product through any irrigation system unless directed by the label; refer to Chemigation Directions for Use.

APPLICATION DIRECTIONS

For surfaces, equipment and structures:
Use StorOx to suppress/control bacteria, fungi and slime-forming algae on surfaces, equipment and structures such as: plastic, benches, walkways, floors, walls, fan blades, watering systems, vats, tanks, coolers, storage rooms, bins, elevators, storage areas, spray equipment, conveyors, irrigation systems, process equipment, process water systems, trucks, structures and related equipment. Follow treatment of any food contact surfaces, equipment or structures with a potable water rinse.

1) Sweep and remove all debris. Use power sprayer to wash all surfaces to remove loose dirt and/or organic material.

2) Use a dilution of 1:100 – 1:300 or 1¼ fl. oz. – ½ fl. oz. of StorOx per gallon of clean water. Use a dilution of 1:50 or 2½ fl. oz. per gallon of clean water if surfaces that are to be treated have not been pre-cleaned with water to remove organic deposits. The use of additional surfactant is acceptable.

3) Apply solution with mop, sponge, power sprayer or fogger to thoroughly wet all surfaces.

   Fog enclosed areas as an adjunct to manual surface application. Wear protective eyewear (goggles or face shield) when fogging. Prior to fogging, surfaces should be pre-cleaned with water to remove any organic deposits. Fog the desired areas using dilution rates of 1:100 – 1:300, or 1¼ fl. oz. – ½ fl. oz. of StorOx, using any type of fogging equipment including but not limited to cold foggers, thermal foggers, low pressure air assisted and high pressure fog systems. Solutions are corrosive to materials that are easily oxidized such as natural rubber, copper, galvanized and black iron pipe. Test solutions on surfaces prior to use.

4) Follow treatment of any food contact surfaces, equipment or structures with a potable water rinse.

5) Scrub off heavy growths of algae and fungi following application. Use a solution of StorOx to wash away dead growth.

6) Reapply as often as needed for control.

For foot bath mats:
Make a solution using ¾ fl. oz. of StorOx per gallon of water and fill foot bath mat to capacity. Change solution as needed.

Surface Treatment for the control of Citrus Canker:
Use StorOx to control and prevent the transfer of *Xanthomonas* bacterial species including Citrus Canker on field equipment and surfaces in packinghouses.

1) Remove loose soil or organic matter with clean water and/or detergent rinse.

2) Use StorOx at a dilution ratio of 1:600 to 1:800 or 21.3 fl. oz. to 16.00 fl. oz. of StorOx per 100 gallons of water. Apply as a coarse spray until runoff.

3) Allow StorOx treated surfaces to air dry. Do not rinse.

Packinghouses:
Apply StorOx to all surfaces and equipment found in commercial packinghouses including, dump tanks, drenches, crates, containers, conveyors, storages, walls, floors, and process lines.

Foaming Applications:
Apply StorOx as a foam treatment to enhance contact on porous surfaces, vertical surfaces and irregular surfaces such as metal grating and structural steel where contact is difficult to maintain with coarse spray treatments. Add a foaming agent to the spray tank that contains the diluted StorOx solution. Apply foam until the surface treated is completely covered. Allow foam treated surface to air dry. Do not rinse.

For clean, non-porous surfaces:
Pots, Flats, Trays:
Use a dilution of 1:100 - 1:300 or 1¼

fl. oz. - ½ fl. oz. of StorOx per gallon of clean water. Spray until runoff. The use of additional surfactant is acceptable.

Cutting Tools:
Use a dilution of 1:100 - 1:300 or 1¼ fl. oz. - ½ fl. oz. of StorOx per gallon of clean water. Soak tools to ensure complete coverage. The use of additional surfactant is acceptable.

Benches and Work Areas:
Sweep and remove all plant debris. Use power sprayer to wash all surfaces to remove loose dirt. Use a dilution of 1:100 - 1:300 or 1¼ fl. oz. - ½ fl. oz. of StorOx per gallon of clean water. Use a dilution of 1:50 or 2½ fl. oz. of StorOx per gallon of clean water if surfaces that are to be treated have not been pre-cleaned with water to remove organic deposits. The use of additional surfactant is acceptable.

Treatment for nonpotable water systems (wash tanks, dip tanks, drench tanks, evaporators, humidification systems and/or storage tanks):
Treat water containing plant pathogens with 1½ fl. oz. of StorOx for every 10 gallons of water or use a dilution rate of 1:2000.

For direct injection into spray waters used on process lines:
Treat water containing plant pathogens by injecting StorOx directly into spray system water with 12.8 fl. oz. of StorOx for every 100 gallons of water or use a dilution rate of 1:1000. Applicable for use on all types of postharvest commodities.

For postharvest spray treatment on process and packing lines:
Inject StorOx directly into spray system water on process and packing lines for bacterial and fungal diseases on postharvest fruits and vegetables. Inject at 1:100 – 1:1,000 StorOx to clean water. For best results, where dump tanks are used, make postharvest spray treatment as fruit is leaving dump tanks. Applicable for use on all types of postharvest commodities.

For postharvest spray treatment:
Use StorOx to prevent bacterial and fungal diseases on postharvest fruits and vegetables. Mix 1¼ – ½ fl. oz. of StorOx per gallon of clean water. Spray fruit or vegetables to runoff using hydraulic, backpack, air-assisted or other similar sprayer or foamer.

For direct injection into dump tanks, hydro coolers and process waters:
For treatment of water containing plant pathogens, inject StorOx and maintain a predetermined residual level by using metering equipment, coupled with ORP measuring probes.

1) Determine biological loading prior to treatment if possible.

2) For waters that contain low levels of biological and organic loading inject StorOx at 2½ fl. oz. – 1¼ fl. oz. of StorOx for every 100 gallons of water or at a dilution rate of 1:5000 – 1:10,000.

3) For clean water inject StorOx at 1¼ fl. oz. – ⅝ fl. oz. of StorOx for every 100 gallons of water or at a dilution rate of 1:10,000 – 1:20,000 to prevent the formation of algae, bacteria and fungi.

Chemigation
General Requirements

1) Apply this product only through a drip system or sprinkler including center pivot, lateral move, end tow, side (wheel) roll, traveler, big gun, solid set, hand move, flood (basin), furrow, border or drip (trickle) irrigation systems. Do not apply this product through any other type of irrigation system.

2) Crop injury, lack of effectiveness, or illegal pesticide residues in the crop can result from non-uniform distribution of treated water.

3) If you have questions about calibration, you should contact State Extension Service specialists, equipment manufacturers or other experts.

4) Do not connect an irrigation system (including greenhouse systems) used for pesticide application to a public water system unless the pesticide label-prescribed safety devices for public water systems are in place.

5) A person knowledgeable of the chemigation system and responsible for its operation, or under the supervision of the responsible person, shall shut the system down and make necessary adjustments should the need arise.

6) Posting of areas to be chemigated is required when:

   a. any part of a treated area is within 300 feet of sensitive areas such as residential areas, labor camps, businesses, day care centers, hospitals, inpatient clinics, nursing homes or any public areas such as schools, parks, playgrounds, or other public facilities not including public roads, or

   b. when the chemigated area is open to the public such as golf courses or retail greenhouses.

7) Posting must conform to the following requirements. Treated areas shall be posted with signs at all usual points of entry and along likely routes of approach from the

listed sensitive areas. When there are no usual points of entry, signs must be posted in the corners of the treated areas and in any other location affording maximum visibility to sensitive areas. The printed side of the sign should face away from the treated area towards the sensitive area. The signs shall be printed in English. Signs must be posted prior to application and must remain posted until foliage has dried and soil surface water has disappeared. Signs may remain in place indefinitely as long as they are composed of materials to prevent deterioration and maintain legibility for the duration of the posting period.

8) All words shall consist of letters at least 2.5 inches tall, and all letters and the symbol shall be a color which sharply contrasts with their immediate background. At the top of the sign shall be the words KEEP OUT, followed by an octagonal stop sign symbol at least 8 inches in diameter containing the word STOP. Below the symbol shall be the words PESTICIDES IN IRRIGATION WATER.

Specific Requirements for Chemigation Systems Connected to Public Water Systems

1) Public water system means a system for the provision to the public of piped water for human consumption if such system has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year.

2) Chemigation systems connected to public water systems must contain a functional, reduced-pressure zone, backflow preventer (RPZ) or the functional equivalent in the water supply line upstream from the point of pesticide introduction. As an option to the RPZ, the water from the public water system should be discharged into a reservoir tank prior to pesticide introduction. There shall be a complete physical break (air gap) between the outlet end of the fill pipe and the top or overflow rim of the reservoir tank of at least twice the inside diameter of the fill pipe.

3) The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump.

4) The pesticide injection pipeline must contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.

5) The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops, or in cases where there is no water pump, when the water pressure decreases to the point where pesticide distribution is adversely affected.

6) Systems must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump) effectively designed and constructed of materials that are compatible with pesticides and capable of being fitted with a system interlock.

7) Do not apply when wind speed favors drift beyond the area intended for treatment.

Specific Requirements for Sprinkler Chemigation

1) The system must contain a functional check valve, vacuum relief valve and low-pressure drain appropriately located on the irrigation pipeline to prevent water source contamination from backflow.

2) The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump.

3) The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.

4) The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops.

5) The irrigation line or water pump must include a functional pressure switch which will stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected.

6) Systems must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump) effectively designed and constructed of materials that are

compatible with pesticides and capable of being filled with a system interlock.

7) Do not apply when wind speed favors drift beyond the area intended for treatment.

Specific Requirements for Flood (Basin), Furrow and Border Chemigation

1) Systems using a gravity flow pesticide dispensing system must meter the pesticide into the water at the head of the field and downstream of a hydraulic discontinuity such as a drop structure or weir box to decrease potential for water source contamination from backflow if water flow stops.

2) The systems utilizing a pressurized water and pesticide injection system must meet the following requirements:

   a. The system must contain a functional check valve, vacuum relief valve and low-pressure drain appropriately located on the irrigation pipeline to prevent water source contamination from backflow.

   b. The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump.

   c. The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.

   d. The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops.

   e. The irrigation line or water pump must include a functional pressure switch which will stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected.

   f. Systems must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump) effectively designed and constructed of materials that are compatible with pesticides and capable of being filled with a system interlock.

Specific Requirements for Drip (Trickle) Chemigation

1) The system must contain a functional check valve, vacuum relief valve and low-pressure drain appropriately located on the irrigation pipeline to prevent water source contamination from backflow.

2) The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump.

3) The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.

4) The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops.

5) The irrigation line or water pump must include a functional pressure switch which will stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected.

6) Systems must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump) effectively designed and constructed of materials that are compatible with pesticides and capable of being filled with a system interlock.

Application Instructions

1) Remove scale, pesticide residues, and other foreign matter from the chemical supply tank and entire injector system. Flush with clean water. Failure to provide a clean tank, void of scale or residues may cause product to lose effectiveness or strength.

2) Determine the treatment rates as indicated in the directions for use and make proper dilutions.

3) Prepare a solution in the chemical tank by filling the tank with the required water and then adding product as required. The product will immediately go into suspension without any required agitation.

4) Do not apply StorOx in conjunction with any other pesticides or fertilizers; this has the potential to cause reduced performance of the product. Avoid application in this manner.

WARRANTY

To the fullest extent permitted by law this material conforms to the description on the label and is reasonably fit for the purposes referred to in the directions for use. Timing, method of application, weather, watering practices, nature of soil, potting medium, disease problem, condition of crop, incompatibility with other chemicals, pre-existing conditions and other conditions influencing the use of this product are beyond the control of the seller. Buyer assumes all risks associated with the use, storage, or handling of this material not in strict accordance with directions given herewith. NO OTHER EXPRESS OR IMPLIED WARRANTY OF FITNESS OR MERCHANTABILITY IS MADE.

DIRECTIONS, RATES AND USAGE

Spray Treatments for newly harvested potatoes before storage

CROPS	DISEASE	APPLICATION RATE	DIRECTIONS
Potatoes	Bacteria Soft Rot Early Blight Fusarium Tuber Rot Late Blight Silver Scurf	5- 1¼ fl. oz. of StorOx per gallon of water.	Spray diluted solution on tuber to runoff to achieve full and even coverage. The use of additional surfactant is acceptable to aid in sticking. Use 1 to 2 gallons of water per ton of potatoes.

Direct injection into humidification water for postharvest potatoes in storage

CROPS	DISEASE	APPLICATION RATE	DIRECTIONS
Potatoes	Bacteria Soft Rot Early Blight Fusarium Tuber Rot Late Blight Silver Scurf	1¼ – ½ fl. oz. of StorOx per gallon of water.	Inject concentrate into makeup water used in humidification of postharvest potatoes in storage.

Treatment of rinses for postharvest potatoes; prior, during or after storage

CROPS	DISEASE	APPLICATION RATE	DIRECTIONS
Potatoes	Odor-causing and/or slime-forming bacteria	1:5000 – 1:1000	Inject concentrate into process water used in potato rinses, and associated tanks, flumes and lines.

BioSafe Systems L.L.C.

For additional information on StorOx, call us toll free: 1.888.273.3088
or visit our website: www.biosafesystems.com

StorOx®
Broad Spectrum Bactericide/Fungicide

MATERIAL SAFETY DATA SHEET

1. IDENTIFICATION

Product Name: StorOx®
Product Type: Bactericide / Fungicide
Manufacturer:
BioSafe Systems LLC
22 Meadow Street, East Hartford, CT 06108
Creation Date: 3/08
NOTE: Not valid two years after creation date.

EPA Registration No. 70299-2
EPA Establishment No. 60156-IL-001

2. HAZARDOUS COMPONENTS

Peroxyacetic Acid 79-21-0
Hydrogen Dioxide 7722-84-1

3. HEALTH HAZARDS DATA

Health effects to over exposure to CONCENTRATE

- Corrosive to mucous membranes, eyes and skin
- The seriousness of the lesions and the prognosis of intoxication depend directly on the concentration and duration of exposure.

Skin: May cause TEMPORARY skin discoloration and irritation

Eyes: May cause severe eye damage

Ingestion: HARMFUL OR FATAL: Causes chemical burns of mouth, throat and stomach.

- Corrosive to gastrointestinal tract
- Paleness and cyanosis of the face
- Excessive fluid in the mouth and nose
- Bloating of stomach and belching
- Nausea and vomiting
- Risk of chemical pneumonitis and pulmonary edema

Inhalation: Vapors or mist can cause irritation. People with asthma or other lung problems may be more affected.

4. FIRST AID

General recommendations:

- In case of product splashing in eyes, treat eyes first
- Submerge soil clothing in water
- Contact physician in all cases

Eyes: Immediately flush with plenty of cool running water. Remove contact lenses. Continue flushing for at least 15minutes, holding eyelids apart to ensure rinsing of the entire eye. Administer analgesic eyewash (oxybuprocaine) Call a physician immediately.

Skin: Immediately flush skin with plenty of cool, running water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse.

Ingestion: Rinse mouth at once; then drink 1 or 2 large glasses of water or milk. DO NOT induce vomiting. NEVER give anything by mouth to an unconscious person. Take person to the hospital.

Inhalation: Immediately move a person to fresh air.

5. FIRE AND EXPLOSION DATA

Special fire hazards: Product (concentrate) can decompose and will release oxygen thereby adding to the fire hazard.
Fire fighting methods: Product is not flammable and can be quickly diluted with clean water.
Oxidizing Agent may cause spontaneous ignition with oxidizing agents.

6. SPILL OR LEAK PROCEDURES

Cleanup: Rinse small amounts to drain when possible. Dike or dam large spills, pump to containers or soak in inert absorbent. Flush residue to sanitary sewer, rinse area thoroughly with clean water.
Avoid materials that are incompatible with concentrate.

Waste Disposal: Consult state and local authorities for restrictions on disposal of chemical wastes. Unused product (concentrate) is classified as a (D002) by RCRA criteria.

7. HANDLING AND STORAGE

- Never return product back to the original container
- Keep concentrate away from reactive substances
- Prevent contact with organic materials
- Keep product in original container
- Store in cool, ventilated area
- Keep out of direct sunlight
- Never use metal containers or spigots
- Use vented container
- Warn personnel of dangers of concentrated product

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Respiratory: Avoid breathing mists or vapors of concentrate.
Eyes: Use chemical splash goggles when handling concentrate. For continued severe exposure, wear a face shield over the goggles.
Skins: Rubber gloves - protective or gauntlet type preferred when handling concentrate. Use aprons.
ACGIH TLV: 1 PPM 8 HOUR TWA 1.4 mg/m^3 TWA
OSHA PEL: 1 PPM 8 HOURS TWA 1.4 mg/m^3 TWA
Respiratory Protection:

- NIOSH approved full-face respirator for excessive conditions
- Hand gloves for handling concentrate = butyl rubber
- Eye protection - chemical proof goggles/face shield for splash risk
- Skin protection - coveralls when handling concentrate

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance: Clear, colorless liquid
Odor: Pungent
Freezing Point: -30°C (-22°F)
Boiling Point: Not applicable, product decomposes
Specific Gravity: 1.09
pH: 1.33
Solubility: Complete
Decomposition Temperature: Self-accelerating decomposition temperature >55°C

10. STABILITY AND REACTIVITY

Stability: Stable under normal conditions, with slow oxygen release.
Conditions to avoid: Heat/Direct Sunlight
Materials to avoid:

- Acids
- Bases
- Reducing Agents
- Organic Materials
- Metals
- Salts of Metals

11. TOXICOLOGICAL INFORMATION

Acute Toxicology:

- Oral route, LD50, rat 330 mg/kg
  Test substance: 7% solution
- Dermal route, LD50 rabbit, 1410 mg/kg
  Test substance: 10% solution
- Inhalation, LD50, four hours, rat 4080 mg/kg
  Test substance: 5% solution

Irritation:

- Rabbit, corrosive (eyes) Test substance: 4% solution
- Rabbit, corrosive (skin) Test substance: 5% solution
- Rat, irritant (respiratory tract)

Chronic Toxicity:

- Dermal = >0.12% solution, irritating effect
- Inhalation = >5 mg/m^3, irritant
- Route of entry = Inhalation/ingestion

12. ECOLOGICAL INFORMATION

Toxic to simple cell and aquatic organisms. Danger to the environment limited; due to product properties.

- No bioaccumulation
- Soil degradation = 99% in 20 minutes
- Considerable abiotic and biotic degradability
- Sediments = Non-significant adsorption
- Weak persistence of degradation products
- Degradation products = water & oxygen

Acute Ecotoxicity:

- Fish, Rainbow trout LC50, 48 hours > 40 mg/L
- Crustaceans, EC 50, 48 hours 126.8 mg/L, 1 mg/L
- Bacteria, Pseudomonas aeruginosa, EC 100, 5 minutes, 5 mg/L

13. DISPOSAL CONSIDERATIONS

- Store in original containers in a cool, well-vented area, away from direct sunlight. Do not allow product to become overheated in storage. This may cause increased degradation of the product, which will decrease product effectiveness. In case of spill, flood area with large quantities of water. Do not store in a manner where cross-contamination with other pesticides or fertilizers could occur.
- Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility. Open dumping is prohibited. If wastes cannot be disposed of according to label directions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste Representative at the nearest EPA Regional Office for guidance.
- Triple rinse (or equivalent). Then offer for recycling or dispose in a sanitary landfill, or incineration, if allowed by state and local authorities by burning. Stay out of smoke.

14. TRANSPORT INFORMATION

DOT Shipping Name: Hydrogen Peroxide and peroxyacetic acid mixture, stabilized, not more than 5% Peroxyacetic acid.
UN Number: 3149
Hazard Class: 5.1
Primary Hazard Label: Oxidizer
Subsidiary Risk Label: Corrosive
Packing Group: II
Shipping Container: UN Certified vented polyethylene. 2.5, 5, 30, 55 and 275 gallon polyethylene drums

Regulatory Information
TSCA Inventory List: YES
CERCLA Hazardous Substance: (40 CFR 302)
Listed Substance: NO
Unlisted Substance: YES
Characteristic: Corrosive
Reportable Quantity: 100 pounds
NFPA Rating Health – 2 Flammability – 0 Reactivity – 3 Special – OXY
HMIS Rating Health – 2 Flammability – 0 Reactivity – 2 PPE - Required
Canadian WHMIS Classification
C – Oxidizing E – Corrosive F – Dangerously Reactive

A PRODUCT OF:
BioSafe Systems L.L.C.

For Additional information on StorOx, call us toll free: 1.888.273.3088
or visit our website:
www.biosafesystems.com

GreenClean® Liquid

Broad Spectrum Algaecide/Bactericide

SPECIMEN LABEL

A treatment for the prevention and control of algae & cyanobacteria in waters.

FOR AGRICULTURAL AND COMMERCIAL USE ONLY

ACTIVE INGREDIENT:

Hydrogen Dioxide: 27%
OTHER INGREDIENTS: 73%
TOTAL: 100%

KEEP OUT OF REACH OF CHILDREN
DANGER - PELIGRO

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle.
(If you do not understand this label, find someone to explain it to you in detail.)

FIRST AID

If in eyes

- Hold eye open and rinse slowly and gently with water for 15 – 20 minutes.
- Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.
- Call a poison control center or doctor for treatment advice.

If on skin or clothing

- Take off contaminated clothing.
- Rinse skin immediately with plenty of water for 15 – 20 minutes.
- Call a poison control center or doctor for treatment advice.

If swallowed

- Call poison control center or doctor immediately for treatment advice.
- Have person sip a glass of water if able to swallow.
- Do not induce vomiting unless told to do so by a poison control center or doctor.
- Do not give anything by mouth to an unconscious person.

If inhaled

- Move person to fresh air.
- If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible.
- Call poison control center or doctor for treatment advice.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-222-1222 for emergency medical treatment information.

NOTE TO PHYSICIAN

Probable mucosal damage may contraindicate the use of gastric lavage.

Sold by:
BioSafe Systems, LLC, 22 Meadow Street
East Hartford, CT 06108
EPA Registration No. 70299-2
EPA Establishment No. 60156-IL-001

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMAN AND DOMESTIC ANIMALS – DANGER: Corrosive. Concentrate causes irreversible eye damage. Concentrate may be fatal if swallowed or absorbed through skin. Concentrate causes skin burns or temporary discoloration on exposed skin. Do not breathe vapor of concentrate. Do not get concentrate in eyes, on skin or on clothing. Wear protective eyewear such as goggles or face shield. Wash thoroughly with soap and water after handling. Remove and wash contaminated clothing before reuse.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

When handling concentrate wear protective eyewear (goggles or face shield) and rubber gloves. Applicators and handlers must wear coveralls over long-sleeved shirt, long pants, and chemical resistant footwear plus socks. Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions exist for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

USER SAFETY RECOMMENDATIONS

Users should wash hands thoroughly with soap and water before eating, drinking, chewing gum, using tobacco or using the toilet. Users should remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing. Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

ENVIRONMENTAL HAZARDS

This pesticide is toxic to birds and fish. Do not contaminate water when disposing of equipment washwaters or rinsate. Exposed treated seed may be hazardous to birds and other wildlife. Dispose of all excess treated seed and seed packaging by burial away from bodies of water.

This product is highly toxic to bees and other beneficial insects exposed to direct contact on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds while bees are actively visiting the treatment area. Do not apply this product or allow it to drift to crops where beneficials are part of an Integrated Pest Management strategy.

PHYSICAL AND CHEMICAL HAZARDS

Corrosive. Strong oxidizing agent. Do not use in concentrated form. Mix only with water in accordance with label instructions. Never bring concentrate in contact with other pesticides, cleaners or oxidative agents.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling. Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation.

AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR Part 170. This standard contains requirements for the protection of agricultural workers on farms, forests, nurseries and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about Personal Protective Equipment (PPE), notification to workers, and Restricted-Entry Interval (REI). The requirements in this box only apply to the uses of this product that are covered by the Worker Protection Standard.

For enclosed environments:

There is a restricted entry of one (1) hour for this product when applied via fogging or spraying to growing plants, surfaces, equipment, structures and non-porous surfaces in enclosed environments such as glasshouses and greenhouses. PPE requirement for early entry to treated areas that is permitted under the Worker Protection Standard and that involves contact with anything that has been treated, such as plants, soil or water, is coveralls worn over long-sleeved shirt and pants, waterproof gloves and shoes plus socks.

There is a restricted entry of zero (0) hours for pre-plant dip, seed treatment, soil drench, mop, sponge, dip, soak, rinse or other non-spraying or fogging application methods when used in enclosed environments such as glasshouses and greenhouses.

For field applications:

Keep unprotected persons out of treated areas until sprays have dried.

Non-Agricultural Use Requirements

The requirements in this box apply to uses of this product that are not within the scope of the Worker Protection Standard for agricultural pesticides (40 CFR Part 170). The WPS applies when this product is used to produce agricultural plants on farms, forests, nurseries or greenhouses.

Keep unprotected persons out of treated areas until sprays have dried.

FOR AGRICULTURAL SPRAY IRRIGATION AND DRAINAGE WATER AND DITCHES

Use GreenClean Liquid to suppress / control algae, bacteria and fungi in agricultural irrigation and drainage water and ditches. For irrigation water, apply 4 to 8 fluid ounces of GreenClean Liquid per 1,000 gallons of water. Product can be simply added to the body of water, as the residual control will allow for even distribution throughout the water column. Where existing algae mats are present at time of treatment, the most effective control will be obtained by breaking up mats and/or evenly dispersing diluted GreenClean

Liquid over the algae mats. Apply GreenClean Liquid as needed to control and prevent algae growth; apply more frequently in times of higher water temperatures.

FOR STOCK TANKS AND LIVESTOCK WATER

Use GreenClean Liquid to suppress / control algae, bacteria and fungi in stock tanks, stock watering ponds, tanks and troughs, and livestock water. Apply 2 fluid ounces of GreenClean Liquid per 250 gallons of water for algae control. Product can be simply added to the body of water as the residual control will allow for even distribution throughout the water column. Where existing algae mats are present at time of treatment, the most effective control will be obtained by breaking up mats and/or evenly dispersing diluted GreenClean Liquid over the algae mats. Apply GreenClean Liquid as needed to control and prevent algae growth; apply more frequently in times of higher water temperatures.

DRIP SYSTEM APPLICATION FOR LIVESTOCK WATERING TANKS

Tanks fed by a continuous flow of spring or well water can be equipped with a chemical drip system designed to meter-in GreenClean Liquid based upon water flow rates. Pre-dilute GreenClean Liquid at a 100:1 rate or 4-mL/minute water flow rate. Treat continuously or as needed to control and prevent algae regrowth.

FOR CONTAINED WATERS

To suppress, control and prevent algae and cyanobacteria in contained waters such as Ponds, Lakes, Lagoons, Water Gardens, Ornamental Pools/Ponds, Ornamental Waterfalls, Fountains, Bird Baths, Irrigation Ponds, Golf Course Ponds, Farm Ponds, Fish Ponds, Fish Hatcheries, Impounded Waters, Bilge Water, Reservoirs, Waterways, Conveyance Ditches, Canals, Laterals, Drainage Systems, Catch Basins, Fire Ponds, Watering Tanks, Storage Tanks, Water Collectors and Domestic/Commercial Waters. Treated waters are permissible to be used without interruption.

DETERMINING WATER VOLUME

Measure length (L), width (W), and average depth (D) in feet (ft) or meters (m) and calculate volume using one of the following formulas:

Square/Rectangular:
L(ft) x W(ft) x D(ft) x 7.5 = Gallons
L(m) x W(m) x D(m) x 1000 = Liters

Circular/Elliptical:
L(ft) x W(ft) x D(ft) x 5.9 = Gallons
L(m) x W(m) x D(m) x 786 = Liters

$$\frac{\text{Avg. Length (ft)} \times \text{Avg. Width (ft)}}{43{,}560} = \textbf{acres}$$

APPLICATION METHODS

In bodies of water where an aerator is available, and when treating the entire water volume, dose at the edges, or in the turbulence created while the aerator runs to facilitate rapid and adequate mixing.

Spot Treatment: Apply GreenClean Liquid directly over the infested area. Re-treatment is required when heavy growth occurs.

Liquid Treatment: Spray solution on the water surface from shore or a properly equipped boat.

Injection Treatment: Inject solution into the water via a piping system.

GENERAL TREATMENT NOTES

- Control is most easily achieved when algae are not yet well established. Treat when growth first begins to appear.
- Apply early in the day under calm, sunny conditions, and when water temperatures are warm. Sunlight and higher temperatures both enhance activity.
- Apply evenly over the water surface directly over the algae to be treated.
- Break up any heavy floating algae mats before or during application.
- If using in conjunction with other water additives (such as bacteria or enzymes), always apply GreenClean Liquid first and wait several hours before adding any other products.
- Re-treat areas if re-growth begins to appear. Allow 48 hours between consecutive treatments.
- Maintain an algae-free pond with maintenance rates at a frequency appropriate for your environmental conditions.
- Do not tank mix with aquatic herbicides or algaecides containing copper or bromides.

EFFECTIVENESS FACTORS

- Effects of GreenClean Liquid treatment are immediately apparent (bubbling, bleaching, & discoloration of algae).
- GreenClean Liquid treatments are successful when contact of the pesticide is made with the algae.
- When treating surface mats and blooms, it is possible that GreenClean Liquid will not penetrate the water column below the infested area, and a second application is then required for treating any bottom growing algae.
- Apply more frequently during the summer months when water consumption and temperatures are high.

CHEMIGATION:

General Requirements

1) Apply this product only through a drip system or sprinkler including center pivot, lateral move, end tow, side (wheel) roll, traveler, big gun, solid set, hand move, flood (basin), furrow, border or drip (trickle) irrigation systems. Do not apply this product through any other type of irrigation system.
2) Crop injury, lack of effectiveness, or illegal pesticide residues in the crop can result from non-uniform distribution of treated water.
3) If you have questions about calibration, you should contact State Extension Service specialists, equipment manufacturers or other experts.
4) Do not connect an irrigation system (including greenhouse systems) used for pesticide application to a public water system unless the pesticide label-prescribed safety devices for public water systems are in place.
5) A person knowledgeable of the chemigation system and responsible for its operation, or under the supervision of the responsible person, shall shut the system down and make necessary adjustments should the need arise.
6) Posting of areas to be chemigated is required when 1) any part of a treated area is within 300 feet of sensitive areas such as residential areas, labor camps, businesses, day care centers, hospitals, in-patient clinics, nursing homes or any public areas such as schools, parks, playgrounds, or other public facilities not including public roads, or 2) when the chemigated area is open to the public such as golf courses or retail greenhouses.
7) Posting must conform to the following requirements. Treated areas shall be posted with signs at all usual points of entry and along likely routes of approach from the listed sensitive areas. When there are no usual points of entry, signs must be posted in the corners of the treated areas and in any other location affording maximum visibility to sensitive areas. The printed side of the sign should face away from the treated area towards the sensitive area. The signs shall be printed in English. Signs must be posted prior to application and must remain posted until foliage has dried and soil surface water has disappeared. Signs may remain in place indefinitely as long as they are composed of materials to prevent deterioration and maintain legibility for the duration of the posting period.
8) All words shall consist of letters at least 2.5 inches tall, and all letters and the symbol shall be a color which sharply contrasts with their immediate background. At the top of the sign shall be the words KEEP OUT, followed by an octagonal stop sign symbol at least 8 inches in diameter containing the word STOP. Below the symbol shall be the words PESTICIDES IN IRRIGATION WATER.

SPECIFIC REQUIREMENTS FOR CHEMIGATION SYSTEMS CONNECTED TO PUBLIC WATER SYSTEMS

1) Public water system means a system for the provision to the public of piped water for human consumption if such system has at least 15 service connections or regularly serves an average of at least 25 individuals daily at least 60 days out of the year.
2) Chemigation systems connected to public water systems must contain a functional, reduced-pressure zone, backflow preventer (RPZ) or the functional equivalent in the water supply line upstream from the point of pesticide introduction. As an option to the RPZ, the water from the public water system should be discharged into a reservoir tank prior to pesticide introduction. There shall be a complete physical break (air gap) between the outlet end of the fill pipe and the top or overflow rim of the reservoir tank of at least twice the inside diameter of the fill pipe.
3) The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump.
4) The pesticide injection pipeline must contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.
5) The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops, or in cases where there is no water pump, when the water pressure decreases to the point where pesticide distribution is adversely affected.
6) Systems must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump) effectively designed and constructed of materials that are compatible with pesticides and capable of being fitted with a system interlock.
7) Do not apply when wind speed favors drift beyond the area intended for treatment.

SPECIFIC REQUIREMENTS FOR SPRINKLER CHEMIGATION

1) The system must contain a functional check valve, vacuum relief valve and low-pressure drain appropriately located on the irrigation pipeline to prevent water source contamination from backflow.
2) The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump.
3) The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.
4) The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops.
5) The irrigation line or water pump must include a functional pressure switch which will stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected.

6) Systems must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump) effectively designed and constructed of materials that are compatible with pesticides and capable of being filled with a system interlock.
7) Do not apply when wind speed favors drift beyond the area intended for treatment.

SPECIFIC REQUIREMENTS FOR FLOOD (BASIN), FURROW AND BORDER CHEMIGATION

1) Systems using a gravity flow pesticide dispensing system must meter the pesticide into the water at the head of the field and downstream of a hydraulic discontinuity such as a drop structure or weir box to decrease potential for water source contamination from backflow if water flow stops.
2) The systems utilizing a pressurized water and pesticide injection system must meet the following requirements:

a. The system must contain a functional check valve, vacuum relief valve and low-pressure drain appropriately located on the irrigation pipeline to prevent water source contamination from backflow.
b. The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump.
c. The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.
d. The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops.
e. The irrigation line or water pump must include a functional pressure switch which will stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected.
f. Systems must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump) effectively designed and constructed of materials that are compatible with pesticides and capable of being filled with a system interlock.

SPECIFIC REQUIREMENTS FOR DRIP (TRICKLE) CHEMIGATION

1) The system must contain a functional check valve, vacuum relief valve and low-pressure drain appropriately located on the irrigation pipeline to prevent water source contamination from backflow.
2) The pesticide injection pipeline must contain a functional, automatic, quick-closing check valve to prevent the flow of fluid back toward the injection pump.
3) The pesticide injection pipeline must also contain a functional, normally closed, solenoid-operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being withdrawn from the supply tank when the irrigation system is either automatically or manually shut down.
4) The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops.
5) The irrigation line or water pump must include a functional pressure switch which will stop the water pump motor when the water pressure decreases to the point where pesticide distribution is adversely affected.
6) Systems must use a metering pump, such as a positive displacement injection pump (e.g., diaphragm pump) effectively designed and constructed of materials that are compatible with pesticides and capable of being filled with a system interlock.

APPLICATION INSTRUCTIONS

1) Remove scale, pesticide residues, and other foreign matter from the chemical supply tank and entire injector system. Flush with clean water. Failure to provide a clean tank, void of scale or residues may cause product to lose effectiveness or strength.
2) Determine the treatment rates as indicated in the directions for use and make proper dilutions.
3) Prepare a solution in the chemical tank by filling the tank with the required water and then adding product as required. The product will immediately go into suspension without any required agitation.
4) Do not apply OxiDate? in conjunction with any other pesticides or fertilizers; this has the potential to cause reduced performance of the product. Avoid application in this manner.

STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage or disposal.

PESTICIDE STORAGE

Store in original containers in a cool, well-vented area, away from direct sunlight. Do not allow product to become overheated in storage. This may cause increased degradation of the product, which will decrease product effectiveness. In case of spill, flood area with large quantities of water. Do not store in a manner where cross-contamination with other pesticides or fertilizers could occur.

PESTICIDE DISPOSAL

Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility. Open dumping is prohibited. If wastes cannot be disposed of according to label directions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste Representative at the nearest EPA Regional Office for guidance.

CONTAINER DISPOSAL

Triple rinse (or equivalent). Then offer for recycling or reconditioning, or puncture and dispose of in a sanitary landfill, or incineration, or, if allowed by state and local authorities, by burning. If burned, stay out of smoke.

WARRANTY

This material conforms to the description on the label and is reasonably fit for the purposes referred to in the directions for use. Timing, method of application, weather, watering practices, nature of soil, potting medium, disease problem, condition of crop, incompatibility with other chemicals, pre-existing conditions and other conditions influencing the use of this product are beyond the control of the seller. Buyer assumes all risks associated with the use, storage, or handling of this material not in strict accordance with directions given herewith. NO OTHER EXPRESS OR IMPLIED WARRANTY OF FITNESS OR MERCHANTABILITY IS MADE.

APPLICATION RATES

Growth/Density (Alga Type)	PPM A.I.	Depth in Feet			
		1	2	3	4
		GALLONS PER SURFACE ACRE			
Low Density	1.0	1.2	2.4	3.6	4.8
	2.0	2.4	4.8	7.2	9.6
(Cyanobacteria)	3.0	3.6	7.2	10.8	14.4
	--- 4.0 ---	---4.8---	---9.6---	---14.4---	---19.2---
Moderate Density	5.0	6.0	12.0	18.0	24.0
	6.0	7.2	14.4	21.6	28.8
	--- 7.0 ---	---8.4---	---16.8---	---25.2---	---33.6---
High Density	8.0	9.6	19.2	28.8	38.4
(Filamentous)	9.0	10.8	21.6	32.4	43.2
	10.0	12.0	24.0	36.0	48.0
Extreme Density	15.0	18.0	36.0	54.0	72.0
	20.0	24.0	48.0	72.0	96.0
(Full Bloom)	25.0	30.0	60.0	90.0	120.0

NOTES:

BioSafe Systems L.L.C.

For additional information on GreenClean Broad Spectrum Algaecide/Bactericide Liquid
call us toll-free at 1.888.273.3088 or visit www.biosafesystems.com.

GreenClean® Liquid
Broad Spectrum Algaecide/Bactericide

MATERIAL SAFETY DATA SHEET

1. IDENTIFICATION
Product Name: GreenClean Liquid®
Product Type: Algaecide/Bactericide
Manufacturer:
22 Meadow Street
East Hartford, CT 06108
Creation Date: 2/08
NOTE: Not valid two years after creation date.

EPA Registration No. 70299-2
EPA Establishment No. 60156-IL-001

2. HAZARDOUS COMPONENTS
Peroxyacetic Acid 79-21-0
Hydrogen Dioxide 7722-84-1

3. HEALTH HAZARDS DATA
Health effects from over exposure to CONCENTRATE:
- Corrosive to mucous membranes, eyes and skin.
- The seriousness of the lesions and the prognosis of intoxication depend directly on the concentration and duration of exposure.

Skin: May cause TEMPORARY skin discoloration and irritation.

Eyes: May cause severe eye damage.

If swallowed: HARMFUL OR FATAL: Causes chemical burns of mouth, throat and stomach.
- Corrosive to gastrointestinal tract
- Paleness and cyanosis of the face
- Excessive fluid in the mouth and nose
- Bloating of stomach and belching
- Nausea and vomiting
- Risk of chemical pneumonitis and pulmonary edema

If inhaled: Vapors or mist can cause irritation. People with asthma or other lung problems may be more affected.

4. FIRST AID
General recommendations:
- In case of product splashing in eyes, treat eyes first
- Submerge soiled clothing in water
- Contact physician in all cases

Eyes: Hold eye open and rinse slowly and gently with water for 15-20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.

Skin: Take off contaminated clothing. Rinse skin immediately with plenty of water for 15-20 minutes. Call a poison control center or doctor for treatment advice.

If swallowed: Call poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by the poison control center or doctor. Do not give anything by mouth to an unconscious person.

If inhaled: Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. Call poison control center or doctor for treatment advice.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1.800.222.1222 for emergency treatment information.

NOTE TO PHYSICIAN: Probable mucosal damage may contraindicate the use of gastric lavage.

5. FIRE AND EXPLOSION DATA
Special fire hazards: Product (concentrate) can decompose and will release oxygen thereby adding to the fire hazard.

Fire fighting methods: Product is not flammable and can be quickly diluted with clean water.

Oxidizing Agent may cause spontaneous ignition with oxidizing agents.

6. SPILL OR LEAK PROCEDURES
Cleanup: Rinse small amounts to drain when possible. Dike or dam large spills, pump to containers or soak in inert absorbent. Flush residue to sanitary sewer, rinse area thoroughly with clean water.

Avoid materials that are incompatible with concentrate.

Waste Disposal: Consult state and local authorities for restrictions on disposal of chemical wastes. Unused product (concentrate) is classified as a (D002) by RCRA criteria.

7. HANDLING AND STORAGE
- Never return product back to the original container
- Keep concentrate away from reactive substances
- Prevent contact with organic materials
- Keep product in original container
- Store in cool, ventilated area
- Keep out of direct sunlight
- Never use metal containers or spigots
- Use vented container
- Warn personnel of dangers of concentrated product

8. EXPOSURE CONTROLS / PERSONAL PROTECTION
Respiratory: Avoid breathing mists or vapors of concentrate.

Eyes: Use chemical splash goggles when handling concentrate. For continued severe exposure, wear a face shield over the goggles.

Skin: Rubber gloves - protective or gauntlet type preferred when handling concentrate. Use aprons.
ACGIH TLV: 1 PPM 8 HOUR TWA
1.4 mg/m^3 TWA
OSHA PEL: 1 PPM 8 HOURS TWA
1.4 mg/m^3 TWA

Respiratory protection:
- NIOSH approved full-face respirator for excessive conditions
- Hand gloves for handling concentrate = butyl rubber
- Eye protection - chemical proof goggles/face shield for splash risk
- Skin protection - coveralls when handling concentrate

9. PHYSICAL AND CHEMICAL PROPERTIES
Appearance: Clear, colorless liquid

Odor: Pungent

Freezing Point: -30°C (-22°F)

Boiling Point: Not applicable, product decomposes

Specific gravity: 1.09

pH: 1.33

Solubility: Complete

Decomposition temperature: self-accelerating decomposition temperature > 55°C

10. STABILITY AND REACTIVITY
Stability: Stable under normal conditions, with slow oxygen release

Conditions to avoid: Heat / Direct Sunlight

Materials to avoid: · Acids · Bases · Reducing Agents · Organic Materials · Metals · Salts of Metals

11. TOXICOLOGICAL INFORMATION
Acute Toxicology:
- Oral route, LD50, rat 330 mg/kg. Test substance: 7% solution
- Dermal route, LD50 rabbit, 1410 mg/kg. Test substance: 10% solution
- Inhalation, LD50, four hours, rat 4080 mg/kg. Test substance: 5% solution

Irritation:
- Rabbit, corrosive (eyes). Test substance: 4% solution
- Rabbit, corrosive (skin). Test substance: 5% solution
- Rat, irritant (respiratory tract)

Chronic Toxicity:
- Dermal = >0.12% solution, irritating effect
- Inhalation = > 5 mg/m^3, irritant
- Route of entry = Inhalation / ingestion

12. ECOLOGICAL INFORMATION
Toxic to simple cell and aquatic organisms. Danger to the environment limited due to product properties.
- No bioaccumulation
- Soil degradation = 99% in 20 minutes
- Considerable abiotic and biotic degradability
- Sediments = Non-significant adsorption
- Weak persistence of degradation products
- Degradation products = water & oxygen

Acute Ecotoxicity:
- Fish, Rainbow trout LC50, 48 hours > 40 mg/L
- Crustaceans, EC 50,48 hours 126.8 mg/L 1 mg/ L
- Bacteria, Pseudomonas aeruginosa, EC 100, 5 minutes, 5mg/L

13. DISPOSAL CONSIDERATIONS
- Store in original containers in a cool, well-vented area, away from direct sunlight. Do not allow product to become overheated in storage. This may cause increased degradation of the product, which will decrease product effectiveness. In case of spill, flood area with large quantities of water. Do not store in a manner where cross-contamination with other pesticides or fertilizers could occur.
- Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility. Open dumping is prohibited. If wastes cannot be disposed of according to label directions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste Representative at the nearest EPA Regional Office for guidance.
- Triple rinse (or equivalent). Then offer for recycling or dispose in a sanitary landfill, or incineration, if allowed by state and local authorities by burning. Stay out of smoke.

14. TRANSPORT INFORMATION
DOT Shipping Name: Hydrogen Peroxide and peroxyacetic acid mixture, stabilized, not more than 5% Peroxyacetic acid.

UN Number: 3149

Hazard Class: 5.1

Primary Hazard Label: Oxidizer

Subsidiary Risk Label: Corrosive

Packing Group: II

Shipping Container: UN Certified vented polyethylene. 2.5, 5, 30, 55 and 275 gallon polyethylene drums

Regulatory Information
TSCA Inventory List: YES
CERCLA Hazardous Substance (40 CFR 302)
Listed substance: NO
Unlisted Substance: YES
Characteristic: Corrosive
Reportable Quantity: 100 pounds
NFPA Rating Health – 2 Flammability – 0 Reactivity – 3 Special – OXY
HMIS Rating Health – 2 Flammability – 0 Reactivity – 2 PPE - Required
Canadian WHMIS Classification
C – Oxidizing E – Corrosive F – Dangerously Reactive

To the extent of our knowledge, the information herein is accurate as of the date of this document. However, neither BioSafe Systems nor any of its affiliates make any warranty, expressed or implied, or accept any liability in connection with the information or its use. The information is for use by technically skilled persons at their own discretion and risk. This is not a license or a patent. The user alone must finally determine suitability of any information or material for any contemplated use, the manner or use and whether any patents are infringed.

7. HANDLING AND STORAGE

- Never return product back to the original container
- Keep concentrate away from reactive substances
- Prevent contact with organic materials
- Keep product in original container
- Store in cool, ventilated area
- Keep out of direct sunlight
- Never use metal containers or spigots
- Use vented container
- Warn personnel of dangers of concentrated product

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Respiratory: Avoid breathing mists or vapors of concentrate

Eyes: Use chemical splash goggles when handling concentrate. For continued severe exposure, wear a face shield over the goggles.

Skin: Rubber gloves - protective or gauntlet type preferred when handling concentrate. Use aprons.

ACGIH TLV: 1 PPM 8 HOUR TWA
1.4 mg/m3 TWA
OSHA PEL: 1 PPM 8 HOURS TWA
1.4 mg/m3 TWA

Respiratory protection

- NIOSH approved full face respirator for excessive conditions
- Hand gloves for handling concentrate = butyl rubber
- Eye protection – chemical proof goggles/face shield for splash risk
- Skin protection – coveralls when handling concentrate

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance: Clear, colorless liquid
Odor: Pungent
Freezing Point: -30˚ C (-22˚F)
Boiling Point: Not applicable, product decomposes
Specific gravity: 1.09
pH: 1.33
Solubility: Complete
Decomposition temperature: self-accelerating decomposition temperature > 55˚

10. STABILITY AND REACTIVITY

Stability: Stable under normal conditions, with slow oxygen release.
Conditions to avoid: Heat/Direct Sunlight
Materials to avoid: Acids, Bases, Reducing Agents, Organic Materials, Metals, Salts of Metals

11. TOXICOLOGICAL INFORMATION

Acute Toxicology

- Oral route, LD50, rat 330 mg/kg. Test substance: 7% solution
- Dermal route, LD50 rabbit, 1410 mg/kg. Test substance: 10% solution
- Inhalation, LD50, four hours, rat 4080 mg/kg. Test substance: 5% solution

Irritation

- Rabbit, corrosive (eyes) Test substance: 4% solution
- Rabbit, corrosive (skin) Test substance: 5% solution
- Rat, irritant (respiratory tract)

Chronic Toxicity

- Dermal = > 0.12% solution, irritating effect
- Inhalation = > 5 mg. m3, irritant
- Route of entry = Inhalation/ ingestion

12. ECOLOGICAL INFORMATION

Toxic to simple cell and aquatic organisms. Danger to the environment limited; due to product properties.

- No bioaccumulation
- Soil degradation = 99% in 20 minutes
- Considerable abiotic and biotic degradability
- Sediments = Non-significant adsorption
- Weak persistence of degradation products
- Degradation products = water & oxygen

Acute Ecotoxicity

- Fish, Rainbow trout LC50, 48 hours > 40 mg/L
- Crustaceans, EC 50, 48 hours 126.8 mg/l 1 mg/ L
- Bacteria, Pseudomonas aeruginosa, EC 100, 5 minutes, 5mg/L

13. DISPOSAL CONSIDERATIONS

- Store in original containers in a cool, well-vented area, away from direct sunlight. Do not allow product to become overheated in storage. This may cause increased degradation of the product, which will decrease product effectiveness. In case of spill, flood area with large quantities of water. Do not store in a manner where cross-contamination with other pesticides or fertilizers could occur.
- Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility. Open dumping is prohibited. If wastes cannot be disposed of according to label directions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste Representative at the nearest EPA Regional Office for guidance.
- Triple rinse (or equivalent). Then offer for recycling or dispose in a sanitary landfill, or incineration, if allowed by state and local authorities by burning. Stay out of smoke.

14. TRANSPORT INFORMATION

D.O.T. Shipping Name: Hydrogen Peroxide and peroxyacetic acid mixture, stabilized, not more than 6% Peroxyacetic acid.
UN Number: 3149
Hazard Class: 5.1
Primary Hazard Label: Oxidizer
Subsidiary Risk Label: Corrosive
Packing Group: II
Shipping Container: UN Certified vented polyethylene. 2.5, 5, 30, 55 and 275 gallon polyethylene drums

REGULATORY INFORMATION

TSCA Inventory List: YES
CERCLA Hazardous Substance (40 CFR 302)
Listed substance: NO
Unlisted Substance: YES
Characteristic: Corrosive
Reportable Quantity: 100 pounds
NFPA Rating Health - 2 Flammability - 0 Reactivity - 3 Special - OXY
HMIS Rating Health - 2 Flammability - 0 Reactivity - 2
PPE - Required
Canadian WHMIS Classification
C - Oxidizing
E - Corrosive
F - Dangerously Reactive

To the extent of our knowledge, the information herein is accurate as of the date of this document. However, neither BioSafe Systems nor any of its affiliates make any warranty, expressed or implied, or accept any liability in connection with the information or its use. The information is for use by technically skilled persons at their own discretion and risk. This is not a license or a patent. The user alone must finally determine suitability of any information or material for any contemplated use, the manner or use and whether any patents are infringed.

BioSafe Systems L.L.C.
1-888-273-3088
www.biosafesystems.com

Form #3000-3 10/07

TerraClean®

Broad Spectrum Bactericide/Fungicide

Specimen Label and MSDS

BROAD SPECTRUM BACTERICIDE/FUNGICIDE

- **Soil treatment for the control of soil-borne plant pathogens.**

FOR AGRICULTURAL AND COMMERCIAL USE ONLY

ACTIVE INGREDIENT:
Hydrogen Dioxide: 27.18%
INERT INGREDIENTS: 72.82%
TOTAL: 100%

KEEP OUT OF REACH OF CHILDREN
DANGER – *PELIGRO*

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle.
(If you do not understand this label, find someone to explain it to you in detail.)

FIRST AID
If in eyes

- Hold eye open and rinse slowly and gently with water for 15 – 20 minutes.
- Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.
- Call a poison control center or doctor for treatment advice.

If on skin or clothing

- Take off contaminated clothing.
- Rinse skin immediately with plenty of water for 15 – 20 minutes.
- Call a poison control center or doctor for treatment advice.

If swallowed

- Call poison control center or doctor immediately for treatment advice.
- Have person sip a glass of water if able to swallow.
- Do not induce vomiting unless told to do so by the poison control center.
- Do not give anything by mouth to an unconscious person.

If inhaled

- Move person to fresh air.
- If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably by mouth-to-mouth, if possible.
- Call a poison control center or doctor for further treatment advice.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment.

NOTE TO PHYSICIAN
Probable mucosal damage may contraindicate the use of gastric lavage.

EPA Registration No: 70299-5
EPA Establishment No: 60156-IL-001

PRECAUTIONARY STATEMENTS
HAZARDS TO HUMAN AND DOMESTIC ANIMALS
CORROSIVE: Concentrate causes irreversible eye damage. Concentrate may be fatal if swallowed. Concentrate causes skin irritation or temporary discoloration on exposed skin. Do not breathe vapor of concentrate. Do not get concentrate in eyes, on skin or on clothing.

PERSONAL PROTECTIVE EQUIPMENT (PPE)
When handling concentrate wear protective eyewear (goggles or face shield) and rubber gloves. Applicators and handlers must wear coveralls over long-sleeved shirt, long pants, and chemical resistant footwear plus socks. Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions exist for washables, use detergent and hot water.

USER SAFETY RECOMMENDATIONS
Users should wash hands thoroughly with soap and water before eating, drinking, chewing gum, using tobacco or using the toilet. Users should remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing. Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

ENVIRONMENTAL HAZARDS
FOR TERRESTRIAL USES. Keep out of lakes, ponds and streams. This pesticide is toxic to birds and fish. Do not apply directly to water, or to areas where surface water is present or to inter-tidal areas below the mean high water mark. Do not contaminate water by cleaning of equipment or disposal of wash waters.

This product is highly toxic to bees and other beneficial insects exposed to direct contact on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds while bees are actively visiting the treatment area. Do not apply this product or allow it to drift to crops where beneficials are part of an Integrated Pest Management strategy.

PHYSICAL AND CHEMICAL HAZARDS
Strong oxidizing agent. Corrosive. Do not use in concentrated form. Mix only with water in accordance with label instructions. Never bring concentrate in contact with other pesticides, cleaners or oxidative agents.

DIRECTIONS FOR USE
It is a violation of Federal law to use this product in a manner inconsistent with its labeling. Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation.

AGRICULTURAL USE REQUIREMENTS
Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR Part 170. This standard contains requirements for the protection of agricultural workers on farms, forests, nurseries and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about Personal Protective Equipment (PPE) and Restricted-Entry Interval (REI). The requirements in this box only apply to the uses of this product that are covered by the Worker Protection Standard.

THERE IS A RESTRICTED ENTRY OF ZERO (0) HOURS FOR THIS PRODUCT.

STORAGE AND DISPOSAL
Do not contaminate water, food, or feed by storage or disposal.

PESTICIDE STORAGE: Store in original containers in a cool, well-vented area, away from direct sunlight. Do not allow product to become overheated in storage. This may cause increased degradation of the product, which will decrease product effectiveness. In case of spill, flood area with large quantities of water. Do not store in a manner where cross-contamination with other pesticides or fertilizers could occur.

PESTICIDE DISPOSAL: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility. Open dumping is prohibited. If wastes cannot be disposed of according to label directions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste Representative at the nearest EPA Regional Office for guidance.

CONTAINER DISPOSAL: Triple rinse (or equivalent). Then offer for recycling or dispose in a sanitary landfill, or incineration, if allowed by state and local authorities by burning. Stay out of smoke.

Directions for Use:

TerraClean works by surface contact with the soils being treated. It is important to ensure that all surfaces are thoroughly wetted and that sufficient quantities of solution are applied to penetrate the soil being treated. TerraClean does not produce any visible residue, distinct odor or deleterious effects to plants when used in accordance with label directions. Areas treated with TerraClean do not need to be covered with tarps or protective plastic. TerraClean is not a fumigant.

TerraClean is effective for the control of soil-borne plant diseases such as Erwinia Fusarium (root rot) – Phytophthora (blights, rots) – Pythium – Rhizoctonia – Thielaviopsis – Verticillium. Use TerraClean as a soil treatment at the time of seeding or transplanting, as well as a periodic treatment throughout the plant's life.

Compatibility:

TerraClean may be combined with water-soluble fertilizers when injected using a separate injection tank. Undiluted TerraClean concentrate is incompatible with liquid fertilizer concentrates. Once diluted into a working solution, TerraClean is compatible with liquid fertilizer concentrates. Metering of TerraClean and fertilizers separately, so as to allow TerraClean and the fertilizer to mix as dilute solutions in the irrigation pipe, is recommended.

APPLICATION DIRECTIONS:
BACTERICIDE/FUNGICIDE

SOIL TREATMENT PRIOR TO SEEDING OR TRANSPLANTING: Cultivation of the soil prior to treatment is recommended. Break-up compacted soil and clods to loosen soil completely. Soil can be seeded or planted immediately after treating with TerraClean.

SOIL TREATMENT WITH ALREADY GROWING PLANTS OR SEEDLINGS: TerraClean may be applied at any stage of plant growth as a soil treatment. Applications may be made using flood or drip irrigation, or soil drench.

Flood Irrigation: Inject TerraClean through a metered system using one gallon of TerraClean per 1,000 gallons of water used. Typical treatment rates should allow enough water to penetrate to the root system.

Drip Irrigation: Inject TerraClean through a metered system using one gallon of TerraClean per 1000 gallons of water used. Typical treatment rates should allow enough water to penetrate to the root system.

Soil Drench: Apply 25 fluid ounces of TerraClean per 200 gallons of water per 1000 square feet of soil to be treated.

CHEMIGATION DIRECTIONS FOR USE

General Requirements:
1) Apply this product only through a sprinkler including a center pivot, lateral move, end tow, side wheel roll, traveler, solid set, hand move, flood basin or drip trickle irrigation system. Do not apply this product through any other type of irrigation system.
2) Crop injury or lack of effectiveness can result from non-uniform distribution of treated water.
3) Ensure that the irrigation system used is properly calibrated and if you have questions, call the state extension service or the equipment manufacturer.
4) Do not connect an irrigation system (including greenhouse systems) used for pesticide application to a public water system unless proper safety devices for public water systems are in place. Read label for instructions.
5) A person knowledgeable of the chemigation system and responsible for its operation, or under the supervision of the responsible person, shall shut the system down and make any necessary adjustments should the need arise.

Specific Requirements:
1) Public water supply means a system for the provision to the public of piped water for human consumption if such system has at least 15 service connections or regularly serves an average of 25 individuals daily at least 60 days throughout the year.
2) Chemigation systems connected to the public water systems must contain a functional, reduced-pressure zone (RPZ), backflow preventer or the functional equivalent in the water supply upstream from the point of pesticide introduction. As an option to the RPZ, the water from the public water system should be discharged into a reservoir tank prior to pesticide introduction.There shall be a complete physical break (air gap) between the outlet end of the fill pipe and the top of the overflow rim of the reservoir tank of at least twice the inside diameter of the fill pipe.
3) The pesticide injection pipeline must contain a functional, automatic, quick closing check valve to prevent the flow of liquid back towards the injector.
4) The pesticide injection pipeline must contain a functional, normally closed, solenoid, operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being drawn from the supply tank when the irrigation system is either automatically or manually shut down.
5) The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops, or in cases where there is no water pump, when the water pressure decreases to the point where pesticide distribution is adversely affected.
6) Systems must use a metering pump, such as a positive displacement injection pump, or equivalent, effectively designed and constructed of materials that are compatible with pesticides and capable of being filled with a system interlock.
7) Do not apply when wind speed favors drift beyond the area intended for treatment.

Application Instructions:
1) Remove scale, pesticide residues, and other foreign matter from the chemical supply tank and entire injector system. Flush with clean water. Failure to provide a clean tank, void of scale or residues may cause product to lose effectiveness or strength.
2) Determine the treatment rates as indicated in the directions for use and make proper dilutions.
3) Prepare a solution in the chemical tank by filling the tank with the required water and then adding product as required. The product will immediately go into suspension without any required agitation.

WARRANTY
This material conforms to the description on the label and is reasonably fit for the purposes referred to in the directions for use. Timing, method of application, weather, watering practices, nature of soil, potting medium, disease problem, condition of crop, incompatibility with other chemicals, pre-existing conditions and other conditions influencing the use of this product are beyond the control of the seller. Buyer assumes all risks associated with the use, storage, or handling of this material not in strict accordance with directions given herewith. NO OTHER EXPRESS OR IMPLIED WARRANTY OF FITNESS OR MERCHANTABILITY IS MADE.

BioSafe Systems L.L.C.
1-888-273-3088
www.biosafesystems.com

Material Safety Data Sheet

1. IDENTIFICATION
Product Name: TerraClean®
Product Type:
Bactericide/Fungicide
Manufacturer:
BioSafe Systems, 22 Meadow Street
East Hartford, CT 06108
Office Telephone Number:
(860) 290-8890
Emergency: **CHEMTREC: 800-424-9300 (24 HOURS EVERY DAY)**
NOTE: NOT VALID TWO YEARS AFTER CREATION DATE.
Creation Date: 10/07

2. HAZARDOUS COMPONENTS
Peroxyacetic Acid:
79-21-0 .....5–5.4%
Hydrogen Dioxide:
7722-84-1 .....20–24%

3. HEALTH HAZARDS DATA
Emergency Overview: Toxic effects are principally related to its corrosive properties and it supports combustion of other substances (oxidizing product). Health effects to over exposure to
CONCENTRATE:
- Corrosive to mucous membranes, eyes and skin
- The seriousness of the lesions and the prognosis of intoxication depend directly on the concentration and duration of exposure.

Skin: Painful irritation, redness and swelling of skin. Risk of burns.
Eyes: May cause severe eye damage. Risk of burns.
Ingestion: **HARMFUL OR FATAL**: Causes chemical burns of mouth, throat and stomach.
- Corrosive to gastrointestinal tract
- Paleness and cyanosis of the face
- Excessive fluid in the mouth and nose
- Bloating of stomach and belching
- Nausea and vomiting
- Risk of chemical pneumonitis and pulmonary edema

Inhalation: Vapors or mist can cause irritation. People with asthma or other lung problems may be more affected. Risk of chemical pneumonitis and pulmonary edema. In case of repeated or prolonged exposure: risk of sore throat, nose bleeds, chronic bronchitis.

4. FIRST AID
General recommendations:
- In case of product splashing in eyes, treat eyes first
- Submerge soil clothing in water
- Contact physician in all cases

Eyes: Immediately flush with plenty of cool running water. Remove contact lenses. Continue flushing for at least 15 minutes, holding eyelids apart to ensure rinsing of the entire eye. Administer analgesic eyewash (oxybuprocaine). Call a physician immediately.
Skin: Immediately flush skin with plenty of cool, running water for at least 15 minutes while removing contaminated clothing and shoes. Wash clothing before reuse.
Ingestion: Rinse mouth at once; then drink 1 or 2 large glasses of water or milk. **DO NOT** induce vomiting. **NEVER** give anything by mouth to an unconscious person. Take person to hospital.
Inhalation: Immediately move a person to fresh air.

5. FIRE AND EXPLOSION DATA
- Special fire hazards: Product (concentrate) can decompose and will release oxygen thereby adding to the fire hazard.
- Fire fighting methods: Product is not flammable and can be quickly diluted with clean water.
- Oxidizing Agent may cause spontaneous ignition with oxidizing agents.

6. SPILL OR LEAK PROCEDURES
- Cleanup: Rinse small amounts to drain when possible. Dike or dam large spills, pump to containers or soak in inert absorbent. Flush residue to sanitary sewer, rinse area thoroughly with clean water.
- Avoid materials that are incompatible with concentrate.
- Waste Disposal: Consult state and local authorities for restrictions on disposal of chemical wastes. Unused product (concentrate) is classified as a (D002) by RCRA criteria.

ZeroTol®

Broad Spectrum Algaecide/Fungicide

SPECIMEN LABEL

PREVENTATIVE TREATMENT FOR ORNAMENTAL PLANTS AND TURF

A treatment for the prevention and suppression / control of horticultural diseases in Commercial Greenhouses, Garden Centers, Landscapes, Nurseries and Interiorscapes.

FOR HORTICULTURAL AND COMMERCIAL USE ONLY

ACTIVE INGREDIENT:	
Hydrogen Dioxide:	27%
OTHER INGREDIENTS:	73%
TOTAL:	**100%**

KEEP OUT OF REACH OF CHILDREN

DANGER – PELIGRO

Si usted no entiende la etiqueta, busque a alguien para que se la explique a usted en detalle. (If you do not understand this label, find someone to explain it to you in detail.)

FIRST AID:

If in eyes

- Hold eye open and rinse slowly and gently with water for 15-20 minutes.
- Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye.
- Call a poison control center or doctor for treatment advice.

If on skin or clothing

- Take off contaminated clothing.
- Rinse skin immediately with plenty of water for 15-20 minutes.
- Call a poison control center or doctor for treatment advice.

If swallowed

- Call poison control center or doctor immediately for treatment advice.
- Have person sip a glass of water if able to swallow.
- Do not induce vomiting unless told to do so by the poison control center.
- Do not give anything by mouth to an unconscious person.

If inhaled

- Move person to fresh air.
- If person is not breathing, call 911 or an ambulance, give them artificial respiration, preferably mouth-to-mouth if possible.
- Call poison control center or doctor for treatment advice.

Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-222-1222 for emergency medical treatment information.

NOTE TO PHYSICIAN:
Probable mucosal damage may contraindicate the use of gastric lavage.

Sold by: BioSafe Systems LLC
22 Meadow Street East Hartford, CT 06108
EPA Registration No. 70299-1
EPA Establishment No. 60156-IL-001

PRECAUTIONARY STATEMENTS HAZARDS TO HUMAN AND DOMESTIC ANIMALS DANGER:

Corrosive: Concentrate causes irreversible eye damage. Concentrate may be fatal if swallowed. Concentrate causes skin irritation or temporary discoloration on exposed skin. Do not breathe vapor of concentrate. Do not get concentrate in eyes, on skin or on clothing.

PERSONAL PROTECTIVE EQUIPMENT (PPE):
When handling concentrate wear protective eyewear (goggles or face shield) and rubber gloves. Applicators and handlers must wear coveralls over long-sleeved shirt, long pants, and chemical resistant footwear plus socks. Follow manufacturer's instructions for cleaning/maintaining PPE. If no such instructions exist for washables, use detergent and hot water.

USER SAFETY RECOMMENDATIONS:
Users should wash hands thoroughly with soap and water before eating, drinking, chewing gum, using tobacco or using the toilet. Users should remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing. Remove PPE immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.

ENVIRONMENTAL HAZARDS:
For Terrestrial Uses: Keep out of lakes, ponds and streams. This pesticide is toxic to birds and fish. Do not apply directly to water, or to areas where surface water is present or to inter-tidal areas below the mean high water mark. Do not contaminate water by cleaning of equipment or disposal of wash waters.

This product is highly toxic to bees and other beneficial insects exposed to direct contact on blooming crops or weeds. Do not apply this product or allow it to drift to blooming crops or weeds while bees are actively visiting the treatment area. Do not apply this product or allow it to drift to crops where beneficials are part of an Integrated Pest Management strategy.

PHYSICAL AND CHEMICAL HAZARDS:
Strong oxidizing agent. **Corrosive.** Do not use in concentrated form. Mix only with water in accordance with label instructions. Never bring concentrate in contact with other pesticides, cleaners or oxidative agents.

DIRECTIONS FOR USE:
It is a violation of Federal law to use this product in a manner inconsistent with its labeling. Do not apply this product in a way that will contact workers or other persons, either directly or through drift. Only protected handlers may be in the area during application. For any requirements specific to your State or Tribe, consult the agency responsible for pesticide regulation.

Agricultural Use Requirements
Use this product only in accordance with its labeling and with the Worker Protection Standard, 40 CFR Part 170. This standard contains requirements for the protection of agricultural workers on farms, forests, nurseries and greenhouses, and handlers of agricultural pesticides. It contains requirements for training, decontamination, notification and emergency assistance. It also contains specific instructions and exceptions pertaining to the statements on this label about Personal Protective Equipment (PPE) and Restricted-Entry Interval (REI). The requirements in this box only apply to the uses of this product that are covered by the Worker Protection Standard.

There is a restricted entry of zero (0) hours for this product.

STORAGE AND DISPOSAL:
Do not contaminate water, food, or feed by storage or disposal.

PESTICIDE STORAGE:
Store in original containers in a cool, well-vented area, away from direct sunlight. Do not allow product to become overheated in storage. This may cause increased degradation of the product, which will decrease product effectiveness. In case of spill, flood area with large quantities of water. Do not store in a manner where cross-contamination with other pesticides or fertilizers could occur.

PESTICIDE DISPOSAL:
Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility. Open dumping is prohibited. If wastes cannot be disposed of according to label directions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste Representative at the nearest EPA Regional Office for guidance.

CONTAINER DISPOSAL:
Triple rinses (or equivalent). Then offer for recycling or dispose in a sanitary landfill, or incineration, if allowed by state and local authorities by burning, stay out of smoke.

- Preventative treatment for suppressing fungal diseases including / Treats / Controls / Prevents: Algae - *Alternaria* - *Anthracnose* - *Aphanomyces* - Black Spot - *Botrytis (grey mold)* - Downy Mildew - *Erwinia* - *Fusarium (root rot)* - Leaf Spot - *Phytophthora (blights, rots)* - *Plasmopara* - *Powdery Mildew* - *Pseudomonas* - *Pythium* - *Rhizoctonia* - Rust - Scab - Smut - *Thielaviopsis* - *Uncinula (powdery mildew)* - *Xanthomonas* - *Wilts & Blights.*

- May be used as a fungicide on bedding plants, flowering plants, roses, poinsettia, ornamentals, nursery stock, trees, turf, cut flowers, bulbs, cuttings, seedlings, seeds and seedbeds.

- May be used as an fungicide and algaecide on greenhouse structures, benches, pots, watering systems, evaporative coolers, storage rooms, ventilation equipment, floors and other equipment.

ZeroTol works by surface contact with the plants and materials being treated. It is important to ensure that all surfaces are thoroughly wetted. ZeroTol does not produce any visible residue, distinct odor or deleterious effects to plants when used in accordance with label directions.

Compatibility:
Do not use at higher than recommended dilution rates as leaf burn may result. ZeroTol has been designed to provide a balanced source of the active ingredient directly to the plant surface and has been shown to not cause adverse cosmetic effects on most plants. Since we have not tested all plant species, however, it is always advisable to test ZeroTol on a few plants before treating large numbers.

Solution Preparation:
- ZeroTol works best when diluted with water containing low levels of organic or inorganic materials and having a neutral pH. Thoroughly rinse out mixing tank with water before mixing concentrate. ZeroTol will readily mix with clean, neutral water and does not require agitation.

- ZeroTol concentrate should not be combined or mixed with any other pesticide or fertilizer.

- ZeroTol is formulated with minimal surfactant for plants having waxy or hairy surfaces. Additional surfactant may be added, if needed for treatment of plants with difficult to reach surfaces.

- ZeroTol is a strong oxidizing agent and may react with residues of metal-based fungicides or supplements. Care should be used when applying ZeroTol as a foliar spray immediately following foliar applications of metal-based products.

USE RATES AND DIRECTIONS FOR GREENHOUSE SURFACES AND EQUIPMENT

ZeroTol can be used to suppress / control fungi and slime forming algae on greenhouse structures, such as: glazing, plastic, benches, walkways, floors, walls, fan blades, ventilation ducts, watering systems, coolers, storage rooms, structures and equipment
1) Sweep and remove all plant debris. Use power sprayer to wash all surfaces to remove loose dirt.
2) Use a dilution of 1:300 or ½ fl. oz. per gallon of clean water. Use a dilution of 1:50 or 2½ fl. oz. per gallon of clean water if surfaces that are to be treated have not been pre-cleaned with water to remove organic deposits. Additional surfactant may be added, if needed.
3) Apply solution with mop, sponge, power sprayer or fogger to thoroughly wet all surfaces.
4) Heavy growths of algae and fungi may have to be scrubbed off following application. Use a solution of ZeroTol to wash away dead growth.
5) Reapply as often as needed for control.

For Clean, Non-Porous Surfaces, Pots, Flats, Trays: Use a dilution of 1:300 or ½ fl. oz per gallon of clean water. Spray until runoff. Additional surfactant may be added, if needed.

For Clean, Non-Porous Surfaces, Pots, Flats, Trays: Use a dilution of 1:100 to 1:300 or 1¼ to ½ fl. oz. per gallon of clean water. Spray until runoff. Additional surfactant may be added, if needed.

Cutting Tools: Use a dilution of 1:300 or ½ fl. oz per gallon of clean water. Soak tools to ensure complete coverage. Additional surfactant may be added, if needed.

For evaporative coolers: treat existing algae and slime contaminated surfaces with a 1:100 dilution. Treat cooler water every week with a dilution of 1:500 or ¼ fl. oz. for every gallon of cooler water.

For irrigation systems (flooded floors, flooded benches, recycled water systems, capillary mats, humidification and misting systems): Treat already contaminated water with a dilution of 1:500 or ¼ fl. oz. for every gallon of water. Treat clean water with a dilution of 1:10,000 or one gallon of ZeroTol per 10,000 gallons of water.

For mist propagation of cuttings and plugs: inject ZeroTol into misting systems to control / suppress algae, fungi and bacterial disease from becoming established on plant material. Inject ZeroTol using a 1:1000 dilution rate, for four to ten days on a consecutive basis. Reduce concentration to 1:5000 and maintain continuous application throughout propagation cycle. At the first sign of disease, increase the concentration of ZeroTol to 1:1000.

As a pre-plant dip treatment: use ZeroTol for the control / suppression of damping-off, root and stem rot diseases such as *Pythium, Phytophthora, Rhizoctonia, Fusarium or Thielaviopsis* on ornamental and nursery plants, seed beds, seeds, seedlings, bulbs, or cuttings.
1) Use 64 fl. oz. per 50 gallons of water, a dilution of 1:100.
2) Immerse plants or cuttings. Remove and allow to drain. Do not rinse.

As a soil or media drench: ZeroTol is effective for the control / suppression of soil borne plant diseases such as *Pythium, Phytophthora, Rhizoctonia, Thielaviopis or Fusarium.* Use as a soil drench at the time

of seeding or transplanting, as well as a periodic drench throughout the plant's life. ZeroTol can also be used on potting soil and growing mediums prior to planting.
1) Use a dilution of 1:100 or 1¼ fl. oz. per gallon of clean water.
2) Apply to soil or growing media to the point of saturation.
3) Wait fifteen minutes before planting or watering.

As a foliar spray treatment in greenhouses: ZeroTol works immediately on contact with any plant surfaces for control / suppression of fungi. Apply ZeroTol to ornamentals, bedding plants, flowering plants, shrubs, and trees. To ensure that this contact fungicide is effective, thorough coverage and wetting of the foliage is necessary.

Initial (Curative) Application:
1) Use a dilution of 1:100 or 1¼ fl. oz. per gallon of clean water. Do not reuse already mixed solution, make fresh daily.
2) Spray, mist or fog plants in early morning or late evening.
3) Thoroughly wet all surfaces of plant, upper and lower foliage, including stems, branches and stalks to ensure full contact with plant and flower tissue.
4) Apply for one to three consecutive days and then follow directions for preventive treatment after the initial application.

Weekly Preventative Treatment:
1) Use a dilution of 1:300 or ½ fl. oz. per gallon of clean water.
2) Spray, mist or fog plants.
3) Thoroughly wet all surfaces of plant, upper and lower foliage, including stems, branches and stalks.
4) Spray every five to seven days as a preventive treatment.
5) At the first sign of disease spray daily with a 1¼ fl. oz. per gallon of water for three consecutive days and then resume weekly preventative treatment.

As a foliar spray treatment in the field: ZeroTol works immediately on contact with any plant surface for control / suppression of disease. Apply ZeroTol to nursery stock such as: woody ornamentals, bedding plants, flowering plants, roses, container plants, azaleas, rhododendrons, conifers, and shade trees. Good coverage and wetting of the foliage is necessary.

Initial (Curative) Application:
1) Use a dilution of 1:100 or 1¼ fl. oz. per gallon of clean water. Do not reuse already mixed solution, make fresh daily.
2) Spray, mist or fog plants and trees, including applications through irrigation or chemigation systems.
3) Thoroughly wet all surfaces of plant, upper and lower foliage, including stems, branches and stalks to ensure full contact with plant and flower tissue.
4) Apply for one to three consecutive days and then follow directions for preventive treatment after the initial application.

Weekly Preventative Treatment:
1) Use a dilution of 1:300 or ½fl. oz. per gallon of clean water.
2) Spray, mist or fog plants and trees, including applications through irrigation or chemigation systems.
3) Thoroughly wet all surfaces of plant, upper and lower foliage, including stems, branches and stalks.
4) Spray every five to seven days as a preventive treatment.
5) At the first sign of disease spray daily with a dilution of 1:100 or 1¼ fl. oz. per gallon of water for three consecutive days and then resume weekly preventative treatment.

For cut flowers: use ZeroTol to prevent fungal diseases such as *Botrytis,* Downy Mildew and Powdery Mildew on flowers in cold storage or in transit. Apply as a post harvest treatment. Use a dilution of 1:500 or ¼ fl. oz. per gallon of clean water. Spray flowers after grading and prior to storage or shipment. Repeat weekly for flowers in storage.

For bareroot nursery stock: use ZeroTol to prevent *Botrytis* on budwood and nursery stock in storage. Use a dilution of 1:100 or 1¼ fl. oz. per gallon of water. Dip plants or spray until dripping wet. Repeat weekly if necessary.

USE RATES AND DIRECTIONS FOR TURF APPLICATIONS

- Broad spectrum treatment for control of algae, fungi and bacteria on turf.
- For use on all turf types such as commercial turf, lawns, athletic fields and golf course fairways, greens and tees.
- Use ZeroTol to control fungi such as: Anthracnose, Brown Spot, Dollar Spot, Copper Spot, Fairy Ring, Pink Snow Mold, Pythium, Phytophthora, Summer Patch, Rhizoctonia, Scum, Take All Patch, Fusarium Blight, Stripe Smut, Leaf Spot, Algae, Slime Molds and their spores.
- ZeroTol controls on contact.

For treatment of turf: use on golf course fairways, greens and tees of Bentgrass, Bluegrass, Bermudagrass, Fescue, Ryegrass, St. Augustinegrass and their mixtures to control / suppress algae, bacterial and fungal diseases, and the odors and conditions that these organisms may cause.

Typical treatment rates involve treating approximately 1000 square feet of lawn area with 3 to 10 gallons of diluted solution. Add a spreader surfactant for best results.

Refer to Table 1 for turf application rates.
- Optimum treatment time is early morning or late afternoon.
- For best results, apply immediately after grass has been cut.
- Applications can be made during wet or rainy weather.
- Use spray solution the same day it is prepared, do not store and reuse mixed spray solution.
- ZeroTol can be injected through automatic irrigation systems in turf areas. Refer to Chemigation Directions for Use for specific instructions on using this product through irritation systems.

For seed bed treatment:
1) Prior to sowing seed, use a dilution of 1:50 or 2½ fl. oz. per gallon of clean water. Thoroughly wet or drench the seedbed, to the point of saturation, with 60 to 100 gallons of dilute solution per 1000 square feet. Let sit for one hour then immediately seed soil.

2) After seeds have germinated, use a dilution of 1:100 or 1¼ fl. oz. per gallon of clean water. Lightly spray or irrigate the soil and seedlings until thoroughly wetted. Retreat once per week until seed is well established.

For soil treatment, pre-inoculation with beneficial organisms: use ZeroTol to reduce the number of potentially plant pathogenic organisms in the soil that will prevent beneficials from becoming established. Use a dilution of 1:50 or 2½ fl. oz. per gallon of clean water. Thoroughly wet or drench the area to be inoculated. Wait one day before inoculating soil.

TABLE 1

DISEASE CONTROLLED	CURATIVE RATE	PREVENTATIVE RATE	NOTES
Anthracnose	6-12 fl. oz. per 1000 sq. ft. Use 3-5 gallons of solution per 1000 sq. ft.	2-6 fl. oz. per 1000 sq. ft. Apply at 7-day intervals.	Curative control may require 2 to 3 consecutive treatments to eradicate disease. Once control is achieved, follow with a 7-day prevention cycle. Combine with a systemic fungicide for residual suppression.
Brown Spot	6-12 fl. oz. per 1000 sq. ft. Use 3-5 gallons of solution per 1000 sq. ft.	2-6 fl. oz. per 1000 sq. ft. Apply at 7-day intervals.	Curative control may require 2 to 3 consecutive treatments to eradicate disease. Once control is achieved, follow with a 7-day prevention cycle. Combine with a systemic fungicide for residual suppression.
Dollar Spot	6-12 fl. oz. per 1000 sq. ft. Use 3-5 gallons of solution per 1000 sq. ft.	2-6 fl. oz. per 1000 sq. ft. Apply at 7-day intervals.	Curative control may require 2 to 3 consecutive treatments to eradicate disease. Once control is achieved, follow with a 7-day prevention cycle. Combine with a systemic fungicide for residual suppression.
Copper Spot	6-12 fl. oz. per 1000 sq. ft. Use 3-5 gallons of solution per 1000 sq. ft.	2-6 fl. oz. per 1000 sq. ft. Apply at 7-day intervals.	Curative control may require 2 to 3 consecutive treatments to eradicate disease. Once control is achieved, follow with a 7-day prevention cycle. Combine with a systemic fungicide for residual suppression.
Summer Patch	6-12 fl. oz. per 1000 sq. ft. Use 3-5 gallons of solution per 1000 sq. ft.	2-6 fl. oz. per 1000 sq. ft. Apply at 7-day intervals.	Curative control may require 2 to 3 consecutive treatments to eradicate disease. Once control is achieved, follow with a 7-day prevention cycle. Combine with a systemic fungicide for residual suppression.
Stripe Smut	6-12 fl. oz. per 1000 sq. ft. Use 3-5 gallons of solution per 1000 sq. ft.	2-6 fl. oz. per 1000 sq. ft. Apply at 7-day intervals.	Curative control may require 2 to 3 consecutive treatments to eradicate disease. Once control is achieved, follow with a 7-day prevention cycle. Combine with a systemic fungicide for residual suppression.
Take All Patch	6-12 fl. oz. per 1000 sq. ft. Use 3-5 gallons of solution per 1000 sq. ft.	2-6 fl. oz. per 1000 sq. ft. Apply at 7-day intervals.	Curative control may require 2 to 3 consecutive treatments to eradicate disease. Once control is achieved, follow with a 7-day prevention cycle. Combine with a systemic fungicide for residual suppression.
Leaf Spot	6-12 fl. oz. per 1000 sq. ft. Use 3-5 gallons of solution per 1000 sq. ft.	2-6 fl. oz. per 1000 sq. ft. Apply at 7-day intervals.	Curative control may require 2 to 3 consecutive treatments to eradicate disease. Once control is achieved, follow with a 7-day prevention cycle. Combine with a systemic fungicide for residual suppression.

DISEASE CONTROLLED	CURATIVE RATE	PREVENTATIVE RATE	NOTES
Fusarium Blight	6-12 fl. oz. per 1000 sq. ft. Use 3-5 gallons of solution per 1000 sq. ft.	2-6 fl. oz. per 1000 sq. ft. Apply at 7-day intervals.	Curative control may require 2 to 3 consecutive treatments to eradicate disease. Once control is achieved, follow with a 7-day prevention cycle. Combine with a systemic fungicide for residual suppression.
Fairy Ring	6-12 fl. oz. per 1000 sq. ft. Use 3-5 gallons of solution per 1000 sq. ft.	2-6 fl. oz. per 1000 sq. ft. Apply at 7-day intervals.	Curative control may require 2 to 3 consecutive treatments to eradicate disease. Drench the soil to saturate the root systems in areas affected. Use 5-10 gallons per 1000 sq.ft.
Pink Snow Mold	6-12 fl. oz. per 1000 sq. ft. Use 3-5 gallons of solution per 1000 sq. ft.	2-6 fl. oz. per 1000 sq. ft. Apply at 7-day intervals.	Spray in early fall to reduce number of dormant spores. Treat throughout winter. May be applied to frozen ground.
Pythium	6-12 fl. oz. per 1000 sq. ft. Use 3-5 gallons of solution per 1000 sq. ft.	2-6 fl. oz. per 1000 sq. ft. Apply at 7-day intervals.	Curative control may require 2 to 3 consecutive treatments to eradicate disease. Drench the soil to saturate the root systems in areas affected. Use 5 - 10 gallons per 1000 sq. ft.
Phytophthora	6-12 fl. oz. per 1000 sq. ft. Use 3-5 gallons of solution per 1000 sq. ft.	2-6 fl. oz. per 1000 sq. ft. Apply at 7-day intervals.	Curative control may require 2 to 3 consecutive treatments to eradicate disease. Drench the soil to saturate the root systems in areas affected. Use 5 - 10 gallons per 1000 sq. ft.
Rhizoctonia	6-12 fl. oz. per 1000 sq. ft. Use 3-5 gallons of solution per 1000 sq. ft.	2-6 fl. oz. per 1000 sq. ft. Apply at 7-day intervals.	Curative control may require 2 to 3 consecutive treatments to eradicate disease. Drench the soil to saturate the root systems in areas affected. Use 5 - 10 gallons per 1000 sq. ft.
Algae & Slime Molds, Scum	6-12 fl. oz. per 1000 sq. ft. Use 3-5 gallons of solution per 1000 sq. ft.	2-6 fl. oz. per 1000 sq. ft. Apply at 7-day intervals.	Curative control may require 2 to 3 consecutive treatments to eradicate disease. Drench the soil to saturate the root systems in areas affected. Use 5 - 10 gallons per 1000 sq. ft.
Heavy Algae	12-25 fl. oz. per 1000 sq. ft.	———	Curative control may require 2 to 3 consecutive treatments to eradicate disease. Once control is achieved, follow with a 7-day prevention cycle. Combine with a systemic fungicide for residual suppression.

CHEMIGATION DIRECTIONS FOR USE:

General Requirements:

1) Apply this product only through a sprinkler including a center pivot, lateral move, end tow, side wheel roll, traveler, solid set, hand move, flood basin, humidification or drip trickle irrigation system, or through misting systems.
2) Crop injury or lack of effectiveness can result from non-uniform distribution of treated water.
3) Ensure that the irrigation system used is properly calibrated and if you have questions, call the state extension service or the equipment manufacturer.
4) Do not connect an irrigation system (including greenhouse systems) used for pesticide application to a public water system unless proper safety devices for public water systems are in place. Read label for instructions.
5) A person knowledgeable of the chemigation system and responsible for its operation, or under the supervision of the responsible person, shall shut the system down and make any necessary adjustments should the need arise.

Specific Requirements:

1) Public water supply means a system for the provision to the public of piped water for human consumption if such system has at least 15 service connections or regularly serves an average of 25 individuals daily at least 60 days throughout the year.
2) Chemigation systems connected to the public water systems must contain a functional, reduced-pressure zone (RPZ), backflow preventer or the functional equivalent in the water supply upstream from the point of pesticide introduction. As an option to the RPZ, the water from the public water system should be discharged into a reservoir tank prior to pesticide introduction. There shall be a complete physical break (air gap) between the outlet end of the fill pipe and the top of the overflow rim of the reservoir tank of at least twice the inside diameter of the fill pipe.
3) The pesticide injection pipeline must contain a functional, automatic, quick closing check valve to prevent the flow of liquid back towards the injector.
4) The pesticide injection pipeline must contain a functional, normally closed, solenoid, operated valve located on the intake side of the injection pump and connected to the system interlock to prevent fluid from being drawn from the supply tank when the irrigation system is either automatically or manually shut down.
5) The system must contain functional interlocking controls to automatically shut off the pesticide injection pump when the water pump motor stops, or in cases where there is no water pump, when the water pressure decreases to the point where pesticide distribution is adversely affected.
6) Systems must use a metering pump, such as a positive displacement injection pump, or equivalent, effectively designed and constructed of materials that are compatible with pesticides and capable of being filled with a system interlock.
7) Do not apply when wind speed favors drift beyond the area intended for treatment.

Application Instructions:

1) Remove scale, pesticide residues, and other foreign matter from the chemical supply tank and entire injector system. Flush with clean water. Failure to provide a clean tank, void of scale or residues may cause product to loose effectiveness or strength.
2) Determine the treatment rates as indicated in the directions for use and make proper dilutions.
3) Prepare a solution in the chemical tank by filling the tank with the required water and then adding product as required. The product will immediately go into suspension without any required agitation.
4) ZeroTol should not be applied in conjunction with any other pesticides or fertilizers; this may cause reduced performance of the product and should be avoided.

WARRANTY:

This material conforms to the description on the label and is reasonably fit for the purposes referred to in the directions for use. Timing, method of application, weather, watering practices, nature of soil, potting medium, disease problem, condition of crop, incompatibility with other chemicals, pre-existing conditions and other conditions influencing the use of this product are beyond the control of the seller. Buyer assumes all risks associated with the use, storage, or handling of this material not in strict accordance with directions given herewith. NO OTHER EXPRESS OR IMPLIED WARRANTY OF FITNESS OR MERCHANTABILITY IS MADE.

ZeroTol®
Broad Spectrum Algaecide/Fungicide

MATERIAL SAFETY DATA SHEET

1. IDENTIFICATION

Product Name: ZeroTol®
Product Type: Algaecide / Fungicide
Manufacturer: BioSafe Systems LLC
22 Meadow Street
East Hartford, CT 16108
Office Telephone: (888) 273-3088
Emergency: CHEMTREC: 800-424-9300
(24 HOURS EVERY DAY)
Creation Date: 3/08
NOTE: Not valid two years after creation date.

EPA Registration No. 70299-1
EPA Establishment No. 60156-IL-001

2. HAZARDOUS COMPONENTS

Peroxyacetic Acid C.A.S. . . . . .#79-21-0
Hydrogen Peroxide C.A.S. . . . . .#7722-84-1

3. HEALTH HAZARDS DATA

Health effects to over exposure to Concentrate
- Corrosive to mucous membranes, eyes and skin
- The seriousness of the lesions and the prognosis of intoxication depend directly on the concentration and duration of exposure.

Skin: May cause TEMPORARY skin discoloration and irritation
Eyes: May cause severe eye damage
Ingestion: HARMFUL OR FATAL: Causes chemical burns of mouth, throat and stomach.
- Corrosive to gastrointestinal tract
- Paleness and cyanosis of the face
- Excessive fluid in the mouth and nose
- Bloating of stomach and belching
- Nausea and vomiting
- Risk of chemical pneumonitis and pulmonary edema

Inhalation: Vapors or mist can cause irritation. People with asthma or other lung problems may be more affected.

4. FIRST AID

If in eyes: Hold eye open and rinse slowly, and gently with water for 15 – 20 minutes. Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. Call a poison control center or doctor for treatment advice.

If on skin or clothing: Take off contaminatedclothing. Rinse skin immediately with plenty of water for 15 – 20 minutes. Call a poison control center or doctor for treatment advice.

If swallowed: Call poison control center or doctor immediately for treatment advice. Have person sip a glass of water if able to swallow. Do not induce vomiting unless told to do so by a poison control center or doctor. Do not give anything by mouth to an unconscious person.

If inhaled: Move person to fresh air. If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. Call poison control center or doctor for treatment advice.

Have the product container or label with you when calling a poison control center or doctor,or going for treatment. You may also contact **1-800-222-1222** for emergency medical treatment information.

NOTE TO PHYSICIAN: Probable mucosal damage may contraindicate the use of gastric lavage.

5. FIRE AND EXPLOSION DATA

- Special fire hazards: Product (concentrate) can decompose and will release oxygen thereby adding to the fire hazard.
- Fire fighting methods: Product is not flammable and can be quickly diluted with clean water.
- Oxidizing Agent may cause spontaneous ignition with oxidizing agents.

6. SPILL OR LEAK PROCEDURES

- Cleanup: Rinse small amounts to drain when possible. Dike or dam large spills, pump to containers or soak in inert absorbent. Flush residue to sanitary sewer, rinse area thoroughly with clean water.
- Avoid materials that are incompatible with concentrate.
- Waste Disposal: Consult state and local authorities for restrictions on disposal of chemical wastes. Unused product (concentrate) is classified as a (D002) by RCRA criteria.

7. HANDLING AND STORAGE

- Never return product back to the original container
- Keep concentrate away from reactive substances
- Prevent contact with organic materials
- Keep product in original container
- Store in cool, ventilated area
- Keep out of direct sunlight
- Never use metal containers or spigots
- Use vented container
- Warn personnel of dangers of concentrated product

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Respiratory: Avoid breathing mists or vapors of concentrate
Eyes: Use chemical splash goggles when handling concentrate. For continued severe exposure, wear a face shield over the goggles.
Skin: Rubber gloves - protective or gauntlet type preferred when handling concentrate. Use aprons.

ACGIH TLV: 1 PPM 8 HOUR TWA
1.4 mg/m3 TWA
OSHA PEL: 1 PPM 8 HOURS TWA
1.4 mg/m3 TWA

Respiratory protection:
- NIOSH approved full-face respirator for excessive conditions
- Hand gloves for handling concentrate = butyl rubber
- Eye protection - chemical proof goggles/face shield for splash risk
- Skin protection - coveralls when handling concentrate

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance: Clear, colorless liquid
Odor: Pungent
Freezing Point: -30 C (-22F)
Boiling Point: Not applicable, product decomposes
Specific gravity: 1.09
pH: 1.33
Solubility: Complete
Decomposition temperature: self-accelerating decomposition temperature > 55C

10. STABILITY AND REACTIVITY

Stability: Stable under normal conditions, with slow oxygen release.
Conditions to avoid: Heat / Direct Sunlight
Materials to avoid: Acids · Bases · Reducing Agents
Organic Materials · Metals · Salts of Metals

11. TOXICOLOGICAL INFORMATION:

Acute Toxicology:
- Oral route, LD50, rat 330 mg/kg. Test substance 7% solution.
- Dermal route, LD50 rabbit, 1410 mg/kg. Test substance: 10% solution
- Inhalation, LD50, four hours, rat 4080 mg/kg. Test substance: 5% solution

Irritation:
- Rabbit, corrosive (eyes) Test substance: 4% solution
- Rabbit, corrosive (skin) Test substance 5% solution
- Rat, irritant (respiratory tract)

Chronic Toxicity:
- Dermal = >0.12% solution, irritating effect
- Inhalation = > 5 mg. m3, irritant
- Route of entry = Inhalation / ingestion

12. ECOLOGICAL INFORMATION

Toxic to simple cell and aquatic organisms Danger to the environment limited; due to product properties.
- No bioaccumulation
- Soil degradation = 99% in 20 minutes
- Considerable abiotic and biotic degradability
- Sediments = Non-significant adsorption
- Weak persistence of degradation products
- Degradation products = water & oxygen

Acute Ecotoxicity:
- Fish, Rainbow trout LC50, 48 hours > 40 mg/L
- Crustaceans, EC 50,48 hours 126.8 mg/l 1 mg/L
- Bacteria, Pseudomonas aeruginosa, EC 100, 5 minutes, % 5mg/L

13. DISPOSAL CONSIDERATIONS

- Store in original containers in a cool, well-vented area, away from direct sunlight. Do not allow product to become overheated in storage. This may cause increased degradation of the product, which will decrease product effectiveness. In case of spill, flood area with large quantities of water. Do not store in a manner where cross-contamination with other pesticides or fertilizers could occur.
- Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility. Open dumping is prohibited. If wastes cannot be disposed of according to label directions, contact your State Pesticide or Environmental Control Agency, or the Hazardous Waste Representative at the nearest EPA Regional Office for guidance.
- Triple rinse (or equivalent). Then offer for recycling or dispose in a sanitary landfill, or incineration, if allowed by state and local authorities by burning. Stay out of smoke.

14. TRANSPORT INFORMATION

DOT Shipping Name: Hydrogen Peroxide and peroxyacetic acid mixture, stabilized, not more than 5% Peroxyacetic acid.
UN Number: 3149
Hazard Class: 5.1
Primary Hazard Label: Oxidizer
Subsidiary Risk Label: Corrosive
Packing Group: II
Shipping Container: UN Certified vented polyethylene. 2.5, 30, 55 and 275 gallon polyethylene drums

Regulatory Information
TSCA Inventory List: YES
CERCLA Hazardous Substance (40 CFR 302)
Listed substance: NO
Unlisted Substance: YES
Characteristic: Corrosive
Reportable Quantity: 100 pounds
NFPA Rating Health – 2 Flammability – 0 Reactivity – 3 Special – OXY
HMIS Rating Health – 2 Flammability – 0 Reactivity – 2 PPE - Required
Canadian WHMIS Classification
C – Oxidizing E – Corrosive F – Dangerously Reactive

To the extent of our knowledge, the information herein is accurate as of the date of this document. However, neither BioSafe Systems nor any of its affiliates make any warranty, expressed or implied, or accept any liability in connection with the information or its use. The information is for use by technically skilled persons at their own discretion and risk. This is not a license or a patent. The user alone must finally determine suitability of any information or material for any contemplated use, the manner or use and whether any patents are infringed.

SANIDATE®

Ready to Use

Sublabel A: Commercial Directions for Use
Sublabel B: Residential Directions for Use

Active Ingredient:
Hydrogen Peroxide 0.108%
Other Ingredients: 99.892%
Total: 100.00%

KEEP OUT OF REACH OF CHILDREN
CAUTION

FIRST AID	
If on skin or clothing	• Take off contaminated clothing. • Rinse skin immediately with plenty of water for 15-20 minutes. • Call a poison control center or doctor for treatment advice.
If in eyes	• Hold eye open and rinse slowly and gently with water for 15 – 20 minutes. • Remove contact lenses, if present, after the first 5 minutes, then continue rinsing eye. • Call a poison control center or doctor for treatment advice.
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. You may also contact 1-800-222-1222 for emergency medical treatment information.	

See (back) (side) (inside) panel for additional precautionary statements and directions for use.

EPA Registration No. (pending as 70299-O)
EPA Establishment No. 68660-TX-001; 58996-MO-001

Sold by:
BioSafe Systems
22 Meadow Street
East Hartford, CT 06108

Net Contents: (32 fl oz, 2 liter, 1 and 5 gallon(s))

ACCEPTED
with COMMENTS
In EPA Letter Dated:
MAY 25 2007
Under the Federal Insecticide, Fungicide, and Rodenticide Act as amended, for the pesticide registered under EPA Reg. No
70299-9

Sublabel A: Commercial Directions for Use

PRECAUTIONARY STATEMENTS

HAZARDS TO HUMANS AND DOMESTIC ANIMALS - CAUTION: Causes moderate eye irritation. Avoid contact with eyes, skin or clothing. Wash thoroughly with soap and water after handling and before eating, drinking, chewing gum or using tobacco.

ENVIRONMENTAL HAZARDS: Do not contaminate water when disposing of equipment washwaters or rinsate. [For 5 gallon products only] Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or other waters unless in accordance with the requirements of a National Pollutant Discharge elimination System (NPDES) permit and the permitting authority has been notified in writing prior to discharge. Do not discharge effluent containing this product to sewer systems without previously notifying the local sewage treatment plant authority. For guidance contact your State Water board of Regional Office of the EPA.

SURFACE SANITATION

SANIDATE® Ready to Use is an effective sanitizer against gram positive and gram negative bacteria (vegetative forms) such as *Staphylococcus aureus*, [redacted], *and Klebsiella pneumoniae.*

Use this product in general commercial environments to clean, sanitize, and deodorize inanimate surfaces, such as:

- Floors, walls, and other non-porous surfaces such as tables, chairs, counter tops, garbage cans/bins, bathroom fixtures, sinks, bed frames, shelves, racks, carts, refrigerators, coolers, tile, and use sites listed on this label made of linoleum, vinyl, porcelain, plastic (such as polyethylene), stainless steel, or glass
- Schools, colleges, industrial facilities, dietary areas, office buildings, recreational facilities, retail and wholesale establishments.
- Animal hospitals, veterinary clinics, animal life science laboratories, kennels, kennel runs, cages, feeding and watering equipment, pet shops, zoos, pet animal quarters, poultry premises, trucks, hatcheries and live stock quarters.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

APPLICATION INSTRUCTIONS

(For Spray Bottle) Turn nozzle to "spray" or "stream". Spray 6 to 8 inches from surface.

Remove Gross Filth

[redacted]

To Sanitize: Pre-clean surfaces to be treated with a recommended detergent, or with a cleaning treatment of SaniDate® Ready to Use. Spray until thoroughly wet; *do not dilute.* Let stand [redacted]s, and then air dry. No potable rinse is required.

5 minutes

ACCEPTED with COMMENTS In EPA Letter Dated: MAY 25 2007

Under the Federal Insecticide, Fungicide, and Rodenticide Act as amended, for the pesticide, registered under EPA Reg. No 70299-9

(For 1 or 5 Gallon Container) Pour required amount into bucket; *do not dilute*. Apply solution with a mop, cloth, sponge, brush, scrubber, or coarse spray device, or by soaking to completely immerse all surfaces to be treated.

General Cleaning: Apply solution directly on to soils and wipe clean. Repeat for heavily soiled surfaces.

To Sanitize: Pre-clean surfaces to be treated with a recommended detergent or with a cleaning treatment of SaniDate® Ready to Use, and rinse well with potable water. Apply fresh solution to surface until thoroughly wet; *do not dilute*. Let stand for 30 seconds; and then air dry. No potable rinse is required.

Remove gross filth

5 minutes

SANITIZING AND DEODORIZING OF ANIMAL HOUSING FACILITIES (BARNS, KENNELS and calfs, and any other areas that are prone to odors caused by microorganisms. Before using:

1. Remove all animals and feed from premises, vehicles and enclosures.
2. Remove all litter, manure, and gross filth from floors, walls and surfaces of barns, pens, stalls, chutes and other facilities occupied or traversed by animals.
3. Empty all troughs, racks and other feeding and watering appliances.
4. Follow Application Directions listed for spray bottle or container.

SANITATION OF NON-FOOD CONTACT PACKAGING EQUIPMENT

Prior to using this product

1. Remove gross soil particles from surfaces.
2. Wash with a recommended detergent solution and rinse thoroughly with potable water.
3. Apply solution according to Application Directions, and *allow surfaces to drain thoroughly before operations are resumed.*

STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage or disposal.

Pesticide Storage: Store in original containers in a cool, well-vented area, away from direct sunlight. Do not allow product to become overheated in storage. This may cause increased degradation of the product, which will decrease product effectiveness. In case of spill, flood area with large quantities of water.

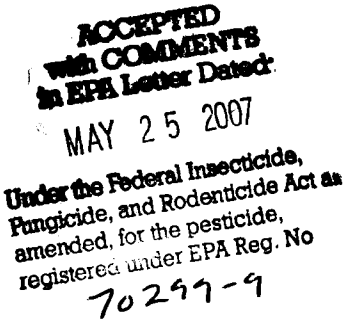
Container Disposal: If empty – Do not reuse this container. Place in trash or offer for recycling if available. **If partly filled** – Never place unused product down any indoor or outdoor drain.

ACCEPTED with COMMENTS In EPA Letter Dated MAY 25 2007

Under the Federal Insecticide, Fungicide, and Rodenticide Act as amended, for the pesticide, registered under EPA Reg. No 70299-9

WARRANTY

This material conforms to the description on the label and is reasonably fit for the purposes referred to in the directions for use. Timing, unfavorable temperatures, water conditions, presence of other materials, method of application, weather, watering practices, nature of soil, disease problem, condition of crop, incompatibility with other chemicals, pre-existing conditions and other conditions influencing the use of this product are beyond the control of the seller. Buyer assumes all risks associated with the use, storage, or handling of this material not in strict accordance with directions given herewith. NO OTHER EXPRESS OR IMPLIED WARRANTY OF FITNESS OR MERCHANTABILITY IS MADE.



PRECAUTIONARY STATEMENTS

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ENVIRONMENTAL HAZARDS: Do not contaminate water when disposing of equipment washwaters or rinsate.

SaniDate® Ready to Use is an activated form of hydrogen peroxide and can be used to clean, sanitize, and deodorize floors, walls, and other hard, non-porous surfaces such as linoleum, vinyl, porcelain tile, plastic polyethylene, stainless steel, and glass.

SaniDate® Ready to Use is an effective sanitizer against gram positive and gram negative bacteria such as *Staphylococcus aureus (Staph)*, [redacted] and *Klebsiella peumoniae*.

DIRECTIONS FOR USE

It is a violation of Federal law to use this product in a manner inconsistent with its labeling.

APPLICATION INSTRUCTIONS

(For Spray Bottle) Turn nozzle to "spray" or "stream". Spray 6 to 8 inches from surface.

~~General Cleaning: Spray product directly on to soils and wipe clean with a dry paper towel or lint free cloth. Repeat for heavily soiled surfaces.~~

To Sanitize: Pre-clean surfaces to be treated with a recommended detergent, or with a cleaning treatment of SaniDate® Ready to Use. Spray until thoroughly wet; *do not dilute*. ~~Let stand 30~~ 5 minutes seconds, and then air dry. No potable rinse is required.

Remove Gross Filth

(For 1 or 5 Gallon Container) Pour required amount into bucket; *do not dilute*. Apply solution with a mop, cloth, sponge, brush, scrubber, or coarse spray device, or by soaking to completely immerse all surfaces to be treated.

~~General Cleaning: Apply solution directly on to soils and wipe clean. Repeat for heavily soiled surfaces.~~

To Sanitize: Pre-clean surfaces to be treated with a recommended detergent or with a cleaning treatment of SaniDate® Ready to Use, and rinse well with potable water. Apply fresh solution to surface until thoroughly wet; *do not dilute*. ~~Let stand for 30~~ seconds; and then air dry. No potable rinse is required. 5 minutes

Remove Gross Filth

ACCEPTED
with COMMENTS
In EPA Letter Dated:
MAY 25 2007
Under the Federal Insecticide, Fungicide, and Rodenticide Act as amended, for the pesticide, registered u[illegible]
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Appendix D

Preharvest Peroxyacetic Acid Sprays Slow Decay and Extend Shelf-life of Strawberries

J.A. Narciso[1], E.A Baldwin, and A. Plotto

USDA-ARS, Citrus & Subtropical Products Laboratory, 600 Avenue S, N.W., Winter Haven, FL 33881

This material is based on work supported by the Florida Strawberry Association.

[1] To whom reprint requests should be addressed. E-mail: jan@citrus.usda.gov

Subject Category: Postharvest Biology and Technology

Preharvest Peroxyacetic Acid Sprays Slow Decay and Extend Shelf-life of Strawberries

Additional index words. *Fragaria* × *ananassa*, *Botrytis cinerea*, *Rhizopus stolonifer*, storage, postharvest

Abstract. Strawberry is the most important berry crop in Florida. Yearly losses can be attributed to pre and postharvest decay caused by *Botrytis cinerea* P. Micheli ex Pers., and postharvest decay due primarily to *Rhizopus stolonifer* (Ehrenb. ex Fr.) Vuillemin. In this study the sanitizer peroxyacetic acid (100 μL/L) was sprayed on the flowers and developing berries 1, 2 and 3 days preharvest. Those berries sprayed 3 days prior to harvest generally had significantly less decay than berries that were sprayed 1 day preharvest or not sprayed when stored at 18 °C. Berries sprayed in the field with peroxyacetic acid and then coated postharvest with a 1% chitosan coating, had reduced decay compared to berries only treated preharvest with PAA for up to 12 days in storage. Sensitivity of *Botrytis* hyphae and conidia to PAA was shown by the presence of a zone of inhibition, using the disc assay method.

The United States is the largest producer of strawberries with average yields ranking highest in the world (USDA, 2005). Florida is second only to California in strawberry production with numbers of exported berries rising. Florida strawberries are almost entirely sold for fresh market, with approximately 69% of the crop picked and shipped in February/March and another 13% harvested in November/December, due to the development of early ripening varieties (USDA, 2005). Americans are large consumers of strawberries, with an increasing demand for high quality berries with adequate post-purchase shelf life.

Strawberries have high levels of antioxidants (Wu et al., 2004) and are under increasing demand by consumers of organic produce. The berry is extremely fragile and perishable, necessitating minimal handling after harvest (Mitcham and Mitchell, 2002). For this reason, strawberries are harvested and packed in the field directly into retail clamshell containers that are delivered to the supermarket. Therefore, any treatment to reduce decay of strawberries would best be done as a pre-harvest operation to fit the current industrial harvesting and handling practices. Postharvest decay treatments to strawberries would only be accepted by the industry if decay reduction and resulting shelf life extension were very significant, justifying a change in the current harvesting and handling operation. In most cases, any postharvest handling of strawberries leads to injury, which provides increased opportunity for wound pathogens and enhances decay.

Berry losses due to diseases are often difficult to assess because of plant variety and cultural practices, which vary with locality, handling, storage and marketing (Maas, 1980). Fungi are the most significant pre and postharvest decay organisms for strawberries in Florida. Botrytis berry rot, (causal organism,

Botrytis cinerea), causes both pre and postharvest disease. It initiates infection in the field at the flowering or young berry stage, often remaining latent until postharvest (USDA, 2005; Blacharski et al., 2001; Maas, 1980). *Botrytis* is a facultative parasite producing a repeating cycle of asexual spores on senescent tissues, diseased flowers or berries, that are dispersed to young plant tissues by rain, wind or insects (Blacharski et al., 2001; Maas, 1980).

More important as postharvest than preharvest pathogens are species of *Rhizopus* and *Muco*r, Zygomycetes, commonly found in soil. These fungi are wound parasites and can become established on ripe berries within 12 hours (Maas, 1980). Preharvest applications of fungicides have been shown to increase yields and decrease postharvest decay caused by *Botrytis.* Fungicides are residual on the fruit/plant, and because they are still present, fungi can acquire resistance to them rendering them ineffective (Maas, 1980; Maas and Smith, 1972), and are not acceptable for the organic market. *Rhizopus* and related opportunistic organisms are not well-controlled by preharvest fungicidal sprays.

After harvest, refrigeration is most commonly used to slow decay in strawberries and maintain quality (Nunes et al., 2002; El Gaouth et al., 1991; Maas, 1980). Most fungicides cannot maintain berry quality without the aid of refrigeration (Blacharski et al., 2001). In addition to preharvest treatments, postharvest applications of films and coatings, such as chitosan, act as antimicrobial agents while maintaining berry quality (USDA, 2005; El Gaouth et al., 1991; 1992; 1997). For organic berries, use of acidic vapors, food additives and water dips offer some protection from decay (Karabulut et al., 2004; Park et al., 2005; Sholberg et al., 2000).

While postharvest surface treatments may delay decay, keeping spores from developing on plant tissues while in the field is most efficacious (USDA, 2005; Blacharski et al., 2001; Maas, 1980; Maas and Smith, 1972). Our primary objective was to lengthen shelf-life of strawberries using the non-residual commercial disinfectant, peroxyacetic acid (PAA), as an antimicrobial preharvest spray, to affect postharvest decay. Postharvest coatings were also applied to the berry surface to enhance the antimicrobial control of the preharvest-applied PAA. This disinfectant/sanitizer is soon to be approved for the organic market and has been shown to be effective against postharvest decay when applied postharvest on mango and citrus (Narcisso and Plotto, 2005; Narcisso, 2005).

Materials and Methods

Experimental strawberry plants, *Fragaria* X *ananassa* Duchesne, variety 'Strawberry Festival', were located at the Florida Strawberry Growers Research and Education Center in Dover, Fla. Plants were situated in a commercial field in a double row bed with 30.5 cm spacing between rows. Water and fertilizer were provided through drip tape subsequent to initial overhead irrigation after transplanting. The rows were approximately 74m long and each row was divided into six blocks with 54-57 plants in each block. A buffer area of approximately 0.61 m at the start and the end of each row was used to better isolate experimental plants from open areas. Studies on strawberry plants in this field began in January 2006.

Spraying: Before spraying, ripe berries were harvested from all plants in the experimental areas (including control or non-sprayed blocks). This left only

flowers or very young berries for synchronized ripening. Commercial PAA (OxiDate, BioSafe Systems, Glastonbury, Conn.) was mixed on-site (100 $\mu L \cdot L^{-1}$) in 8 L hand-sprayers (Chapin, Batavia, N.Y.). Spraying took place 3 days, 2 days and 1 day (3S, 2S and 1S) before harvesting the berries from the experimental rows (e.g. 3S berries were harvested the morning of the 4th day after spraying, leaving plant in "contact" with the spray for 3 days). Three days before the first harvest, the first blocks of each of two experimental rows was sprayed (3S) with 14 L of PAA per one block area, using a heavy mist setting and completely covering all surfaces and all parts of the plant. Plants were not re-sprayed during the course of each experiment. Hand-held plastic barriers were used to prevent spray from drifting to unsprayed areas. The following day, the spray protocol was repeated, and again on the third day. Three days after the initial spray, all the ripe berries in the experimental spray and non-sprayed areas were harvested. The berries were picked with gloved hands and placed directly into PETE (polyethylene terephthalate) 325 mL vented clamshell containers (Pactiv Corp., Lake Forest, Ill.), 10 berries per container, 6 to 15 containers per treatment, similar to commercial operations. The clamshells were packed in plastic crates and taken back to the Citrus and Subtropical Products Laboratory in Winter Haven. The berries were stored at 5 °C overnight to remove field heat, and then moved to an 18 °C storage room with 95% relative humidity (RH). Commercially, strawberries are held at 1-3 °C to prevent decay (Mitcham and Mitchell, 2002), but the abusive storage temperature of 18 °C was used to accelerate decay. Temperature and humidity were monitored by data loggers (Dickson Pro Series, Dickson, Addison, Ill.). Decay was evaluated every few

days depending on decay advance and was logged when evident. Berries were considered decayed when 30% or more of the surface was covered with lesions or there was visible mycelium. This process of spraying and evaluating decay was repeated three times in January, February and March of 2006.

Determination of Microbial Load on Immature Berries: A study of the effect of PAA on the microbial load of developing berries was made concurrently with the March 2006 spray experiment. On the first day of spraying (3 days prior to harvest) immature berry samples (green to white color stage) were randomly picked from each of the 3 experimental blocks (spray areas) and placed into sterile WhirlPak bags (Nasco, Modesto, Calif.), 5 berries per bag, 4 bags per experimental block. The bags were placed in a cooler and taken back to the laboratory where they were weighed. After weighing, 99 mL of sterile phosphate buffer (pH 7.2) was added to each bag and the berries and the buffer were manually agitated for 2 minutes to remove the microflora from the surface of the berries. The buffer was analyzed by the protocol described by Narciso and Plotto (2005).

Weather: Averages of weather parameters during duration of each study such as air temperatures (60 cm above the surface of the ground), precipitation, wind speeds and solar radiation were evaluated to better understand differences in field results. Weather data was obtained from the Florida Automated Weather Service, Dover, Fla, Station.

Postharvest treatments: In March 2006, experimental blocks were sprayed 3 days preharvest with 100 ppm solution PAA following the protocol previously described. On harvest day, approximately 300 berries from plants

sprayed 3 days earlier were picked and placed in a clean container. Three-hundred berries were also picked from the corresponding no-spray (control) group of plants and placed in a separate container. Berries were taken back to the laboratory, sorted and stored at 5 °C until treated.

Previously sprayed and non-sprayed stored berries were divided into 4 groups of 10 per treatment. Treatments were manually sprayed onto berries using 250 mL misters (Fisher Scientific, Atlanta). There were 5 treatments applied to the berries harvested from sprayed and non-sprayed sections of the field: no-treatment; distilled water; 50 $\mu L \cdot L^{-1}$ PAA (a formulation of PAA rated for post harvest, StorOx, BioSafe Systems, Glastonbury, Conn.); chitosan (0.1% in 0.5% glacial acetic acid, France-Chitine, Orange , France); and sodium propionate (0.5%, Avocado Research Chemicals, Ltd, Lancashire, UK). The berries were spread on plastic mesh (commercial mesh size 0.9 × 1.3cm) stretched between 30.5 × 30.5 cm PVC frames to allow the treatments to drain and the berries to dry.

After drying, the berries were placed into containers as described above, 10 berries per container. The berries were stored at 18 °C at 95% RH. Decay was logged as previously described.

Determination of *Botrytis* and *Rhizopus* sensitivity to PAA and chitosan:

To test the effect of PAA on *Botrytis* and *Rhizopus* spores, the disc assay method was used. Spores were collected from plates of *Botrytis* or *Rhizopus.* Organisms were grown on potato dextrose agar for 5-7 days at 25 °C. Spores were removed from the colony surface with a solution of sterile water and 0.1% Tween 20 while gently rubbing plate surface with a sterile glass rod. Spores were filtered through three layers of cheesecloth and adjusted to ~3.0 X 10^5 spores/mL with a

haemocytometer. Two hundred and fifty μL of inoculum of either *Botrytis* or *Rhizopus* were placed on the surface of potato dextrose agar plates and evenly spread with a sterile glass rod. Four sterile filter paper discs (10.5 mm) (Ace Glass Inc., Vineland, N.J.) were placed in a container with a solution of 100 ppm PAA and swirled for 30 sec. The discs were drained, removed with sterile forceps and placed on the surface of the inoculated plates. Plates were incubated at 25 °C for 10-14 days.

Determination of sensitivity of *Botrytis* to chitosan coating: Effect of chitosan on growth of *Botrytis* was determined using the same method described above. The discs were placed in 0.1% chitosan in 0.5% glacial acetic acid for 30 seconds and placed on plates coated with the *Botrytis* inoculum. The chitosan buffer was also tested.

Statistical Analysis: The Wilcoxon Rank-Sum Test for Difference in Medians and Equal Variance (T-Test) and the Kruskal-Wallis test were used to determine significance between decay rates of the different spray groups and the average decay of the non-spray group. Tests were based on data distribution (Number Cruncher Statistical System, Kaysville, Utah; and SAS System Software Version 9.1, SAS Institute, Cary, N.C.) with $P \leq 0.05$ designated as significance of difference.

Results and Discussion

Designations are (S) for sprayed (NS) for non-sprayed berries. 3S berries were sprayed 3 days before harvest, 2S berries were sprayed 2 days before harvest and 1S berries were sprayed the day before harvest.

In January, two experimental groups were picked within 3 days of each other and designated as harvest 1 and 2. For harvest 1, sixteen days postharvest, 3S berries had significantly less decay (20%) than NS berries (50%) while 2S and 1S berries had 35% and 63% decay, respectively, and were not significantly different from the average NS decay rate of 50% (Fig. 1 and 2A). However, 17 days after harvest, both 3S and 2S berries had significantly less decay (37% and 42% respectively) than the NS group (60%). Twenty days postharvest, all sprayed groups had decay (3S=81%; 2S=84%; 1S= 92%) that was not different from the NS group (91%) (Fig. 1 and 2A).

Data from harvest 2 in January, showed similar results. Thirteen days postharvest, 3S and 2S spray berries had significantly less decay (12% and 21% respectively) than the 1S (43%) or the NS group (48%) (Fig. 1 and 2B). Seventeen days postharvest , only the 3S group had less decay (54%) than the NS (82%) (2S = 75%) (Fig. 1 and 2B). For both January trials, those berries sprayed 3 days (3S) before harvest had slightly less decay than the 2S group and significantly slower rates of decay than the 1S and NS group. Weather parameters for these trials showed temperatures at 60 cm above the surface of the soil with an average high of 22.6°C and average low temperature of 5.86° C with negligible rain and intermittent sun (163 w/m^2).

In February, there were two experimental groups picked from different sectors of the commercial field: experiment 1 contained interior blocks protected from open spaces and experiment 2 contained exterior blocks at the edge of the field. Data for experiment 1 showed no significant difference in decay between sprayed and non-sprayed berries until 13 days after harvest (Fig. 1 and 3A). After

thirteen days, 3S and 2S groups had less decay (67% and 48%, respectively) than the 1S (80%) and the NS (81%) group (Fig. 1 and 3A). After 17 days, all groups had decay greater than 90%.

Data for experiment 2 was comparable to experiment 1 with the exception that decay was slower in all groups. Nine days postharvest, 3S and 2S had less decay (8% and 4% respectively) than the 1S (27%) and the NS (27%) group (Fig. 1 and 3B). Thirteen days postharvest, the 3S and 2S groups remained significantly less decayed (39% and 53% respectively) than the 1S (68%) and the NS (77%) group (Fig. 1 and 3B).

Weather data for this time period showed temperatures with an average high of 20.0 °C, and average low of 16.0 °C at 60 cm above the soil surface with negligible rain and intermittent sun (159 w/m^2). Wind speeds, as would have affected the exterior block, were between 2 and 4 mph during this period. Although the actual decay rates were different between the January and February experimental groups, the berries that were sprayed 3 days prior to harvest had the slowest decay rates followed by the 2S group. Those berries sprayed the day before harvest generally did not show any difference in decay rates when compared to the non-sprayed group.

Data for March show decay rates for all three spray groups (3S, 2S and 1S) were significantly less than those of the NS group (Fig. 1 and 4). Nine days postharvest, percent decay of 3S, 2S and 1S was 9%, 10% and 13% respectively while the NS group was 28%. At 17 days postharvest, decay for the sprayed berries was still less (3S = 80%, 2S = 82% and 1S = 85%) than the NS group (94%) (Fig. 1 and 4). Temperatures for March at 60 cm above the soil surface

ranged from an average high of 25 °C to a low of 10 °C. One cold night (4.6 °C) offset a general increase in temperatures. Precipitation was minimal but there were several sunny days (244 w/m^2).

Data for all months show that berries sprayed 3 days prehavest reduced decay when compared to berries sprayed 1 day preharvest or not sprayed.

Microflora on Immature Berries: To understand what seemed to be a residual effect of PAA on berry decay organisms, green berries were daily assessed for surface microflora populations. Data showed a continuing decline in microbial populations after the initial spray when compared to the initial non-sprayed plants (Fig. 5). Microorganisms on the surface of the immature berries were significantly reduced in the 3S, 2S and the 1S groups up to 3 days post spray (Fig. 5).

PAA is volatile, breaking down to release oxygen and acetic acid, but as a compound, is not residual on berry surfaces. The data from the immature berry study suggests that it continues to reduce microbial populations after initial application. This would indicate that over time the number of organisms on the berry surfaces decrease due to cell death when exposed to PAA. Sublethal cells would be unable to make repairs while remaining on the now acidified environment of the berry surface. Immature berries showed a continued decline in the microbial population after spraying, which corresponds with ripe berry studies. Berries sprayed 3 or 2 days preharvest had significantly lower rates of decay than berries sprayed just prior to harvest or non-sprayed, likely due to a reduction in microorganisms and subsequently, their growth.

Determination of *Botrytis* and *Rhizopus* sensitivity to PAA: Evidence of sensitivity of *Botrytis* hyphae and conidia to PAA was shown by the presence of a zone of inhibition (~1 cm) around each of the discs after 5 days growth . After 10 days, the inhibition area was still obvious, although *Botrytis* hyphae were beginning to move closer to the discs (Fig. 6). *Rhizopus* was not as sensitive as *Botrytis* to the presence of PAA. After 10 days, *Rhizopus* growth in PAA plates was almost as dense as in the control. The only indication that PAA had any effect on *Rhizopus* was decreased sporulation over parts of the plate that had exposure to PAA (Fig. 7). The disc assay study served as an indicator of the possible reduction of growth of *Botrytis* and *Rhizopus* by PAA when applied on strawberries in the field.

Postharvest treatments: To determine if postharvest anti-decay treatments could enhance the decay reduction obtained with the preharvest PAA sprays, berries sprayed with PAA 3 days preharvest and berries from corresponding non-sprayed blocks were harvested, brought to the laboratory and treated with postharvest anti-decay compounds or coatings, including a lower (approved for postharvest application) concentration of PAA (Table 1). The preharvest PAA sprayed berries with the postharvest spray treatment had generally less decay than non-sprayed berries with postharvest treatments, except for the postharvest PAA treatment and sodium propionate after 12 days in storage (Table 1). This was significant for “no postharvest treatment” day 6, postharvest water treatment, day 12; and the postharvest chitosan treatment, days 6-12. Chitosan coating on pre-sprayed fruit significantly reduced decay (17.5% decay) for 8 days longer than the control (no preharvest spray or postharvest treatment, 62.5% decay) (Table 1).

Potato dextrose plates containing 10 day *Botrytis* cultures and filter discs with chitosan or its buffer showed no difference in fungal growth when compared with the control plates (Fig. 6), indicating that chitosan did not have a direct effect on the pathogen, but may have protected the fruit by eliciting a plant defense response (Kendra and Hadwigger, 1984). Other studies have reported chitosan to damage fungal hyphae (El Ghaouth et al., 1997).

Studies by other workers have also shown that chitosan is effective in extending the shelf-life of strawberries (El Ghaouth et al., 1991; 1992; Park et al., 2005). Data in Table 1 show that on some berries, exposure to PAA preharvest, prior to further treatment, reduced postharvest decay. PAA reduces microflora populations on the berry. As an additional postharvest treatment, however, PAA has no effect or may even be damaging to the berry. If trichomes of the berries were damaged, it would result in increased infection. The high acidity of the combined pre- and postharvest PAA treatments may have damaged these structures. Discs with PAA in *Botrytis* plates maintained areas of reduced or no growth (zones of inhibition) even after 10 days (Fig. 6).

Significance of results. All berries in these experiments were held at abusive temperatures (warmer than commercial storage). Many studies have shown that cooling after harvest and in storage is important in extending shelf life (Nunes et al., 2002; El Ghaouth et al., 1991; Maas, 1980). In this study, at temperatures above storage optimum, berries sprayed 3 days preharvest generally had significantly less decay than berries sprayed 1 day prior to harvest or non-sprayed. The majority of decay in the stored berries in this study was caused by *Botrytis cinerea* followed by *Rhizopus stolonifer*. These organisms are the most

problematic postharvest pathogens on strawberries (Blacharski et al., 2001; Bristow, 1986; Maas, 1980; Maas and Smith, 1972). Studies suggest that *Botrytis* gains entrance into the berries in the field, remains latent and causes decay after harvest (Bristow, 1986; Maas, 1980). Suggested controls include preharvest fungicide sprays prebloom or at the flowering or young berry stage (Blacharski et al., 2001; Maas, 1980; Maas and Smith, 1972). The prophylactic activity of the fungicide decreases the spores of *Botrytis* that can invade young tissues. *Rhizopus* is more difficult to control with field sprays as it is a wound pathogen and ripe fruit offer a good substrate (Maas, 1980).

PAA reduces spore populations on berry surfaces (Narciso, 2005). When PAA was sprayed on flowers and young berries (as shown in the immature berry study, Fig. 5), spore numbers were reduced on surfaces, so fewer spores germinated and infected young tissue. Plants that were sprayed 3 days preharvest had only flowers and very young berries (all ripe berries were harvested before the initial spraying). Our storage data show that decay was generally significantly reduced when PAA was sprayed on flowers and young berries when compared to PAA sprays on ripe (1S groups) or non- sprayed berries (Figs. 1-4). Differences in results in onset of decay for storage studies from January through March could be attributed to changes in disease pressure in the field and the aging strawberry plants stressed by the increase in nighttime temperatures.

Other studies have also shown that *Botrytis* and *Rhizopus* spread in storage with berry-to-berry contact (Maas, 1980). In our clamshells, we found disease development on one or two stored berries that spread from the point of contact until all berries in the clamshell were involved. A preharvest treatment to

reduce spores and a postharvest antimicrobial treatment to reduce in storage spread of decay organisms would seem an ideal system to lengthen shelf-life of these fragile berries.

At a 100 $\mu L \cdot L^{-1}$ solution, PAA was not phytotoxic on leaves, flowers or berries. Pollinating insects were not deterred from flowers just sprayed (data not shown). As EPA field allowances for PAA are higher than what we used in this study, future work will involve testing increasing concentrations of preharvest PAA applications for better postharvest decay control. Times of applications, as well as assessing ripening berries for both their microbial loads and the effectiveness of PAA on these loads will be further studied.

Studies with postharvest treatments on strawberries previously sprayed with PAA showed variable results. In most cases the addition of a coating or surface treatment did not lengthen storage time of the berries, with the exception of the chitosan coating. The activity of the PAA and surface treatments needs further analysis to determine what combined pre- and postharvest treatments will most effectively lengthen shelf life and maintain the quality of the strawberries.

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Table 1: Percent decayed berries treated or not with a preharvest peroxyacetic acid (100 μL·L^{-1}PAA) spray, and treated postharvest with water, PAA, chitosan or sodium (Na)-propionate. Numbers are percent decay out of 40 berries[z].

		Days in storage at 18 °C			
Pre-harvest PAA	Post-harvest treat.	4	6	8	12
No	Nothing	2.5	55.0*	62.5	80.0
Yes	Nothing	0.0	15.0*	42.5	72.5
No	Water	0.0	57.5	72.5	100.0*
Yes	Water	2.5	52.5	77.5	87.5*
No	PAA	0.0	25.0	42.5	82.5
Yes	PAA	10.0	40.0	52.5	67.5
No	Chitosan	0.0	77.5*	87.5*	97.5*
Yes	Chitosan	0.0	12.5*	17.5*	55.0*
No	Na-propionate	5.0	52.5	70.0	72.5
Yes	Na-propionate	0.0	22.5	40.0	80.0

[z]Means followed by a "*" indicates significant differences ($P \leq 0.05$) between pre-harvest PAA treated and non-treated fruit within a post-harvest application treatment and day in storage using the Wilcoxon two-sample test (or the Kruskal-Wallis test).

Figures

Figure 1: Chart showing significance between decay rates in sprayed and Control (unsprayed) berries during days in storage: 3S, sprayed 3 days preharvest; 2S, sprayed 2 days preharvest; 1S, sprayed 1 day preharvest; NS group not sprayed.

Figure 2: Decay rates of berries in clamshells stored at 18C for up to 24 days: 3S (sprayed 3 days preharvest); 2S (sprayed 2 days preharvest,); 1S (sprayed 1 day preharvest); NS block not sprayed. Data are means of 6 to 12 clamshells containing ten berries each. A: Fruit harvested 20 Jan. 2006; B: Fruit harvested 23 Jan. 2006.

Figure 3: Decay rates of berries harvested 24 Feb. 2006, and stored in clamshells at 18C: 3S (sprayed 3 days preharvest); 2S (sprayed 2 days preharvest); 1S (sprayed 1 day preharvest); NS block not sprayed. Data are means of 11-15 clamshells with 10 berries each. A: Fruit from blocks in the interior of the field; B: Fruit from blocks in the edge of the field.

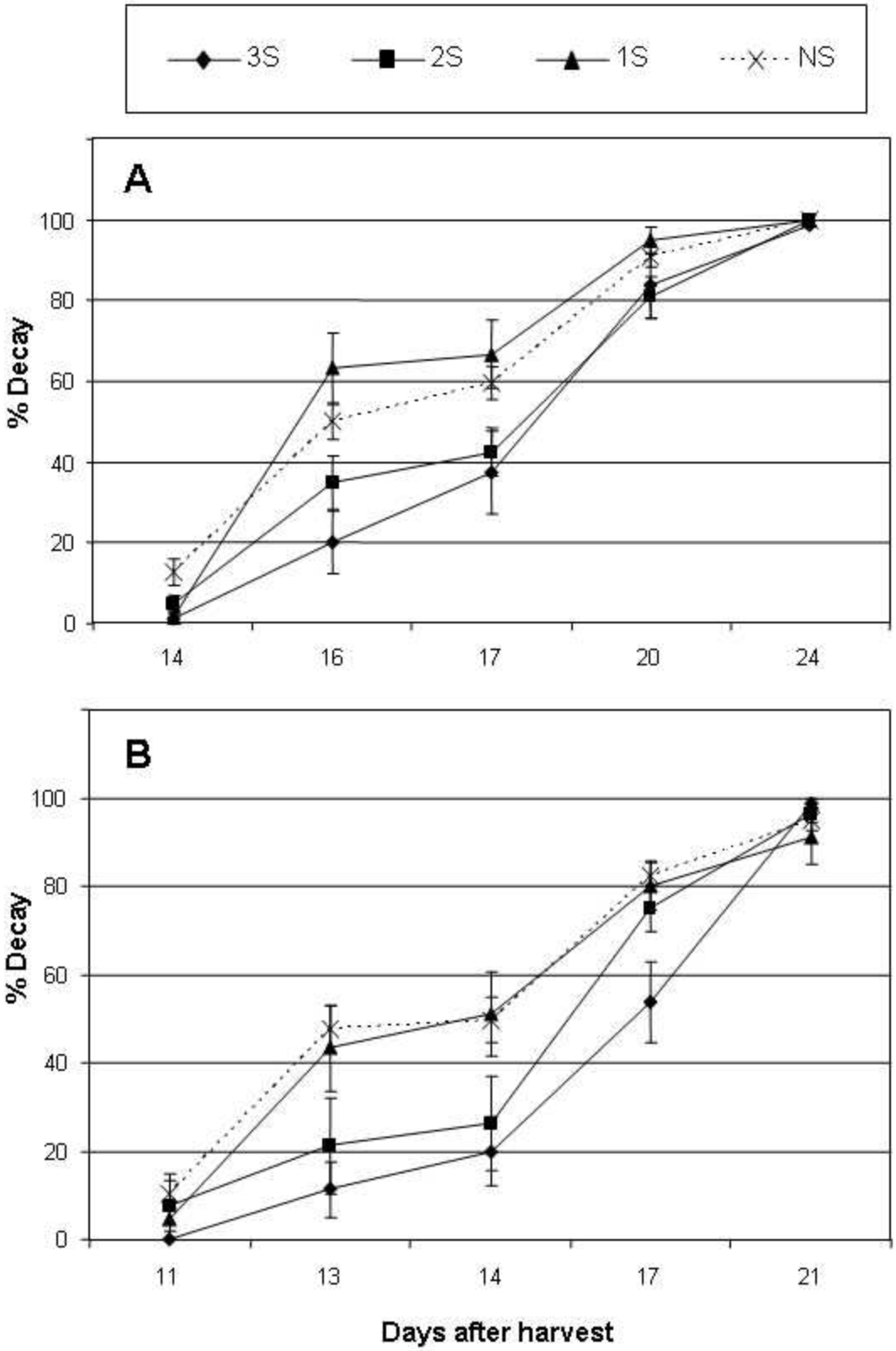
Figure 4: Decay rates of berries harvested 10 March 2006 in clamshells stored at 18C: 3S (sprayed 3 days preharvest); 2S (sprayed 2 days preharvest); 1S (sprayed 1 day preharvest); NS block not sprayed. Data are means of 14-17 clamshells with 10 berries each.

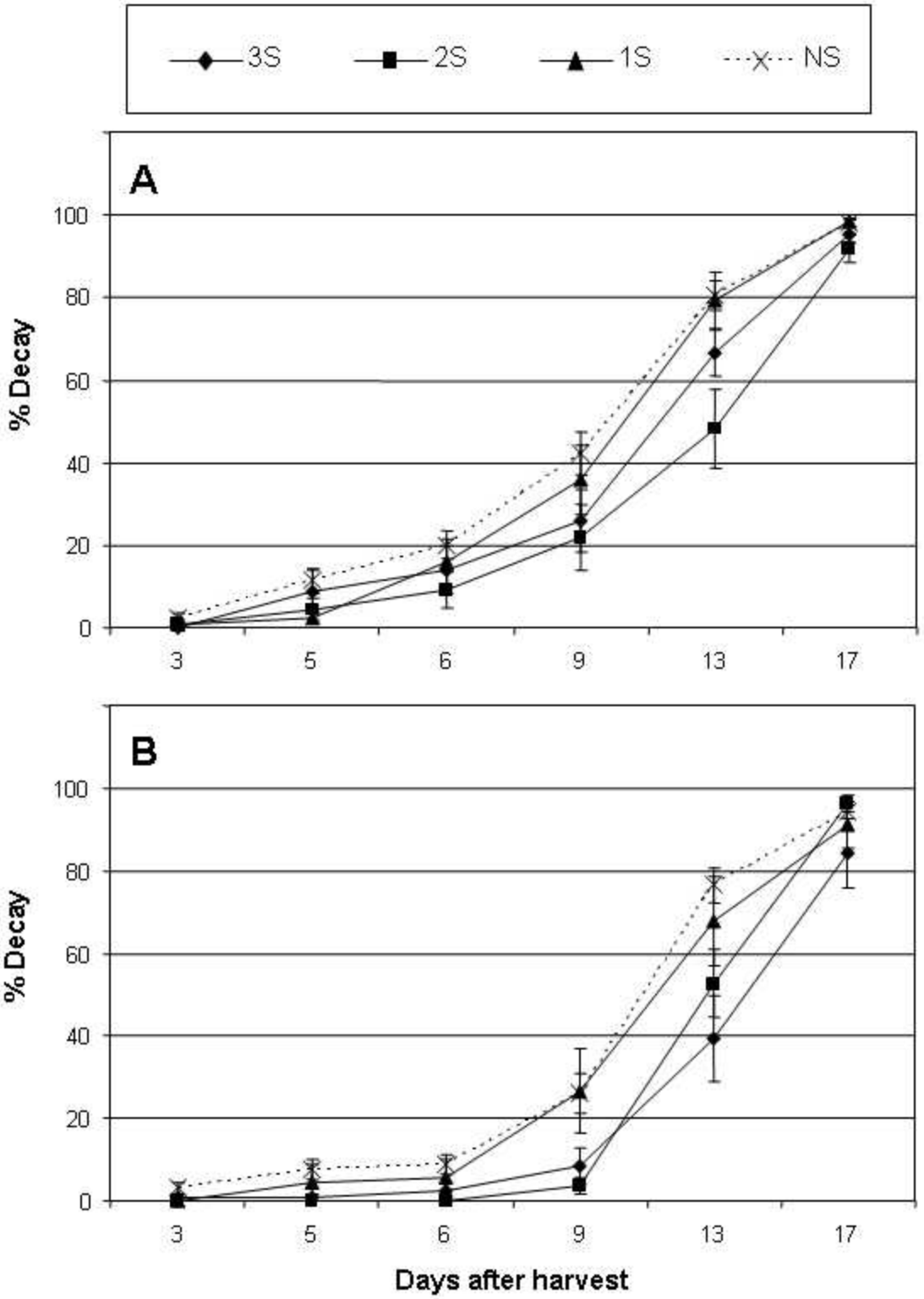
Figure 5: Numbers of microorganisms on immature berry surfaces before (solid bar) and after spraying 3 (3S), 2 (2S), and 1 (1S) day preharvest. Data are means of 4 bags containing 5 berries each. Stars indicate significant differences between initial unsprayed plants (first column, solid bar) and sprayed berries 2, 1, and 0 days before harvest of ripe berries: *,**,*** significant at $P \leq 0.05$, 0.01, 0.001, respectively.

Figure 6: Ten day old *Botrytis cinerea* cultures growing on potato dextrose agar plates with discs containing PAA, chitosan and sterile water (control).

Figure 7: Ten day old *Rhizopus stolonifer* cultures growing on potato dextrose agar plates with discs containing PAA and sterile water (control).

X	significance between this population and the Control (unsprayed group) population of the same day							
NS	no significance between this population and the Control population of the same day							
January			Day 14	Day 16	Day 17	Day 20	Day 24	
	Harvest 1:	3S	NS	X	X	NS	NS	
		2S	NS	NS	X	NS	NS	
		1S	NS	NS	NS	NS	NS	
			Day 11	Day 13	Day 14	Day 17	Day 21	
	Harvest 2:	3S	NS	X	X	X	NS	
		2S	NS	X	X	NS	NS	
		1S	NS	NS	NS	NS	NS	
February			Day 3	Day 5	Day 6	Day 9	Day 13	Day 17
	Exp. 1:	3S	NS	NS	NS	NS	X	NS
		2S	NS	NS	NS	NS	X	NS
		1S	NS	NS	NS	NS	NS	NS
	Exp. 2	3S	NS	NS	NS	X	X	NS
		2S	NS	NS	NS	X	X	NS
		1S	NS	NS	NS	NS	NS	NS
March			Day 7	Day 9	Day 11	Day 15	Day 17	Day 19
		3S	NS	X	X	X	X	NS
		2S	NS	X	X	X	X	NS
		1S	NS	X	X	X	X	NS


3S
2S
1S
NS
A
% Decay
100
80
60
40
20
0
14
16
17
20
24
B
% Decay
100
80
60
40
20
0
11
13
14
17
21
Days after harvest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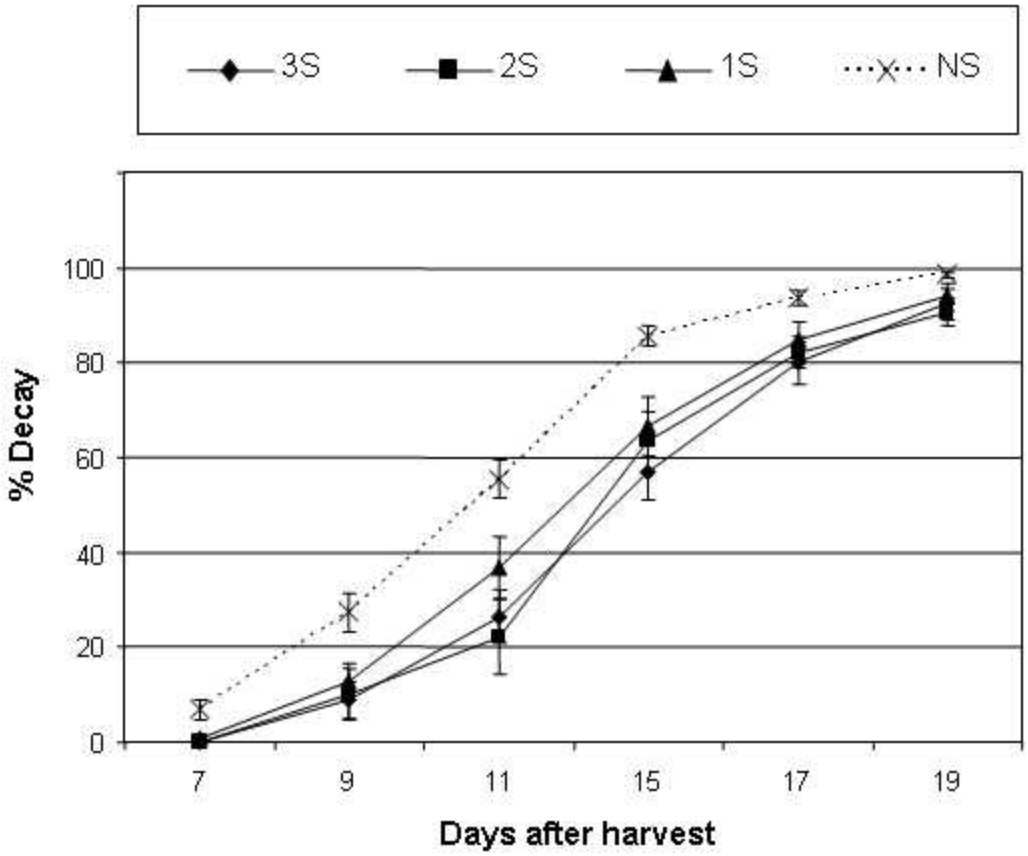
17
Days after harvest


3S
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7
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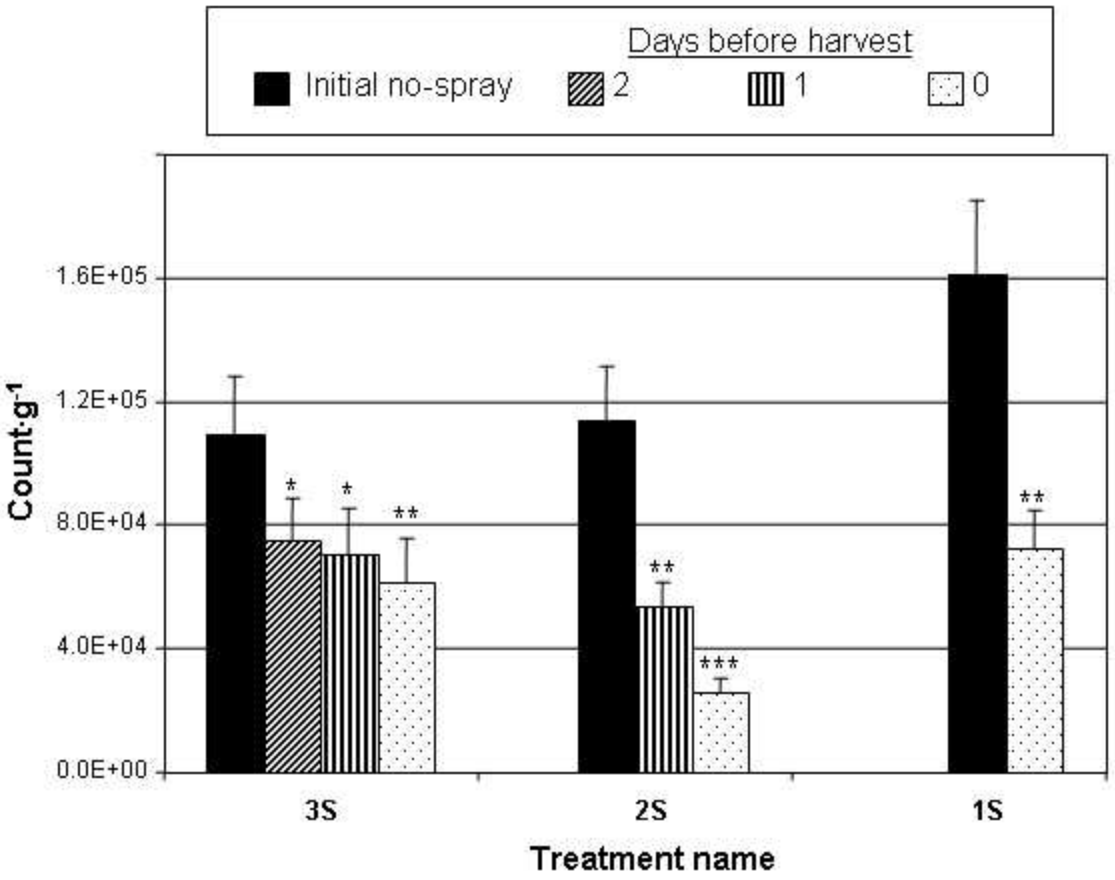
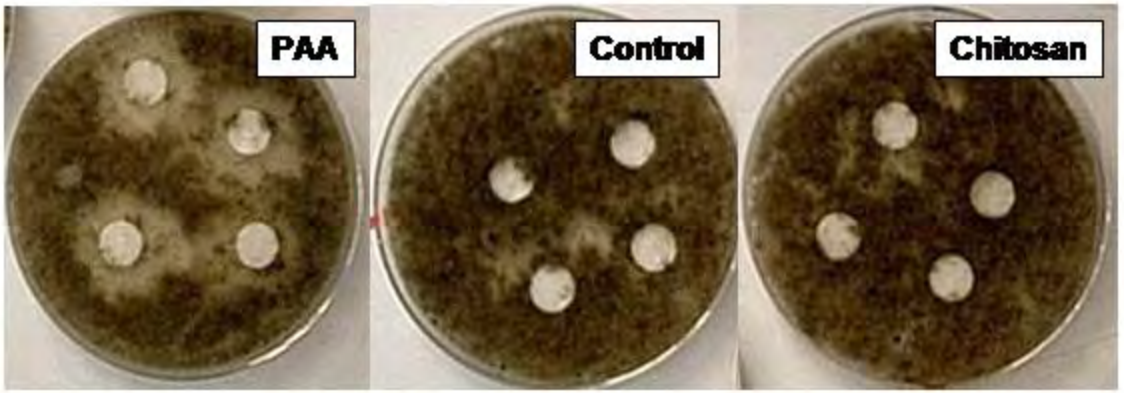
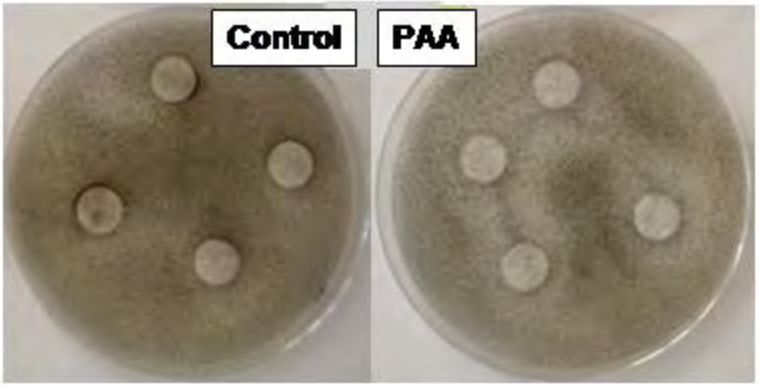
17
19
Days after harvest


Days before harvest
Initial no-spray
2
1
0
1.6E+05
1.2E+05
8.0E+04
4.0E+04
0.0E+00
Count·g-1
*
*
**
**
***
**
3S
2S
1S
Treatment name


PAA
Control
Chitosan


Control
PAA

Summary Report for 2002-03 Anthracnose Dip Experiment

J. Mertely and T. Seijo
University of Florida
Gulf Coast Research and Education Center
Dover, Florida

July 15, 2003

Methods

During the 2002-03 season, a replicated field experiment was conducted to test the ability of pre-plant dip treatments to reduce mortality and increase the vigor of strawberry transplants naturally infected by *Colletotrichum acutatum*. This fungus attacks various strawberry tissues including fruit, petioles, stolons, crowns, and roots. Root necrosis caused by *C. acutatum* is associated with stunting and poor establishment after transplant. In September 2002, more than 800 green top, bare root strawberry plants (cultivar Camarosa) were obtained from anthracnose-diseased areas of a Canadian nursery and stored in a cooler at 2-3° C. On 10 Oct, the plants were randomly bundled into groups of 20. Four bundles were set aside, while the remaining bundles were thoroughly washed with a garden hose sprayer to remove soil adhering to the roots (as recommended on the 24c labels for pre-plant dip treatment with Captan or Quadris). All plants were returned to the cooler overnight. On 11 Oct, eight treatments were applied to groups of four washed bundles (80 plants) each. The treatments consisted of submerging plants for 5 min in various solutions or suspensions of Captan 80WP, Quadris 2.08F, Switch 62.5WG, Brotomax 8-0-0, and OxiDate (27% H_2O_2) in water (Table 1). Control treatments involved soaking washed plants for 5 min in water alone (wet control), or planting unwashed, untreated plants according to normal commercial practices (dry control).

After each treatment was applied, the plants were immediately transplanted into plots in an experimental area consisting of four plastic mulched raised beds (28 in wide on 4-ft centers) previously fumigated with a 67:33 mixture of methyl bromide and chloropicrin. Individual plots consisted of 20 plants in two staggered rows on each bed, 15 in apart within rows and 12 in apart between rows. The plots were arranged in a randomized block design with ten treatments in four blocks, each block confined to a single bed. The transplants were irrigated by overhead sprinklers for 11 days to facilitate establishment, then irrigated and fertilized through drip tape for the remainder of the experiment. No post-plant fungicide applications were made.

Plant evaluations were conducted 12 and 47 days after planting (DAP). The initial evaluation was carried out to assess plant damage noted during the establishment period. Newly emerging leaves were chlorotic and/or partially necrotic on some, but not all plants in the affected treatments. Damaged plants were enumerated in each plot and the resulting data expressed in percent. Plant mortality and plant vigor were determined 47 DAP. Plant mortality was determined by counting dead plants/plot and expressing the data in percent. Vigor was assessed by evaluating the remaining live plants in each plot as a group using a rating scale ranging from 1 (small, stunted) to 5 (large, vigorous). A two-way ANOV was performed on each data set using SAS. Treatment means were separated by Fisher's protected LSD procedure ($P \leq 0.05$). Prior to analysis, percentage data and plant vigor data were transformed by arcsine square root and square root (x + 0.5) expressions respectively.

After the final evaluation, isolations were made from eight stunted wet control plants (2 plants/plot) to determine if *C. acutatum* was associated with the observed symptoms. Tissue segments were aseptically removed from each crown and transferred to a selective medium for growth and identification.

Results and Conclusions

Chemical phytotoxicity was initially suspected as causing the plant damage assessed 12 DAP. However, plant damage was also observed in the wet control treatment, consisting of plants that were washed and soaked in water for 5 min, but were not treated with any chemical (Table 1). In contrast, no plant damage was observed in the dry control, consisting of plants that had not been washed, soaked, or treated prior to transplant. Apparently, the plants in treatments one through nine were severely stressed, either by the experimental procedure of washing one day, refrigerating overnight, and planting the following day, or by the time needed to apply treatments and set transplants prior to activating the overhead sprinklers. This stress resulted in stunting and plant mortality, which confounded the evaluation of experimental treatments, since root infection by *C. acutatum* produces similar symptoms.

In spite of the use of stressed plants, significant differences between treatments were observed 47 DAP (Table 2). Substantial plant mortality occurred in the first three treatments, i.e., the wet control and two Captan treatments. Plant survival was considerably better in treatment four (which combined Captan and Quadris), and in the remaining treatments. Plant vigor was also significantly reduced in the first three treatments, and in the Brotomax treatment (Table 3). **However, plants treated with Quadris, Switch, or OxiDate were as vigorous as those in the dry control. These products may have protected weakened plants from pathogen attack, either by systemic activity or by reducing superficial inoculum on roots and foliage.**

C. acutatum was isolated from the crowns of two out of eight plants obtained from the wet control plots. Since the majority of stunted plants were not demonstrably infected, *C. acutatum* was probably not responsible for the pervasive stunting observed in this experiment. Moreover, plants in the dry control treatment grew vigorously, even though they originated from the same batch of infected plants used in the other treatments. Although these transplants were obtained from a nursery field with plants showing visible anthracnose lesions on petioles and stolons, the frequency or severity of infection must have been relatively low. Transplants used in future experiments could be artificially inoculated to produce consistently infected plants for the testing of preplant dip treatments.

Additional Comments

The conclusions that can be drawn from this experiment were confounded by procedures which unintentionally produced weakened, stressed transplants. However, during normal digging, shipping, transplanting, and establishment activities, strawberry transplants are routinely exposed to physical and environmental stresses that weaken them**. According to this study, weakened transplants grew more vigorously and experienced lower mortality when protected by preplant dips of Quadris, Switch, or OxiDate. OxiDate performed surprisingly well considering that the active ingredient (H_2O_2) provides only transient disinfectant activity on the plant surface. The beneficial effects produced by these products may have resulted from the control of multiple pathogens, and not *C. acutatum* alone.**

Not all treatments produced the beneficial effects of Quadris, Switch, or OxiDate. Plants treated with two formulations of Captan exhibited high mortality and only moderate increases in vigor of the remaining live plants. In addition, the Captan 80WP formulation appeared phytotoxic to stressed plants at the rate tested (compare treatments 1 and 2 in Table 1). Most plants treated with Brotomax survived, but grew less vigorously than those treated with Quadris, Switch, or OxiDate (Table 2).

The stunting and plant mortality observed in the wet control treatment is of practical concern and merits further study.

Table 1. Products tested and rates applied during 2002-03 Anthracnose dip experiment, and initial results observed 12 days after planting (DAP)

Treatment[a]	Rate (per 100 gal)	Rate (per liter)	% damage[b]
1. Wet control (wash + 5 min dip in H_2O)	na	na	43.8 c[c]
2. Wash + Captan 80 WP dip	3.125 lb	3.74 g	75.0 d
3. Wash + Captan 80 WDG dip	3.125 lb	3.74 g	50.0 c
4. Wash + Captan 80 WP/Quadris 2.08 F dip	3.125 lb, 5 fl oz	3.74 g, 0.4 ml	47.5 c
5. Wash + Quadris 2.08 F dip (low rate)	5 fl oz	0.39 ml	20.0 b
6. Wash + Quadris 2.08 F dip (high rate)	8 fl oz	0.62 ml	8.8 b
7. Wash + Switch 62.5 WG dip	50 g / 100 L	0.5 g	15.0 b
8. Wash + Brotomax 8-0-0 dip	1 gal	10 ml	20.0 b
9. Wash + OxiDate 27% H_2O_2 dip	1 gal	10 ml	11.3 b
10. Dry control (no wash, no dip)	na	na	0.0 a

[a]Plants in treatments 1 through 9 were washed to remove soil from the roots prior to treatment.
[b]Percent of plants which developed chlorosis or necrosis of newly emerging leaves 12 DAP. This damage was produced by washing/storage procedures and counteracted by several treatments.
[c]Figures followed by the same letter are not significantly different by a Fishers protected LSD test ($P \leq 0.05$).

Table 2. Assessment of plant mortality and vigor 47 days after treatment

Treatment[a]	Mortality (%)	Vigor[b]
10. Dry control (no wash, no dip)	2.5 a	4.8 a[c]
6. Wash + Quadris 2.08 F dip (high rate)	0.0 a	4.5 a
5. Wash + Quadris 2.08 F dip (low rate)	0.0 a	4.0 ab
7. Wash + Switch 62.5 WG dip	0.0 a	3.8 ab
9. Wash + OxiDate 27% H_2O_2 dip	1.3 a	3.8 ab
4. Wash + Captan 80 WP/Quadris 2.08 F dip	1.3 a	3.0 bc
8. Wash + Brotomax 8-0-0 dip	3.8 ab	2.3 cd
3. Wash + Captan 80 WDG dip	17.5 bc	2.0 de
2. Wash + Captan 80 WP dip	20.0 c	1.3 ef
1. Wet control (wash + 5 min dip in H_2O)	18.8 c	1.0 f

[a]Plants in treatments 1 through 9 were washed to remove soil from the roots prior to treatment.
[b]Living plants in a plot were assessed for vigor as a group using a rating scale ranging from 1 (small, stunted) to 5 (large, vigorous).
[c]Figures followed by the same letter are not significantly different by a Fishers protected LSD test ($P \leq 0.05$).

Research Report Summary

Report Title:
"Efficacy of OMRI-Approved Products for Tomato Foliar Disease Control"

Report Author:
Abby Seaman

Address:
IPM Program Office
Area Extension Educator
P.O. Box 462
Cornell Cooperative Extension 630 W. North St.
Geneva, N.Y. 14456
Phone: (315)787-2422
Fax (315)787-2360

General Description:
This was an organic tomato production trial conducted at the New York State Agricultural Experiment Station in Western New York. The trail started in 2001 and was repeated in 2002. They used OxiDate in 2002 only. In 2002, they compared five organically approved products to control naturally occurring foliar diseases with Oxidate amoung them.

Production Methods:
- Tomato cv. Daybreak
- Black plastic mulch and trickle irrigation
- 6' between-row , 18" in-row
- Plant date 6/10/02
- Foliar sprays with CO2 backpack sprayer delivering 60gal per acre

Experimental Design:
- Randomized complete block design with 4 replicates
- Each rep was 15' long with the middle 5' being sampled

Foliar Treatments:
- Dates 7/31/02, 8/15/02, 8/29/02 (every 2wks)
- OxiDate @ 1:100

Data:
- Percent of foliage diseased
- Measurements taken weekly from 8/22/02 through 9/12/02 (four dates)

Results:
- OxiDate spray statistically significant lower disease levels verses the untreated control (table and chart for 2002).

Efficacy of OMRI-Approved Products for Tomato Foliar Disease Control

Abby Seaman, NYS IPM Program, Lee Stivers, Pennsylvania State Cooperative Extension, Joe Shail, and Hugh Price, Department of Horticultural Science, New York State Agricultural Experiment Station

A total of five materials approved for organic production were tested for foliar disease control on tomatoes on a certified organic farm in western New York. Trials were conducted during the 2001 and 2002 growing seasons. Tomatoes of the variety Daybreak were transplanted into black plastic with trickle irrigation on June 8 in 2001 and June 10 in 2002. The field rotation for the previous two years had been barley underseeded with clover followed by a year of clover hay. Composted chicken manure was broadcast over the field at a rate of 1T/A, and an additional 1.5T/A was rototilled into the beds before the plastic was laid. Between-row spacing was 6 ft. and in-row spacing was 18 inches. The plants were not staked. Plots consisted of 15 ft of a single row of plants. Treatments were replicated four times and randomized in a complete block design.

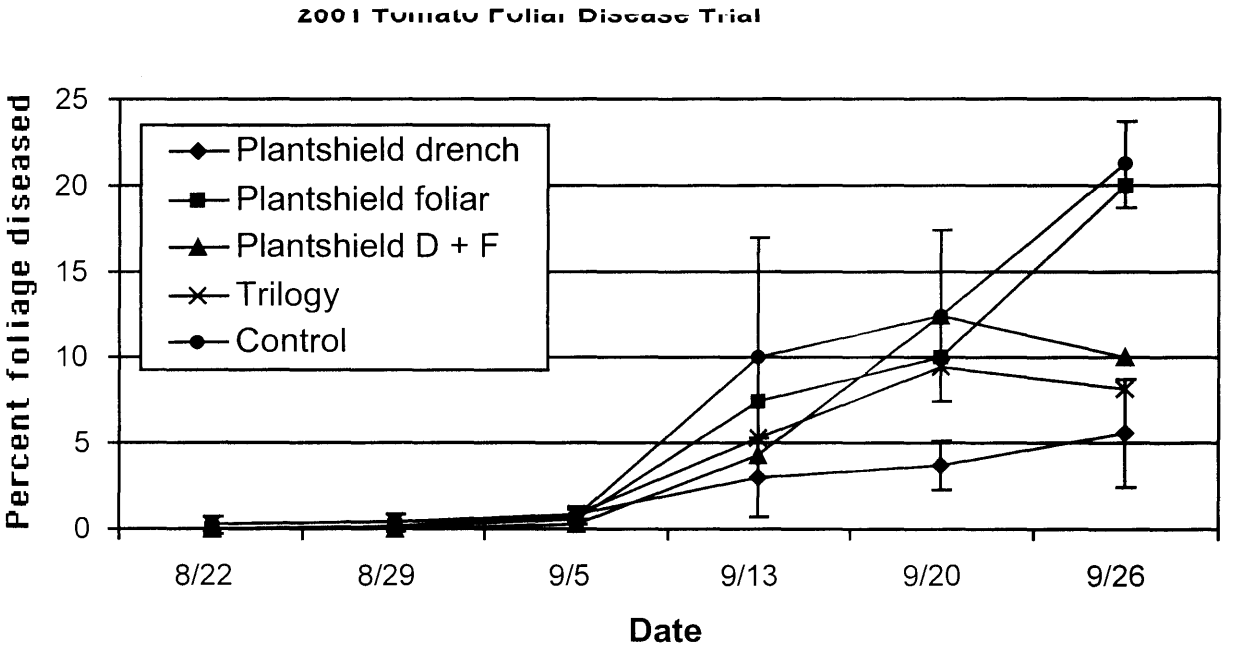
	Tested in:		
Treatment	**2001**	**2002**	**Rate**
Plantshield drench at transplanting	√	√	10 oz./100 gallons
Plantshield foliar applications	√	√	2 lb./A
Mycostop Drench		√	.01% suspension
Plantshield drench plus foliar	√	√	10 oz./100 gallons drench, 2 lb./A foliar
Trilogy	√	√	1% solution
Serenade		√	4 lb./A
Serenade		√	8 lb./A
Oxidate		√	128 oz/100 gallons
Untreated control	√	√	

Plantshield is a formulation of the beneficial fungus *Trichoderma harzianum* labeled for foliar and soil drench applications. Mycostop is a formulation of the beneficial actinomycete *Streptomyces griseoviridis* labeled for seed treatment, potting soil amendment, and drench applications. Trilogy is a neem oil extract labeled for foliar application on a variety of fruit and vegetable crops. Serenade is a formulation of the beneficial bacterium *Bacillus subtilis* labeled for foliar application on a number of fruit and vegetable crops. Oxidate is a hydrogen peroxide product that is labeled for pre-pant dip treatment, soil drench, and foliar applications on a variety of crops. Plants in plots receiving the drench treatments were drenched the day after transplanting in 2001 and nine days after transplanting in 2002 with 4 oz. of solution, enough to saturate the root ball. Foliar treatments were applied with a CO2 backpack sprayer in the equivalent of 60 gpa of water. A soy oil-based spreader-sticker (Natur'l Oil, 0.2%) was used with the Plantshield and Serenade foliar applications. Each foliar treatment was applied three times, at approximately two-week intervals, starting on July 27 and ending on August 22 in 2001, and starting on July 31 and ending on August 28 in 2002. Percent foliage diseased was recorded for each plot at weekly intervals, starting August 22 in 2001 and September 12 in 2002. Plants in the middle 5 ft. of each plot were rated.

Both growing seasons were very dry, with a total 7.5 inches of rain falling during the months on June through September of 2001 and a total of 7.7 inches falling during the months of June through September in 2002. Leaf wetness periods were short during the entire period of both trials, and disease pressure was very light. The trickle irrigation kept the plants growing well, and the fruit load was heavy. When the last foliar treatments were applied, disease had not yet started to appear on the plants and harvest had not begun. Early blight (caused by *Alternaria solani*) was the only foliar disease observed in both trials.

Figure 1 shows the disease progression for the 2001 season. The error bars indicate the standard deviation for the Plantshield drench treatment and untreated control.

Figure 1



An analysis of variance performed on the data from the final disease rating revealed significant differences between treatments (p=.001). Least significant differences were calculated to separate means. Lowest levels of disease were observed in the Plantshield drench and Trilogy treatments (Table 1), which were both significantly different from the control. The Plantshield foliar and foliar plus drench treatments were not significantly different from the untreated control.

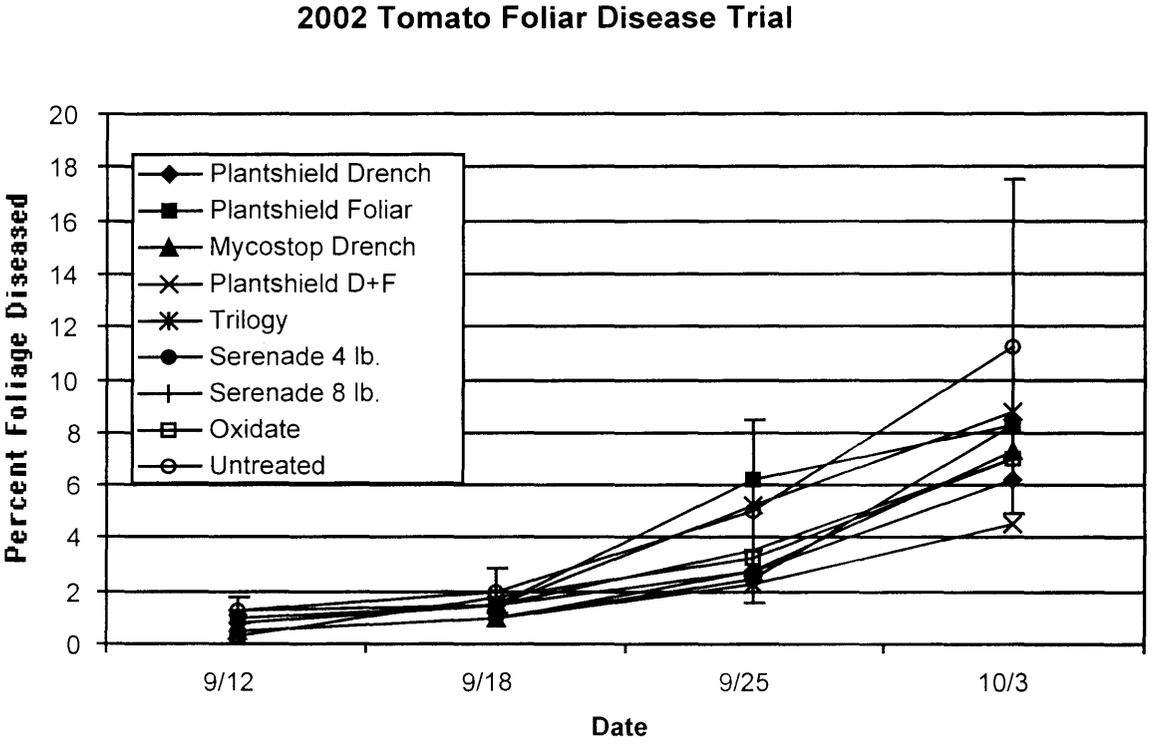
Table 1.
For 9/26 rating

Treatment	Mean	St. Dev
Plantshield drench	5.6a	3.1
Plantshield foliar	20b	7.1
Plantshield D + F	10ab	7.1
Trilogy	8.1a	3.7
Control	21.3b	2.5

LSD = 11.85

Figure 2 shows the disease progression for the 2002 growing season. The error bar indicates the standard deviation for the untreated control.

Figure 2.



An analysis of variance performed on the data from the final disease rating showed significant differences between treatments (p=.032). Least significant differences were calculated to separate means. Lowest levels of disease were observed in the Plantshield drench plus foliar treatment, which was significantly different from all other treatments. The Plantshield drench, Mycostop drench, Serenade 8 lb., and Oxidate treatments were significantly different from the

Date: December 19, 2005

Crop: Tomato (*Lycopersicon esculentum* Cultivar FL 47)

Organism: Bacterial spot (*Xanthomonas campestris* pv. vesicatoria)

Researchers: Tim Momol, Steve Olson,
University of Florida/IFAS

Laura Ritchie, and Jackie Snell
NFREC
155 Research Road
Quincy, FL 32351

EFFICACY OF SEVERAL COMPOUNDS ON BACTERIAL SPOT IN TOMATO, 2005: Several compounds were tested and evaluated for control of bacterial spot in a field experiment located in Quincy Florida. Naturally occurring *Xanthomonas campestris* pv. vesicatoria was the source of infections. Foliar treatments of Actigard, Kocide 2000, Manzate 75DF, K-phite, Serenade Max, Biotune, Tanos, GX569, GET #T205, Airone SC and Oxidate were applied weekly or on alternate weeks (as per experiment set up, Table 1) in the field using a 5 nozzle tomato boom and backpack ,CO_2 pressurized at 60 psi, and calibrated at 70.8 gallons per acre.

Untreated control (UTC) received no treatment. Treatments were arranged in randomized complete block design with 4 replications. Tomato (Cultivar FL 47) seedlings were transplanted July 29 on to raised beds previously fumigated with methyl-bromide (67%)+chloropicrin (33%) and covered with metalized polyethylene (mulch), drip irrigated and staked (fertilizer applied 195-60-195 lb/A N-P_2O_5-K_2O). Each plot was 40 feet in length and consisted of 18 plants spaced 20 inches apart.

Foliar treatments in the field were applied weekly beginning August 3rd and ending October 19th. Average temperatures in Quincy were as follows:

July (25-31)	80.8°F
August	79.2°F
September	77.1°F
October	66.9°F

(note: October 1-15 averaged 73.2°F and October 16-31 averaged 61°F).

Total rainfall for each month was as follows:

July (26-31)	0.60 inches
August	11.57 inches
September	2.36 inches
October	0.15 inches.

Foliar disease was assessed on September 21, October 3, October 14, and November 3. Fruit were harvested from 12 plants per plot October 17, October 24, and November 1, graded to USDA standards, and weights of marketable and unmarketable yields were determined. The SAS system was used to separate the means of the disease incidence data (Table 1) and the fruit yield data (Table 2).

Table 1. Efficacy of the Products on Bacterial Spot Severity

	% Disease Severity[1] Fall 2005			
Treatments	September 21	October 3	October 14	November 3
UTC[2]	15.0a	23.5a	41.3a	55.0a
Actigard[3]	5.3c	8.5b	17.0b	31.3cd
K-phite (solo)[4]	5.5bc	10.0b	18.8b	38.8bc
K-phite (alternated)[5]	6.0bc	10.8b	18.0b	33.8cd
Serenade[6]	6.5bc	13.3b	25.0b	42.5b
Tanos + Kocide (2lb)[7]	6.5c	10.3b	17.0b	30.0d
Tanos + Kocide (1lb)[8]	6.3bc	8.8b	17.0b	31.3cd
Tanos + GX569 [9]	7.8bc	11.0b	18.8b	36.3bcd
GET #T205 [10]	9.0b	12.3b	21.8b	43.8b
Airone[11]	6.0bc	8.3b	18.0b	31.3cd
Oxidate (1/200)[12]	5.3c	11.8b	21.3b	37.5bcd
Oxidate (1/400)[13]	5.5bc	9.3b	18.0b	38.8bc

[1] Means with the same letter are not significantly different (P=0.05) by Duncan's multiple range test (SAS).
[2] Untreated Control
[3] Actigard (0.5oz/A) alternated weekly with Kocide 2000 (2lb/A) + Manzate 75DF (2lb/A), foliar application
[4] K-phite (1-2qt/A) weekly, foliar application. Used 1 qt/A when tomato boom had 2 nozzles open for spray, used 2 qt/A when tomato boom had 4 and 5 nozzles open for spray.
[5] K-phite (1-2qt/A) alternated weekly with Kocide 2000 (2lb/A) + Manzate 75DF (2lb/A), foliar application. Used 1 qt/A when tomato boom had 2 nozzles open for spray, used 2 qt/A when tomato boom had 4 and 5 nozzles open for spray.
[6] Serenade Max (1lb/A) + Biotune (0.2% v/v) + Kocide 2000 (2lb/A) weekly, foliar application
[7] Tanos (8oz/A) + Kocide 2000 (2lb/A) + Manzate 75DF (2lb/A) alternated weekly with Kocide 2000 (2lb/A) + Manzate 75DF (2lb/A), foliar application
[8] Tanos (8oz/A) + Kocide 2000 (1lb/A) + Manzate 75DF (2lb/A) alternated weekly with Kocide 2000 (1lb/A) + Manzate 75DF (2lb/A), foliar application
[9] Tanos (8oz/A) + GX569 (1lb/A) + Manzate 75DF (2lb/A) alternated weekly with GX569 (1lb/A) + Manzate 75DF (2lb/A), foliar application
[10] GET #T205 root drench (3%) at transplant, foliar application (2%) at ~$^1/_4$ growth stage (Aug. 17), foliar application (2%) ~14 days after fruit set (Sep. 21), foliar applications (2%) October 5, 12, and 19.
[11] Airone SC(2pt/A) + Manzate 75DF (2lb/A) weekly, foliar application
[12] Oxidate (1/200) + Kocide 2000 (1.5lb/A) + Manzate 75DF (1.5lb/A) weekly, foliar application
[13] Oxidate (1/400) + Kocide 2000 (2lb/A) + Manzate 75DF (2lb/A) weekly, foliar application

Table 2. Total Yield of Tomatoes Harvested on October 17 and 24, and November 1

	Yield (lb/plant)[1] Fall 2005				Percent
Treatments	Medium	Large	X-Large	Total	Marketable
UTC[2]	0.98a	1.99b	4.25abc	7.22abc	79.8
Actigard[3]	1.12a	2.49ab	4.94ab	8.56abc	86.8
K-phite (solo)[4]	1.33a	2.18ab	3.42bc	6.92bc	85.1
K-phite (alternated)[5]	1.29a	2.26ab	3.06c	6.61c	83.8
Serenade[6]	1.29a	2.59ab	4.26abc	8.14abc	85.7
Tanos + Kocide (2lb)[7]	1.16a	2.56ab	5.65a	9.37ab	88.8
Tanos + Kocide (1lb)[8]	1.08a	2.42ab	4.84abc	8.33abc	86.5
Tanos + GX569 [9]	1.44a	2.95a	5.22ab	9.62a	88.8
GET #T205 [10]	1.06a	2.55ab	4.98ab	8.59abc	85.9
Airone[11]	1.14a	2.08b	4.56abc	7.79abc	86.1
Oxidate (1/200)[12]	1.35a	2.03b	3.09c	6.47c	84.7
Oxidate (1/400)[13]	1.13a	2.04b	3.94abc	7.10abc	88.9

[1] Means with the same letter are not significantly different (P=0.05) by Duncan's multiple range test (SAS).
[2] Untreated Control
[3] Actigard (0.5oz/A) alternated weekly with Kocide 2000 (2lb/A) + Manzate 75DF (2lb/A), foliar application
[4] K-phite (1-2qt/A) weekly, foliar application. Used 1 qt/A when tomato boom had 2 nozzles open for spray, used 2 qt/A when tomato boom had 4 and 5 nozzles open for spray.
[5] K-phite (1-2qt/A) alternated weekly with Kocide 2000 (2lb/A) + Manzate 75DF (2lb/A), foliar application. Used 1 qt/A when tomato boom had 2 nozzles open for spray, used 2 qt/A when tomato boom had 4 and 5 nozzles open for spray.
[6] Serenade Max (1lb/A) + Biotune (0.2% v/v) + Kocide 2000 (2lb/A) weekly, foliar application
[7] Tanos (8oz/A) + Kocide 2000 (2lb/A) + Manzate 75DF (2lb/A) alternated weekly with Kocide 2000 (2lb/A) + Manzate 75DF (2lb/A), foliar application
[8] Tanos (8oz/A) + Kocide 2000 (1lb/A) + Manzate 75DF (2lb/A) alternated weekly with Kocide 2000 (1lb/A) + Manzate 75DF (2lb/A), foliar application
[9] Tanos (8oz/A) + GX569 (1lb/A) + Manzate 75DF (2lb/A) alternated weekly with GX569 (1lb/A) + Manzate 75DF (2lb/A), foliar application
[10] GET #T205 root drench (3%) at transplant, foliar application (2%) at ~$^1/_4$ growth stage (Aug. 17), foliar application (2%) ~14 days after fruit set (Sep. 21), foliar applications (2%) October 5, 12, and 19.
[11] Airone SC (2pt/A) + Manzate 75DF (2lb/A) weekly, foliar application
[12] Oxidate (1/200) + Kocide 2000 (1.5lb/A) + Manzate 75DF (1.5lb/A) weekly, foliar application
[13] Oxidate (1/400) + Kocide 2000 (2lb/A) + Manzate 75DF (2lb/A) weekly, foliar application

Tomato (*Solanum lycopersicum* Cultivar FL 47)
Bacterial spot (*Xanthomonas campestris* pv. vesicatoria)

Tim Momol, Steve Olson, Botond Balogh, and Laura Ritchie
University of Florida/IFAS NFREC
155 Research Road
Quincy, FL 32351

EFFICACY OF SEVERAL COMPOUNDS ON BACTERIAL SPOT IN TOMATO, 2006: Several compounds were tested and evaluated for control of bacterial spot in a field experiment located in Quincy Florida. Naturally occurring *Xanthomonas campestris* pv. vesicatoria was the source of infections. Treatments were arranged in randomized complete block design with 4 replications. Tomato (Cultivar FL 47) seedlings were transplanted August 1 on to raised beds previously fumigated with methyl-bromide (67%)+chloropicrin (33%) and covered with white polyethylene (mulch), drip irrigated and staked (fertilizer applied 195-60-195 lb/A N-P_2O_5-K_2O). Each plot was 40 feet in length and consisted of 15 plants spaced 20 inches apart. Foliar treatments in the field were applied weekly beginning August 7 and ending October 12. Foliar disease was assessed on September 6, 9, 13, 20, 26 and October 4, 11, and 18. Fruit were harvested from 5-11 plants per plot October 24 and October 31, graded to USDA standards, and weights of marketable and unmarketable yields were determined.

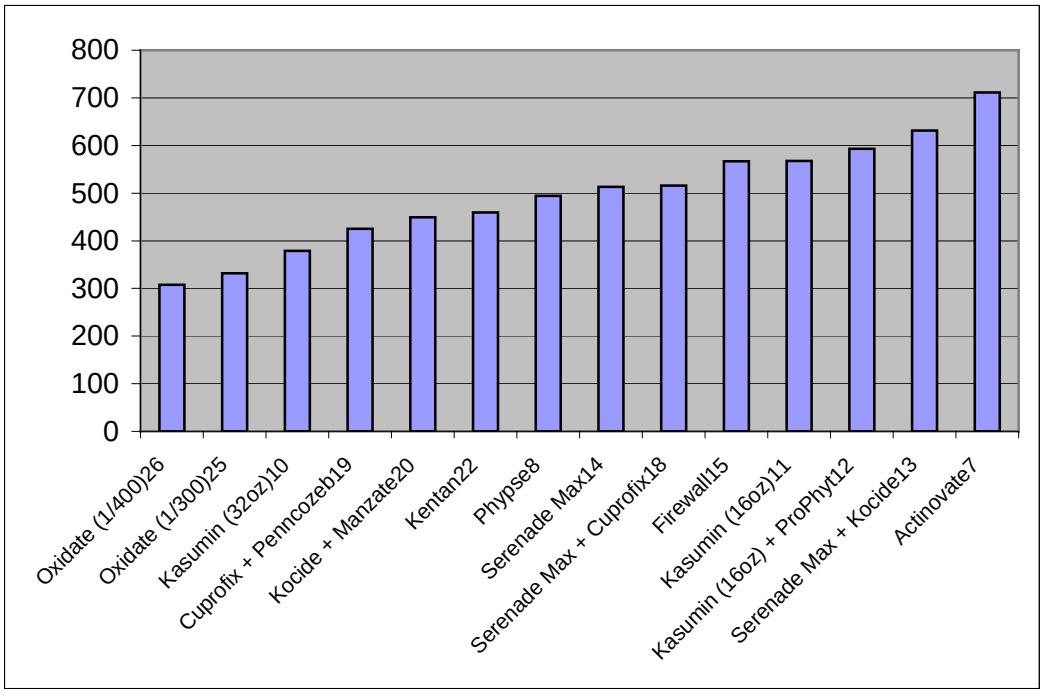
Table 1. Efficacy of the Products on Bacterial Spot Severity – Final Rating

Treatment	% Disease Severity[1] Final on October 18, 2006	AUDPC[1]
Control[2]	23.4abc	549.1abcde
Actigard[3]	16.9abc	378.8cdef
Actigard + Surround[4]	17.6abc	379.0cdef
Surround[5]	19.7abc	429.3abcdef
Prophyt alt. Serenade Max[6]	30.9a	630.2abc
Actinovate[7]	29.5ab	711.0a
Phypse[8]	22.5abc	494.5abcdef
Kasumin (32oz)[10]	18.3abc	378.6cdef
Kasumin (16oz)[11]	29.1ab	567.5abcde
Kasumin (16oz) + ProPhyt[12]	30.5a	593.0abcd
Serenade Max + Kocide[13]	29.5ab	631.5abc
Serenade Max[14]	21.1abc	513.5abcdef
Firewall[15]	25.8abc	566.6abcde
Serenade Max + Cuprofix[18]	22.5abc	516.1abcdef
Cuprofix + Penncozeb[19]	22.1abc	425.4bcdef
Kocide + Manzate[20]	19.7abc	449.5abcdef
Kentan[22]	21.0abc	459.7abcdef
Oxidate (1/300)[25]	13.4bc	331.9def
Oxidate (1/400)[26]	15.9abc	307.8ef

[1] Means with the same letter are not significantly different (P=0.05) by Duncan's multiple range test (SAS).
[2] Untreated Control
[3] Actigard (acibenzolar-S-methyl)(0.5oz/A) alternated weekly with Kocide 2000 (copper hydroxide)(2lb/A) + Manzate 75DF (mancozeb)(2lb/A), foliar application
[4] Actigard (acibenzolar-S-methyl)(0.5oz/A) + Surround (kaolin) (25lb/a) alternated weekly with Kocide 2000 (copper hydroxide)(2lb/A) + Manzate 75DF (mancozeb)(2lb/A), foliar application
[5] Surround (kaolin) (25lb/a), foliar application

[6] ProPhyt (potassium phosphite)(4pt/a) alternated weekly with Serenade Max (Bacillus subtilis) (1lb/a) + Kocide 2000 (copper hydroxide)(1lb/A) + Biotune (alkylbenzene sulfonate)(0.2%v/v), foliar application
[7] Actinovate SP (Streptomyces lydicus)(12oz/a) + Biotune (alkylbenzene sulfonate)(0.2%v/v), foliar application
[8] Phypse (beta 1-3[1-6] glucan)(9.7 fl.oz/a), foliar application.
[10] Kasumin (kasugamycin)(32 fl.oz/50 gal), foliar application
[11] Kasumin (kasugamycin)(16 fl.oz/50 gal), foliar application
[12] Kasumin (kasugamycin)(16 fl.oz/50 gal) + ProPhyt (potassium phosphite)(4pt/a), foliar application
[13] Serenade Max (Bacillus subtilis)(1lb/a) + Kocide 2000 (copper hydroxide)(1lb/A) + Biotune (alkylbenzene sulfonate)(0.2%v/v), foliar application
[14] Serenade Max (Bacillus subtilis)(1lb/a), foliar application
[15] Firewall (phosphorous acid, nutrients)(1gal/a), foliar application
[18] Serenade Max (Bacillus subtilis)(1lb/a) + Cuprofix Ultra 40 (basic copper sulfate)(1.25lb/a), foliar application
[19] Cuprofix Ultra 40 (basic copper sulfate)(1.25lb/a) + Penncozeb 75DF (mancozeb)(2lb/a), foliar application
[20] Kocide 2000 (copper hydroxide)(2lb/A) + Manzate 75DF (mancozeb)(2lb/A), foliar application
[22] Kentan (copper hydroxide)(1.75lb/a) + Manzate 75DF (mancozeb)(2lb/A), foliar application
[23] Badge SC (copper oxychloride, copper hydroxide)(2pt/a) + Manzate 75DF (mancozeb)(2lb/A), foliar application
[25] Oxidate (hydrogen dioxide)(1gal/300gal) + Kocide 2000 (copper hydroxide)(2lb/A) + Manzate 75DF (mancozeb)(2lb/A), foliar application
[26] Oxidate (hydrogen dioxide)(1gal/400gal) + Kocide 2000 (copper hydroxide)(2lb/A) + Manzate 75DF (mancozeb)(2lb/A), foliar application

Table 3. Area Under the Disease Progress Curve (AUDPC) based on 7 weekly ratings.



Tomato (*Lycopersicon esculentum* 'FL 47')
Bacterial spot; *Xanthomonas perforans*
Early blight; *Alternaria solani*

P. D. Roberts and R.E. Systma
Department of Plant Pathology
University of Florida/IFAS
SWFREC
Immokalee, FL 34142

Evaluation of compounds for control of foliar diseases in tomato, fall 2007.

Tomato seedlings were transplanted on 4 Sep into Immokalee fine sand at the Southwest Florida Research and Education Center, Immokalee, FL. Treatments were arranged in a randomized complete block design with four replications. Each plot consisted of 15 plants spaced 18 in. apart within a 21 ft row with 10 ft between each plot and 6 ft between each row. Guidelines established by the University of Florida/IFAS were followed for land preparation, fertility, irrigation, weed management and insect control. Sprays were applied with a high clearance sprayer designed specifically for applications in staked tomato plots at 2 mph and at 200 psi. A double drop boom equipped with 6 nozzles delivered a spray volume of 66 gal/A. A suspension of the bacterial spot pathogens (*Xanthomonas vesicatoria* race 1 and *Xanthomonas perforans* race 3 at 1×10^8 CFU/ml) was inoculated onto plots on 4 Oct at approximately 15 ml/plant using a hand pump sprayer. A suspension of mycelia, sporangia and zoospores of *Phytophthora infestans* was applied to plants on 7 Nov. Disease ratings as disease severity (percentage symptomatic tissue) were partitioned for disease symptoms when both diseases were present. Fruit were harvested on 5 and 6 Dec. Fruit were categorized as either marketable or non-marketable (small, misshapen or diseased). The yield and AUDPC were subject to one-way ANOVA and significant differences between means were separated using Tukey Multiple Comparison. Average monthly high and low temperatures (°F) were 94 and 69 in Sep, 97 and 68 in Oct, 88 and 44 in Nov and 86 and 42 in Dec. Rainfall totals for Sep, Oct, Nov and Dec were 4.7, 3.4, 0.09 and 0.4 in., respectively.

Severe drought conditions prevailed during the fall 2007. Despite this, bacterial spot symptoms were severe and climbed to the top of the plants. Late blight did not establish on plants in this trial. Foliar damage due to the fungal disease early blight was observed and recorded. Microscopic examination confirmed presence of *Alternaria* sp. associated with typical early blight symptoms. Two ratings for bacterial spot are shown in the table. Treatments which were statistically reduced both rating dates compared to the untreated control were 2, 4, 7, 8,10, 11, 12, 13, 15, and 24. Treatment 7 which consisted only of Bravo Weather Stik appears to be an anomaly as this compound typically does not exhibit bacterial suppression. For foliar disease ratings, treatments 5, 11, and 19 were the only plants which were rated as significantly reduced compared to the untreated control; however this separation may be due more to difficulty in distinguishing symptoms of late blight in the presence of severe bacterial spot. As typical, yield differences were not noted. Ratings are representative of appearance of plants in the field as there was generally very little difference in overall plant appearance regardless of treatment. Overall, the severe drought undoubtedly impacted the results of this trial as plants were grown under considerable stress even with increased attention to irrigation and field moisture.

Trt #	Treatment/Rate per A	Application timing[z]	10/18/2007 Bacterial spot % ds[y]	11/2/2007 Bacterial spot % ds	11/2/2007 Fungal % dis	Yield Marketable[x]	Weight Marketable	Yield Non-Marketable	Weight Non-Marketable
1	UTC	……	20 a[w]	21 ab	11 a	155 b-f	61 bcd	114 ab	38 a-d
2	Manzate Pro-Stick 75DG 2 lb	1-14……..	9 b-g	14 b-e	9 abc	166 b-f	57 cd	97 abc	35 a-d
	Kocide 3000 2 lb	1-14							
	Bravo Weather Stik 6F 3 pt	2, 3, 4, 6, 8, 10, 12, 14							
	Quadris 6 fl oz	5, 7, 9, 11, 13							
3	Manzate Pro-Stick 75DG 2 lb	1-14……	6 efg	18 a-d	12 a	176 a-f	65 bcd	65 cde	26 def
	Kocide 3000 2 lb	1-14							
	Bravo Weather Stik 6F 3 pt	2, 3, 4, 6, 8, 10, 12, 14							
	Evito 480SC 1.9 oz	5, 7, 9, 11, 13							
	Induce 0.25% v.v.	5, 7, 9, 11, 13							
4	Manzate Pro-Stick 75DG 2 lb	1-14……	7 c-g	8 e	5 bc	175 a-f	65 bcd	65 cde	26 c-f
	Kocide 3000 2 lb	1-14							
	Bravo Weather Stik 6F 3 pt	2, 3, 4, 6, 8, 10, 12, 14							
	Evito 480SC 3.8 oz	5, 7, 9, 11, 13							
	Induce 0.25% v:v	5, 7, 9, 11, 13							
5	Polyoxin-D 28 oz	1-14……	14 a-e	15 a-e	9 abc	178 a-e	69 a-d	100 abc	33 a-d
6	MF Chlorothalonil 6.0SC 1.5 pt	1-14……	14 a-e	20 abc	9 abc	133 ef	59 bcd	119 a	42 a
7	Bravo Weather Stik 6F 4.5 pt	1-14……	4 fg	11 de	6 abc	206 ab	76 ab	78 a-e	29 a-f
8	V-10161 4.00 SC 2 oz	1-14……	8 b-g	11 de	6 abc	173 b-f	72 abc	48 de	15 f
9	V-10161 4.00 SC 4 oz	1-14……	15 abc	18 a-d	11 a	144 c-f	61 bcd	110 ab	41 ab
10	V-10161 4.00 SC 2 oz	1-14……	9 b-g	13 cde	9 abc	163 b-f	66 bcd	99 abc	35 a-d
	Maneb 75DF 1.5 lb	1-14							
11	Oxidate 1/300 v:v	1-14……	3 g	13 cde	4 c	169 b-f	68 a-d	102 abc	37 a-d
	Manzate Pro-Stick 75DG 2 lb	1-14							
	Kocide 3000 2 lb	1-14							
	CAF-06 0.8 oz/gal	1-14							
12	Serenade Max 1 lb	1-14……	6 efg	13 cde	9 abc	185 a-d	70 a-d	85 a-e	29 a-f
	Cuprofix Ultra 40 DF 1.25 lb	1-14							
13	Milsana 0.5% v:v	1, 3, 5, 7, 9, 11, 13……..	7 defg	13 cde	6 abc	190 a-d	75 abc	73 b-e	30 a-e
	Manzate Pro-Stick 75DG 2 lb	2, 4, 6, 8, 10, 12, 14							
	Kocide 3000 2 lb	2, 4, 6, 8, 10, 12, 14							
14	Milsana 1% v:v	1, 3, 5, 7, 9, 11, 13……..	12 a-f	16 a-d	11 a	163 b-f	66 a-d	71 b-e	27 b-f
	Manzate Pro-Stick 75DG 2 lb	2, 4, 6, 8, 10, 12, 14							
	Kocide 3000 2 lb	2, 4, 6, 8, 10, 12, 14							
15	Cuprofix Ultra 40DF 1.5 lb	1-14……	9 b-g	14 b-e	8 abc	174 a-f	65 bcd	71 b-e	27 b-f
	Penncozeb 75DF 2 lb	1-14							
16	Cuprofix Ultra 40DF 1.5 lb	1-14……	4 g	19 a-d	8 abc	192 abc	76 ab	79 a-e	29 a-f
	Penncozeb 75DF 2 lb	1-14							
	Bravo Weather Stik 6F 3 pt	2, 3, 4, 6, 8, 10, 12, 14							
	Quadris 2.08SL 6 fl oz	5, 7 , 9, 11, 13							
17	Kasumin 64oz/100gal	1, 2, 4, 5, 7	12 a-f	16 a-d	11 ab	159 b-f	66 a-d	112 ab	41 abc
	Manzate Pro-Stick 75DG 2 lb	3, 6, 8, 9, 10, 11, 12, 13, 14							

	Kocide 3000 2 lb	3, 6, 8, 9, 10, 11, 12, 13, 14							
	Bravo Weather Stik 6F 3 pt	2, 3, 4, 6, 8, 10, 12, 14							
	Quadris 6 fl oz	5, 7, 9, 11, 13							
18	Kasumin 64 oz/100gal	1, 2, 4, 5, 7	10 b-g	14 b-e	7 abc	225 a	85 a	44 e	17 ef
	Kocide 3000 2 lb	1-14							
	Manzate Pro-Stick 75DG 2 lb	3, 6, 8, 9, 10, 11, 12, 13, 14							
	Bravo Weather Stik 6F 3 pt	2, 3, 4, 6, 8, 10, 12, 14							
	Quadris 6 fl oz	5, 7, 9, 11, 13							
19	Omega-Plus 2% v:v	1-14……	16 ab	23 a	5 bc	162 b-f	63 bcd	101 abc	35 a-d
20	V-10161 4.00SC 4 oz	1-14……	12 a-f	17 a-d	11 ab	169 b-f	67 a-d	91 a-d	30 a-e
	Maneb 75DF 1.5 lb	1-14							
21	Proud -3 2 qt	1-14……	10 b-g	15 a-e	6 abc	124 f	51 d	114 ab	32 a-d
22	QRD 800 2.5 lb	1-14……	7 d-g	16 a-d	10 ab	168 b-f	70 a-d	76 a-e	27 b-f
23	QRD 800 1.25 lb	1-14……	14 a-d	13 cde	8 abc	177 a-e	75 abc	77 a-e	29 a-f
24	QRD 800 1.25 lb	1-14……	9 b-g	13 cde	9 abc	139 def	63 bcd	101 abc	37 a-d
	Cuprofix Ultra 40DF 1.25 lb	1-14							

[z]1=11 Sep, 2 =18 Sep, 3 =25 Sept, 4 =2 Oct, 5 =9 Oct, 6 =16 Oct, 7 =23 Oct, 8 =30 Oct, 9 =6 Nov, 10 =12 Nov, 11=19 Nov,12 =26 Nov, 13 =3 Dec, 14= 10 Dec,

[y] %ds= percentage disease severity

[x] Mean weight of fruit per plot in lb

[w] Numbers followed by the same letter are not significantly different at P=0.05 by Tukey's multiple comparison.

Pepper (*Capsicum annuum* 'Enterprise')
Bacterial Spot (*Xanthomonas campestris* pv *vesicatoria*)

P.D. Roberts, EA Bolick, RE Systma
University of Florida-IFAS
SWFREC
Immokalee, FL 34142

Evaluation of compounds for the control of bacterial spot in peppers, Spring 2003. The experiment was located at the Southwest Florida Research and Education Center in Immokalee, FL. The soil was Immokalee fine sand (97:2.5:0.3% sand-silt-clay, pH 4.2, O.M. 1.96%). Raised beds were made on 13 Feb after fumigation with Telone C-35 applied in-bed at 35 gal/treated A. Beds were fertilized with a bottom mix of 5-17-8 at 800 lb/A and top mix applied in two bands on the bed top of 19-0-19 at 1000 lb/A. Beds had 32"-wide and 6'-centers. Plant spacing was 12" between plants with two rows per bed. Plots consisted of 20 plants each and plots had 6 ft buffers. Fields were watered by seep irrigation. Eight-week-old seedlings of pepper cultivar 'Crusader' were transplanted to the field on 3 Mar in a complete randomized block treatment design with four replications. Insecticides and herbicide applications were applied as needed and consistent with commercial production of fresh-market pepper in southwest Florida. The fungicide and bactericide formulations, rates, and application intervals are presented in the table. NA2101 is a combination of 17 microorganisms and Oxidate is a non-traditional fungicidal compound. Foliar compounds were applied with a backpack CO_2 sprayer at 40 psi with a single hollow cone nozzle at 23.6 gal/A. Soil applications were made with a handheld pump sprayer delivering a standardize amount (20 ml/plant) of the liquid suspension directly to the base of the plants through the holes in the plastic.

Plants were inoculated with bacterial spot (*Xanthomonas campestris* pv. *vesicatoria* pepper race 3 and 6) on 17 Apr. Inoculum was prepared by growing the culture overnight in nutrient broth (NB) on a shaker incubator. Culture was transferred to a larger volume of NB (500 ml per flask) and grown until exponential growth phase approximately 6 hr. Cells were adjusted using distilled water and a spectrophotometer at 600 nm to 1×10^8 colony forming units per ml. All the plants in the plot were inoculated using a hand pump sprayer to apply an equal amount of inoculum per plant.

Rainfall amounts were 2.87, 3.54, 6.57, and 8.93 inches in Mar, Apr, May and June, respectively. Temperatures ranged from a high of 94 F in May to a minimum of 37.3 F in Apr. Plants were evaluated for disease symptoms at two-week intervals. The percentage of foliage exhibiting disease symptoms was estimated at 2-week intervals. A disease rating using a scale of 1 to 8 where 1 was no disease and 8= entire plant dead was used at 92 and 118 days after transplanting (DAT). Fruit were harvest on 19 May. Fruit were rated as marketable or non-marketable (small, misshapen or diseased). Yield and disease ratings were subjected to ANOVA and the means tested for significance using Tukey Multiple Comparision.

All plants with treatments had reduced disease severity compared to the control. Differences were not detected using the disease scale to estimate defoliation. Only plants treated with Ridomil and oversprayed with Kocide and Maneb had significantly reduced marketable yield compared to the control. Plants treated with Oxidate had similar disease evaluations and yield compared to plants in the other treatments. All treatments reduced disease severity by approximately half. Products used as in this trial may help to suppress bacterial spot on peppers.

Treatment, Rate and Application Date[1]	No. Fruit Marketable	Yield Marketable	No. Fruit Non-Marketable	Yield Non-Marketable	Disease Severity Combined[2]	Disease Scale Combined[3]
Untreated Control	24.25 a[4]	7.75 a	33.75 a	8.05 a	26.88 a	5.56 a
AtEze 1:250 drench (1,3,5,7,9,11,13,15) Kocide 2000 2 lb/A (2,3,4…16)[6] +Maneb 75 3 lb/A (2,3,4…16)	21.25 ab	7.60 a	26.75 a	7.63 ab	12.50 b	5.43 a
Ridomil 1 pint/treated A (1) Kocide 2000 2 lb/A (2,3,4…16) +Maneb 75 3 lb/A (2,3,4…16)	11.25 b	3.43 b	21.25 a	5.10 b	11.88 b	4.89 a
OxiDate 1:100 (1,2,3,4…16)[5]	24.00 a	7.69 a	24.75 a	6.80 ab	10.63 b	4.68 a
Kocide 2000 2 lb/A (2,3,4…16) +Maneb 75 3 lb/A (2,3,4…16)	23.50 a	8.18 a	23.50 ab	6.65 ab	14.38 b	5.8 a
NA2101 2 quarts per A soil drench (1,3,5,7,9,11,13,15) Kocide 2000 2 lb/A (2,3,4…16) +Maneb 75 3 lb/A (2,3,4…16)	17.25 ab	6.10 ab	30.75 a	8.58 a	13.75 b	4.29 a
NA2101 2 quarts per A soil drench (1,3,5,7,9,11,13,15) Kocide 2000 2 lb/A (2,3,4…16) +Maneb 75 3 lb/A (2,3,4…16)	18.25 ab	6.2 ab	28.50 a	7.38 ab	13.13 b	5.11 a

[1] Sprays were applied as follows : 1 = 10 Mar; 2 = 19 Mar; 3 = 26 Mar; 4 = 2 Apr; 5=9 Apr; 6= 16 Apr; 7 = 23 Apr; 8 = 30 Apr; 9= 7 May; 10 = 14 May; 11 = 21 May; 12 = 28 May; 13 = 4 June; 14 = 11 June; 15 = 11 June; 15 = 18 June; 16 = 28 June; [2] Data is combination of disease severity estimates taken at 72 DAT and 89 DAT; [3] Data is combination of disease scale ratings taken at 92 DAT and 118 DAT; [4]Means followed by the same letter are not significantly different, P=0.05, LSD; [5] Sprays applied consecutively on spray dates 1 though 16 and also on 29 and 30 Apr and 1 May; [6] Sprays applied consecutively on spray dates 2 though 16.

Pepper (*Capsicum annuum* 'Alliance)
Bacterial Spot (*Xanthomonas campestris* pv *vesicatoria*)

P.D. Roberts, EA Bolick, RE Systma
University of Florida-IFAS
SWFREC
Immokalee, FL 34142

Evaluation of compounds for the control of bacterial spot in peppers, Spring 2005.

The experiment was located at the Southwest Florida Research and Education Center in Immokalee, FL. The soil was Immokalee fine sand (97:2.5:0.3% sand-silt-clay, pH 4.2, O.M. 1.96%). Raised beds were made on 1 Feb after fumigation with Telone C-35 applied in-bed at 35 gal/treated A. Beds were fertilized with a bottom mix of 5-17-8 at 800 lb/A and top mix applied in two bands on the bed top of 19-0-19 at 1000 lb/A. Beds had 32"-wide and 6'-centers. Plant spacing was 12" between plants with two rows per bed. Plots consisted of 20 plants each and plots had 5 ft buffers. Fields were watered by seep irrigation. Eight-week-old seedlings of pepper cultivar 'Alliance' donated by Johnson Plants Inc., Immokalee, FL, transplanted to the field on 6 Mar in a complete randomized block treatment design with four replications. All compounds were applied with a backpack CO_2 sprayer at 40 psi with a single hollow cone nozzle at 23.6 gal/A. Insecticides and herbicide applications were applied as needed and consistent with commercial production of fresh-market pepper in southwest Florida. The fungicide and bactericide formulations, rates, and application intervals are presented in the table.

Plants were inoculated with bacterial spot (*Xanthomonas campestris* pv. *vesicatoria* pepper race 3 and 6) on 28 Apr, with hand pump sprayer to apply an equal amount of inoculum per plant. Inoculum was prepared by growing the culture overnight in nutrient broth (NB) on a shaker incubator. Culture was transferred to a larger volume of NB (500 ml per flask) and grown until exponential growth phase approximately 6 hr. Cells were adjusted using distilled water and a spectrophotometer at 600 nm to 1×10^8 colony forming units per ml.

The percentage of foliage exhibiting disease symptoms was estimated at 1- to 2-week intervals. A disease rating using a scale Fruit were harvest on 12 May. Fruit were rated as marketable or non-marketable (small, misshapen or diseased). Yield and disease ratings were subjected to ANOVA and the means tested for significance using Tukey Multiple Comparison.

Not enough data points were obtained to calculate AUDPC, therefore the final reading which showed significant differences between treatments are shown. The rating scale is a modified Horsfall-Barratt where the estimate of disease severity (percentage of symptomatic tissue) 0=0%; 1=1-3; 2=3-5; 3=6-15; 4=16-25; 5= 26-50; 6= 51-75; 7=75-100. Bacterial spot reached fairly high disease severity rating by the end of the season in the untreated control plots. Only two treatments, TD2463 plus maneb and Tanos (10 oz) plus Kocide plus Manex significantly reduced disease ratings compared to the untreated control. No significant differences were detected in marketable or non-marketable yield.

Pepper Table Spring 2005

	Bacterial Spot Disease Severity Rating	Marketable Yield		Non marketable Yield	
	5/13/2005	Mean number of fruit per plot[2]	Mean lb per plot[3]	Mean number of fruit per plot[2]	Mean lb per plot[3]
Untreated Control (UTC)	5.75 a[4]	4.75 a	14.75 a	5.0 a	17.5 ab
Kocide 2000 2 lb tp/A (1,2,3…11)[1] Maneb 2 lb tp/A (1,2,3…11)	4.5 abc	3.13 a	9.5 a	5.0 a	14.25 ab
TD2463 2 lb tp/A (1,2,3…11) Maneb 75 2 lb (1,2,3…11)	0.75 c	4.75 a	15.5 a	3.88 a	12.0 b
TD2463 1.75 lb tp/A (1,2,3…11) Maneb 75 2 lb (1,2,3…11)	3.5 abc	4.75 a	18.25 a	4.13 a	16.25 ab
TD2463 1.25 lb tp/A (1,2,3…11) Maneb 75 2 lb (1,2,3…11)	4.5 abc	5.88 a	18.5 a	5.63 a	16.75 ab
Tanos 8 oz tp/A (1,3,5,7,9,11) Kocide 2000 2 lb tp/A (1,2,3…11) Manex 1.6 qt/A (1,2,3…11)	2.5 abc	5.50 a	18.25 a	5.63 a	18.0 ab
Tanos 8 oz tp/A (1,3,5,7,9,11) GX569 1 lb/A (2,4,6,8,10) Manex 1.6 qt/A (1,2,3…11)	3.5 abc	6.63 a	17.25 a	5.13 a	15.50 ab
Tanos 10 oz tp/A (1,3,5,7,9,11) Kocide 2000 2 lb tp/A (1,2,3…11) Manex 1.6 qt/A (1,2,3…11)	1.25 bc	4.38 a	13.25 a	7.5 a	30.50 a
AG3 2.0%/A (1,2,3…11)	3.0 abc	4.13 a	11.5 a	7.0 a	22.50 ab
Oxidate 1:300 v:v (1,2,3…11) Kocide 2000 2 lb tp/A (1,2,3…11) Maneb 2 lb tp/A (1,2,3…11)	2.5 abc	4.50 a	14.75 a	4.0 a	13.25 b

[1] Sprays were applied as follows : 1 = 15 Mar; 2 = 22 Mar; 3 = 29 Mar; 4= 5 Apr; 5=12 Apr; 6= 19 Apr; 7 = 26 Apr; 8 = 3 May; 9= 10 May; 11 = 24 May; [2] Mean number of fruit per plot; [3] Mean weight of fruit in lb.\ lot; [4] Means followed by the same letter are not significantly different, P=0.05, LSD;

Lettuce Growers Field Day

C&B Farms, Devil's Garden
March 1, 2006

Richard N. Raid
University of Florida, IFAS
Everglades Research and Education Center
Belle Glade, FL 33430

Evaluation of Fungicides for Lettuce Downy Mildew

Six trials are on demonstration to evaluate the efficacy of various fungicides for control of lettuce downy mildew caused by the fungus *Bremia lactucae*. An unspecified variety of leaf lettuce was direct-seeded in four rows with a 10-inch row spacing on top of 8-in raised beds formed on 6-ft centers. The dense spacing creates conditions favorable for downy mildew development, providing ideal testing conditions. Each trial consisted of six treatments replicated three times along the length of the crop bed. Experimental units were 12 feet long by 6 feet wide. All applications were made with a hand-held CO2 boom sprayer equipped with three flat fan nozzles. Two rows were sprayed with each pass using a spray volume of 79 GPA. Sprays were initiated at the 3-4 leaf stage, prior to the observation of downy mildew in the trial area. However, inoculum in adjacent fields was known to exist in the area at trial initiation. Three fungicide applications were made at weekly intervals. Dates of application were: Feb 3, 10, and 17. Lettuce downy mildew was observed at less than 1% incidence on Feb 10. Downy mildew ratings were conducted by rating the percent severity (leaf area exhibiting downy mildew symptoms) on twelve leaves per plot on Feb. 27.

Each trial consisted of an untreated check, a maneb treatment, a phosphonic fungicide treatment, and one of six fungicides of interest alone and in combination with maneb or the phosphonic fungicide. Fungicides of interest and the trials they are exhibited in are listed below.

Trial 1	Syngenta A12946B 250SC (Mandipropamid) Not yet registered
Trial 2	DuPont Tanos 50DF (Famoxadone/Cymoxanil) Registered
Trial 3	BioSafe Oxidate (Hydrogen Dioxide) Registered
Trial 4	Bayer Reason 500SC (Fenamidone) Registered w/ some restrictions
Trial 5	Bayer Previcur Flex EC (Propamocarb) Registered w/ some restrictions
Trial 6	BASF Forum SC (Dimethomorph) Currently registered as Acrobat 50W

Lettuce Downy Mildew Trial C&B #1

Evaluation of Syngenta A12946B for lettuce downy mildew control

#	Fungicide Treatment	Rate/Acre	Schedule	% Incidence	% Severity
1	Untreated Check	---	---	100 a	67.9 a
2	Manex 4F	1.6 qt	7-day	64 b	7.8 bc
3	ProPhyt	3.0 pt	7-day	56 b	10.9 b
4	A12946B	5.5 fl oz	7-day	70 b	4.9 cd
5	A12946B + Manex 4F	5.5 fl oz 1.6 qt	7-day	8 c	0.3 d
6	A12946B + ProPhyt	5.5 fl oz 3.0 pt	7-day	14 c	0.8 d

Lettuce Downy Mildew Trial C&B #2

Evaluation of Tanos for lettuce downy mildew control

#	Fungicide Treatment	Rate/Acre	Schedule	% Incidence	% Severity
1	Untreated Check	---	---	100 a	82.8 a
2	Manex 4F	1.6 qt	7-day	97 a	32.8 cd
3	ProPhyt	3.0 pt	7-day	92 a	40.0 bc
4	Tanos 50DF	8.0 oz	7-day	97 a	52.4 b
5	Tanos 50DF + Manex 4F	8.0 oz 1.6 qt	7-day	89 ab	22.4 d
6	Tanos 50DF + ProPhyt	8.0 oz 3.0 pt	7-day	78 b	30.5 cd

Lettuce Downy Mildew Trial C&B #3

Evaluation of Oxidate for lettuce downy mildew control

#	Fungicide Treatment	Rate/Acre	Schedule	% Incidence	% Severity
1	Untreated Check	---	---	100 a	81.3 a
2	Manex 4F	1.6 qt	7-day	100 a	38.6 d
3	ProPhyt	3.0 pt	7-day	100 a	53.8 c
4	Oxidate	76 fl oz	7-day	100 a	76.3 ab
5	Oxidate + Manex 4F	76 fl oz 1.6 qt	7-day	92 b	24.5 e
6	Oxidate + ProPhyt	76 fl oz 3.0 pt	7-day	100 a	67.7 b

Lettuce Downy Mildew Trial C&B #4

Evaluation of Previcur for lettuce downy mildew control

#	Fungicide Treatment	Rate/Acre	Schedule	% Incidence	% Severity
1	Untreated Check	---	---	100 a	72.2 a
2	Manex 4F	1.6 qt	7-day	58 b	10.7 b
3	ProPhyt	3.0 pt	7-day	72 b	10.6 b
4	Previcur Flex	2 pt	7-day	56 b	3.3 c
5	Previcur Flex + Manex 4F	2 pt 1.6 qt	7-day	3 c	0.1 c
6	Previcur Flex + ProPhyt	2 pt 3.0 pt	7-day	6 c	0.1 c

Lettuce Downy Mildew Trial C&B #5

Evaluation of Reason for lettuce downy mildew control

#	Fungicide Treatment	Rate/Acre	Schedule	% Incidence	% Severity
1	Untreated Check	---	---	100 a	81.3 a
2	Manex 4F	1.6 qt	7-day	94 a	25.9 b
3	ProPhyt	3.0 pt	7-day	94 a	32.9 b
4	Reason	6.85 fl oz	7-day	14 b	0.3 c
5	Reason + Manex 4F	6.85 fl oz 1.6 qt	7-day	0 c	0.0 c
6	Reason + ProPhyt	6.85 fl oz 3.0 pt	7-day	17 b	0.7 c

Lettuce Downy Mildew Trial C&B #6

Evaluation of Forum 500SC for lettuce downy mildew control

#	Fungicide Treatment	Rate/Acre	Schedule	% Incidence	% Severity
1	Untreated Check	---	---	100 a	88.3 a
2	Manex 4F	1.6 qt	7-day	89 a	30.0 c
3	ProPhyt	3.0 pt	7-day	100 a	47.3 b
4	Forum 500SC	6.1 fl oz	7-day	94 a	20.8 d
5	Forum 500SC + Manex 4F	6.1 fl oz + 1.6 qt	7-day	72 b	6.5 e
6	Forum 500SC + ProPhyt	6.1 fl oz + 3.0 pt	7-day	89 a	11.9 e

Efficacy of OxiDate in Controlling *Phytophthora infestans* (Late Blight of Potatoes)

Khalil Al-Mughrabi, Ph.D., P.Ag.

Potato Development Centre, New Brunswick Department of Agriculture, Fisheries and Aquaculture, 39 Barker Lane, Wicklow, New Brunswick, Canada E7L 3S4
E-mail: khalil.al-mughrabi@gnb.ca

ABSTRACT

A laboratory trial was conducted to test the efficacy of OxiDate® in controlling the late blight of potato and tomato fungus, *Phytophthora infestans*. In addition to the control, three OxiDate concentrations (1:150, 1:100, and 1:50 of OxiDate to water) were used in this study. A total of 17 different late blight isolates collected from New Brunswick, Prince Edward Island, Manitoba, and Quebec were subjected to various concentrations of OxiDate in a replicated experiment using 2-way completely randomized design. Growth of all isolates was inhibited when the 1:50 OxiDate concentration was used. At the 1:100 concentration, growth of 94.1% of the late blight isolates used was completely inhibited. At the lowest concentration of 1:150 OxiDate, the growth of 76.5% of the isolates tested was completely inhibited. The results of this study suggest that OxiDate has the potential to be used in preventing the occurrence of late blight in potato tubers if applied on potatoes in the proper manner after harvest and before storage.

MATERIALS AND METHOSD

A total of seventeen isolates from New Brunswick (3), Prince Edward Island (6), Manitoba (7), and Quebec (1) were used in this study. Some of these isolates belong to the more aggressive strain (US-8) of late blight (Table 1). Others belong to the less aggressive isolate US1 (A2) strain.

Fungal isolates of late blight of potatoes were maintained on Rye Extract Agar (REA) medium, and the cultures were stored at room temperature. The medium (10-ml) was dispensed in sterile Petri plates and allowed to cool down before use. The isolates were allowed to grow for 7-10 days before they were used in the microbial studies.

Methods of Al-Mughrabi *et al*. (2001) were followed. OxiDate was diluted with sterile distilled water (SDW) to give a final concentration of 0.0, 1:50, 1:100, and 1:150. The solution of each extract was evenly distributed on REA in the designated Petri plates. Each plate received 2 ml of the designated OxiDate solution. Control plates received 2 ml of SDW each. Plates were left for 2 hours before inoculation with *Phytophthora infestans* in order for the solutions to be absorbed through the media.

With a 10 cm long spring-loaded plunger of 5 mm diameter, a plug of inoculum from the actively growing margin of a Petri plate culture of late blight was placed in the center of each Petri plate with the mycelium face down. Each isolate for each solution was inoculated onto four plates and was allowed to incubate for 8 days at room temperature (~ 22°C). Four control plates receiving SDW only were run along each fungal isolate and OxiDate solution.

The radial growth (average of 2 readings: vertical and horizontal) was measured for each plate 8 days after inoculation. Data

were analyzed using CoStat Statistical Software based on a randomized completely block design.

Table 1. *Phytophthora infestans* isolates used in the OxiDate study, 2003.

Isolate	Source	Strain
01NB	New Brunswick	US8 (A2)
02NB	New Brunswick	US1 (A1)
03NB	New Brunswick	N/A*
01PEI	Prince Edward Island	N/A
02PEI	Prince Edward Island	N/A
03PEI	Prince Edward Island	N/A
04PEI	Prince Edward Island	US8 (A2)
05PEI	Prince Edward Island	US8 (A2)
06PEI	Prince Edward Island	US1 (A1)
02MB	Manitoba	N/A
03MB	Manitoba	N/A
04MB	Manitoba	N/A
05MB	Manitoba	N/A
06MB	Manitoba	N/A
07MB	Manitoba	N/A
08MB	Manitoba	N/A
03QC	Quebec	N/A

* Not identified.

RESULTS AND DISCUSSION

Results of the analysis of variance (ANOVA) show that there are significant differences between OxiDate treatments in their effect on controlling the late blight fungus *Phytophthora infestans* (Table 2).

Table 2. ANOVA table for OxiDate treatments and *Phytophthora infestans* isolates used in a laboratory study, 2003.

Source	DF	MS	F	P
Treatment (T)	3	2867.5	0.000	***
Isolate (I)	16	90.7	0.000	***
Interaction (TxI)	48	25.4	0.000	***
Model	67	168.3	0.000	***
Error	204			
Total	271			

Results of mean separation, using Student-Newman-Keuls test (Figure 1), showed that all OxiDate treatments were significantly different compared to the untreated control ($LSD_{0.05}$ = 1.1506). All OxiDate treatments were effective against late blight isolates including the most aggressive strain US8. Average colony growth for all isolates in the control plates was 46.26 mm, compared to 3.64 mm, 2.90 mm and 0.00 mm at 1:150 (0.0067% OxiDate), 1:100 (0.01% OxiDate) and 1:50 (0.01% OxiDate), respectively.

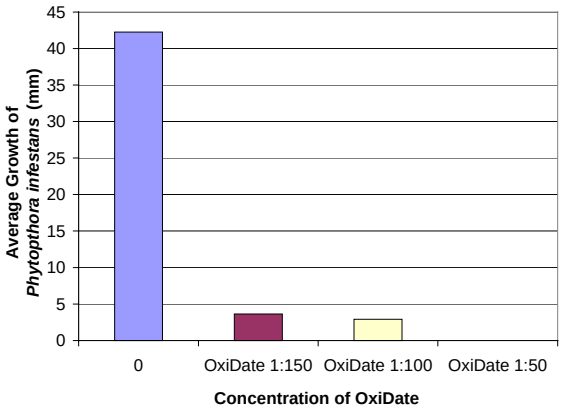


Figure 1. Average growth of all *Phytophthora infestans* isolates grown on rye extract agar (REA) plates amended with various concentrations of OxiDate.

None of the 17 *Phytophthora infestans* isolates grew on the 1:50 OxiDate concentration (Figure 3). Only one isolate (05PEI) grew on the 1:100 concentration and 4 isolates (01NB, 02NB, 05PEI, and 02MB) grew on the 1:150 concentration (Figure 4).

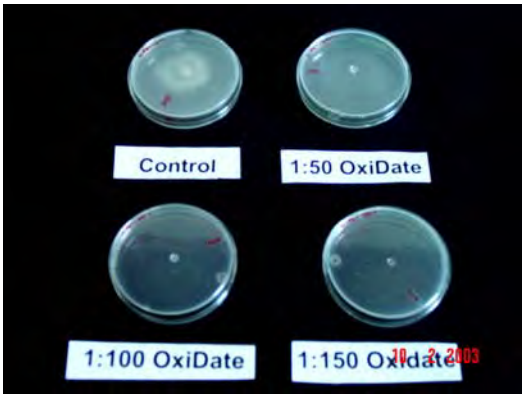


Figure 3. Growth of *Phytophthora infestans* on REA amended with OxiDate compared to the untreated control plate.

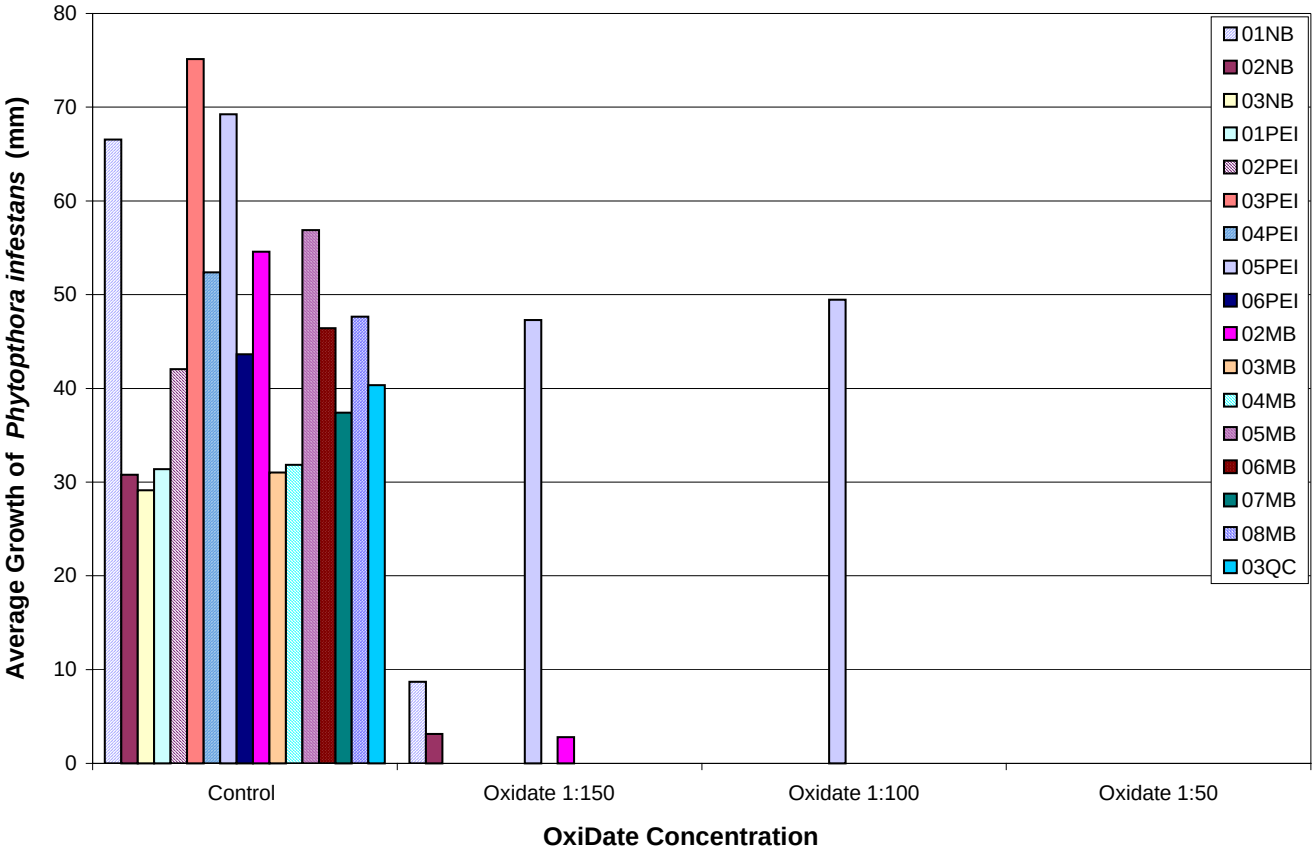


Figure 4. Average growth of 17 isolates of *Phytophthora infestans* on REA amended with various concentrations of OxiDate.

Based on these results, it is concluded that OxiDate was very effective in controlling late blight *in-vitro*. Both 1:100 and 1:50 concentrations gave excellent inhibitory effect of *Phytophthora infestans*. The 1:150 concentration was effective, however, some isolates of the US8 (A2 - most aggressive strain) and US1 (A1 - less aggressive strain) were not completely inhibited by OxiDate at this lower concentration.

It is recommended that either 1:50 or 1:100 OxiDate to water concentrations be used to protect potato tubers from infection with late blight. Application of OxiDate should be done immediately after harvest and before storing potatoes. The initial application at the conveyer belt might be useful to protect any late blight spores present on the surface of the tuber from surviving and penetrating through wounds or natural orifices. More research (greenhouse, growth chamber, *etc*.) is recommended to test the effect of OxiDate on potato tubers by applying OxiDate and then infecting with *Phytophthora infestans*.

ACKNOWLEDGEMENTS

Thanks to my colleagues from Prince Edward Island, Manitoba, Quebec and New Brunswick who supplied me with the various isolates *of Phytophthora infestans*.

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Effects of Zerotol on Eukaryotic and Prokaryotic Algal Numbers on a Bermudagrass Putting Green

Researchers: V.L. Maddox, M.S., and J.M. Goatley Jr., Ph.D.

Department of Plant and Soil Sciences
Mississippi State University
Box 9555
Mississippi State, MS 39762

MATERIALS AND METHODS

Description of Sampling Site. The study was conducted on a'Tifgreen' bermudagrass green *[Cynodon dactylon* (L.) Pers. x *C. transvaalensis* BurttDavy] in the summer of 2001. The green was native soil covered with sand/peat mix. A native soil green was utilized for this study since greens of this type often experience algal/cyanobacterial problems. The green was located at the Starkville Country Club, south of Starkville, MS. Turf cover ranged from 37 to 67 percent throughout the four-week study. Irrigation was used as needed, and the green was mowed to 4.0 mm daily. Two topdressings and one core aerification event occurred during the study. Soil chemical analyses showed levels of phosphorus at 135 kg ha-'(121 lb X'), potassium at 270 kg ha-1 (241 lb A-'), magnesium at 113 kg ha-1 (101 lb X'), and zinc at 11.0 kg ha-1 (9.8 lb A-'). Calcium levels were 711 kg ha-1 (635 lb X') and pH was 6.1. The soil consisted of 1.48 percent organic matter and the CEC was 3.82 meq 100 g-' (3.82 cmol kg-1).

Chemical Applications. The green was blocked across a slight elevation change with three replications per treatment. Experimental units were 1.8 M^2 in size. A 0.6 m alleyway was left between each block to prevent chemical drift and tracking between blocks. All treatments were applied four times on one week intervals. Applications were made on 9, 16, and 23 July, and 6 and 13 August 2001. The following treatments and rates were applied: chlorothalonil (tetrachloroisophthalonitrile)(Daconil 2797, ISK Biotech Corp., Mentor, OH) at

6 oz product 1000 ft-2 (0.96 g ai M-2) , hydrogen dioxide (Zerotol, Biosafe Systems, Glastonbury, CT) at 1.25 fl. oz product g-' (9.8 mL L-1, or 1 mL M-2) for the first two applications and at 2.5 fl. oz product g-1 (19.6 mL 2 L-1, or 2 mL M-2) for the last two applications and an untreated control. Hydrogen dioxide and chlorothalonil were applied in a water carrier at a volume of 100 mL M-2 (200 mL M-2 on last two applications of hydrogen dioxide) by a C02-powered boom sprayer with pressure at 1.75 kg cm-2 . For the purposes of this study, these chemicals were evaluated for both algicidal (using eukaryotic algal numbers) and cyanobactericidal (using prokaryotic algal numbers) activity.

Sampling of Putting Greens. Sampling was initiated on 6 August 2001. Each week, two soil samples from each experimental unit were taken with a 1.9 cm diameter steel corer to a depth of 2.5 cm. Soil samples were taken from the center of each experimental unit at opposite ends. Each week, soil samples were collected within 2.5 cm of the location of the last soil sample to reduce sampling variation among weeks.

Eukaryotic and prokaryotic algal numbers in soil samples were analyzed under a light microscope (Bausch and Lomb Dynazoom Research Laboratory Microscope). Each soil sample was placed in a 25 x 150 mm test tube and 25 mL of distilled water was added to each sample and shaken vigorously for 30 s. A Pipetman 200 micropipette was used immediately to collect a sample of the unsettled solution. Two-25 pL drops were placed on a microscope slide at

opposite ends, and each drop was covered with a cover slip. Three microscope fields at 20OX were analyzed from each drop to determine eukaryotic and prokaryotic algal numbers, resulting in is a total of twelve microscope fields for each treatment replication. Genera counted as eukaryotes were *Chlamydomonas sp.*, *Navicula mutica* KUtz., and *Hantzschia amphioxys* (Ehr.) Grun. Prokaryotes (cyanobacteria) counted were three *Oscillatoria spp.*, *Lyngbya sp.*, *Nostoc* sp. and *Phormidium* sp. These seven genera were enumerated since they were found in highest numbers at the time of initiation on 6 August 2001. Visual pigment coloration was used to determine viability. Only eukaryotic and prokaryotic algal taxa with pigment coloration were counted. Due to the difficulty in counting single cells within a trichome and the functioning of trichomes as a single unit, trichomes consisting of more than one cell *(Lyngbya sp., Oscillatoria spp., Phormidium* sp., and *Nostoc* sp.) were counted as one unit or observation. Data is presented as the number pL^{-1} of sample solution.

The experimental design was a Randomized Complete Block having three replications. Data were analyzed using analysis of variance (ANOVA) for main effects, across weeks, and across treatments (SAS Inst., 1988a).

Visual algal and turfgrass cover ratings were used for comparisons with the numerical counts by using the Pearson product-moment correlation procedure (SAS Inst., 1988b). The visual rating scales ranged from 0 percent cover (equaling no visible algal/cyanobacterial or turfgrass cover) to 100 percent cover (complete cover of algal/cyanobacterial or turfgrass).

RESULTS AND DISCUSSION

Eukaryotic and Prokaryotic Algal Numeric *Interactions. A* significant year by week interaction (P:~ 0.05) was indicated by an ANOVA analysis of eukaryotic algal numbers. As a result, caution should be taken when interpretating the mean column data in Table 2. This interaction was indicated for prokaryotic algae numbers, algal cover, or turf cover. However, these data were analyzed by week and treatment to show possible spacial and/or temporal trends (Tables 1 and 2). Overall means are also presented in the last column for these three dependent variables.

Eukaryotic and Prokaryotic Algal Numbers. Eukaryotic algal numbers were consistant throughout this study (Table 2) compared to eukaryotic algal numbers (Table 1). The problem with low numbers is the high variability between observations. In general, trends are difficult to determine with low algal numbers. Increasing sampling size is one way to overcome these fluctuations. However, in algal populations one group of organisms tend to dominate. In this study, prokaryotic algae were dominant. Increasing sample size may exceed what is adequate numerically. In addition, more time is required which can cause additional sampling problems. Another way to increase sampling size is to pool data across weeks to obtain an average over several observations. If this is done for Table 2, ZeroTol appeared to have high activity on the eukaryotic algae in this study.

Prokaryotic algal numbers also appear to have been reduced in the ZeroTol treatment during this study, (Table 1). Numbers were considerably lower in the ZeroTol treatment compared to chlorothalonil and the control following the first application. This is also reflected in the overall means. However, this is not reflected in the visual algal cover ratings (Table 3). At three weeks after initiation, visual algal cover in the ZeroTol treatment were significantly lower compared to chlorothalonil.

This group of organisms can be both prevalent and persistent on putting greens (Maddox et al., 1997). Cyanobacteria (prokaryotic algae) have the ability to fix atmospheric nitrogen. Oxygen can be detrimental to nitrogen fixation in microorganisms. It is theorized that ZeroTol may oxidize cell walls and/or prevent nitrogen fixation in this group of organisms. However, the mucilaginous outer layers of the cell wall which are typical of this group may create a barrier for the product. As a result, this group of algae may be more difficult to control with ZeroTol compared to thinner walled algal species. Higher concentration rates may overcome the mucilaginous outer layers of the cell wall. The time of year can also

influence cell wall thickening and/or layering which could influence product efficacy. The results of this study are not conclusive regarding these issues. Significant differences for numeric data and visual ratings confirm that current rates are efficacious, additional work is needed with higher rates to more fully clarify current data.

Evaluation of Visual Ratings and Correlation Analyses. Algal cover rating showed a decreasing trend during the study (Table 3). This trend was not consistent with prokaryotic algal numbers which is re-enforced with the correlation analysis (Table 4). The correlation between prokaryotic algal numbers and algal cover was not significant. Correlations between eukaryotic algal numbers and algal cover ratings were significant. However, the r-value was -0.354. There may have been interactions between eukaryotic and prokaryotic algae during the study. However, eukaryotic numbers were low during the study which makes data interpretation difficult.

Turf cover did improve during the course of the study. Coring and topdressing activities on the green may have influenced turf cover. In turn, turf cover may have influenced algal cover. The correlation between algal cover and turf cover was significant. The r -value for the correlation was -3.338, indicating that as turf cover increased, algal cover decreased. This is an expected response since both turf and algae utilize light for energy.

Since this is field data, additional year(s) of data would be required to make more conclusive inferences. This must be taken into account when drawing conclusions from a single year of data. Each year is environmentally unique as well as the data it yields. Trends which are repeatable from year to year greatly reinforce inferences which are made from data. For this reason, only two or more years of repeated data are generally published in scientific journals.

Research conduscted in 2001 indicated more efficacious results that was previously reported in 1998. As with the 1998 study, additional research is needed with higher rates of ZeroTol. The volumes utilized in this study appear to be adequate. However, the inconsistencies between visual and numeric data indicate a need for more conclusive data.

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Table 1. The effects of six algaecide treatments on prokaryotic algae (Lyngbya sp., Oscillatoria spp., Nostoc sp., and Phormidium sp.) numbers µL(-1) of sample solution from a bermudagrass green in 2001.

		WAT					
		0	1	2	3	LSD	Mean
Treatment	rate(x) m(-2)	Number µL(-1)					
ZeroTol	1, or 2 mL	183	182	175	110	S	162
Chlorothalonil	0.96 g ai	339	351	243	408	NS	335
Control	-	280	321	260	367	N	307

(z)WAT= Week After Treatment.

(y)Mean separation across weeks within treatment and across treatments within week by Fisher's protected least significant difference ($P \leq 0.05$);

NS= nonsignificant. S= Significant

(x)Treatments were applied in a water carrier in a volume of 359 mL m(-2); ai= active ingredient.

Table 2. The effects of six algaecide treatments on eukaryotic algae (Chlamydomonas sp., Hantzschia amphioxys, and Navicula mutica.) numbers µL(-1) of sample solution from a bermudagrass green in 2001.

		WAT					
		0	1	2	3	LSD	Mean
Treatment	rate(x) m(-2)	Number µL(-1)					
ZeroTol	1, or 2 mL	2	3	5	7	S	4.25
Chlorothalonil	0.96 g ai	2	2	44	22	18	17
Control	-	19	5	7	45	NS	19
LS D(y)		NS	NS	NS	NS	-	NS

(z)WAT= Week After Treatment.

(y)Mean separation across weeks within treatment and across treatments within week by Fisher's protected least significant difference ($P \leq 0.05$);

NS= nonsignificant. S= Significant

(x)Treatments were applied in a water carrier in a volume of 359 mL m(-2); ai= active ingredient.

Table 3. The effects of six algaecide treatments on eukaryotic and/or prokaryotic algae on a bermudagrass green in 2001 as determined by visual cover ratings.

		Algal Cover Rating WAT						Turf Cover Rating WAT					
		0	1	2	3	LSD mean		0	1	2	3	LSD mean	
Treatment	rate m	-------Percent Algal Cover----						-----Percent Turf Cover---					
ZeroTol	1, or2 mL	30	47	42	33	NS	38	33	32	33	30	NS	31.25
Chlorothalonil	0.96 g ai	78	67	63	60	18	67	68	57	60	67	11	63
Control	-	80	78	80	57	NS	74	47	47	50	62	NS	51
LSD(y)		NS	NS	NS	5	-	5	NS	6	5	NS	-	7

Visual Cover Rating Scale: Percent cover of 0= no visible algal or turf cover to 100 percent cover= total plot covered with algal colonies or turf.
WAT=Week After Treatment.
Mean separation across weeks within treatment and across treatments within week by Fisher's protected least significant difference ($P \leq 0.05$); NS=nonsignificant.

Table 4. Pearson correlation analysis between eukaryotic and prokaryotic algal numbers and visual

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NOTES

Evaluation of Several Commercial Algicides for Control of Odor-producing Cyanobacteria

KEVIN K. SCHRADER[1]

INTRODUCTION

The production of certain odorous metabolites is an undesirable attribute of cyanobacteria (blue-green algae) growth in aquaculture ponds [e.g., channel catfish (*Ictalurus punctatus*)] and in drinking water reservoirs. The most common odorous compounds encountered in catfish aquaculture are geosmin (*trans*-1,10-dimethyl-*trans*-9-decalol) and 2-methylisoborneol (*exo*-1,2,7,7-tetramethylbicyclo[2.2.1]heptan-2-ol). These compounds are also frequently encountered worldwide in reservoirs and aqueducts used for municipal drinking water systems (Schrader et al. 2002). Geosmin is typically described as having an "earthy" odor while 2-methylisoborneol (MIB) is referred to as "musty." The uptake of these compounds by catfish occurs mainly across the gill membranes and can taint the flesh causing them to be unpalatable and subsequently unmarketable. Catfish producers must hold the catfish in ponds until they lose the earthy and/or musty "off-flavor" which can take weeks or months. These delays in harvest have been estimated to cost producers as much as $30 million annually (Schrader et al. 2003). Earthy and musty off-flavors in municipal drinking water systems are also costly due to additional management expenses in order to remove the off-flavor compounds (e.g., carbon filtration or ozone treatments) or preventive treatments (e.g., application of algicides).

The most common management approach in catfish aquaculture to control earthy and musty off-flavors is the use of algicides. The application of algicides may initially make the off-flavor episode more intense since damaged and dying cyanobacterial cells will release intracellular stores of geosmin or MIB (Peterson et al. 1995). Currently, only copper-based products (e.g., chelated-copper products and copper sulfate) have United States Environmental Protection Agency (USEPA) approval for use in catfish aquaculture ponds and municipal drinking water systems for the management of earthy/musty off-flavors. Diuron [*N*'-(3,4-dichlorophenyl)-*N*, *N*-dimethylurea], under section 18 emergency exemption permission by the USEPA for management of MIB-related off-flavors in catfish, must be approved annually and future approvals are not guaranteed. These synthetic algicides have several negative attributes including broad-spectrum toxicity towards phytoplankton, persistence in the environment, and the public's negative perception to the use of synthetic compounds in food-fish production ponds and municipal drinking water systems.

Several new products, some of which are natural-based, have become available commercially that may be useful as selective algicides in managing off-flavor producing cyanobacteria. In this study, several of these algicides were evaluated using a rapid bioassay to determine their effectiveness in controlling the MIB-producing cyanobacterium *Oscillatoria perornata* from a west Mississippi catfish pond and the MIB-producing *Pseudanabaena* sp. (strain LW397) from Lake Whitehurst, Virginia, used as a city water supply reservoir. The cyanobacterium *Oscillatoria agardhii*, not a MIB-producer, and the green alga *Selenastrum capricornutum*, found in catfish ponds in the southeastern United States, were included in the bioassay to help determine potential broad-spectrum toxicity of the commercial products.

MATERIALS AND METHODS

An isolate of *O. perornata* was obtained from a water sample collected from a west Mississippi catfish pond (van der Ploeg et al. 1995). A culture of *Pseudanabaena* sp. (strain LW 397) was obtained from George Izaguirre, Metropolitan Water District of Southern California, La Verne, California. An isolate of *O. agardhii* was also obtained from a west Mississippi catfish pond and *S. capricornutum* was obtained from Dr. J. C. Greene, United States Environmental Protection Agency, Corvallis, Oregon. Each culture was maintained separately in continuous, steady-state growth using the conditions outlined in Schrader et al. (1997) to provide a source of cells growing at a fairly constant rate.

The rapid bioassay of Schrader et al. (1997) was used to evaluate the commercial products. The following commercial products were evaluated in this study: 1) AlgaeFix®[2]; 2) MICROBE-LIFT® Barley Straw Concentrated Extract[3]; 3) SAVIO Natural Barley Extract™[4]; and 4) ZeroTol™[5]. Stock solutions of each commercial product were made in sterile,

[1]United States Department of Agriculture, Agricultural Research Service, Natural Products Utilization Research Unit, National Center for Natural Products Research, Post Office Box 8048, University, MS 38677, USA; e-mail: kschrader@msa-oxford.ars.usda.gov. Received for publication February 25, 2005 and in revised form April 17, 2005.

[2]AlgaeFix® is a registered trademark of Aquarium Pharmaceuticals, Inc., Chalfont, PA.

[3]MICROBE-LIFT® Barley Straw Concentrated Extract is a registered trademark of Ecological Laboratories, Inc., Freeport, NY.

[4]SAVIO Natural Barley Extract™ is a trademark of SAVIO Engineering, Inc., Sante Fe, NM.

[5]ZeroTol™ is a trademark of BioSafe Systems, Glastonbury, CT.

deionized water [0.00004, 0.0004, 0.004, 0.04, and 0.4% (v/v) for AlgaeFix and ZeroTol; 0.01, 0.1, 1.0, and 10.0% (v/v) for each barley straw extract product]. Stock solutions of AlgaeFix and ZeroTol were added (50 µL per well) to appropriate microplate wells (96-well polystyrene microplate, Corning Incorporated, Corning, NY) containing 150 µL of culture from one of the continuous cultures. Stock solutions and undiluted solutions of MICROBE-LIFT barley straw extract and SAVIO barley extract were added (10 µL per well) to appropriate wells containing 190 µL of culture from one of the continuous cultures. Final treatment concentrations were 0.00001, 0.0001, 0.001, 0.01, and 0.1% (v/v) for AlgaeFix and ZeroTol while final treatment concentrations for MICROBE-LIFT barley straw extract and SAVIO barley extract were 0.0005, 0.005, 0.05, 0.5, and 5.0% (v/v). Sterile, deionized water was added to the controls. Three replications were used for each commercial product concentration and control, and experiments were repeated. Microplates were placed in a growth chamber held at 29 ± 1°C and were illuminated continuously by fluorescent lights (40 W, cool white) at a photon flux density of 21 to 27 µE/m²/s. Absorbance measurements of each well were measured at 650 nm at 24-h intervals for 4 days using a Packard model SpectraCount microplate photometer (Packard Instrument Company, Meriden, CT). Mean values and standard deviations of absorbance measurements were calculated and graphed to determine the lowest-observed-effect concentration (LOEC), lowest-complete-inhibition concentration (LCIC), and 96-h IC50 (50% inhibition concentration).

AlgaeFix, marketed as a liquid formulation, contains 4.5% of the active ingredient poly[oxyethylene-(dimethyliminio) ethylene(dimethyliminio)ethylene dichloride], and product information states that AlgaeFix can cause the cellular membranes of algae to leak and may also adversely affect nutrient and ion flow across cellular membranes. This product is registered with the USEPA for use in fish aquaria and ornamental water garden ponds.

ZeroTol is also registered with the USEPA for use as a fungicide and algicide in greenhouses, nurseries, and garden centers, and it contains 27% of the active ingredient hydrogen dioxide. Hydrogen dioxide is derived by combining hydrogen peroxide with peracetic acid. Previous research found that hydrogen peroxide has algicidal activity (Kay et al. 1982); however, hydrogen peroxide can quickly break down when exposed to sunlight. According to product information, ZeroTol is stabilized to help prevent rapid breakdown.

Both barley straw extract products contain material from decomposed barley straw. None of the products evaluated in this study have been label-approved by the USEPA for use in catfish aquaculture. The IC50 values for AlgaeFix and ZeroTol are based upon active ingredients while LOEC and LCIC values are based upon product formulations.

RESULTS AND DISCUSSION

Research dealing with the discovery of natural and natural-based algicides has garnered more attention recently due to increased environmental concerns about and the negative attributes of currently available algicides for controlling noxious cyanobacteria in freshwater ecosystems. There have been several different approaches and bioassay methods used in the discovery of novel natural-based algicides. Gross et al. (1991) used an agar-overlay plate method to discover the allelochemical fischerellin that is produced by the cyanobacterium *Fischerella muscicola* and inhibits the growth of other species of cyanobacteria and certain species of green algae (chlorophytes). More recently, Gross et al. (1996) have used a bioassay in which the inhibition of alkaline phosphatase activity is measured by fluorescence spectrometry to identify algicidal polyphenols produced by the aquatic plant *Myriophyllum spicatum*. Walker and Higginbotham (2000) used shake-flask culture studies to help discover an aquatic bacterium (SG-3) that lyses cyanobacteria including *O. perornata*. Scale-up studies were later performed using 757-L polypropylene tanks containing catfish pond water with blooms of *Oscillatoria* spp. (e.g., *O. perornata*) to further evaluate the algicidal properties of bacterium SG-3 (Walker 2003).

The rapid bioassay of Schrader et al. (1997) has been found to be reproducible and reliable as a primary evaluation of compounds and commercial products for algicidal selectivity. It does not provide definitive information as to the efficacy of certain compounds and commercial products in aquatic environments. However, a compound or commercial product that does not show promise in the primary evaluation (i.e., bioassay) is unlikely to be effective when tested in secondary or scale-up type studies such as the use of limnocorrals (fiberglass enclosures) placed in catfish aquaculture ponds for efficacy testing of compounds and commercial products (see Schrader et al. 2000).

AlgaeFix was effective at 0.01% (v/v) (or 4.5 mg/L of the antimicrobial active ingredient) against each of the test organisms based upon LCIC results. The LOEC and LCIC values are above the label-recommended initial application rate of 0.0026% (v/v) (or 1.2 mg/L of the active ingredient), and AlgaeFix was not found to be selectively toxic towards the cyanobacteria tested when compared to *S. capricornutum* based upon IC50 results. The IC50 values were all higher for each cyanobacterium tested (1.8-2.8 mg/L) compared to an IC50 of 0.9 mg/L for *S. capricornutum* (Table 1). Also, AlgaeFix is not economically practical for use in large commercial-size catfish ponds when compared to diuron label application rates (10 µg/L) (Tucker and Leard 1999) and the inexpensive commercial price of $13/kg for diuron.

Results from this study showed that neither of the barley extract products tested was effective in killing the four test organisms (Table 1). The initial label-recommended application rate of MICROBE-LIFT and SAVIO Barley Extract are 0.0066% (v/v) and 0.0078% (v/v), respectively. The LCIC and LOEC for both products was >5% (the highest concentration tested was 5%). The 96-h IC50 was not determined for these two barley extract products.

Previous research by Newman and Barrett (1993) demonstrated that rotting barley straw inhibited the growth of the cyanobacterium *Microcystis aeruginosa*. However, research by Wills et al. (1999) found that decomposing barley straw when placed in Mississippi catfish ponds did not reduce the occurrence of musty off-flavor in catfish. The lack of toxicity of the barley extracts towards the cyanobacteria tested in this study is unclear. Pillinger et al. (1994) suggest that the oxidation of phenolic compounds and lignin derivatives from decomposing barley straw under aerobic conditions may yield quinones. Several

TABLE 1. RAPID SCREENING RESULTS OF COMMERCIAL PRODUCTS TO EVALUATE TOXICITY TOWARDS SELECTED PHYTOPLANKTON. PERCENTAGES ARE BASED UPON A VOLUME/VOLUME BASIS.

	Test Organism											
	O. perornata			*O. agardhii*			*Pseudanabaena* sp. LW397			*S. capricornutum*		
Test Product	LOEC	LCIC	IC50	LOEC	LCIC	IC50	LOEC	LCIC	IC50	LOEC	LCIC	IC50
AlgaeFix	0.01%	0.01%	1.8	0.01%	0.01%	2.8	0.01%	0.01%	2.8	0.01%	0.01%	0.9
MICROBE-LIFT Barley Extract	>5.0%	>5.0%	ND	>5.0%	>5.0%	ND	>5.0%	>5.0%	ND	>5.0%	>5.0%	ND
SAVIO Barley Extract	>5.0%	>5.0%	ND	>5.0%	>5.0%	ND	>5.0%	>5.0%	ND	>5.0%	>5.0%	ND
ZeroTol	0.0001%	0.001%	0.4	0.001%	0.001%	1.4	0.0001%	0.001%	1.7	0.001%	0.01%	3.4

LOEC = Lowest-observed-effect concentration; LCIC = Lowest-complete-inhibition concentration; IC50 = 50% Inhibition concentration after 96 hours and expressed as mg/L of active ingredient; ND = Not determined.

quinones have been found to be selectively toxic towards *O. perornata* in laboratory and pond efficacy studies (Schrader et al. 1998, Schrader et al. 2003). However, the chemical compositions of the two barley extracts were not elucidated in this study to determine the presence or types of quinones.

ZeroTol was the most selectively toxic of the four commercial products evaluated, with a LCIC of 0.001% for each cyanobacterium tested compared to a LCIC of 0.01% for *S. capricornutum* (Table 1). The IC50 values of ZeroTol for *O. perornata* and *Pseudanabaena* sp. LW397 were determined to be 0.4 and 1.7 mg/L, respectively, compared to an IC50 of 3.4 mg/L for *S. capricornutum*. Although diuron is more toxic towards *O. perornata*, ZeroTol can be considered more environmentally safe due to low environmental persistence and its degradation products of water and oxygen.

ZeroTol appears to be the most promising of the commercial products evaluated in this study for potential use in managing noxious types of cyanobacteria in catfish aquaculture ponds. Efficacy studies need to be performed in a dose-response format in catfish ponds using limnocorrals (fiberglass enclosures) (Schrader et al. 2000) to help further evaluate the effects of ZeroTol on phytoplankton community structure. In addition, studies need to be conducted to evaluate the toxicity of ZeroTol towards channel catfish. Such studies would help determine if there is a sufficient margin between phytotoxic and ichthyotoxic concentrations of ZeroTol for its use in catfish aquaculture.

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The bacterial, fungicidal and sporicidal properties of ZeroTol™; properties of hydrogen dioxide and peracetic acid.

M.G.C. Baldry: Research and Development Department, SIC LTD

Baldry. M.G.C. The bacterial, fungicidal and sporcidal properties of ZeroTol Algaecide/ Fungicide has been examined, using the active ingredients of hydrogen dioxide and peracetic acid. ZeroTol exhibited excellent antimicrobial properties, especially under acidic conditions. Reductions by a factor of 10 in the numbers of vegetative bacteria are obtained within less than one (1) min of contact time at 25°C using a solution containing 1-3 ppm of ZeroTol. Rapid activity against both bacterial spores and yeast also occur.

The antimicrobial properties of peroxygen compounds have been recognized for many years and a variety of applications have been developed. Diluted solutions of hydrogen peroxide have been used as antiseptics (Gump 1979) and the sproicidal activity of this substance (Curren et al. 1940 ; Swartling & Lindgren 1968;; von Bockelmann & von Bockelmann 1972: Ito et al. 1973; Toledo et al 1973; Wardel & Reiniger 19975) has led to use in aseptic packaging techniques. Peracetic acid is the most effective biocide when used as both in an aqueous solution and as both an aerosol spray and or vapor, for sterilization in gnotobitic environments.

Recently, BioSafe Systems LLC, Medford New Jersey has developed a formulation that is designed to act as a broad spectrum algaecide, biocide and fungicide and which has been specifically formulated to be non phytotoxic to living plant tissue.

Experiments were undertaken to test the effectiveness of the ZeroTol peroxygen formulation using combinations of hydrogen peroxide in combination with peracetic acid, to determine the bactericidal, fungicidal and sporicidal properties of the ZeroTol formulation.

Materials and Methods

MICRO-ORGANISMS

All the microorganisms used were standard strains. The bacteria were obtained from the American Type Culture Collection, Rockville MD. The yeast's were supplied by the National Collection of Yeast Cultures. The microorganisms were maintained by serial sub-culture, fresh cultures being started at monthly intervals from stock cultures. Asporogenous bacteria were sub-cultured daily in Nutrient Broth (Oxiod) while spore formers were treated in a similar fashion in a sporulation broth containing 10 mg/l bacteopetone and 20 mg/l maganese sulfate. Yeasts were subcuultured twice per week on Wort Agar. All experiments were performed in duplicate.

CHEMICAL

The peroxygen compound tested was manufactured by BioSafe systems LLC, of Medford, NJ USA under the trade name ZeroTol

BACTERIOSTATIC ACTION

For testing bacteriostatic activity, a 24h culture of bacteria was diluted in sterile quarter-strength solution and added to give final concentration of 104 cfu /ml, to a growth medium containing 7 g/l bactopheptone, 5 g/l glucose, the biostat under test and sufficient amounts of di-sodium hydrogen ortho-phosate dodecahydrate and citric acid to buffer at the desired pH. The systems were incubated at 37°C for 5 d and then examined visually for signs of growth, i.e. Turbidity.

BACTERICIDAL AND FUNGICIDAL ACTION

To determine activity against bacteria, a solution of the biocide under test was prepared in quarter-strength solution, maintained at the desired pH by the cirate-phosphate buffer. A 24h (10 for spore-formers) culture of bacteria, diluted in quarter strength Ringer solution, was added to give 10° cfu/ml and at various time intervals 1 ml/ samples were transferred aseptically to 10 ml volumes of Nutrient Broth No. 2 containing an appropriate deactivator. After incubation at 37° C for 3 d (21 d for spore-formers) , the media were examined for growth.

The activity of ZeroTol against yeast was evaluated in a similar fashion. The yeasts were given two 24-h sub-cultures in Sabouraud Liquid Medium, followed by a 48-h sub-culture in this medium, which was then used to form the inoculum in an experiment. Sabouraud Liquid Medium with deactivators was used as the growth/recovery medium, the cultures being incubated for 7 d at 25°C.

The effect of the repeated exposure of the yeasts to sub-lethal concentrations of ZeroTol was also determined. Eight serial sub-cultures (two per week) were performed by adding 1 ml of yeast suspension to 10 ml of a solution containing 0-47 mmol/l of ZeroTol. After exactly one minute of time, 1 ml of this suspension was used to inoculate 10 ml of fresh Sabouraud Liquid Medium. Since deactivators were not used, the Sabouraud Liquid Medium contained residual ZeroTol at concentrations of 47u mol/l and 12u mol/1 respectively.

SPORICIDAL ACTION

Sprocidal action was determined using bacterial spores dried on carriers. The carriers used were stainless steel rings of 15 mm length, 10 mm outside diameter and 2 mm wall thickness. These were cleaned before using by washing with Triton X-100, followed by a thorough rinsing. They were then sterilized by heating to 180°C for 3 h in an oven. A 10 d culture of spore-forming bacteria 10 ml volume was shaken on a vortex mixer with glass balls of 1.5-2.0 mm diameters to assist in the disintegration of the pellicle. Four cooled, sterile carriers were placed in each 10 ml volume of bacterial culture and left to stand for 15 min. The carriers were then removed from the suspension and dried over calcium chloride *in vacuo* for 24 h. Samples *(12 ml)* of the system under test were transferred into sterile test tubes. The pH of the solutions was controlled, when desired by standard buffer powders. Five dried, contaminated carriers were then placed in each aliquot and left for the required time. The carriers were then transferred aseptically to individual tubes containing 10 ml of Nutrient Broth No 2. And deactivator. The media were incubated for 21 d at 37°C prior to inspection

RESULTS

The effectiveness of ZeroTol is directly related the to strength of concentration used. It is also apparent that pH has little or no effect on the effectiveness of ZeroTol with respect to effectiveness against the yeast strains tested.

The yeasts exposed to sub-lethal doses did not exhibit any greater difference in the resistance to the biocide. While it is impossible to demonstrate that resistance will never develop, these results strongly suggest that any loss of sensitivity to ZeroTol will not develop easily or rapidly.

Table 1. Action of ZeroTol on yeast

Time required for complete kill

pH	Concentration Of ZeroTol (mmol/1)	*Saccharomyces Cerevisia 762* yeast	*Saccharomyces Cerevisie* 1026 yeast	*Zyqosaccharomyces Bailli* 580 yeast
5-0	0-13	>30	>30	<5
	0-40	>30	30	<5
	0-66	10	>5	<5
	1-3	<5	>5	<5
	6-6	<5	>5	<5
	13	<5	>5	<5
6-5	0-13	>30	>30	>30
	0-40	>30	>30	>30
	0-66	10	<10	>5
	1-3	<5	>5	>5
	6-6	<5	>5	>5
	13	<5	>5	>5
8-0	0-13	>30	>30	20
	0-40	>30	>30	>5
	0-66	10	<10	>5
	1-3	<5	>5	>5
	6-6	<5	>5	>5
	13	<5	>5	>5

Table 2. Sporicidal action as measured by the suspension test

Time required for complete kill of *Bacillus Subtillis*

Concentration mmol/1	pH 5-0	pH 6-5	pH 8-0
1-3	>6	>6	.6
13	1	3	>6
130	>.05	>.05	<.05
380	>.05	>.05	<.05

The results of the suspension test indicate that ZeroTol is an excellent sporicide, and seems to be most effective at pH ranges between 5- 7. The more stringent carrier tests also indicate that ZeroTol is a very effective sporicide. In this test, the spores were protected from the biocide not only by the carriers themselves but also by the dried residues from the sporulation broth.

As expected, a higher dose is required to kill spores than vegetative bacteria or fungi. It is expected that the effectiveness of the biocide is due in part to its ability to exert sporicidal activity on the spore by attacking the protein from the coat of the spore, as well as removing the exosporia

Table 3. Sproicidal activity as measured by the carrier test

Concentration mmol/l	Contact time min.	pH	Number of viable spores Total of 15 potential
13	24	3-1	7/15
39	5	2-9	1/15
39	1	2-9	0/15
39	2	2-9	2/15
39	4	2-9	1/15
39	6	2-9	1/15
130	24	2-9	1/15
130	1	2-6	1/15
390	5	2-6	0/15
390	5	2-3	0/15
390	5	4-0	0/15
390	5	9-0	0/15

A DEMONSTRATION TRIAL OF BIO-FUNGICIDES WITH EFFICACY FOR CONTROLLING DOLLAR SPOT IN TURFGRASSES

A bio-fungicide demonstration trial was conducted for controlling dollar spot of bermudagrass at Mississippi State University in the summer of 2004. The number of infection centers per square foot, turfgrass quality, and percent infection based on the percent area of dollar spot infection within a 4 ft x 6 ft plot were recorded throughout the duration of bio-fungicide application. The data detailing the number of infection centers per square foot reflects the magnitude of dollar spot symptoms in a plot. Phytotoxicity due to bio-fungicide applications was not observed, therefore not compromising turfgrass quality. Dollar spot symptoms were present at the time of the initial bio-fungicide application on 17 May 2004. In mid-June, disease activity increased due to favorable environmental conditions and disease pressure was considered high. During this period (17-25 June), the ZeroTol treatments resulted in significantly fewer infection centers within a plot compared to the untreated control (Table 1). The ZeroTol treatments were as effective for controlling dollar spot as the standard, iprodione fungicide. These results suggest that ZeroTol can be used alone or in rotation with a chemical fungicide in a preventive manner for controlling dollar spot of bermudagrass.

Dollar spot incidence was low during the late season bio-fungicide trial however ZeroTol treatments had significantly fewer infection centers within a plot compared to the untreated control (Table 2).

The results of the 2004 bio-fungicide demonstration trial suggests that EcoGuard, TurfShield, and ZeroTol are effective in a preventive manner for controlling dollar spot of bermudagrass regardless of the magnitude of disease pressure.

ZeroTol treatments were applied, along with Activate Plus™ non-ionic surfactant (0.06% v/v), with a CO_2 backpack sprayer using a two nozzle (11002 T-Jet) boom at 40 psi at a spray volume of 3 gal water/1000 ft^2. All treatments were replicated four times in a randomized complete block design with a plot size of 4 ft x 6 ft. Data was analyzed using the general linear model procedure of the Statistical Analysis System (SAS).

A demonstration trial of ZeroTol with efficacy for controlling dollar spot of bermudagrass
- late season dollar spot -

Table 2.

	20 September			5 October			13 October		
Treatment, rate/1000 sq ft, spray interval	**IC[z]**	**TQ[y]**	**% INF[x]**	**IC**	**TQ**	**% INF**	**IC**	**TQ**	**% INF**
ZeroTol 12.0 fl oz + surfactant (0.06% v/v)	0.0	5.3	0.0	0.0c[w]	6.3	0.0	0.2bc	6.0	1.0bc
ZeroTol 12.0 fl oz + surfactant (0.06% v/v) alt. w/ Iprodione 2.0 fl oz; 7-d	0.0	5.5	0.0	0.2c	6.3	1.0	0.0c	6.3	0.0c
Iprodione 2.0 fl oz; 14-d	0.3	5.8	2.5	0.0c	6.0	0.0	0.0c	5.8	0.0c
Untreated control	0.8	5.8	2.5	2.3a	6.0	13.0	4.4a	5.3	11.0ab

[z] IC = the number of infection centers per square foot in a plot.

[y] TQ = turfgrass quality visual rating on a scale of 1 to 9, where 9 = best.

[x] % INF = the percent area of dollar spot infection within a 4 ft x 6 ft plot.

[w] Means within a column, followed by the same letter, are not significantly different at α=0.05 according to Fisher's protected least significant difference test.

A demonstration trial of ZeroTol with efficacy for controlling dollar spot of bermudagrass
- early season dollar spot -

Table 1.

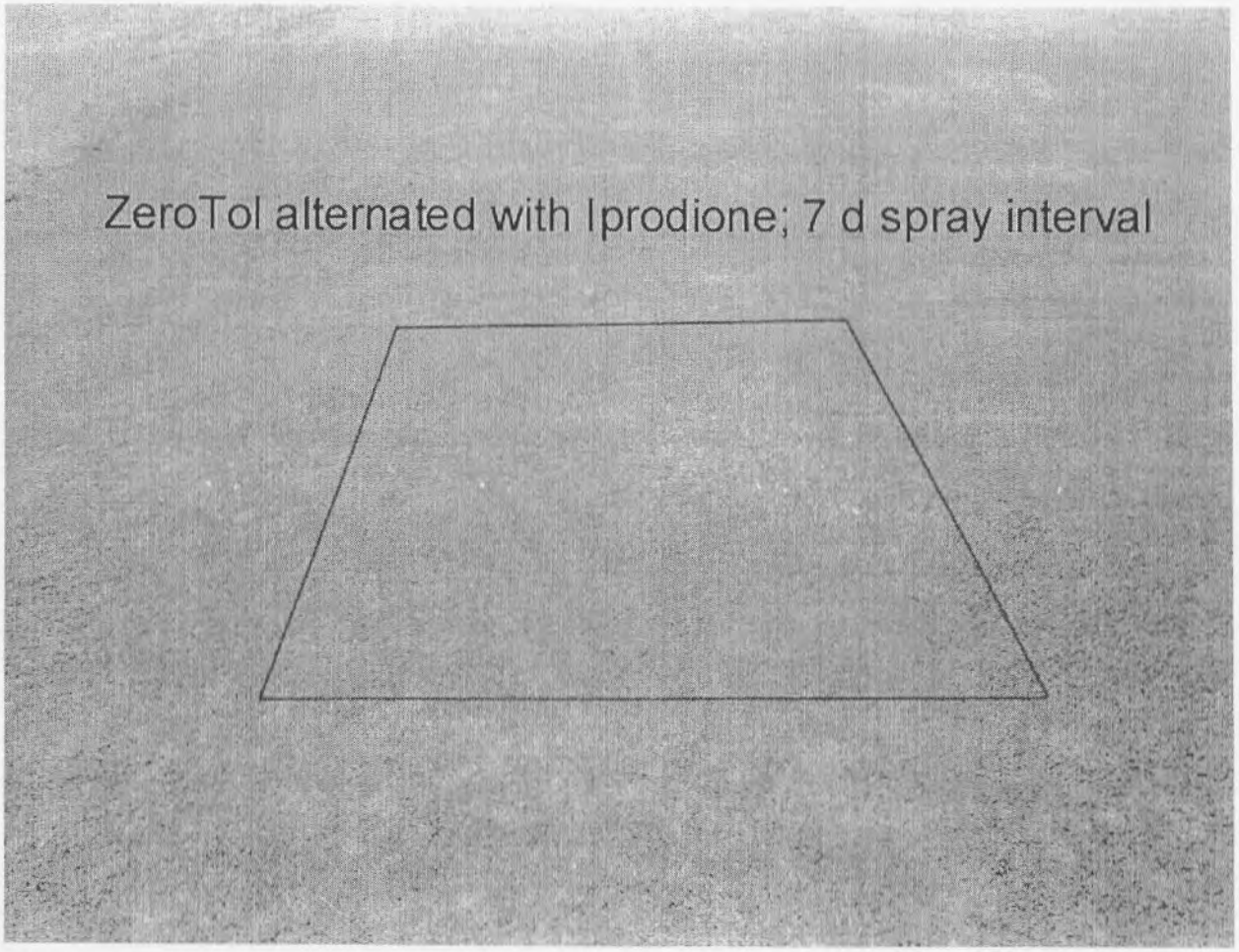
	17 May			24 May			2 June		
Treatment, rate/1000 sq ft, spray interval	**IC[z]**	**TQ[y]**	**% INF[x]**	**IC**	**TQ**	**% INF**	**IC**	**TQ**	**% INF**
ZeroTol 12.0 fl oz + surfactant (0.06% v/v)	16.0	6.0	22.0	3.0	7.3	6.0	6.0	7.0	9.0
ZeroTol 12.0 fl oz + surfactant (0.06% v/v) alt. w/ Iprodione 2.0 fl oz; 7-d	15.0	6.7	22.0	5.0	7.0	10.0	8.0	7.3	13.0
Iprodione 2.0 fl oz; 14-d	20.0	7.0	13.0	2.0	7.0	8.0	8.0	6.5	16.0
Untreated control	16.0	6.7	15.0	4.0	6.3	15.0	9.0	5.8	21.0

[z] IC = the number of infection centers per square foot in a plot.
[y] TQ = turfgrass quality visual rating on a scale of 1 to 9, where 9 = best.
[x] % INF = the percent area of dollar spot infection within a 4 ft x 6 ft plot.

Table 1 (con't.)

	10 June			17 June			25 June		
Treatment, rate/1000 sq ft, spray interval	**IC[z]**	**TQ[y]**	**% INF[x]**	**IC**	**TQ**	**% INF**	**IC**	**TQ**	**% INF**
ZeroTol 12.0 fl oz + surfactant (0.06% v/v)	2.0	7.5	4.0	3.0b[w]	5.8	10.0b[v]	1.0b[w]	6.0	1.0
ZeroTol 12.0 fl oz + surfactant (0.06% v/v) alt. w/ Iprodione 2.0 fl oz; 7-d	4.0	7.3	14.0	2.0b	5.5	10.0b	2.0b	5.8	3.0
Iprodione 2.0 fl oz; 14-d	4.0	7.5	20.0	5.0b	5.8	11.0b	4.0b	6.0	8.0
Untreated control	5.0	6.3	20.0	20.0a	4.8	25.0a	26.0a	5.5	10.0

[z] IC = the number of infection centers per square foot in a plot.
[y] TQ = turfgrass quality visual rating on a scale of 1 to 9, where 9 = best.
[x] % INF = the percent area of dollar spot infection within a 4 ft x 6 ft plot.
[w] Means within a column, followed by the same letter, are not significantly different at α=0.05 according to Fisher's protected least significant difference test.
[v] Means within a column, followed by the same letter, are not significantly different at α=0.1 according to Fisher's protected least significant difference test.



ZeroTol plot surrounded by dollar spot symptoms; 13 October 2004.

Appendix E

CONFIDENTIAL BUSINESS INFORMATION

Appendix F

untreated control. The Plantshield foliar, Trilogy, and Serenade 4 lb. treatments were not significantly different from the untreated control (Table 1).

Table 1.

Treatment	Percent Foliage Diseased
Plantshield Drench	6.25 bc
Plantshield Foliar	8.25 ab
Mycostop Drench	7.25 bc
Plantshield Drench + Foliar	4.50 c
Trilogy	8.75 ab
Serenade 4 lb.	8.25 ab
Serenade 8 lb.	7.00 bc
Oxidate	7.00 bc
Untreated Control	11.25 a

LSD = 3.4

Discussion

Because both these trials were conducted in such dry seasons with low levels of disease in the untreated controls, it's difficult to demonstrate significant differences and also not possible to say with confidence that any of the products would provide adequate disease control during a wetter season. However, it is interesting to note that a treatment involving a drench of Plantshield resulted in the lowest disease levels in both trials, and that the foliar treatment alone was not significantly different from the control in either trail, indicating that the drench component of the treatment is providing the effect. The two soil-applied products (Plantshield and Mycostop) could be affecting the disease resistance of the foliage by inducing disease resistance or by increasing the vigor of the plants, making them less susceptible to a disease like early blight that is associated with plant stress.

Because of the dry seasons in which the trials were conducted, and the variable performance of Trilogy between the two trials, it would be useful to repeat the trial for one more season, hopefully one with better disease pressure.

Thanks to AgBio Development, Agraquest, Bioworks, BioSafe Systems, and Certis USA for supplying products for these trials, and to Steve Porter at Porter Farms for hosting them.

Peracetic Acid (CAS No. 79-21-0) and its Equilibrium Solutions

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4 Avenue E. Van Nieuwenhuyse (Bte 6), 1160 - Brussels, Belgium.

Peracetic Acid (CAS No. 79-21-0)
and its Equilibrium Solutions

CONTENTS

EXECUTIVE SUMMARY

This report has been produced as part of the Joint Assessment of Commodity Chemicals (JACC) programme. It presents a critical evaluation of the physicochemical, ecotoxicity and toxicity data of peracetic acid (PAA) solutions. At present no other comprehensive review is available. A risk assessment, inter alia, will be required under the EU Biocidal Products Directive[a].

Most studies have been performed with different grades of equilibrium PAA solutions, i.e. formulations containing PAA, acetic acid and hydrogen peroxide dissolved in water in different concentration ratios. PAA solutions are clear, colourless and acidic liquids with a pungent vinegar-like odour. Upon dilution with water, their components tend to re-equilibrate slowly within several days. Solutions with a high (> 15%) PAA content can produce flammable vapours and exothermic decomposition can occur, liberating large volumes of oxygen gas. To guard against this, commercial PAA formulations are stabilised.

If released into the environment PAA will be distributed almost entirely to the aquatic compartment, where it is degraded by hydrolysis or decomposition. Hydrolysis is faster at high pH, such as in seawater. Biodegradation is rapid, although limited by the biocidal effect of PAA at higher concentrations. Bioaccumulation is not expected to occur.

PAA solutions are acutely toxic to aquatic organisms. The toxicity is related to the PAA content, except for solutions with a relatively high ratio of hydrogen peroxide. In those cases, the toxicity is attributable to the hydrogen peroxide.

The studies of acute mammalian toxicity do not reveal a clear dose-response that could be related to the PAA content or concentration alone. A particular problem with the inhalation studies is the instability of the vapour/aerosol phase. The available repeated-dose toxicity studies suffer from deficiencies in reporting, inadequate histopathological examination and limited number of dose levels tested. The presence of infectious disease in a number of the animal studies obscured and confounded the test findings. It was thus not possible to derive clear, no-adverse effect levels from the existing studies.

In spite of these limitations, it can be concluded that the main effect of PAA seen in experimental animals is severe irritation and corrosion of skin, eyes and mucous membranes. This is consistent with information on human exposure. However, the limited data available suggest that a systemic effect after repeated exposure to PAA cannot be completely excluded. The skin sensitisation potential of PAA appears to be low. The data do not raise immediate concern for mutagenicity, carcinogenicity or toxicity to reproduction.

[a] European Parliament and Council Directive 98/8/EC concerning the placing of biocidal products on the market (EU, 1998)

THE ECETOC SCHEME FOR THE JOINT ASSESSMENT OF COMMODITY CHEMICALS

This report has been produced by an ECETOC Task Force as part of the Joint Assessment of Commodity Chemicals (JACC) programme for preparing critical reviews of the toxicology and ecotoxicology of selected existing industrial chemicals. In the programme, commodity chemicals (i.e. those produced in large tonnage by several companies and having widespread and multiple uses) are jointly reviewed by experts from a number of companies with knowledge of the chemical. It should be noted that in a JACC review only the chemical itself is considered; products in which it appears as an impurity are not normally taken into account.

This report presents a critical evaluation of the ecotoxicology, toxicology and physicochemical properties of peracetic acid (PAA, CAS No. 79-21-0) and its equilibrium solutions. Commercial grades (formulations) of equilibrium PAA contain the main components PAA, hydrogen peroxide (H_2O_2) and acetic acid (HOAc) dissolved in water at a number of different concentration ratios. A distilled (non-equilibrium) solution containing PAA and water is also marketed. These PAA solutions are reviewed here together because they contain PAA and have similar physicochemical properties, environmental and (eco)toxicity profiles and use patterns.

In this report, for each study, the composition of the solution (formulated product) tested has been specified as far as possible in terms of its content of PAA, H_2O_2 and HOAc. In addition, for each of the toxicological and ecotoxicological studies the actual dose or concentration of the main component PAA is given.

Where relevant, the Task Force has assigned a Code of Reliability (CoR)[a] to (eco)toxicological studies to reflect the degree of confidence that can be placed on the reported results. The criteria used to assess and categorise reliability are included in Appendix B.

[a] A list of special abbreviations used throughout this report is at Appendix A

1. SUMMARY AND CONCLUSIONS

This report reviews the available physicochemical, ecotoxicity and toxicity data on different peracetic acid (PAA) solutions. PAA is completely soluble in water and solutions are clear and colourless with a pungent vinegar-like odour. PAA solutions are acidic (pH < 1).

PAA is produced commercially as a solution in which PAA is in equilibrium with hydrogen peroxide (H_2O_2), acetic acid (HOAc) and water, or as a distilled (non-equilibrium) solution containing primarily PAA and water. Equilibrium solutions are generally prepared by reacting glacial HOAc with H_2O_2 in the presence of a catalyst such as mineral acid. Specific grades are formulated by controlling the concentration and amount of H_2O_2 and HOAc used during the manufacturing process. Commercial PAA grades (formulations) are available in PAA concentrations ranging from about 0.3% to 40% by weight.

The production of non-equilibrium solutions involves the vacuum distillation of PAA from a mixture containing HOAc, H_2O_2, a catalyst (e.g. mineral acid) and de-ionised water. Final formulations contain only minor amounts of HOAc and H_2O_2. Distilled PAA solutions are produced on site or shipped, normally in concentrations ranging from 25 to 40%. These grades are usually shipped cooled (< 0°C) to slow down the hydrolysis reaction.

Major uses of PAA are in chemical synthesis, disinfection and bleaching. PAA is also generated *in situ* from laundry detergents containing sodium perborate or sodium percarbonate and tetra-acetyl ethylenediamine (TAED).

Emissions of PAA to the environment through production and use are considered negligible due to the processes applied. However, the current emission situation is not well described.

Possible routes of human exposure to PAA are by inhalation of vapours or aerosols during production and use as well as dermal contact, mostly to diluted solutions. The available data on workplace exposure are limited. This may be due partly to difficulties in the analytical determination of PAA in air samples and to the instability of PAA in air.

The decomposition of PAA is strongly exothermic, liberating large volumes of oxygen gas. Decomposition can be initiated by high temperatures, high pH, and contamination with metal catalysts such as copper, iron, chromium, and incompatible organic materials. To prevent decomposition, commercially available equilibrium and distilled formulations contain low concentrations of proprietary stabilisers, which protect against decomposition induced by metal ions and minor contamination.

Most of the equilibrium grades containing less than 15% PAA exhibit closed-cup flash points, but no open-cup flash point. Thus, these grades are not flammable where the liquid is open to the atmosphere. Grades containing greater than 15% PAA exhibit both open and closed-cup flash points and the vapours can be flammable.

Volatilisation from aqueous solutions is relatively low, but dependent on the partial vapour pressure. When PAA formulations are diluted with water, the solution slowly begins to re-equilibrate in a temperature dependent reaction until a final equilibrium is attained. At ambient temperature re-equilibration usually takes several days.

Mackay level 1 calculations suggest that, once released into the environment, PAA is expected to partition mainly (> 99%) to the aquatic compartment, while a minor part (< 1%) will be distributed into the atmosphere. No partitioning of PAA into soil, suspended matter or biota is expected. Based on its chemical reactivity and short half-life, PAA is not expected to persist in the atmosphere. Airborne PAA vapours have a low stability, with a half-life of about 20 minutes at ambient temperature. When entering the aquatic environment, PAA is subject to a concentration-, pH- and temperature-dependent hydrolysis or decomposition; the half-life is lower as pH increases. At acidic pH, the half-life of PAA will be around 7 to 12 days, while at neutral or alkaline pH, half-lives may be 1 day or less. In seawater degradation is expected to be rapid (half-life < 1 h). In soil a diluted PAA solution will be rapidly degraded by hydrolysis and decomposition evoked by transition metals. At low PAA concentrations, biodegradation could contribute to degradation in soil and surface waters. In sewage treatment plants with adapted activated sludge PAA is rapidly biodegraded. The low octanol-water partition coefficient of PAA (log P_{ow} = -0.52) suggests that PAA has no potential to bioaccumulate.

Several studies on acute toxicity to aquatic species are available for all trophic levels. PAA formulations were toxic to algae. The lowest 120-h no-observed-effect concentration (NOEC) of 0.13 mg PAA/l was found for *Selenastrum capricornutum*, with an EC_{50} (median concentration expected to have an effect in 50% of the test organisms) value of 0.18 mg/l for growth inhibition. PAA was also toxic to *Daphnia magna* with 48-h EC_{50} values of 0.5 to 1.0 mg PAA/l. Toxicity to fish was lower and 96-h LC_{50} (median concentration expected to cause the death of 50% of the test organisms) values ranged from 0.9 to 3.3 mg PAA/l in most freshwater species. In general, the aquatic toxicity tests were reproducible if concentrations were expressed as PAA irrespective of the concentrations of H_2O_2 and HOAc. Thus, the PAA concentration alone may explain the toxicity of PAA formulations. However, when PAA concentrations are low compared to H_2O_2 concentrations, H_2O_2 apparently contributes to the toxic effects, in particular for algae and daphnids. In these cases, the effect concentrations of PAA formulations are close to those of H_2O_2 alone. For fish there was not always evidence of an additional toxic effect of H_2O_2. The results of the aquatic toxicity studies also suggest a relationship between the size of the organisms and their sensitivity. Small test organisms were more sensitive than larger organisms, probably because of their high body surface-weight ratio, which enables a relatively high uptake of the test substance (per gram body weight). This phenomenon can be related to the relatively non-specific mode of action of the compound, i.e. its oxidising properties, which is relevant to all organisms.

Only few data on the toxicokinetic properties of PAA in mammals are available. Due to the high water solubility and low octanol-water partition coefficients, absorption into the circulation would be expected to be limited. However, PAA seems to be rapidly absorbed through damaged skin when the skin barriers are destroyed due to the corrosivity of PAA solutions.

Distribution is only likely in body fluids and limited by the degradation of PAA. PAA may be degraded in the organism either non-enzymatically, by hydrolysis, dismutation or reaction with reducing agents such as cysteine and glutathione (GSH), or enzymatically by catalases or peroxidases. The catalase reaction with PAA is independent of the PAA concentration and may therefore be saturated. H_2O_2 is also degraded by peroxidases, catalases and a number of antioxidants and thus the equilibrium between PAA, H_2O_2 and HOAc will also be influenced by the continuous elimination of H_2O_2 from the equilibrium under physiological conditions.

PAA possesses a moderate acute toxicity via the oral route. The acute oral toxicity of PAA solutions is dependent on the composition (i.e. the relative content of PAA, H_2O_2 and HOAc) and concentration of the applied (diluted) test solution. Usually PAA solutions containing less than 10% of PAA are of low oral toxicity. The acute dermal toxicity of PAA solutions in rabbits is relatively low and depends upon the applied concentration and presence of local irritations. The available acute inhalation toxicity studies in rats and mice with aerosols and vapours derived from different PAA solutions suffer from difficulties in achieving and measuring constant PAA concentrations due to the instability of the substance itself and the aerosol droplets. Consequently, the LC_{50} values show a relatively wide variation, the main effect being local irritation of the respiratory tract. The predominant effect in all acute toxicity studies is local irritation at the site of contact, which strongly depends on the applied concentration.

PAA solutions containing > 10% PAA were severely corrosive to rabbit skin already 3 minutes after application. Formulations containing between 3.4 and 5% PAA were corrosive to rabbit skin after occluded exposure for 4 or 24 hours. Dilutions containing 0.034 to 0.35% PAA were reported to be not irritant or slightly irritant. PAA solutions are corrosive or severely irritant to the rabbit eye at concentrations of 0.2% and higher. A study of sensory irritation in rats revealed an RD_{50} (concentration inducing a 50% reduction of respiratory rate) value of 21.5 to 24.1 mg PAA/m^3.

No evidence for skin sensitisation was observed in two Bühler tests in guinea pigs with different solutions of PAA. In one guinea pig maximisation test a positive result was claimed, but the report does not allow a critical evaluation of the results. Despite the use of PAA in hand and surface disinfection no cases of skin sensitisation have been reported in humans. Taken together, there seems to be no indication for a skin sensitisation potential of PAA solutions in humans.

The available repeated dose toxicity studies in experimental animals suffer from deficiencies in reporting, including uncertainties about the composition, concentration and stability of the test substance, inadequate histopathological examination and limited number of dose levels tested. In a number of studies the test animals suffered from infectious diseases and it remains unclear to what extent the reported effects are the result of administration of PAA. It is not possible to derive clear, no-adverse effect levels from the existing studies. In spite of these limitations, the following conclusions may be drawn.

The predominant effects after repeated oral, dermal or inhalation exposure of experimental animals to PAA appear to be related to local irritation at the site of contact. The toxicokinetic data suggest that PAA might become available systemically when the detoxifying enzyme systems are saturated. The detoxification reaction could then be slower than the speed of distribution to organs, such as liver and kidney.

Limited information is available on the effects of PAA on deoxyribonucleic acid (DNA) and its potential to induce gene and chromosome mutations *in vitro* or *in vivo*. Bacterial tests showed predominately negative results. These tests are of limited value because PAA is a biocide and will exert cytotoxicity at low doses. In most cases, cytotoxicity could be diminished by the addition of an exogenous metabolic system. Two DNA repair tests in human foetal lung cells did not indicate a genotoxic potential of PAA. In the *in vitro* chromosome aberration test, positive findings were obtained only at cytotoxic concentrations. Under *in vivo* conditions, PAA did not produce micronuclei in two mouse micronucleus tests after oral administration. In one study, the authors claimed to have observed positive effects in a series of chromosomal aberration tests with single intraperitoneal and dermal administration. The validity of this test is however highly questionable due to serious deficiencies in the experimental procedure and reporting. In an *in vivo / ex vivo* assay of unscheduled DNA synthesis (UDS) in rats after oral administration, PAA did not show a genotoxic potential. Overall these data do not raise immediate concern with regard to the mutagenic potential of PAA.

No specific data are available on the carcinogenicity or chronic toxicity of PAA. A limited initiation-promotion study on mouse skin indicates that PAA might have a tumour-promoting potential, which is not unusual for a corrosive substance.

Limited data are available on reproductive toxicity of PAA in experimental animals. Summary publications on multiple-generation studies indicate no effect on reproduction and development, offering some reassurance for this endpoint.

Human experience with PAA is limited to reported effects seen after acute inhalation and dermal exposure. Vapour concentrations below 0.5 mg PAA/m^3 (0.16 ppm) seem to be well tolerated. Concentrations up to 1.2 mg/m^3 (0.38 ppm) were not immediately irritant but unpleasant after exposure for an extended time period. Human eye irritation seems to be the most pronounced effect after exposure to PAA vapours or aerosols. Washing hands with a 0.2% PAA solution was without effect; higher concentrations of 0.5% PAA caused skin irritation when used as a wash solution.

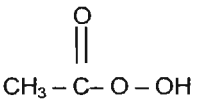
In conclusion, the main effect of PAA reported in mammalian toxicology studies was severe irritation and corrosion of skin, eyes and mucous membranes. This is consistent with reports of effects of human exposure. The skin sensitisation potential of PAA appears to be low. The limited data available from the experimental studies suggest that a systemic effect following repeated exposure to PAA cannot be completely excluded. The available data do not indicate an immediate concern for mutagenicity, carcinogenicity or toxicity to reproduction.

2. IDENTITY, PHYSICAL AND CHEMICAL PROPERTIES, ANALYTICAL METHODS

2.1 Identity

Name:	Peracetic acid
IUPAC Name:	Peroxyethanoic acid
Synonyms:	Acetyl hydroperoxide Ethaneperoxoic acid Peroxyacetic acid
Danish:	Pereddigesyre
Dutch:	Perazijnzuur
Finnish:	Peretikkahappo
French:	Acide peracétique
German:	Peressigsäure
Greek:	Υπεροξικό οξύ
Italian:	Acido peracetico Acetil-idroperossido
Norwegian:	Perettikusyre
Portuguese	Acido peracetico
Spanish:	Acido peracético
Swedish:	Perättiksyra
CAS Name:	Ethaneperoxoic acid
CAS Registry No.	79-21-0
Formula:	$C_2H_4O_3$

Structural formula:



Molecular Weight: 76.05

2.2 Conversion Factors

Conversion factors for concentrations of PAA in air at standard conditions (20°C and 1,013 hPa) are:

- 1 ppm = 3.162 mg/m^3
- 1 mg/m^3 = 0.316 ppm

In this report, converted values are given in parentheses.

2.3 EU Classification and Labelling

The following EU classification and labelling applies to pure PAA according to Directive 98/98/EEC, effective from 1 July 2000 (EC, 1998).

EC (EINECS) No.	201-186-8
Index No.	607-094-00-8
EEC classification:	R 10, flammable
	O, oxidising; R 7, may cause fire Xn, harmful; R 20/21/22, harmful by inhalation / in contact with skin / if swallowed C, corrosive; R 35, causes severe burns N, dangerous to the environment; R 50, very toxic to aquatic organisms

EEC labelling: Symbols:	O, Oxidising C, Corrosive N, Dangerous to the environment
R-phrases:	R 10, flammable R 7, may cause fire R 20/21/22, harmful by inhalation / in contact with skin / if swallowed R 35, causes severe burns R 50, very toxic to aquatic organisms
S-phrases:	S 1/2, keep locked up / keep out of the reach of children S 3/7, keep in a cool place / keep container tightly closed S 14, keep away from ... (incompatible materials to be specified by the manufacturer) S 36/37/39, wear suitable protective clothing, gloves and eye/face protection S 45, In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible) S 61, Avoid release to the environment. Refer to special instructions/Safety data sheets

Preparations must be classified in accordance with Directive 1999/45/EC (EU, 1999). Specific concentration limits for health hazards of PAA in preparations are specified in Directive 98/98/EEC above.

Concentration ≥ 10%	C, corrosive; R20/21/22, harmful by inhalation / in contact with skin / if swallowed; R35, causes severe burns
5 ≤ Concentration < 10%	C, corrosive; R34, causes burns
1 ≤ Concentration < 5%	Xi, irritant; R 36/37/38, irritant to eyes / respiratory system / skin

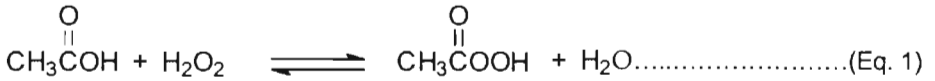
For the classification of equilibrium PAA solutions, the concentrations of hydrogen peroxide (H_2O_2) and acetic acid (HOAc) have to be considered as well following the same rules of the preparations Directive 1999/45/EEC.

2.4 Commercial Formulations

Peracetic acid (PAA) is produced commercially either as an equilibrium solution in which PAA is in equilibrium with H_2O_2, HOAc and water (Swern, 1970) or as a distilled product containing primarily PAA and water (Dalin, 1996; Jäkärä *et al*, 1998).

2.4.1 Equilibrium PAA solutions

Equilibrium PAA solutions are generally prepared by reacting glacial HOAc with H_2O_2 in the presence of a catalyst such as a mineral acid. The equilibrium reaction is shown in the following equation:



.....(Eq. 1)

Specific grades are obtained by controlling the concentration and amount of H_2O_2 and HOAc used during the manufacturing process. Adding an acid such as sulphuric acid or increasing the temperature during the manufacturing process can accelerate the establishment of the final equilibrium concentration (grade). The final solution contains PAA in equilibrium with H_2O_2, HOAc and water. Commercial PAA grades are available in PAA concentrations ranging from about 0.3% to 40% by weight. For a given PAA formulation, the equilibrium concentration is temperature dependent, so that a decrease of temperature will increase the PAA content. The equilibrium aspects are further discussed in Section 2.5.

2.4.2 Distilled PAA solutions

The production of distilled solutions involves vacuum distillation of PAA from a mixture containing HOAc, H_2O_2, a catalyst (e.g., mineral acid) and de-ionised water. Final formulations contain only minor amounts of HOAc and H_2O_2. Distilled solutions of PAA in water are produced on site or shipped in concentrations normally ranging from 25 to 40%. These grades are usually shipped cooled (< 0°C) to slow down the hydrolysis reaction, which in effect slows down the formation of HOAc and H_2O_2.

2.5 *Physical and Chemical Poperties*

All PAA solutions are clear, colourless liquids with a pungent vinegar-like odour and are soluble in polar solvents, aromatics and acetates (Swern, 1970). Physical and chemical properties characteristic of the component PAA are shown in Table 1.

Table 1: Physical and Chemical Properties of PAA

Property	Value, unit	Reference
pH	< 1	Safety data sheets[a]
Solubility in water at 20°C	1,000 g/kg[b]	Swern, 1970; Safety data sheets[a]
pK_a at 20°C	8.2	Swern, 1970
Partition coefficient, log K_{ow} (octanol/water) at 25°C	- 0.52[c] - 1.25[d]	Byers, 1998 Thus, 1994
Odour threshold	50 ppb	Ancker and Zetterberg, 1997
Henry's law constant at 25°C	0.22 Pa·m³/mole	Lind and Kok, 1986

a Ausimont, 1997a,b; Bactria, 1995, 1997; Bioxal, 2000a,b; Chemoxal, 1997; Degussa, 1996a,b, 1997; FMC, 1998a,b,c; Henkel, 1995, 1997a,b; Solvay, 1997a,b,c,d

b Reported as 100%

c Measured, reported as K_{ow} = 0.30

d Calculated

e Measured, reported as 467.6 mol/l·atm

Other physical and chemical properties are specific to the concentration ratio of the individual components in the formulation.

2.5.1 Equilibrium PAA grades

Equilibrium grades of PAA are produced in various concentrations ranging from about 0.3% to 40%. Many of the chemical and physical properties are specific to the concentrations (ratios) of each component, i.e. PAA, H_2O_2, HOAc and water, in the different grades. Generally, most commercial 5% to 35% equilibrium grades from different producers have similar compositions and physico-chemical properties. Table 2 shows chemical and physical properties specific for equilibrium grades of 5%, 15% and 35% PAA. Producers' material safety data sheets should be consulted for data pertaining to their commercial grades.

Table 2: Physical and Chemical Properties of Three Equilibrium Grades of PAA

Property		Value, unit			Reference
		5%	15%	35%	
Ratio components PAA: H_2O_2:HOAc:H_2O		5 : 22 : 10 : 63%[a]	15 : 20 : 15 : 50%[a]	35 : 7 : 40 : 18%[a]	Safety data sheets[b, c, d]
Melting point		-26 to -30°C[e]	-30 to -50°C[e]	-44°C[e]	Safety data sheets[b, c, d]
Boiling point		99 to 105°C	> 100°C	> 105°C	Safety data sheets[b, c, d]
Relative density D_4^{20} at 20°C (density of water at 4°C is 1,000 kg/m^3)		1,120 kg/m^3	1,150 kg/m^3	1,130 kg/m^3	Safety data sheets[b, c, d]
Vapour Pressure at 20°C		21 to 27 hPa	25 hPa	17 hPa	Safety data sheets[b, c, d]
Partial pressure at 20°C	PAA	0.3 hPa (4%)	1.1 hPa (14%)	2.7 hPa (32%)	Caropreso, 2000
(vapour phase concentrations)	H_2O_2	0.4 hPa (2%)	0.5 hPa (3%)	0.2 hPa (1%)	
	HOAc	0.8 hPa (9%)	1.6 hPa (16%)	4.1 hPa (38%)	
	H_2O	25.0 hPa (85%)	21.8 hPa (67%)	10.1 hPa (28%)	
Flash point,	open cup	No data	> 100°C	No data	Safety data sheets[b, c, d]
	closed cup	74 to 83°C	68 to 81°C	46 to 62°C	
Auto ignition temperature		270 to 430°C	≈ 265°C	≈ 218°C	Safety data sheets[b, c, d]
SADT[f] (55 US gallons[g] drum)		> 55 to > 65°C	> 50°C	> 55°C	Safety data sheets[b, c, d]
Sustained flammability		No	No	Yes, flammable	FMC, 1998[a, b, c]

a Each producer will have specified concentrations
b 5% PAA grade: Bactria, 1995; Henkel, 1995; Ausimont, 1997a; Degussa, 1997; Solvay, 1997a,b ; FMC, 1998a; Bioxal, 2000a
c 15% PAA grade: Henkel, 1995; Degussa, 1996a; Ausimont, 1997b; Bactria, 1997; Chemoxal, 1997, 1999; Solvay, 1997c,d; FMC, 1998b; Bioxal, 2000b
d 35% PAA grade: Degussa, 1996b; Henkel, 1997b; Akzo Nobel, 1998; FMC, 1998c.
e Decomposes
f Self-accelerating decomposition temperature
g One US gallon = 3.758 l

However, there are formulations on the market which have the same PAA concentration but different concentrations of HOAc and H_2O_2, so that the physico-chemical properties may be completely different. The equilibrium equation (Eq. 1, Section 2.4) shows that by changing the concentration of one component in a PAA formulation, the concentration of the other components will also change to re-establish the equilibrium (Section 2.4.1). Examples of formulations with the same PAA concentrations but with different concentrations of the other components are given in Tables 3 and 4.

Table 3: Composition of Two Commercial PAA 10% Formulations *(Steiner, 2000)*

	PAA (%)	H_2O_2 (%)	HOAc (%)	H_2O (%)
Formulation 1	10	1	78	11
Formulation 2	10	18	18	52

According to the UN classification system for transport of dangerous goods (UN, 1995), formulation 2 in Table 3 is an organic peroxide type F, while formulation 1 is an organic peroxide type D that is also flammable because of the high HOAc content. The UN system is explained in Section 3.4.

Table 4: Composition of Two Commercial PAA 15% Formulations *(Block, 1991)*

	PAA (%)	H_2O_2 (%)	HOAc (%)	H_2O (%)
Formulation 1	15	23	16	45
Formulation 2	15	14	25	42

Although the composition of these two 15% PAA grades is different, the formulations exhibit similar physical properties and both are classified as organic peroxide type F.

As soon as water is added, the solution slowly begins to re-equilibrate until a new final equilibrium composition is attained. Usually, re-equilibration takes several days. If the diluted solution is not going to be used within a few days, the amount of water needed to halve the concentration of PAA will be different from that calculated by simple material balance. Cooling to about 20°C can decrease the rate at which equilibrium is established. Conversely, increasing the temperature can increase the rate. As can be seen in Table 5, the PAA concentration of a 1:1 dilution mixture of a commercial 15% PAA acid formulation with water dropped from 7.3% to 2.8% after 12 days storage at 20°C. The active oxygen concentration remained constant, i.e. no decomposition occurred.

Table 5: Re-equilibrium of PAA 15%[a] after Dilution with Deionised Water at 20°C *(Reinold, 2000)*

Dilution:	1:1	1:2	1:3
Time after dilution	PAA concentration (%)		
1 min	7.3	4.9	3.7
12 d	2.8	1.2	0.8

[a] Measured composition of test solution: 14.7% PAA and 21.9% H_2O_2

2.5.2 Distilled aqueous PAA grades

Table 6 shows chemical and physical properties for a 38% distilled aqueous grade of PAA. Producers' material safety data sheets should be consulted for data specific to their commercial grades.

Table 6: Physical and Chemical Properties of Distilled PAA (38%) *(Akzo Nobel, 1998)*

Property		Value, unit
Ratio Components PAA: H_2O_2 :HOAc		38 : < 1 : < 3%
pH		≈ 2
Melting point		≈ -12°C
Boiling point		105 - 110°C[a]
Relative density at 20°C		1,070 kg/m^3
Vapour pressure at 20oC		No data
Flash point	open cup	No data
	closed cup	≈ 65 to 70°C
Auto ignition		No data
SADT (55 gal drum)		No data
Sustained flammability		Not flammable

[a] Decomposes

2.5.3 Flashpoint and autoignition temperature

A comparison of producers' safety data sheets shows considerable scatter in measured flashpoints (Table 2). This scatter may be attributed to several factors e.g., PAA reacting with the sample container used in the flash point determination, thermal instability of the PAA solutions, loss of volatile material during analysis due to decomposition and excessive gassing, releasing oxygen and water which tend to extinguish any flame. While the reported flash point value may not be exact, it is an indication of the temperature at

which vapours can ignite. Most of the PAA equilibrium grades ranging from 5% to 15% exhibit closed-cup flash points but no measurable open-cup flash points. Thus, these grades are not flammable under conditions where the liquid is open to the atmosphere. However, a sustained flame is possible in a closed system. Decomposition of PAA produces oxygen. A closed system prevents the release of the oxygen, which in the presence of the organic (acetic acid) can sustain a flame. Thus, all the gases produced remain in the system and they can burn. Equilibrium grades of concentrations ≥ 30% PAA or higher exhibit both open and closed-cup flash points and are flammable.

Equilibrium PAA grades exhibit autoignition temperatures ranging from 218 to 430°C (Table 2).

2.6 Stability

The decomposition of PAA is strongly exothermic, liberating large volumes of oxygen gas. Decomposition can be initiated by high temperatures, high pH, and contamination with metal catalysts such as copper, iron and chromium, and incompatible organic materials.

2.6.1 Stabilisers and impurities

To prevent decomposition, commercially available equilibrium and aqueous formulations contain low concentrations of proprietary stabilisers, which protect against decomposition induced by metal ions and minor contamination. The concentration of impurities in commercially available PAA solutions is generally low. Common stabilisers include dipicolinic acid and phosphonates.

2.6.2 Decomposition of PAA in air

PAA vapour in air is found to have limited stability. For example, measurements taken at ambient temperature showed a decrease in concentration from 1 ppm (3.16 mg/m^3) to 0.5 ppm (1.58 mg/m^3) in 22 minutes (Ancker and Zetterberg, 1997).

2.6.3 Decomposition of PAA in aqueous solutions

Yuan *et al* (1977a,b) reported that decomposition of PAA solutions can involve three competitive reactions:

Spontaneous $2\ CH_3C(O)OOH \longrightarrow 2\ CH_3C(O)OH + O_2$ ..... (Eq. 2)

Metal [M] catalysed $2CH_3C(O)OOH + [M] \rightarrow 2CH_3C(O)OH + O_2 + [M]$ ..... (Eq. 3)

Hydrolysis $CH_3C(O)OOH + H_2O \rightarrow CH_3C(O)OH + H_2O_2$ ..... (Eq. 4)

Increasing temperature or pH will result in accelerated decomposition (Mücke, 1977; Yuan *et al*, 1977a). For example, Mücke (1977) showed that in the absence of heavy metal ions, dilute PAA solutions undergo hydrolytic decomposition (Eq. 4) in a manner that is the reverse of the formation reaction, to form HOAc and H_2O_2. The rate of hydrolysis increases with increasing temperature and pH.

Drimus and Matasa (1966) studied the thermal decomposition of PAA solutions. Analysis of the gas evolved during decomposition suggested that the decomposition process consisted of several distinct reactions, such as:

$$2\ CH_3C(O)OOH \longrightarrow 2\ CH_3C(O)OH + O_2 \quad \text{(Eq. 2)}$$

$$CH_3C(O)OOH \longrightarrow CH_3OH + CO_2 \quad \text{(Eq. 5)}$$

2.7 Chemical Reactivity

2.7.1 Compatibility

Good stability has been achieved in the presence of certain surfactants, mineral acids, thickening agents and perfumes (James and Shehad, 1995). However, it is important that all materials are tested for compatibility and stability in the presence of the specific PAA solution before being added to the formulation. Incompatible materials could cause the PAA solutions to decompose rapidly with the evolution of large quantities of oxygen and other vapours.

2.7.2 Chemical characteristics

PAA is a strong oxidising agent. For that property, it is used commercially in a variety of applications (Section 3.5).

2.8 Analytical Methods

An EU Project with the objective to develop methods for the quantitative determination of PAA in air and aqueous solutions will be finalised by the end of year 2000 and public reports will follow (Euperox, 1997). Several publications mentioned in this section originate from this project. One of these (Effkemann *et al*, 1999b) includes useful recommendations on choice of analytical methods for different purposes, as explained below.

Concerning animal experiments and other studies in air or in water, one has to consider that if the (diluted) PAA formulation used contains H_2O_2 it is necessary to record both compounds using a method that fits from the viewpoint of sensitivity and accuracy. Even when a H_2O_2-free PAA formulations is used, it might be necessary to record the levels of both compounds since H_2O_2 may be formed as a hydrolysis product of PAA. Due to the instability of PAA (and H_2O_2) in vapours and also in water, it is important to record continuously or regularly the concentrations of the components.

2.8.1 In aqueous solutions

Table 7 gives a summary of analytical methods for concentrated and diluted PAA solutions.

Table 7: Analysis of PAA in Aqueous Solutions

Analytical technique	Range (mg PAA/l)	Detection limit (mg PAA/l)	Reference
Concentrated (and diluted) products			
Titration with cerium sulphate (for H_2O_2) followed by iodometric titration (for PAA)	10 - 50,000	10	Greenspan and MacKellar, 1948
Titration at 0°C with $KMnO_4$ in presence of NaF (for H_2O_2) followed by iodometric titration (for PAA)	10 - 50,000	10	Senf, 1984
Dilute solutions			
Colorimetric oxidation of DPD[a] reagent (Merckoquant test strips)	5 - 50	5	Merck, 1995, 1998
Colorimetric oxidation of tetra-methylbenzidine in buffered potassium iodide (RQflex[b] photometer with Reflectoquant test strips)	1 - 100	1	Fischer *et al*, 1989; Merck, 1994
Successive reaction of PAA with MTS[c] and of H_2O_2 with triphenylphosphine, HPLC[d] analysis	0.1 - several 1,000	0.1	Pinkernell *et al*, 1994, 1997a
Selective oxidation of enzyme substrate ABTS[e], HPLC analysis	Not stated	0.1	Pinkernell *et al*, 1997b
Oxidation of ADS[f], HPLC , detection at 410 nm	0.007 - 0.7	0.002	Effkemann and Karst, 1998
HPLC with electrochemical detection on line (Prominent Perox Controller)	10 - 200 or 100 - 2,000	10	Pinkowski, 1995; Prominent, 1997
HPLC with electrochemical detection	Not stated	0.1	Kirk *et al*, 1992; Qi and Baldwin, 1993

[a] N,N'-diethyl-*p*-phenylenediamine
[b] Reflectometer Quality flexible (strips)
[c] Methyl *p*-tolyl sulphide
[d] High performance liquid chromatography
[e] 2,2´-Azino-*bis*-(3-ethyl-benzo-thiazoline)-6-sulphonate
[f] 2-((-3(2-(4-Amino-2-(methylsulphanyl)phenyl)-1-diazenyl)phenyl)sulphonyl)-1-ethanol

The generally accepted method, suitable for concentrated solutions (10 - 500,000 mg PAA/l), starts with the determination of the concentration of H_2O_2 by cerium sulphate titration. The PAA content is then measured by iodometric titration with sodium thiosulphate. This procedure is carried out at low temperature (< 0°C) to prevent re-equilibration (Greenspan and MacKellar, 1948). An alternative method is to determine the H_2O_2 content by titration with potassium permanganate ($KMnO_4$) at 0° C, and then determine the PAA content with iodometric titration as described above (D'Ans, 1912 as quoted in Swern, 1970; Senf, 1984). The cerium-based method is regarded as more accurate and less dependent on operator skill compared to the $KMnO_4$/iodometric method.

The method according to Pinkernell (1994, 1997a) is suitable for the analysis of PAA + H_2O_2 in dilute solutions but too cumbersome for determination of PAA alone. The Merck RQflex-Reflectoquant test is considered more selective than the DPD method, which cannot be used in the presence of active chlorine compounds. The electrochemical method of Prominent (1997) is easy to use (e.g. calibration) and useful, amongst others, for on-line control of disinfectant solutions in the food industry.

2.8.2 In air

Table 8 summarises analytical methods for the determination of PAA in air. All of these methods are selective for PAA, rather than determining total PAA + H_2O_2 concentrations. An overview of nine existing gas monitoring methods for PAA has been made, including applicability of the methods and costs (Solvay, 1999). Five of these are included in Table 8.

Table 8: Analytical Methods in Air

Analytical technique	Detection limit (mg PAA/m³)	Air sample volume (l)	Reference
Iodide catalysed oxidation of ABTS[a] in coated test tubes or impingers	0.35	3 - 5	Effkemann *et al*, 2000
Oxidation of ADS[b] on coated test tubes or impingers. HPLC[c], detection at 410 nm	0.13	5	Effkemann *et al*, 1999a
Oxidation of MTS[d], HPLC, UV detection	0.035[e]	NS	Thus *et al*, 1996
Impinger. Amine colour reaction (Merck PAA test 15975)	0.5	20	Fischer *et al*, 1989, Solvay 1999
Direct measurement in vapour phase with FTIR[f] and Michelson interferometer	0.15	1,000[g]	Ancker and Zetterberg, 1997
Photo-acoustic FTIR	0.09[h]	NS	Solvay, 1999

NS Not Stated

a 2,2´-Azino-*bis*-(3-ethyl-benzo-thiazoline)-6-sulphonate

b 2-((-3(2-(4-Amino-2-(methylsulphanyl)phenyl)-1-diazenyl)phenyl)sulphonyl)-1-ethanol

c High performance liquid chromatography

d Methyl *p*-tolyl sulphide

e H_2O_2 0.16 mg/m³

f Fourier transform infrared (spectroscopy)

g Range 0.15 - 100 mg PAA/m³ or higher

h H_2O_2 0.1 mg/m³

For ambient workplace air and personal measurements at the workplace, the method by Thus *et al* (1996) provides high sensitivity for both PAA and H_2O_2 without interference between PAA and H_2O_2. Another sensitive and portable technique is the photo-acoustic Fourier transform infrared (FTIR) spectroscopy technique of Solvay (1999). Among the two methods developed by Effkemann *et al* (1999a, 2000), the ABTS test tube method is recommended for screening purposes. The ABTS impinger method and also the ADS impinger or test tube methods are more selective and accurate. The direct FTIR spectroscopic method according to Ancker and Zetterberg (1997) is suitable for personal and area measurements at the workplace, indoors and outdoors.

There are few methods available which are sensitive enough for atmospheric PAA measurements. An enzyme fluorometric method developed mainly for H_2O_2 (Lazrus *et al*, 1986) might be further developed for such a purpose.

3. PRODUCTION, STORAGE, TRANSPORT AND USE

3.1 Production

3.1.1 Industrial production

In general, peroxycarboxylic acids can be made by numerous methods generally involving the reaction of H_2O_2 with the corresponding carboxylic acid or carboxylic acid derivatives (Klenk *et al*, 1991; Swern, 1970).

Peroxyacetic acid (PAA) solutions are produced by three industrial methods. Equilibrium mixtures of PAA are obtained by reacting HOAc, H_2O_2 in the presence of an acid catalyst, normally sulphuric acid. Equilibrium PAA grades of this type are commercially available with a PAA content of up to 40%.

Optionally, PAA can be distilled from equilibrium mixtures of HOAc and H_2O_2 to yield an aqueous PAA solution with low residual H_2O_2 and HOAc. Commercially, distilled PAA is available with a content of 25-40% PAA.

Alternatively, PAA is produced by the oxidation of acetaldehyde in the presence of a solvent, e.g. ethylacetate, yielding a product with approximately 25% PAA content (Swern, 1970).

Accurate data on the quantities of PAA produced in Europe or USA are not available. CEFIC (2000a) estimated a figure of > 32,430 tonnes for western Europe.

3.1.2 Generation *in situ*

PAA acts as a low temperature bleaching agent and is generated *in situ* during the washing process from sodium perborate / percarbonate and TAED (Jakobi and Löhr, 1991). In Europe, powder detergents with bleach typically contain 15-25% persalt and up to 5% TAED corresponding to approximately 3.5% PAA equivalent (100%) (Jakobi and Löhr, 1991).

Minor quantities of PAA precursors such as TAED, acetyl salicylic acid or HOAc anhydride are used for generation *in situ* of PAA in the sterilisation of medical instruments and in the textile industry (Wurster, 1992).

In 1999, approximately 48,500 tonnes of TAED (corresponding to 32,300 tonnes PAA (100%) generated *in situ*) were employed in European detergents (Battelle, 1999). AISE (2000) estimated that approximately 60,000 tonnes PAA is generated in this way worldwide, excluding South America and Africa.

3.1.3 Quantities used

In Europe, the equilibrium PAA consumption (as such) is estimated at 25,000 t/y. This is mainly used for disinfection and does not include use in chemical synthesis (CEFIC, 1998). In Scandinavia the consumption of distilled PAA in pulp bleaching is estimated at 2,000-3,000 tonnes (100%) mainly driven by demand for total chlorine free (TCF) pulp grades (Sandström *et al*, 1999).

In the USA, the PAA consumption is estimated to be less than 10,000 t/y (as such) for non-synthesis applications (CEFIC, 1998). Approximately 20,000 tonnes of PAA were produced in the USA by autoxidation of acetaldehyde (Johnson, 1995).

Worldwide consumption in chemical synthesis including captive use and *in situ* generation has been estimated at 45,000-50,000 tonnes (PAA 100%) in 1998 (CEFIC, 2000b). In 1999 the worldwide consumption of acetaldehyde for PAA production was expected to be 41,000 tonnes corresponding to 72,500 tonnes PAA (100%) (Tecnon Consulting, 1999). The Task Force was not aware of any production by this route in Europe.

3.2 Compatibility

3.2.1 Storage and transportation containers

Generally, PAA is stable in containers made from glass, certain high density linear polyethylene grades, polyvinylchloride, poly-*tetra*-fluoroethylene and properly passivated stainless steel 304L and 316. However, it is important to check the compatibility and stability with all containers before long-term use; PAA can degrade (embrittle) plastics with extended contact time. Degradation rates are enhanced by elevated temperature. The German authorities have restricted the maximum storage time for PAA > 17% in standard polyethylene containers to 6 months from the day of filling. Extensions can be obtained for containers that exhibit long-term storage stability with PAA by passing the required tests (drop test) after contact with PAA for a defined time period (BAM, 1999).

PAA solutions are capable of leaching metal ions from stainless steel. This effect is enhanced by some of the mineral acids (e.g. H_2SO_4) added as catalysts. Many of these metal ions, e.g., iron, nickel, chromium, and molybdenum can cause product instability.

3.2.2 Non-compatible materials

Concentrated PAA is not compatible with aluminium, carbon steel, some cross-linked polyethylene and metal alloys containing copper. It is important to determine compatibility before using PAA with any material. PAA is rapidly decomposed upon contact with metal salts, alkalis and activated carbon.

3.3 Storage

Equilibrium PAA is stabilised and stored at ambient conditions in certain polyethylene, polyvinylidene fluoride containers, or passivated stainless steel tanks, with the appropriate safety measures e.g. pressure relief. PAA should be kept away from metals, metal salts, alkalis and reducing agents. PAA storage containers made of polyethylene are protected from UV radiation. Storage temperature conditions are determined individually for every formulation depending on the physical properties, in particular flash point and self-accelerating decomposition temperature (SADT).

Distilled PAA is typically stored and transported in cooled (< 0°C) stainless steel containers, in order to prevent an equilibrium shift from PAA to H_2O_2 and HOAc. For storage in stainless steel containers the addition of special corrosion inhibitors may be required in order to prevent accelerated leaching of metals into the product causing enhanced decomposition (see also Section 3.2).

Several national regulations apply for the storage and handling of PAA, e.g. in Germany on precautions for the handling of organic peroxides (BG Chemie, 1993) and on explosive substance regulations in other countries. In Germany, PAA is listed as water polluting in "Wassergefährdungsklasse (WGK) 2" (Bundesminister, 1999; Umweltbundesamt, 2000).

3.4 Transportation

Mixtures of H_2O_2 and PAA ≤ 5% may be classified as Oxidiser in division 5.1 of UN Recommendation 3149, provided they are thermally stable, do not detonate in the cavitated state, do not deflagrate at all, nor show any effect when heated under confinement nor any explosive power (UN, 1995; ECE, 1996). PAA solutions > 5% or not meeting the above-mentioned provision are classified as organic peroxides in division 5.2 (type D = UN 3105, type E = UN 3107 or type F = UN 3109). The appropriate type has to be determined by testing pursuant to the UN Recommendations on the Transport of Dangerous Goods, Manual of Tests & Criteria, Part II (UN, 1995; ECE, 1996).

In the USA, a mixture of PAA 6% and H_2O_2 may be classified as Oxidiser in division 5.1 (UN 3149) pursuant to an approval of the national competent authority (US-DOT, 1995).

PAA solutions are subjected to temperature control during carriage if the SADT is ≤ 45°C for type E and F, or ≤ 50°C for type D showing a medium effect when heated under confinement, or ≤ 45°C for type D showing a low or no effect when heated under confinement.

Equilibrium PAA is permitted for transport by road, rail and sea in plastic drums made of high-density polyethylene. Intermediate bulk containers (IBCs) made of stainless steel or rigid plastic (high-density polyethylene) and portable tanks made of stainless steel are permitted for type F for European and US American land transport with an upper limit of 43 % PAA. Transport by portable tanks requires approval of the competent authorities of the country of origin. For transport by sea, IBCs made of stainless steel or rigid plastic (high-density polyethylene) and portable tanks made of stainless steel are permitted for type F with an upper limit of 17% PAA only. Approval of the competent authorities is required for both IBCs and portable tanks.

At present distilled PAA is permitted for transport by road and rail, pursuant to an exemption of the competent authority of Finland, which submitted the content of the approval as proposal document ST/SG/AC.10/C.3/2000/10 to the 18th session of the UN Sub-Committee of Experts session held in Geneva on July 2000. Depending on the concentration and the individual product properties cooling may be required.

3.5 Use

Major uses of PAA are in chemical synthesis, disinfection and bleaching (Table 9). Low concentrations (1-15%) are used as sanitisers, disinfectants and sterilants in the food, beverage and medical industries. Concentrated (> 15%) solutions are used for the oxidation of organic compounds.

Table 9: Applications Ranked by Decreasing Quantity

Application	Method of use	Reference
Food Industry		
Clean-in-place (breweries and dairies)	In-line into closed vessels or pipework	Lever Industrial,
Surface cleaning	High or low pressure spray systems	1987; Lenahan,
Fish/meat/poultry processing	In process water	1992
Vegetable processing	In process water	
Sugar beet processing	In-line into process liquors	Bowler *et al*, 1996
Starch processing	In-line into process liquors	Pehrsson *et al*,
Bottle cleaning	Spray into bottles	1995
Agriculture / horticulture		
Animal house and glasshouse surface disinfection	High or low pressure spray and fogging	
Equipment disinfection	Open bath	
Animal waste / slurry	In slurry or liquid waste	
Irrigation water	Loosely covered tanks and pipelines	
Harvested fruit and vegetables	Open bath or spray	
Pulp and paper		
Chemical pulp bleaching	In-line into pulp	Kramer, 1997;
White water	In-line into white water	LaZonby, 1997
Pulp de-inking	In-line into pulp	
Health		
Renal dialysis machines and cartridges	Open baths or soak treatment or in line in pipework	Fischbach, 1985; Crow, 1992
Endoscopes	Open baths or automated washing systems	
Dental instruments	Open baths	
Consumer		
Household cleaners	Open operations	
Chemical Industry		
Oxidiser during synthesis of chemicals	Closed reaction vessels	
Miscellaneous		
Effluent treatment	In-line in open pipes or lagoons	Baldry *et al*, 1990,
Sludge debulking	In-line in pipework, sump or lagoon	1991, 1995;
Algal control	Low pressure spray onto water or solid surface	Rudd, 1989
Industrial laundries	Into closed washing machines	

PAA is employed as a sanitiser in the food processing and beverage industry. This includes meat and poultry processing plants, canneries, dairies, animal houses, green houses breweries, wineries and soft drink plants where it is used in clean-in-place (CIP) systems at concentrations of 50 to 200 ppm PAA (158 - 632 mg/m^3) (Jäger and Püspok, 1980; Schröder, 1982; Lever Industrial, 1987; Baldry and Fraser, 1988; Dychdala, 1988; Cords and Dychdala, 1993; Cords, 1994; Mrazek, 1996). At lower temperatures (up to

40°C), PAA (0.04-0.1%) is an alternative for H_2O_2 in aseptic packaging (Mrazek, 1996; Blakistone *et al*, 1999).

Another major use of PAA is as a bleaching and disinfecting agent in industrial and hospital laundries (Potokar *et al*, 1996).

PAA has been found useful in the disinfection of vegetables, fruits, starch products and plant growing media such as coir (strong fibre of coconut husk) (Chalkley, 1992). PAA is permitted in the US as a secondary and indirect food additive (US-FDA, 1996a,b) at concentrations up to 100 mg/l. PAA is also used as a disinfectant in sugar beet extraction (Bowler *et al*, 1996).

Because PAA has agricultural applications, residues potentially could be found in animals. Council Regulation 2377/90 of 26 June 1990 established a Community procedure for maximum residue limits of veterinary medicinal products in foodstuffs of animal origin (EEC, 1990). According to Commission Regulation 1433/96 of 23 July 1996, PAA is not subject to these limits (EC, 1996).

PAA has found applications in sewage sludge oxidation (Fraser, 1986) and municipal wastewater treatment (Baldry *et al*, 1991). Treatment of municipal wastewater with 10 mg PAA/l for 30 minutes proved sufficient to meet WHO faecal coliforms guideline values and for the water to be reused in agricultural irrigation (Liberti *et al*, 1998, 1999). PAA has also been evaluated for the disinfection of drinking water (Profaizer *et al*, 1997). In process water of paper mills PAA is employed as a slimicide in order to avoid corrosion and odour problems (Klahre, 1996a,b). PAA is also effective in removal and growth inhibition of biofilms and algae in cooling systems (Kramer, 1997).

PAA based systems are used for the sterilisation of medical equipment (Block, 1991; Malchesky, 1993). Pyrogens were significantly reduced at a concentration of 0.1% PAA for 30 minutes (Werner, 1988).

PAA is also applied for disinfection of stables and for drinking water conservation in animal farming (Krüger *et al*, 1977; Kurzweg *et al*, 1988). It has been employed for farm effluent disinfection where concentrations of up to 0.4% (PAA 100%) are applied for 15 minutes (Meyer, 1976). In greenhouses, PAA is used as a cleaner and disinfectant in water circuits.

Distilled PAA has found application as a bleaching agent mainly in TCF cellulose pulp production processes replacing chlorine dioxide (Basta *et al*, 1995; Thomasfolk *et al*, 1996; Ruohoniemi *et al*, 1998; Sandström *et al*, 1999). Small quantities of PAA are used in the bleaching of recycled fibres, de-inking and in textile finishing (Steiner, 1995).

High-strength equilibrium (> 15%) and distilled PAA products are in general employed as oxidising agents in the manufacture of organic chemicals and pharmaceuticals. Examples of oxidation reactions include the epoxidation of olefins and the production of sulphoxides and sulphones, such as in the synthesis of cephalosporins. Other examples are ε-caprolactone, epoxidised soybean oil (Swern, 1970), modified starch products and penicillin (V) sulphoxide, a key intermediate in the synthesis of cephalosporin antibiotics (Feigenbaum, 1997).

4. ENVIRONMENTAL DISTRIBUTION AND TRANSFORMATION

4.1 Emissions

4.1.1 Natural sources

Organic hydroperoxides such as PAA are thought to be formed in air by the reaction of peroxyl and hydroxyl radicals as follows (Gunz and Hoffmann, 1990).

$$R - C = OO^{\cdot} + HO^{\cdot}{}_2 \longrightarrow R - C = OOH + O^{\cdot}{}_2 \quad \text{(Eq. 6)}$$

The origin of these atmospheric radicals in polluted and unpolluted air has been reviewed (Wayne, 1991; Thompson, 1994).

The formation of PAA and other hydroperoxides has been demonstrated in smog chamber studies using chlorine atoms as initiator (e.g. Hanst and Gay, 1983).

Traces of PAA were found in mountain air, but have not been demonstrated in ambient air or atmospheric deposition samples (Section 5.1.1).

4.1.2 Emissions during production and use

Emissions to the atmosphere during production are normally avoided by scrubbing the exhaust using an alkaline scrubber. For the manufacture of equilibrium PAA an effluent-free process is applied. Thus no emissions to the aquatic environment are expected under normal operating conditions.

In the manufacture of distilled PAA, a minor liquid effluent flow essentially free of PAA is produced.

Water emissions during bleaching of pulp with distilled PAA are expected to be negligible due to the low stability of PAA in the bleaching liquids.

In the USA, the Toxic Release Inventory lists the reported releases (annual quantities emitted) from industrial facilities having 10 or more full-time employees and manufacturing or processing ≥ 25,000 lbs (11,364 kg)[a] or otherwise using ≥ 10,000 lbs (4,545 kg). The latest available figures indicate a total quantity release on- and off-site of 7,345 lbs (3,330 kg) PAA in 1997 (US-EPA, 1999a). These release figures represent a worst-case estimate, because they are based on conservative assumptions and do not take into consideration any breakdown on-site by biological or physical means such as waste-water treatment, incineration and flaring (US-EPA, 1999b).

1 lb = 1 pound = 0.4535924 kg

4.2 Envionmental Fate and Biotransformation

4.2.1 Distribution

The theoretical distribution of PAA has been estimated using the fugacity model of Mackay, Level 1 (Mackay *et al*, 1992). The calculations were conducted for the equilibrium grades of PAA in Table 10, using the partial vapour pressure of PAA in those solutions. According to the model, the majority of PAA (99.3 to 99.9%) released into the environment enters the water phase, while the remainder is found in air. No partitioning into soil, suspended matter or biota is expected (Table 10).

Table 10: Distribution of PAA, for Different Grades of PAA, between Environmental Compartments at 25°C *(Jacobi, 1997)*

Grade (%):	5	15	35
Compartment / Distribution:	(%)	(%)	(%)
Air	0.08	0.29	0.70
Water	99.92	99.71	99.29
Soil	0.00	0.00	0.00
Sediment	0.00	0.00	0.00
Suspended matter (aquatic)	0.00	0.00	0.00
Biota	0.00	0.00	0.00

4.2.2 Atmospheric fate

Henry's Law constant of PAA, measured in the concentration range of 1×10^{-6} 1×10^{-4} mol/l at 25°C, is 0.22 Pa·m^3/mol (Lind and Kok, 1986) (Table 1). This value is 2-3 orders of magnitude lower than the value determined for H_2O_2 (Gunz and Hoffmann, 1990). So PAA may be washed out by rain but less easily than H_2O_2.

As stated in Section 2.6.2, PAA is quickly decomposed by 50% in the vapour phase within 22 minutes (Ancker and Zetterberg, 1997). This value may be taken as the atmospheric half-life, assuming first-order kinetics. Based on its chemical reactivity and short half-life, PAA is not expected to persist in the atmosphere.

4.2.3 Aquatic fate

The Henry's Law constant for PAA is measured as 0.22 Pa·m^3/mol at 25°C (Table 1). This value indicates that PAA will volatilise slowly from water surfaces.

Table 10 above shows that PAA will not partition into sediment, suspended matter or biota and for this reason the aquatic fate of PAA is mainly determined by degradation in the water phase. Degradation could be due to abiotic decomposition, hydrolysis, biodegradation or reaction with organic compounds, following the general reaction:

$$2\ CH_3C(O)OOH \longrightarrow 2\ CH_3C(O)OH + O_2 \quad \text{(Eq. 2)}$$

Decomposition can be spontaneous or initiated by metal catalysts such as copper, iron and chromium. Enzyme-calalysed degradation by catalase and peroxidase is also possible (Kirk *et al*, 1994) (Section 7.2.1). Decomposition results in a decrease of the active oxygen content of the solution.

Hydrolysis

Hydrolysis of PAA is based on the following reaction:

$$CH_3C(O)OOH + H_2O \longrightarrow CH_3C(O)OH + H_2O_2 \quad \text{(Eq. 4)}$$

When hydrolysis takes place the active oxygen content of the solution remains the same, which is in contrast to decomposition.

Yuan *et al* (1977a,b) calculated theoretical half-lives of PAA in water using a kinetic equation. The results revealed extensive half-lives which are not supported by experimental data. Both Yuan *et al* (1977a,b) and Mücke (1977) reported that the rate of hydrolysis is accelerated by increasing temperature, and more so by increasing pH. Mücke (1977) suggests that hydrolysis occurs almost exclusively by hydrolytic cleavage. He showed hydrolysis half-lives at 20°C, for a 2% PAA solution, of about 1 week at pH 4.4 and less than 1 day at pH 7.

Bioxal (1999) showed that the loss of PAA by hydrolysis of a 5% commercial grade of equilibrium PAA diluted to 1,000 mg PAA/l and 100 mg/l at 15°C, pH 3.4, was about 34% to 36% in 8 days.

Dychdala (1988) showed a 50% loss of PAA from a solution containing 170 mg PAA/l, at 21°C, pH 3.4, within 12 days (half-life). Teral and Gouges (1997) determined the rate of hydrolysis for a 19.7% distilled (non-equilibrium) PAA solution at various temperatures. Results at 20°C showed the half-life to be about 12 days. The pH was not stated, but a low pH may be assumed.

These data suggest that at acidic pH, the half-life of PAA will be around 7 to 12 days, while at neutral or alkaline pH, the rates will be more rapid, with half-lives of 1 day or less.

Degradation Studies

Abiotic degradation tests with diluted PAA solutions studies were performed according to EEC method C7 of Directive 92/69/EEC. Buffered solutions were prepared according to document L 383A (appendix to Directive 92/69 EEC). High PAA concentrations were measured by cerimetric titration, low concentrations by Merckoquant or Reflectoquant colorimetry (Table 7). Both decomposition and hydrolysis were expected to occur in these PAA degradation tests. The results (Table 11) show that the degradation was more rapid at a high temperature and increased with increasing pH. Decomposition half-lives seemed to be shorter when diluted solutions were used.

Table 11: Abiotic degradation of equilibrium PAA at different temperatures, pH and concentrations in buffered solution

Concentration (mg/l)	Temperature (°C)	pH	Half-life (h)	Reference
20	25	4	31[a]	Chemoxal, 1995a,b
20	50	4	3.3	
10	50	4	3.1	
20	50	7	1.6	
20	50	9	< 0.25	
20	60	4	1.7	
20	70	4	0.7	
748	25	4	62	Pierre *et al*, 2000
748	25	7	63	
748	25	9	< 64[b]	
95	25	4	48	
95	25	7	48	
95	25	9	< 3.6[c]	

a Obtained by calculation

b Based on the results the half-life was 64 hours. However, the pH at the end of the test was 5.3 and therefore the half-life is reported as < 64 hours

c Based on the results the half-life was 3.6 hours. However, the pH at the end of the test was not measured and it could have decreased. Therefore the half-life is reported as < 3.6 hours

In another test, Pierre *et al* (2000) studied the abiotic degradation of PAA in distilled water (pH 2) at 25°C and at concentrations of 95 and 748 mg/l. In this case the half-life was 18 and 19 days, respectively.

Solutions containing approximately 100 mg PAA/l in fresh water from a pond or a stream were found to degrade for 66% in 96 hours and completely (99%) in 3 weeks. The same solution in demineralised water was found to degrade for 80% within 3 weeks. H_2O_2 decomposition in the same period was comparatively small with a maximum loss of 8% in 96 hours. The overall breakdown of a 0.2% PAA solution (2,000 mg/l) was 45% in 120 hours. In drinking water and pond water, PAA degraded more rapidly than in demineralised water or lake or stream water. The tests were conducted under laboratory conditions (Chalkley, 1991a,b).

Half-lives of diluted PAA solutions (prepared from equilibrium PAA 40%, 14% H_2O_2 and 27% HOAc dissolved in drinking water) containing up to 200 mg PAA/l were less than 24 hours (Krüger *et al*, 1977). PAA concentrations measured in drinking-water

bottles of rats were found to decrease rapidly within 1 day. Concentrations between 3.1 and 200 mg/l decreased up to one third and one half of the original concentration, respectively. After 4 days the concentration decreased slowly to one fourth of the original concentration (Juhr *et al*, 1978).

PAA concentrations have also been measured during ecotoxicity studies with PAA in fish and water fleas (Section 6.2). During a semi-static test with the fish *Brachydanio rerio*, the mean loss of a 1 mg/l PAA solution was 7.5% in 4 hours. The loss of a 10 mg/l PAA solution was 5.1% in 4 hours (Bazzon *et al*, 1997). During the test with water fleas (*Daphnia magna*) the loss at 0.1 mg/l was 21% in 4 hours (Lamy *et al*, 1997).

The degradation of PAA in demineralised water, drinking water and seawater has been compared (Table 12). The data show 97% and 96% degradation in seawater after 1 day when the initial nominal concentration was 20 and 10 mg PAA/l, respectively.

Table 12: Degradation of PAA in Water at 20°C *(Teral and Hamon, 1995)*

Type of water	pH	Nominal concentration (mg/l)	Measured concentration (mg/l) Day 0	Day 1	Day 2	Day 4
Demineralised water	5	20	19.1	16.7	16	13.7
Drinking water	6	20	18.8	1	0	NS
Seawater	7	20	18.5	0.5	0	NS
Demineralised water	5	10	12	8.3	7.9	6.4
Drinking water	6	10	10.3	0.5	0	NS
Seawater	7	10	12.1	0.5	0	NS

NS Not Stated

The degradation of PAA in synthetic seawater was studied using a 15% PAA solution. With an initial concentration of 52.5 mg PAA/l, the half-life was 2 minutes at 3.3% and 2% salinity. When the concentration was doubled to 105 mg PAA/l, the respective half-lives at 3.3% and 2% salinity were 7 and 20 minutes. Thus, increased salinity enhanced the degradation rate (Kuhn, 2000).

The degradation of PAA is seawater seems to be faster than the degradation in fresh water, which could be related to the high pH and salinity (ionic strength).

4.2.4 Terrestrial fate

Degradation of a 1.1% PAA solution (11,190 mg PAA/l) was tested on a sample of dried soil (not specified). Following extraction with demineralised water, 99.2% of the compound appeared to have been destroyed in about 20 minutes (Chalkley, 1991c).

The penetration of PAA into soil (John Innes compost) columns was investigated with a solution containing approximately 2,000 mg PAA/l, prepared from equilibrium PAA 5% (20% H_2O_2 and 27% HOAc). One ml of the test solution was added to the top of each soil column. After 5 minutes, each column was washed with 100 ml of demineralised water (sufficient to remove all PAA) and the eluate content determined. Of the PAA, 21.5% was recovered at a soil depth of 25 mm, while 42% H_2O_2 was found at the same depth. PAA recovery decreased to 3.2% at 50 mm, 0.3% at 100 mm and < 0.2% at 150 mm, where 10% of the H_2O_2 was still present. Similarly after 10 minutes only 8.7% PAA was recovered at 25 mm depth (Chalkley, 1991a).

4.2.5 Biodegradation

The biodegradability of PAA was evaluated in various experimental test systems.

PAA appeared to be not readily biodegradable in the OECD Closed Bottle Test. However, when inoculum of adapted bacteria derived from a Zahn-Wellens Test with the same compound was added, PAA (initial concentration of 2 - 5 mg/l) proved to be highly (> 79%) degradable (Gerike and Gode, 1990).

In a Coupled Units Test with PAA, where the organic carbon is measured to estimate ultimate biodegradability, 56% carbon removal was found. In another test using detection of recalcitrant metabolites 98% carbon removal was measured (Gerike and Jasiak, 1983; Gerike and Gode, 1990).

Inhibition of the microbial degradation by PAA was measured with an oxygen consumption inhibition test. PAA was shown to have inhibitory activity at 90 mg/l (Gerike and Gode, 1990).

In a Modified OECD Screening Test (OECD 301 E) which determines ultimate biodegradation by measurement of removal of dissolved organic carbon (DOC), PAA was added once at a concentration of 5 mg DOC/l. A bactericidal effect was found and a biodegradable reference substance was not degraded. Therefore, the test procedure was modified and PAA doses were increased stepwise over 2 weeks until the nominal concentration of 5 mg DOC/l was reached. Thus, a very high DOC removal of 98% was achieved within the 28-day test period (Richterich and Gode, 1986), supporting the view of the ready biodegradability of the compound. Based on a simple distribution (PAA is very soluble in water and the volume of bacterial cells is very low compared to the volume of the medium), no significant uptake of PAA is expected to have taken place. Active uptake is very unlikely.

The hydrolysis products HOAc and H_2O_2 are both readily biodegradable (Verschueren, 1983; Groeneveld and De Groot, 1999).

4.2.6 Bioaccumulation

The octanol-water partition coefficient was measured for PAA and H_2O_2 using the US Environmental Protection Agency (EPA) shake flask method (Byers, 1998). The values were 0.30 ± 0.13 and 0.40 ± 0.07 for PAA and H_2O_2, respectively. Compounds with such

a low octanol-water partition coefficient are not considered to be bioaccumulable.

4.2.7 Evaluation

PAA released in the environment will partition almost exclusively (> 99%) to the water compartment. Only a minor part (< 1%) will remain in the atmosphere, where it is expected to undergo rapid decomposition with a half-life of 22 minutes. The fate of PAA in the environment is mainly determined by its degradation.

The fate of PAA in water will be influenced by abiotic degradation, which yields HOAc and oxygen and hydrolysis which forms HOAc and H_2O_2, both of which are easily (bio)degradable compounds. The abiotic degradation increases with temperature and pH. At acidic pH, the half-life of PAA will be around 7 to 12 days, while at neutral or alkaline pH, half-lives may be 1 day or less. In seawater degradation is expected to be rapid (half-life < 1 h). Most abiotic degradation studies of PAA in water were done at concentrations that resulted in acute effects on aquatic organisms. In these situations, abiotic degradation is the single degradation pathway of PAA. However, these concentrations are not realistic environmental concentrations during normal use of PAA products. At low PAA levels (< 1 mg/l), the biotic degradation by algae, and micro-organisms could significantly increase the degradation in aquatic ecosystems.

In the soil, a diluted PAA solution is rapidly and easily degraded by hydrolysis and transition metal decomposition, which is an instantaneous reaction. At low concentrations biodegradation could contribute to the degradation in soils.

Biodegradation studies with PAA show a rapid degradation of PAA if the biocidal effect is not too strong. Sewage treatment plants with adapted activated sludge, would easily degrade PAA. The biodegradation is also enhanced when the biomass is high (as in the case of sewage treatment plant).

Based on the low octanol-water partition coefficient and the rapid degradation in the environment, PAA is not bioaccumulable.

In conclusion PAA should be easily degraded in air, water and soil and does not persist or accumulate in the environment.

5. ENVIRONMENTAL LEVELS AND HUMAN EXPOSURE

5.1 Environmental Levels

5.1.1 Air

No specific measurement data are available.

Based on atmospheric model calculations, trace levels (4 ppbv[a]) of PAA were predicted by Calvert *et al* (1985) and Gaffney *et al* (1987).

Hellpointer and Gäb (1989) could not demonstrate PAA (detection limit 0.07 µmol/l) in 32 rainwater samples collected at Freising near Munich in Germany (April and May 1988).

Junkermann *et al* (1993), using the sensitive (detection limit 0.06 ppb) enzyme fluorometric method developed by Lazrus *et al* (1986) (Section 2.8), found PAA to be present among other hydroperoxides and H_2O_2 in mountain air at two different altitudes at sites in Germany (Schafberg 1,175 m and Wank summit 1,780 m). A pronounced seasonal and daily variation in the total concentration and composition of the hydroperoxides was seen (Junkermann *et al*, 1993).

Heikes *et al* (1991) measured soluble organic peroxides, including PAA, in remote marine air over the South Pacific ocean (Australia and Fiji). The total concentration was 0.4 ppbv near the sea surface (< 91.4 m) and 0.6 ppbv between the marine layer and the free troposphere (914.4 m to 3,352 m). At high altitude (5,638 m), the level was 0.2 ppbv. No specific concentrations for PAA were given.

Tanner and Schorran (1995) reported total gaseous peroxide levels near the Grand Canyon (USA) in the range of 1.0 - 5 ppbv. The results varied, depending on the daylight and the season.

Peroxide measurements of cloud and rainwater collected (48 samples) in the eastern USA indicated the presence of organic hydroperoxides in only some of samples (Kelly *et al*, 1985).

5.1.2 Water, soil and biota

No data are available on concentrations of PAA in water, soil and biota.

5.2 Human Exposure Levels and Hygiene Standards

5.2.1 Non-occupational exposure

No data are available.

[a] Parts per billion by volume

5.2.2 Simulated occupational exposure studies

A number of measurements of atmospheric concentrations were performed in an experimental setting to obtain an indication of possible occupational exposures levels during certain operations (Table 13).

Table 13: Simulated Occupational Exposure Studies

Description	Results (mg PAA/m³)	Reference
Fogging of 0.2% PAA in closed shed, measured at different distances	0.7 - 7 H_2O_2[a]	Fraser and
Fogging of 0.2% PAA in closed shed, measured 5 - 60 minutes	ND - 3 H_2O_2[b]	Thorbinson, 1986
Pulp mill A, refrigeration room, doors closed	1.8	Cerne *et al*, 1999
Pulp mill A, refrigeration room, doors open	0.45	
Pulp mill B, refrigeration room, doors closed	0.45	
Pulp mill B, refrigeration room, doors open	< 0.15 (ND)	
Distillation, spill of 20 litres cold PAA (intentional), doors closed	1.5	Ancker and
Container filling above manhole outdoors	0.5	Zetterberg,1997
Laboratory, beakers w/o lid	0.15 - 0.5	
Laboratory, beakers w/o lid in vented hood	0.3-3	
Bath with 0.35% PAA, measured at 0.4 meter above bath	0.8 - 1.0[c]	Simms, 1995
Bath with 0.35% PAA, measured at 0.1 meter above bath	3.3[d]	
Bath with 0.35% PAA, measured at 2.7 meter from bath	< 0.3[e]	
Ten litre 0.35% PAA in water bath (50 x 29 x 19 cm) at 28°C in room without ventilation or air changes	< 0.7	Harvey, 1992
Filling of 1,000 kg IBC[f] with 15% PAA, measured at 0.6 m from top of container	0.3 - 0.5[g]	Rowbottom, 1996a
Filling of 1,000 kg IBC with 5% PAA, measured at 0.6 m from top of container	< 0.5[h]	
Distillation house A of PAA, near ground floor, small leak in pump	0.9 - 1.2[i]	McDonagh, 1997;
Distillation house A and B of PAA, first floor	0.4 - 0.5[ii]	Rowbottom, 1996b
Ten litre 0.35% PAA in water bath, ambient temperature, closed room	< 0.02	Harvey, 1993
Ten litre 0.35% PAA in water bath, temperature of 32°C, sealed room	< 0.02	

a Reported as 0.5 - 5 ppm H_2O_2
b Reported as < 0.5 - 2.0 ppm H_2O_2
c Reported as 0.35 - 0.46 mg/m³ H_2O_2
d Reported as 1.46 mg/m³ H_2O_2
e Reported as < 0.15 mg/m³ H_2O_2
f Intermediate bulk container
g Reported as 0.1 - 0.15 ppm PAA
h Reported as < 0.15 ppm PAA
i Reported as 0.3 - 0.4 ppm PAA
j Reported as 0.13 - 0.17 ppm PAA

During the studies of Fraser and Thorbinson (1986), Harvey (1992 and 1993), Simms (1995), Rowbottom (1996a,b) and McDonagh (1997), the air samples were drawn through an alkaline solution of phenolphthalein. Peracids and H_2O_2 produced a pink colour by the formation of phenolphthalein, which was detected spectrophotometrically, and the results were reported as total peroxygen concentrations.

Fraser and Thorbinson (1986) fogged a solution containing 0.2% PAA into a hen house, which means that an aerosol was present. The product which was used (4% equilibrium PAA) contained presumably also a relatively high content of H_2O_2 which meant that a significant quantity of the measured atmospheric peroxygen might have been H_2O_2 (assuming a constant composition). Therefore, the results of this experiment are expressed in Table 13 as H_2O_2 concentrations.

Also Harvey (1992, 1993), Simms (1995), Rowbottom (1996a,b) and McDonagh (1997) measured the total peroxygen concentrations but in this case a vapour was present. Because PAA has a higher vapour pressure than H_2O_2 (Section 2.5), the measured peroxygen was probably mainly PAA. The results of these studies are presented in Table 13 as PAA concentrations.

The analytical measurements reported by Ancker and Zetterberg (1997) and Cerne *et al* (1999) were based on FTIR spectroscopy (Table 8) . In this case the PAA concentration was measured directly.

5.2.3 Occupational exposure

Given the applications of PAA there is a possibility for occupational exposure to aerosols or vapours or dermal exposure to the liquid. Hygiene procedures are designed to minimise skin, eye and inhalation exposure by appropriate technical and personal protective equipment depending on the situation at the particular workplace. Recommended safe handling procedures are provided (Section 10.2).

Workplace (area) measurements at Akzo Nobel, Eka Chemicals were reported in 1997 using direct FTIR spectroscopy (Table 8). PAA could only be measured near the distillation reactor where short-term concentrations ranged from 0.15 mg PAA/m^3 (detection limit) to 0.30 mg PAA/m^3 (original data given in ppm). No PAA was detected near the storage tank or outside a laboratory hood (Ancker and Zetterberg, 1997). Using the same method, no PAA was detectable at the dosage area of two pulp mills in 1998 (Cerne *et al*, 1999). No further information is available.

Measurements carried out at Ausimont during 1999 indicate short-term workplace concentrations of PAA ranging from < 0.1 to 0.9 mg PAA/m^3 in different areas of the production plant, in particular the filling area. Sampling was performed 3 x 2 h and 14 x 1 h. The analytical method was not stated (Ausimont, 1999, 2000).

Degussa (1990a) reported levels of < 0.1 to 0.5 mg PAA/m^3 (20 - 30 min/area) during bottle disinfection at a pharmaceutical company in 1990. The analytical method was not detailed. PAA was calculated from the amount of active oxygen taking into account the measured H_2O_2 levels.

PAA exposure was determined in a university hospital where employees (150 workers) used 0.12 to 2% aqueous disinfection and sterilisation solutions prepared from an equilibrium PAA 40% (3.5% H_2O_2, 46% HOAc). There were 121 samples taken at 45 different areas (2 - 6 measurements at each workplace). PAA was determined by means of a spectrophotometric technique (oxidative formation of iodine from a potassium iodine solution) with a detection limit of 0.005 mg/m^3. Workplace, 8-hour concentrations ranged from below the detection limit to 1.84 mg PAA/m^3. The majority (60%) of employees had readings below 0.1 mg/m^3, 95% were below 1 mg/m^3 (Schaffernicht and Müller, 1998).

5.2.4 Hygiene standards

No country has adopted an Occupational Exposure Limit Value (OEL) for PAA.

An internal OEL of 0.15 ppm PAA (0.45 mg/m^3) for an 8-h time-weighted average (TWA) concentration has been developed by Solvay (2000).

The following table gives examples of national OEL values for the three principal components of PAA formulations (Table 14).

Table 14: Examples of OEL Values for Components of PAA Formulations

Country	TWA[a] (ppm)	(mg/m^3)	Ceiling Limit (ppm)	(mg/m^3)	STEL[b] (ppm)	(mg/m^3)	Reference
PAA	-	-	-	-	-	-	
H_2O_2							
Germany	1	1.4	2[c]	2.8[c]	-	-	DFG, 1999a
UK	1	1.4			2	2.8	HSE, 2000
USA	1	1.4[d]	-	-	-	-	ACGIH, 2000
HOAc							
Germany	10	25	20[c]	50[c]	-	-	DFG, 1999a
UK	10	25			15	37	HSE, 2000
USA	10	25[d]	-	-	15	37[d]	ACGIH, 2000

[a] Time-weighted average concentration (8-h working period)
[b] Short-term exposure limit (15 min, unless specified otherwise)
[c] 5 min, maximum 8 times per shift
[d] Not reported as such

6. EFFECTS ON ORGANISMS IN THE ENVIRONMENT

6.1 Micro-Organisms

PAA formulations are fast-acting oxidising biocides that are effective against a broad spectrum of micro-organisms including bacteria, yeasts and moulds, protozoa, algae and viruses. Spores, bacteriophages and enteroviruses are also susceptible.

PAA is effective against micro-organisms over a wide range of conditions (Block, 1991). PAA is most active at pH values below the pKa (8.2) and also displays biocidal activity under mildly alkaline conditions up to pH 9. PAA remains efficacious even at low temperatures (5°C) (Schliesser and Wiest, 1979; Baldry, 1983; Block, 1991). The activity of PAA is relatively unaffected by organic matter compared to other oxidising biocides (Block, 1991).

Concentrations of > 300 mg PAA/l (as diluted equilibrium products) were highly effective against vegetative bacteria and yeasts in suspension tests where a 99.999% reduction was achieved within 5 minutes. More diluted concentrations of 30 mg/l were still effective against vegetative bacteria. Higher concentrations and longer exposure times were needed to inactivate spores formed by bacteria and moulds (Baldry, 1983; Bloomfield *et al*, 1991; Setlow *et al*, 1997).

Lensing and Oei (1985) reported 2,500 mg PAA/l to be effective against *Bacillus subtilis* and *B. cereus* within 30 minutes. Krzywicka (1970) reported 2,000 mg/l being effective against *B. subtilis* in 10 minutes. For moulds, the PAA dose required was variable. Some mould spores were inactivated at 500 mg PAA/l in 5 minutes, while others were affected at > 1,000 mg PAA/l for longer exposure periods.

PAA is effective against bacteriophages and enteroviruses such as the poliovirus, rotavirus and Coxsackie virus. Concentrations in the range 400 - 2,250 mg PAA/l for a 5 or 10 minute contact period were reported. Lower concentrations were effective over longer contact times (Kline and Hull, 1960; Harakeh, 1984; Baldry *et al*, 1990).

The effect of PAA (2 mg/l) on the microbial respiration or sewage sludge, measured as conversion of ^{14}C-glucose to $^{14}CO_2$, has been studied at sludge concentrations of 2.5 to 50 mg (dry weight)/l (Thus *et al*, 1997). Independent of the sludge concentration, conversion of ^{14}C-glucose to $^{14}CO_2$ was reduced to 10% of expected in the first 24 hours. When after 24 hours fresh sludge was added the respiration was comparable to controls again, indicating that no PAA toxicity remained.

6.2 Aquatic Organims

The results of toxicity tests with aquatic organisms are summarised in Table 15.

Table 15: Toxicity of PAA to Aquatic Organisms

Species	Duration (h)	Composition (%) PAA	H_2O_2	HOAc	Endpoint, result EC_{50} or LC_{50} (mg PAA/l)	NOEC (mg PAA/l)	Reference	CoR[a]
Algae					**Growth inhibition** EC_{50}			
Selenastrum capricornutum[b]	120	5.2	20	NS	0.18	0.13	Hicks *et al*, 1996	2b
Selenastrum capricornutum	72	18.0	0.3	NS	< 1.0	< 1.0	Petit-Poulsen *et al*, 1997[c]	2b
Scenedesmus subspicatus	72	0.35	7	NS	0.035 - 0.35	0.035	Licata-Messana, 1995a	2b
Invertebrates					**Immobility** EC_{50}			
Daphnia magna	48	15	14	28	0.50	0.15	Douglas and Pell, 1986a	2b
Daphnia magna	48	4.5	27.5	NS	1.1	0.45	Burgess and Forbis, 1983	2b
Daphnia magna	48	15.5	22	15	0.69	0.16	Terrell, 1987a	2b
Daphnia magna	48	5.2	20	NS	0.73	0.56	Gardner and Bucksath, 1996a	2b
Daphnia magna	48	18.0	0.3	NS	< 1.0	< 1.0	Lamy *et al*, 1997	2b
Daphnia magna	48	0.35	7	NS	0.035 - 0.350	> 0.035	Licata-Messana, 1995b	2b
					Lethality LC_{50}			
Crangon crangon[d]	96	12	20	8	15	6.7	Tinsley and Sims, 1987a	2e
Mytilus edulis[d] *embryo*	48	12.5	19	18	0.27	0.13	Fairhurst, 1987	2e
Crassostrea gigas[d] *embryo*	48	12.5	19	18	0.28	0.13	Butler, 1987	2e

Table 15 continued

Species	Duration (h)	Composition (%) PAA	H_2O_2	HOAc	Endpoint, result EC_{50} or LC_{50} (mg PAA/l)	NOEC (mg PAA/l)	Reference	CoR[a]
Fish								
Oncorhynchus mykiss[e]	96	15	14	28	2.0	1.5	Douglas and Pell, 1986b	2b
Oncorhynchus mykiss	96	15.5	22	15	0.91	0.16	Terrell, 1987b	2b
Oncorhynchus mykiss	96	4.5	27.5	NS	1.0	0.45	Cohle and McAllister, 1983	2b
Oncorhynchus mykiss	96	5.2	20	NS	1.6	0.82	Gardner and Bucksath, 1996b	2b
Lepomis macrochirus	96	4.5	27.5	NS	1.2	0.45	McAllister and Cohle, 1983	2b
Lepomis macrochirus	96	15.5	22	15	3.3	2.7	Terrell, 1987b	2b
Lepomis macrochirus	96	5.2	20	NS	1.1	0.47	Gardner and Bucksath, 1996c	2b
Brachydanio rerio	96	18.0	0.3	NS	1.0	< 1.0	Bazzon *et al*, 1997[c]	2b
Brachydanio rerio	96	0.35	7	NS	≈ 0.35	> 0.035	Licata-Messana, 1995c	2b
Pleuronectes platessa[d]	96	12	20	8	11	6.7	Tinsley and Sims, 1987b	2e

a Code of reliability (Appendix B)
b Presently known as *Pseudokirchneriella subcapitata* or *Rhaphidocelis subcapitata*
c Analytical methods following Gouges and Teral, 1997
d Saltwater species
e Previous name: *Salmo gairdneri*
NS Not Stated

6.2.1 Algae

A study with a freshwater green alga (*Selenastrum capricornutum*) and equilibrium PAA (5.2%) has been reported. The study was performed to good laboratory practice (GLP) guidelines. The test concentrations were 0, 0.065, 0.13, 0.25, 0.50 and 1.0 mg PAA/l. Growth was determined by algal cell counts. The concentration of H_2O_2 was measured in the test solutions. At the start of the test, the H_2O_2 content of all test solutions was close to the nominal concentration. At the end of the test, the measured concentration was lower than the detection limit except for concentrations of 0.50 and 1.0 mg PAA/l where the remaining measured H_2O_2 concentrations were 84% and 110% of the nominal values, respectively. At a concentration of 0.13 mg PAA/l an initial, statistically significant, inhibition of growth was found between 0 and 72 hours. Growth had recovered at the end of the test probably due to decreased exposure. Based on the cell count at the end of the test, a concentration of 0.13 mg/l was considered to be an NOEC. At a concentration of 0.25 mg/l the cell count at the end of the test was 3% of the control value. The 120-hour EC_{50} value was estimated to be 0.18 mg/l (Hicks *et al*, 1996). This indicates a remarkably steep dose-response curve.

In another GLP study with the alga *Selenastrum capricornutum*, distilled PAA (18%) was used to prepare test solutions with concentrations of 0, 1.0 and 10 mg PAA/l (Petit-Poulsen *et al*, 1997). The solutions were renewed every 4 hours. The algal suspensions were centrifuged followed by re-suspension of the algae in freshly prepared test solutions. Concentrations of PAA were analytically determined before and after renewal of the test solutions without algae. The mean decrease in concentration in the 4-hour periods was 14.3 and 6.5% at concentrations of 1.0 and 10 mg/l, respectively. Although the algae were centrifuged and resuspended 17 times during the test, the control cell density of the algae increased 20-fold during the 72-hour test period, which was higher than the minimum value of 16-fold (validity criterion). The growth of the algae was completely inhibited at 1.0 and 10 mg PAA/l.

A GLP study with *Scenedesmus subspicatus* and diluted equilibrium PAA (0.35%) was performed at nominal, static test concentrations of 0.035, 0.35 and 0.88 mg PAA/l. No analytical concentration measurements were made. At the end of the test, at a concentration of 0.035 mg/l, the growth rate was inhibited by 3% and total biomass by 11% of controls, but the inhibition of biomass was not statistically significant. At concentrations of 0.35 and 0.88 mg/l the growth of the algae was completely inhibited (Licata-Messana, 1995a). A concentration of 0.035 mg PAA/l can be considered as a NOEC. The H_2O_2 content of the product was 20 times higher than the PAA content and therefore the effect on the algae could be due to H_2O_2.

The effect of diluted equilibrium PAA (5%, 20% H_2O_2, 10% HOAc) on cyanobacteria (*Anabaena variabilis* and *Synecococcus leopoliensis*) and green algae (*Chlamydomonas eugametos* and *Scenedesmus quadricauda*) was studied using microtitre plates. In many tests an initial effect on algal growth was found at various concentrations, but growth recovered, probably due to a decrease in PAA concentration during the tests. The results were strongly dependent on the initial density of algal cells. A high cell density resulted in a strong decrease of the PAA concentration and a small effect on algal growth.

Cyanobacteria appeared to be more sensitive to than green algae. NOEC and EC_{50} values were not reported (Rodgers, 1991). This study is not reliable due to the use of a non-standard test methodology and reporting of insufficient detail. It is not clear whether the concentrations are expressed on the basis of the product PAA or the component PAA.

Evaluation
Three well-designed algal tests were performed in accordance with GLP guidelines. The study reported by Petit-Poulsen *et al* (1997) did not include a full concentration range, but the concentration of PAA was measured and maintained due to regular renewal of the test solutions. The study by Hicks *et al* (1996) was performed with a representative product, including a full concentration range, but only the concentration of H_2O_2 was determined analytically, and the PAA concentration calculated. The study of Hicks *et al* showed a decrease of the H_2O_2 concentration and a recovery of algal growth at relatively low concentrations. If concentrations are sufficiently low, an initial effect on the algae is expected but the algae will be able to degrade the product and growth may fully recover. At high concentrations algal growth will be completely inhibited and the product not degraded. Therefore recovery of the growth does not occur.

A test with H_2O_2 in the green alga *Chlorella vulgaris* according to a modified OECD Guideline 201 revealed EC_{50} and NOEC values of 2.5 and 0.1 mg H_2O_2/l, respectively (Degussa, 1991). Based on these values and the relatively high H_2O_2 (compared to PAA) content of the tested solutions, H_2O_2 could have contributed significantly to the observed toxicity. In particular, Hicks *et al* (1996) used a product with a relatively high content of H_2O_2.

6.2.2 Invertebrates

Daphnia magna
Three toxicity tests with diluted equilibrium PAA (4.5-15.5%) in the fresh water flea *Daphnia magna* have been reported, without analysis of the PAA, active oxygen or H_2O_2 concentrations in the test solutions (Douglas and Pell, 1986a; Burgess and Forbis, 1983; Terrell, 1987a,b) (Table 15). A GLP toxicity test with equilibrium PAA (5.2%) in *Daphnia magna* and was reported. During this study the H_2O_2 content of the test solutions was determined spectrophotometrically, based on titration with potassium permanganate, and the PAA concentrations calculated accordingly. During the test the decrease in H_2O_2 concentration ranged between 19 and 35%. Nominal test concentrations were 0, 0.19, 0.32, 0.54, 0.90 and 1.5 mg PAA/l (Gardner and Bucksath, 1996a).

A test with distilled PAA (18%) in *Daphnia magna* was performed at test concentrations of 0, 1.0 and 10 mg PAA/l. At the highest concentration all daphnids were immobilised after 4 hours. At 1.0 mg/l the daphnids were transferred to fresh solutions each 4-hour period and PAA concentrations were measured spectrophotometrically, using titration with potassium iodide, before and after each renewal. The mean decrease in concentration over the 4-hour periods was 21%. At the end of the test the immobility of the daphnids was 75% at 1.0 mg/l (Lamy *et al*, 1997).

Exposure of *Daphnia magna* to concentrations of 0, 0.0035, 0.035 and 0.35 mg PAA/l (dilutions of equilibrium PAA 0.35%) for 48 hours resulted in immobilisation rates of 5%, 5%, 5% and 100%, respectively. The EC_{50} value was 0.035 - 0.35 mg PAA/l (Licata-Messana, 1995b). It should be noted that the H_2O_2 content of the product, and test solutions, was relatively high. At the highest concentration the H_2O_2 concentration was equivalent to 7 mg/l, while the 24-h EC_{50} is 2.3 mg H_2O_2 (reported as 7.7 mg/l for a 30% solution) (Bringmann and Kühn, 1982). Thus, the low EC_{50} value, expressed as PAA concentration, can be explained by the high concentration of H_2O_2. However, also during the studies of Burgess and Forbis (1983) and Gardner and Bucksath (1996a) an effect of H_2O_2 on the observed toxicity cannot be excluded if the results are compared with the 24-h EC_{50} value of 2.3 mg H_2O_2/l reported by Bringmann and Kühn (1982).

The EC_{50} values of four tests with *Daphnia magna* ranged between 0.50 and 1.1 mg PAA/l, which shows a good reproducibility. In another test (Lamy *et al*, 1997) the immobility was 75% at 1.0 mg/l and, although only two concentrations were tested, the results of this test do not conflict with the previous four *Daphnia magna* test results. The test of Licata-Messana (1995b) is not so representative of PAA products because of the relatively high H_2O_2 content.

Other invertebrates

The study with equilibrium PAA (12%) in brown shrimp (*Crangon crangon*) revealed an 96-h LC_{50} value of 15 mg PAA/l. The medium was renewed daily during the study but analytical concentration measurements were not made. The mean weight of these saltwater crustaceans was 1.25 g (Tinsley and Sims, 1987a). The larger size of the organism compared to daphnids may explain the lower sensitivity of the shrimp. The high LC_{50} value could also be related to the rapid degradation of PAA in seawater (Section 4.2.3)

Two embryo-larval assays were carried out on marine oysters with nominal concentrations of equilibrium PAA (12.5%) dissolved in seawater, to determine any effects during their first 48 hours of their development from embryo to larva. In this period a protective D-shaped shell was formed. Without a shell the embryos were extremely sensitive to reduced water quality. Both tests were conducted under static conditions. In the first test with embryos of the pacific oyster (*Crassostrea gigas*), a 48-hour EC_{50} of 0.28 mg PAA/l was obtained (Butler, 1987). Another test with embryos of the common mussel (*Mytilus edulis*) resulted in an EC_{50} value of 0.27 mg PAA/l (Fairhurst, 1987).

The effect of PAA on the fertilisation rate of a marine tubeworm (*Pomatoceros triqueter*) was reported. Eggs and sperm were mixed with the test compound and then left for 3.5 hours. The reported EC_{50} value was 0.12 - 0.24 mg/l. Abnormal embryos were also recorded at concentrations of 0.06 and 0.13 mg/l, but further data, which could have enabled quantification of the effects at these concentrations, were not presented (Dixon,1988; CoR 2c). For this reason a reliable NOEC cannot be derived from this study. Ageing of the test solutions for 24 hours (as a 12 mg/l stock in seawater) resulted in a marked reduction of the toxicity, probably due to decomposition of the test solution.

In conclusion, the PAA toxicity studies with other aquatic invertebrates showed a relatively low toxicity for the large brown shrimp but consistent EC_{50} values of 0.1 to 0.3 mg/l were found when small and young organisms were used.

6.2.3 Fish

Four acute studies with rainbow trout (*Oncorhynchus mykiss*) have been reported (Table 15). The studies with this cold-water species were conducted at temperatures of 12-14°C. Only during the study of Douglas and Pell (1986b) were the test solutions renewed daily. Gardner and Bucksath (1996b) made analytical measurements of H_2O_2 in the test solutions. Between the start (0-hour) and the end of the test (96-hour) the decrease in the concentration of H_2O_2 ranged between 14 and 26%. The LC_{50} values of these toxicity tests show a good reproducibility.

Three acute studies with the warm-water bluegill sunfish (*Lepomis macrochirus*) have been performed (McAllister and Cohle, 1983; Terrell, 1987b; Gardner and Bucksath, 1996c). During the first two studies the test solutions were not renewed and chemical analysis were not conducted. Gardner and Bucksath (1996c), in a preliminary test using concentrations of 0.32; 0.54; 0.90; 1.5 and 2.5 mg PAA/l, measured concentrations of H_2O_2 after 96 hours to be less than 5% of the nominal concentrations. Therefore the test solutions were renewed daily during the final test. The mean decrease in the H_2O_2 concentration over a 24-hour period was 12% and the decrease ranged between 0 and 36%.

A semi-static acute toxicity test was conducted with distilled PAA (18%) in zebra fish (*Brachydanio rerio*); the tested concentrations were 0, 1.0 and 10 mg PAA/l. The zebra fish were exposed for 96 hours and they were transferred to fresh solutions each 4-hour period. The PAA concentrations were measured before and after each renewal using a titration with potassium iodide followed by a spectrophometry. In this case the mean decrease in concentration in the 4-hour period was 7.5% (Bazzon *et al*, 1997).

Another toxicity test in *Brachydanio rerio* was conducted with equilibrium PAA (0.35%) at concentrations of 0, 0.0035, 0.035 and 0.35 mg PAA/l. After 96 hours the percentage mortality was 0, 10, 0 and 60, respectively. This showed that the calculated LC_{50} was slightly lower than 0.35 mg/l (Licata-Messana, 1995c). The low LC_{50} value may have been partly due to the relatively high H_2O_2 concentration (7 mg/l) of the test solution, although LC_{50} values for fish are generally higher than 7 mg H_2O_2 (ECETOC 1993). For the other fish tests with PAA there is no indication of a contribution of H_2O_2 to the observed toxicity of PAA based on the LC_{50} of H_2O_2.

In the study of Tinsley and Sims (1987b), plaice (*Pleuronectes platessa*), a saltwater fish species, with a mean weight of 8.5 g was used. Test solutions were renewed daily during this semi-static test. The high LC_{50} could be due to the rapid degradation of PAA in seawater. The half-life in seawater is less than 1 hour and therefore the exposure during the fish test could have been low (Section 4.2.3).

6.2.4 Birds

When quails were given a commercial mash diet containing 750 ppm PAA for 5 days, no signs of toxicity were observed (Terrel, 1986b; CoR 4a). The diet was not analysed for PAA and because the substance was probably unstable in the diet the actual exposure to PAA is unknown.

6.3 Summary and Evaluation

PAA is an active bactericide, fungicide and sporicide. Spores are generally more resistant, as well as viruses. Many studies are available which describe the effect of PAA solutions on these target organisms, but these studies are in general conducted at relatively high concentrations and few concentrations per study, and are therefore not very useful for an environmental hazard assessment.

Toxicity tests with PAA and wildlife species, plants or other terrestrial organisms are not available.

Many different toxicity tests with aquatic organisms have been reviewed in the previous sections. Full reports were in general available allowing critical evaluation of the data. Although analytical measurements were conducted for only a few studies, those without analytical measurements provide useful information about the acute toxicity of PAA solutions.

For several standard species, e.g. *Selenastrum capricornutum*, *Daphnia magna*, *Oncorhynchus mykiss* and *Lepomis macrochirus*, more than one toxicity test was performed. The toxicity tests were reproducible if concentrations were expressed as PAA concentrations irrespective of the concentrations of H_2O_2 and HOAc. This indicates that the PAA concentration explains the toxicity of PAA formulations and therefore the concentration of H_2O_2 and HOAc are less relevant in this respect. However, for algae and daphnids the absolute concentrations of H_2O_2, at the effect concentrations of PAA, were close to the effect concentrations of studies with H_2O_2 alone. For fish the absolute concentrations of H_2O_2, at the effect concentrations of PAA, were not close to the effect concentrations of studies with H_2O_2 alone. In conclusion, it can be stated that for algae and daphnids there could be a contribution of H_2O_2 to the toxicity of the PAA formulations, while for fish there is not always evidence for an effect of H_2O_2 on the toxicity of PAA. If the product contains 0.35% PAA and 7% H_2O_2 then evidence for a contribution of H_2O_2 to the toxicity of the product for fish was found. Apart from this one example the data for fish did not evidence than effect of H_2O_2 content on the toxicity of the PAA formulation.

The results of the toxicity studies indicate a relationship between the size and sensitivity of the organisms. Small test organisms, like unicellular algae and mussel and oyster embryos, seemed to be relatively sensitive while larger test organisms such as brown shrimp and fish seemed to be less susceptible. This phenomenon could be related to the relatively unspecific mode of action of the compound. The mode of action of PAA is based on the oxidising properties that are relevant for all organisms. Small organisms are probably more sensitive because their body-surface to body-weight ratio is relatively high, which results in a relatively high uptake (per gram body weight).

The lowest endpoint was reported for an algal study with *Scenedesmus subspicatus* which revealed a NOEC of 0.035 mg PAA/l (Licata-Messana, 1995a). However, this study employed an atypical product composition (0.35% PAA, 7% H_2O_2). Based on the remaining standard toxicity tests, the lowest reported NOEC is 0.13 mg PAA/l.

A NOEC of 0.13 mg PAA/l was found for the algal study with *Selenastrum capricornutum* (Hicks *et al*, 1996). Although, an initial effect on growth was observed at this concentration a recovery of growth was found during the last part of the test. Probably the algae are able to degrade PAA if the initial concentration is sufficiently low. At higher initial concentrations the algae are killed and in this case PAA is more stable. No initial effect on the growth of *Selenastrum capricornutum* was found at a concentration of 0.061 mg PAA/l.

It can be concluded that small organisms are relatively sensitive to PAA. Taking account of the large number of standard toxicity test with algae, invertebrates and fish, the lowest NOEC was 0.13 mg PAA/l. At such a low concentration, the organisms were apparently able to promote the degradation of PAA.

7. KINETICS AND METABOLISM

7.1 Absorption and Distribution

An *in vitro* skin penetration test with freshly prepared pig skin was described by Krüger and Jancke (1976). A solution of 0.8% PAA (110 ml) (diluted from 40% PAA containing 5% H_2O_2 and 40% HOAc) was incubated with pig skin (5 cm surface area) in a diffusion cell at 37°C for 24 hours. The receptor fluid, physiological saline (110 ml) was analysed every 2 hours for active oxygen using photometric detection after reaction with potassium iodide solution with a detection limit of 2 µg. No PAA could be detected in the receptor fluid when intact skin was used (7 samples). Only in one experiment with a damaged skin sample in which the deeper layers were affected 2.6 mg active oxygen (calculated as PAA) was detected.

Phillips (1994a) studied the fate of ^{14}C-labelled PAA solution after dermal application to 4 male Sprague-Dawley rats. As the skin of the animals was severely damaged due to the corrosive effects of the applied solution, the results of this study cannot be used to assess absorption of PAA through intact skin.

Details of the preparation of the sample and test solution are given in Table 16.

Table 16: Protocol Used by Phillips (1994a)

	PAA test solution	Control PAA-free solution
Chemical composition	Distilled woter 0.35 ml	None
	HOAc (glacial) 0.13 ml	HOAc (glacial) 0.1 ml
	[1-^{14}C]-HOAc, Na salt (≈ 130 µCi) 0.12 ml	[1-^{14}C]-HOAc, Na salt (≈ 130 µCi) 0.61 ml
	H_2O_2 solution 70% (v/v) 0.286 ml	H_2O_2 solution 70% (v/v) 0.28 ml
	Dequest 2010 (stabiliser) 10 µl	None
	Dipicolinic acid 2 µl	None
Preparation method	Heated to 50°C for 3 days in Sovirel tube	Mixed immediately before use
Final concentration	PAA 5.02%[a], H_2O_2 22.3%[a]	PAA < 0.04%[b]
Distribution of radioactivity	^{14}C: 14.39 µCi/100 µl attributable to HOAc (74%) and PAA (24%)[cd]	^{14}C: 13.10 µCi/100 µl[c] wholly attributable to HOAc[cd]

[a] Determined by cerimetric titration
[b] Determined by iodometric titration
[c] Determined by liquid scintillation counting
[d] Ratio determined by HPLC analysis and liquid scintillation of the appropriate fractions

A volume of 100 µl of the test and control solutions were applied to an area of 2.5 cm^2 of the clipped rat skin using a acrylic glass ring glued to the skin of the animals. Medical gauze was glued to the top surface of the plastic ring and the animals were then immediately placed in a metabolic cage for 72 hours. Water-soluble vapours (i.e. evaporating HOAc and PAA), exhaled CO_2, urine and faeces were collected and analysed at regular intervals. After 72 hours the animals were killed and the total radioactivity content was determined of the following organs: liver, kidneys, heart, lungs, testes, brain, stomach, small intestines, caecum/large intestines, muscle and perirenal fat samples, residual carcass. In a pre-experiment quantitative recovery of radioactivity due to volatilisation of HOAc and PAA from the test solution and of HOAc from the control solution in the metabolic cage had been demonstrated after placing samples of the solutions in the cage.

Body weight gain was not significantly different in the two groups. The skin of the test group animals was severely damaged after the 3-day exposure period and revealed substantial areas of scar tissue whereas that of the positive control animals appeared undamaged. The main results with regard to recovery of radioactivity are summarised in Tables 17 to 19.

Table 17: Percent[a] radioactivity recovered after 72 hours *(Phillips, 1994a)*

	PAA test solution	Control solution
Evaporated from skin	0.44 ± 0.1	19 ± 11.42
$^{14}CO_2$	35.68 ± 7.24	26.97 ± 5.33
Urine	10.47 ± 3.02	16.67 ± 3.85
Faeces	2.64 ± 1.2	3.37 ± 1.26
Cumulative total	49.24	66.01

[a] Values represent the mean % ± SD from 4 rats given a single dermal dose of 100 µl solution

Table 18: Distribution[a] of radioactivity recovered after 72 hours *(modified from Phillips, 1994a)*

	PAA test solution	Control solution
Evaporated from skin	0.71 ± 0.14	25.86 ± 15.73[b]
$^{14}CO_2$	57.82 ± 4.16	37.10 ± 7.63
Urine	17.16 ± 5.16	22.82 ± 4.76
Faeces	4.40 ± 2.31	4.68 ± 1.92
Tissues, carcass	19.91 ± 3.99	9.54 ± 2.79

[a] Values represent the mean % ± SD from 4 rats given a single dermal dose of 100 µl solution

[b] Includes one low value of 1 animal

Table 19: Distribution[a] of absorbed[b] radioactivity (%) recovered after 72 hours *(Phillips, 1994a)*

	PAA test solution	Control solution
$^{14}CO_2$	58.3 ± 4.2	50.2 ± 2.5
Urine	17.3 ± 5.2	30.8 ± 2.5
Faeces	4.4 ± 2.4	6.3 ± 2.4
Tissues, carcass	20.0 ± 4.0	12.8 ± 1.3

[a] Values represent the mean % ± SD from 4 rats given a single dermal dose of 100 µl solution

[b] Total recovered minus part that evaporated from skin

Total recovery of radioactivity in air evaporated from skin, expired air, urine and faeces was about 49% in the test group and 66% in the control group (Table 17). Evaporation of radioactivity from the rat skin during the treatment (captured in a water trap) was less than 1% of the applied radioactivity for the test group and 29 to 41% for 3 control group animals in the first 24 hours. In one control group animal only 2.5% of the total radioactivity was detected in the water trap within 24 hours.

When the recovered radioactivity is presented as a percentage of the absorbed dose (dose minus part that evaporated) significant differences between the test and control animals were obtained, in particular with regard to the amount eliminated in urine (31% in controls versus 17% in test group animals) and exhaled as $^{14}CO_2$ (50% in controls, 58% in test group animals). Recovery in the tissues and carcass was 13% in controls and 20% in test group animals.

In the test group $^{14}CO_2$ exhalation was rapid up to 8 hours following administration (including initial lag phase of 1 - 2 h), and then continued at a lower rate up to 72 hours. In the first 24 hours, 5 to 10% of the total recovered radioactivity was excreted in urine. On day 2 and 3, 1 to 3% was recovered in urine. Excretion of radioactivity in the faeces of the test group animals varied between 0.4 and 3% of the total recovered radioactivity per day. About 20% of the total recovered radioactivity was found in the tissues and carcass of the test animals. Highest tissue levels of radioactivity were observed in the residual carcass, the liver, the gastro-intestinal tract and the skin. Recovery of radioactivity was significantly higher than in controls in a number of tissues including kidney, liver, testes and gastro-intestinal tract.

In 3 of the control animals, $^{14}CO_2$ exhalation started immediately after application of the control solution and a substantial proportion of the radioactivity was recovered after the first 3 hours, thereafter the rate was much lower. Urine recovery of radioactivity was approximately 5% of the total recovered radioactivity after 24, 48 and 72 hours for all control animals. Excretion of radioactivity in the faeces of the control group animals varied between 0.4 and 3% of the total recovered radioactivity per day and was thus similar to that of the test group animals. In the controls about 9.5% of the total recovered radioactivity was found in tissues and the carcass. Highest tissue levels of radioactivity were observed in the residual carcass, the liver, the gastro-intestinal tract and the skin.

The authors concluded that the metabolic fate of the absorbed [1-^{14}C]acetic acid in the control animals was consistent with the known fate of HOAc in mammals. Free acetate is known to be metabolised by extra-hepatic tissues such as muscle and gut and is incorporated into carbohydrates, fatty acids, glycogen, cholesterol and protein. Acetate carbon atoms are mainly excreted as CO_2 and urea. An exhalation of 50% of the dose as CO_2 is consistent with literature data on acetate. The main differences observed between the PAA solution and the acetate control treatment were the lower amount evaporating from the skin within 24 hours and the apparent lag phase in exhalation of radioactive CO_2, the lower excretion in urine and a higher retention of radioactivity in tissues.

The higher dermal absorption could be due to the severe damage of the barrier of the skin observed after application of the PAA solution, resulting in an enhanced absorption rate. This would be consistent with the *in vitro* data of Krüger and Jancke (1976). The other differences observed could, according to the authors, suggest a different metabolic fate of the PAA/HOAc mixture compared to HOAc alone. However, the difference in absorption rate between intact and damaged skin could also explain these differences. It is possible that the lag phase is due to a lower blood flow in skin capillaries and a slower distribution due to the formation of micro-emboli from oxygen formation from H_2O_2 and/or PAA after a higher absorption rate through damaged skin.

No toxicokinetic data are available for other routes of exposure.

7.2 Evaluation

Although only limited experimental data are available on the absorption and distribution of PAA, some general assumptions can be derived from the physico-chemical data. All components of the equilibrium are of low molecular weight, high water solubility, low fat solubility and have no tendency to bioaccumulate (Section 4.2.5). For the PAA molecule itself an octanol/water partition coefficient of log P_{ow} = 0.3 was determined (Table 1). For H_2O_2, a log P_{ow} < 1 can also be estimated, while for HOAc a log P_{ow} of -0.31 to -0.17 has been reported (Verschueren, 1983). It can be assumed that absorption of PAA through skin and mucous membranes is possible, but limited by the high water solubility and low partition coefficients of the equilibrium compounds. Degradation of PAA itself and in particular H_2O_2 at the site of entry may further limit absorption due to capillary microembolism (Hauschild *et al*, 1958), detachment of epithelium and mechanical rupture of tissues close to the port of entry (Sheehan and Brynjolfson, 1960; Ludewig, 1965; Urschel, 1967). However, a considerable intake of radioactivity (from PAA and/or HOAc) was observed in damaged skin, once the skin barrier is destroyed by the corrosive effects of PAA solutions (Phillips, 1994a). In the stomach at pH 2 the undissociated acid is the predominant species (from the pKa-value of 8.2 a ratio acid/anion 10^7/1 can be calculated) which can penetrate into the cells. At a cellular pH 7.4 the ratio of the acid to the anion is smaller (6/1). It is possible that the diffusion into the cells may be enhanced by the concentration gradient for the undissociated acid. However, in the stomach fluid and inside the cells enzyme-catalysed degradation is to be expected. Once absorbed, PAA is expected to be distributed in the body fluid and metabolised; it can be anticipated that no accumulation in organs or body fat occurs.

The study of Phillips (1994a) seems to support those assumptions as it was shown that radioactivity of [1-^{14}C] labelled HOAc and PAA in a PAA solution was mainly exhaled as $^{14}CO_2$ and excreted in the urine. Radioactivity recovered in other organs and tissues is most probably due to the metabolism of HOAc in physiological pathways and synthesis of biomolecules.

7.3 Metabolism

7.3.1 Enzymatic reactions *in vitro*

In vitro experiments with a number of different enzymes and peroxo acids showed that there were no significant degradations of PAA by different lipases, proteases and butylcholinesterase. Rates of degradation were generally below 0.05 µmol/min/ml (concentration of the acid 0.02 mM, enzyme concentration 0.3 mM, phosphate buffer pH 8, 25oC, 15 min). A slightly higher rate of decomposition was observed with pig liver esterase (2.3 µmol/min/ml) and acetylcholinesterase 0.48 µmol/min/ml under the same experimental conditions. Generation of PAA was observed when 25 mM acetylcholine was incubated with acetylcholinesterase 25 U[a] /ml and 10 mM of H_2O_2 at pH 7. H_2O_2 was consumed within 5 minutes and PAA generated which was then degraded slowly with a half-life of about 25 min (Kirk *et al*, 1994).

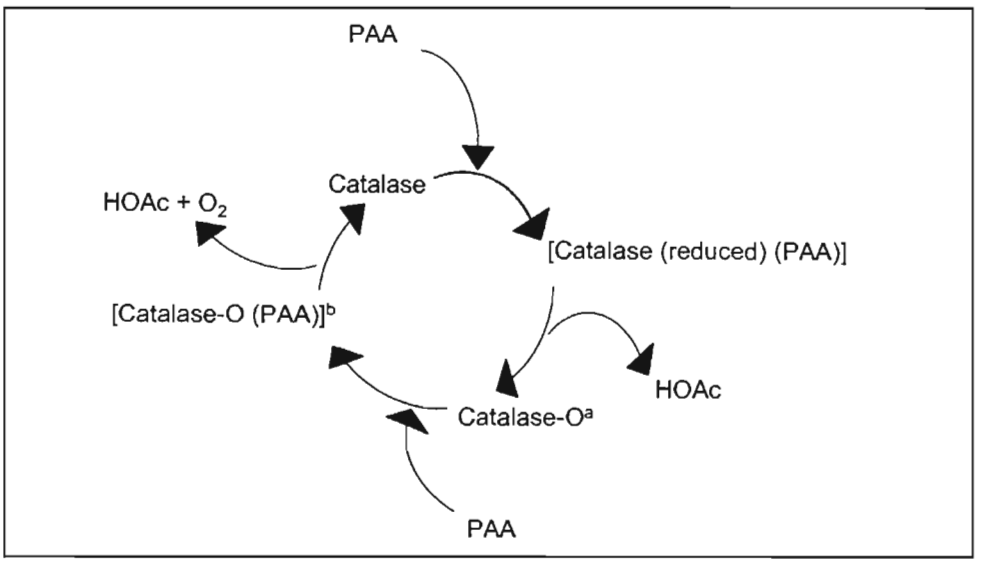
Several authors have shown that PAA is a substrate of catalases.

In vitro activity of beef liver catalase on PAA was evaluated by Ferri (1990). Beef liver catalase was dissolved in sodium phosphate buffer (70 mM, pH 7.0). Stock solutions of PAA (composition not stated) 5 mM in phosphate buffer were pre-treated with 8 nM catalase for 20 min at 20°C. Thereafter the stock solutions were diluted to the final concentrations. Spectrophotometry was performed using a double beamed spectrophotometer and thermostatically controlled cell. The difference in the molar absorption coefficients of the various oxidation states of the haem at 405 and 435 nm was used to quantify the kinetics of the inter-conversion of the different steps of the reaction. An amount of 1 nmol PAA corresponded to 5×10^{-3} absorbency units at 505 nm. Samples (70 µl) of the PAA solutions were added to a freshly prepared reaction mixture of phosphate buffer (0.1 M, pH 7.0), phenol (30 mM), 4-aminoantipyrine (6 mM), and horseradish peroxidase (2 U/ml). Under these conditions the peroxidase activity of catalase did not interfere with the assay. Catalase activity on H_2O_2 was assayed separately. The catalase reaction followed the summary equation:

$$2\ CH_3C(O)OOH \longrightarrow 2\ CH_3C(O)OH + O_2 \quad \text{(Eq. 2)}$$

[a] Activity Unit

Figure 1: Metabolism of PAA *(adapted from Ferri, 1990)*



[ ]	Theoretical intermediate
a	Compound I
b	Compound II
PAA	Peracetic acid
HOAc	Acetic acid
O_2	Oxygen

The first step is a first order reaction of catalase with substrate leading to immediate conversion of the enzyme-substrate complex to the oxidised state (Compound I) and the release of HOAc. Compound I is spectroscopically identifiable as a stable intermediate. The second step, first order with regard to Compound II and independent of the PAA concentration, regenerates the free catalase in a reduction reaction (kinetic constant $k_4 = 2 \times 10^{-4}\ s^{-1}$). Oxygen and a second molecule of HOAc are released in that step which is the rate limiting reaction. The author showed that the catalytic cycle rate for PAA is independent of the substrate concentration and the rate determining step is the electron rearrangement inside the cycle rather than the adduct formation. This is different from the reaction of catalase with H_2O_2 or alkyl peroxide which is dependent on the substrate concentration.

Under steady-state conditions the PAA consumption was independent of the PAA concentration and the zero order rate constant was calculated to be $4 \times 10^{-7}\ s^{-1}$.

Another reaction was catalysed by catalase when the enzyme solution was supplemented with an excess of ethanol (10^3 to 10^4 times the enzyme concentration) prior to addition of PAA. Under these conditions ethanol was oxidised to acetaldehyde. In this reaction PAA was used as the source of oxygen for the oxidation reaction of ethanol. Because of the large excess of ethanol the reaction was only dependent on the PAA concentration

and the first order rate constant was determined to be 1.1×10^4 mol/l/s. During the reaction the enzyme spectrum was that of the resting state.

Jones and Middlemiss (1972) determined reaction rates of PAA (36 to 40%, no further data) with bacterial catalase (from *Micrococcus lysodeictikus*) or ox liver catalase. The PAA solutions used in the experiment were pre-treated with a small amount of catalase (2 nM) incubated for 30 min; the absence of H_2O_2 was assured by cerimetric titration. The PAA concentrations were determined iodometrically. The formation of Compound I was followed spectrophotometrically and was much slower than with H_2O_2. The reaction was more rapid with the ox catalase than with bacterial catalase. The pseudo first order rate constants were directly proportional to the PAA concentration, but the second order rate constants decreased with increasing pH. At pH 7 the first order rate constants for the formation of Compound I were respectively $1.44 \times k_{HA}$/mol/s with ox catalase and $5.72 \times 10^{-2} \times k_{HA}$/mol/s with bacterial catalase. The rate constant apparently depended on the degree of dissociation and could be described as:

$$k_o = a\,(k_A^- - k_{HA}) + k_{HA} \quad \text{(Eq. 10)}$$

where A^- is the peroxoacetate ion, HA the undissociated PAA and a the degree of dissociation.

Different buffer systems showed similar results. From the results at different pH values the authors concluded that the reaction occurs predominantly with the undissociated acid. Compound I in this study was remarkably stable with the bacterial catalase, but less with the ox liver enzyme although a slow regeneration of free catalase eventually occurred. When ethanol or formate was added to a steady-state concentration of Compound I, the reaction rate with those substrates greatly exceeded the reformation of Compound I. The regeneration curves were first order and the pseudo first order rate constants were proportional to the substrate concentrations.

The reaction with human erythrocyte catalase *in vitro* confirmed that Compound I formation is a pH-dependent process. From pH 5.8 to 6.5 the rates were in the same range, but slowed down as PAA was deprotonated (pKa = 8.2). At pH 5.8 to 6.5 the apparent 2nd order rate constant for the formation of Compound I was 2.7×10^4/mol/s (Palcic and Dunford, 1980). Under the same conditions the rate constant is 6×10^6/mol/sec for H_2O_2 (Schonbaum and Chance, 1976). Below pH 5.8 Compound I was not stable and decomposed before steady state was achieved.

Addition of PAA to calf serum at a concentration of 0.05% at 4°C resulted in a degradation of PAA within 4 hours. Degradation is increased in whole blood owing to the presence of erythrocytes (Mücke, 1977).

One or 0.5 ml, respectively, of a 10% or 20% suspension of rat stomach fluid was added to 5 or 2.5 ml of aqueous solutions of PAA (5 to 200 mg/l) and PAA concentrations measured immediately after mixing. The PAA content was reduced by 28 to 76% depending on the concentrations. Addition of 100 µl of human saliva to 5 ml or 2.5 ml of PAA solutions containing 5 to 200 mg/l reduced the PAA content by 2 to 42 percent

immediately after addition of the saliva. These experiments indicate a catalytic degradation by catalases present in saliva and stomach fluid (Juhr *et al*, 1978).

The importance of the catalase reaction for the metabolism of PAA can be illustrated by looking at the distribution of catalases in the mammalian organism.

Catalases are present at a wide range of concentrations in nearly all mammalian cells; the enzymes are particularly efficient in metabolising large amounts of H_2O_2 (Chance *et al*, 1979). Catalases are located in sub-cellular compartments, mainly in peroxisomes (De Duve and Bauduin, 1966). Soluble catalases were found in erythrocytes (Saito *et al*, 1984).

The highest catalase content is observed in cells of the duodenum, liver, spleen, kidney, blood, mucous membranes and other highly vascularised tissues; the lowest catalase activity occurs in brain, thyroid, testes and connective tissue cells (Matkovics and Novak, 1977).

For a more detailed discussion of catalase activity, inter- and intra-species differences, the reader is referred to an ECETOC assessment of hydrogen peroxide (ECETOC, 1993, 1996).

7.3.2 Non-enzymatic degradation

In the absence of metal ions, diluted PAA solutions may undergo a pH-dependent hydrolysis yielding HOAc and H_2O_2. In the presence of metal ions, PAA may also decompose via the dismutation reaction to oxygen and HOAc (Mücke, 1977, see also Sections 2 and 3). While PAA is relatively stable at pH values around pH 2 it rapidly degrades to HOAc and oxygen at pH values at or above 7. PAA is stable at the pH of the stomach (pH 2) but will probably be degraded in the intestinal tract and locally after absorption in the cells. These reactions may play a role under physiological conditions. Reaction of PAA with reducing agents such as cysteine or gluthathione leads to a rapid reduction of PAA to HOAc (Mücke, 1977). This is likely to be important for the metabolic detoxification of PAA.

7.4 Elimination

Due to its rapid metabolism it can be assumed that PAA will not be excreted unchanged in urine, but will be degraded to oxygen and HOAc, the latter being further metabolised via normal physiologic pathways, ultimately to CO_2 and water. After dermal absorption of a PAA solution containing [1-^{14}C]-labelled PAA and HOAc it has been shown that the 58% of the absorbed radioactivity was exhaled as $^{14}CO_2$ and 17% was excreted in the urine (Philips, 1994a) (Section 7.1).

7.5 Summary and Conclusions

Only limited data are available on the kinetic properties of PAA. Due to the high water solubility and the low octanol water partition coefficients and possibly limited absorption by the formation of micro-bubbles of oxygen in the capillaries and tissues surrounding the exposed tissues, absorption into the circulation is assumed to be limited (ECETOC, 1993, 1996). However, skin damaged due to the corrosivity of PAA solutions can enhance the absorption of the components PAA and HOAc. In the stomach at pH 2 the undissociated acid is the predominant species (ratio acid/anion $10^7/1$) which can penetrate into the cells. At a cellular pH 7.4 the ratio of the acid to the anion is smaller (6/1). However, in the stomach fluid and inside the cells enzyme catalysed degradation is to be expected. Distribution is only likely in the body fluids and limited by the degradation of PAA. PAA may be degraded in the organism either non-enzymatically by hydrolysis, dismutation or reaction with reducing agents (cysteine, GSH), or enzymatically by the catalase reaction. The catalase reaction with PAA is independent of PAA concentration and may therefore be saturated. H_2O_2 is degraded rapidly by peroxidases, catalases and a number of other enzymes and antioxidants. As re-equilibration is probably slow, the influence of the withdrawal of H_2O_2 from the equilibrium on the degradation of PAA cannot be predicted from the available data.

8. EFFECTS ON EXPERIMENTAL ANIMALS AND *IN VITRO* TEST SYSTEMS

8.1 Acute Toxicity

8.1.1 Oral

A number of oral acute toxicity studies have been carried out in rats using aqueous solutions with different concentrations of PAA ranging from 0.89 to 40%. Details of these studies including the composition of the PAA solutions tested are shown in Table 20. Some studies were carried out keeping the volume constant and changing the PAA concentration according to the dose. Other studies were carried out using a constant concentration of PAA and changing the volume of administration according to the dose (indicated by a footnote in Table 20). In the older studies, the test concentrations were nominal, calculated from the basic PAA grade. In the most recent studies the PAA quality was analysed and the concentration of components measured. The more recent studies were carried out in accordance with standard OECD/EU/US-EPA and international GLP guidelines.

Table 20: Acute Oral Toxicity in Rats

Strain	Sex	Composition (%) PAA	H_2O_2	HOAc	pH	LD_{50}[a] (mg/kgbw)	LD_{50}[a] (mg PAA/kgbw)	Effects observed	Reference	CoR
Sprague-Dawley	M+F	0.15	0.64[c]	NS	NS	> 5,000	> 7.5	None	Freeman, 1991a	1a
Wistar	M	0.89	7.27	10.85	NS	> 2,000	> 17.8	Severe inflammation of gastro-intestinal tract	Den Besten, 1994	1a
	F					1,663	14.8			
	M+F					> 2,000	> 17.8			
Wistar	M	2	7	19	< 0.7	1,175	23.5	No gross alterations at necropsy	Joakimson da Silva and Keiko s. Coimbra, 1990a	3a
Sprague-Dawley,	M	4.89	19.72	10[d]	NS	316	15.5	Local irritation in gastro-intestinal tract, nose, eyes and respiratory tract, diarrhoea	Kuhn, 1996a; Loera, 1996[e]	1a
	F					118	5.8			
	M+F					185	9.0			
Sprague-Dawley	M	5[f]	22[f]	10[f]	NS	1,993	99.7	Abdominal gripping and distension, loss of muscle control, gait disturbances, eye irritation, whitening of tissues and blood in gastro-intestinal tract	Freeman, 1998	1a
	F					1,859	93			
	M+F					1,922	96.1			
Sprague-Dawley	M	5.6	26.9	7.6	0.1	3,271	183.2	Soft faeces, reduced activity, irritation of gastro-intestinal tract	Haynes and Brightwell, 1998a[e]	1a
	F					4,217	236.2			
	M+F					3,622	202.8			
Sprague-Dawley	M	10	NS	NS	NS	2,540[g]	254	Sedation, local irritation of gastro-intestinal tract	Degussa, 1977a	1d
	F					2,390[g]	239			
Sprague-Dawley	M+F	10.85	17.19	19	NS	200[h] - 1,000	21.7 - 325.5	Congestion of different organs, adherence of stomach, liver and gastro-intestinal tract	Gomond, 1998	2e
Sprague-Dawley	M	11.69	18.05	20[i]	NS	846	98.9		Kuhn, 1996b; Loera, 1996	1a
	F					314	36.7			
	M+F					652	76.2			
Wistar	M	14i	23i	16i	0.5	330i	23.1	No gross alterations at necropsy	Joakimson da Silva and Keiko s. Coimbra, 1990b	3a

Table 20 continued

Strain	Sex	Composition (%) PAA	H_2O_2	HOAc	pH	LD_{50}[a] (mg/kgbw)	LD_{50}[a] (mg PAA/kgbw)	Effects observed	Reference	CoR
Wistar	M F	15	21[k]	16[k]	< 2[k]	1,026 1,015	153.9 152.3	Local irritation of gastro-intestinal tract, respiratory tract and eyes	Degussa, 1982a[e]	1b
Sprague-Dawley	M F	17	22.9	NS	4	> 1,000 - < 1,260 < 397	> 170 - < 214.2 < 67.5		Cascieri and Freeman, 1983a	2b
Sprague-Dawley	M+F	35	7.3	NS	NS	50 - 500	17.5 - 175	Local irritation of respiratory tract and gastro intestinal tract (blood-filled stomach and intestines)	Freeman, 1987	1a
Albino	F	36 - 40.5		30	NS	263	95 - 105	Restlessness, increased respiration and cyanosis, hyperaemia and oedema of the gastro-intestinal tract, necrosis of kidney tubules	Busch and Werner, 1974[e]	2e
Albino	F	100	NA	NA	NS	314.8	314.8	Restlessness, increased respiration and cyanosis, hyperaemia and oedema of the gastro-intestinal tract,necrosis of kidney tubules	Busch and Werner, 1974[e]	2e

[a] Median dose expected to cause the death of 50% of the test animals after a 14 day observation period, except for the studies by Busch and Werner, who observed the rats for 3 days

[b] Code of reliability (Appendix B)

[c] Assumed value

[d] From Solvay, 1997a

[e] Dosage by constant volume

[f] Before dosing diluted to 1.25% PAA, 5.5% H_2O_2 and 2.5% HOAc

[g] Reported as 3.00, 3.00, 2.21 and 2.08 ml/kgbw; converted to mg/kgbw assuming a relative density of 1.15 (Table 2)

[h] Diluted to increase the dosed volume to 2.5 ml/kgbw

[i] From Solvay, 1997b

[j] Dispersed (1:1) in vegetable oil

[k] From Degussa, 1996b

F Female

M Male

NA Not applicable

NS Not stated

In the study of Den Besten (1994), 1 male rat and 4 females at the two highest dose groups were killed *in extremis* within 5 days of dosing. Clinical signs consisted of abnormal posture and gait, decreased locomotion, sniffeling, respiratory difficulties, ptosis and distended abdomen. Recovery became apparent from 2 days post dosing onwards, although surviving females at the highest dose level did not fully recover after 14 days of observation. Gross alteration in the female animals that were killed *in extremis* revealed severe inflammatory changes in the gastro-intestinal tract. No changes were seen in the survivors sacrificed at the end of the observation period.

Kuhn (1996a,b) administered two different concentrations of PAA (4.89 and 11.69%) to rats. Both concentrations caused overall the same clinical signs: decrease of activity as well as diarrhoea, nasal and ocular discharge, piloerection, gasping, polyuria, ptosis, staining of muzzle and back, salivation and respiratory chirp. In the vast majority of the animals, the signs were no longer evident at the end of the observation period of 14 days. The necropsy of the dead animals revealed gas in the gastro-intestinal tract and discoloured stomach, intestine, lungs, liver and spleen. The majority of the findings are indicative of the local irritant effect of the product; the authors did not explain the observed discoloration of the lungs and the spleen. No abnormalities were seen in survivors at the end of the observation period.

In the study of Freeman (1998), the most significant clinical signs observed were abdominal gripping and distension, loss of muscle control, squinting eyes, staggered gait, tremors, walking on toes, hypersensivity to touch, splayed hind limbs and hypothermia. Recovery was essentially complete after 7 days of dosing even if some signs persisted for up to 13 days. Examination of the animals that died revealed blanched stomachs and intestines, mottled and blanched livers, distended stomachs with thin linings, darkened red adrenals and white tracheas. Blood was found in the stomach and intestines. In the animals killed at the end of the observation period, only thinning of the stomach wall was seen at necropsy.

Haynes and Brightwell (1988a) reported general clinical signs, such as soft or mucoid faeces, reduced activity and piloerection, at all dose levels. Surviving animals generally recovered within 3 days. Macroscopic examination of the dead animals revealed abnormalities in the liver, stomach and regions of the gastro-intestinal tract. The stomach was commonly distended and white in colour. The intestines were dark red in colour. The liver either appeared dark or exhibited multiple pale areas. No significant abnormalities were found on necropsy of the survivors at the end of the observation period. The macroscopic findings in the dead animals are indicative of a local irritant effect of the product.

In the Degussa (1977a) study, clinical signs consisted of sedation, bloody discharge from the nose, ataxia and dyspnoea. Pathological findings were adhesion between the stomach and adjacent organs, perforation of the stomach in the animals found dead and haemorrhagic erosions of the stomach wall and oesophagus indicative of a severe irritation.

In the study of Gomond (1998), there were no deaths at the low dose level, while the mortality at the higher doses was between 60 to 100%, but without dose-response relationship. The autoptic examination of the descendants showed alterations to the stomach and congestion of different organs. The gross alteration of the survivors at the end of the observation revealed adhesion of different organs such as stomach, liver and gastro intestinal tract. No findings were see at the lowest dose level. The signs consisted of piloerection, abdominal constriction, hypoactivity and lessened muscular tone. These signs were evident a few hours after the administration and lasted up to 5 to 7 days following treatment. The method of administration of the low dose (dilution with distilled water) makes interpretation of the results difficult. This is also confirmed by the lack of a dose-response relationship at the higher dosages, supporting the hypothesis that all doses tested without dilution were severely irritant to the gastro-intestinal tract.

In the Degussa (1982a) study, signs indicative of irritation of the gastro-intestinal tract (writhing syndrome, stilted gait, and tremor), laboured breathing and bloody lachrymation were observed. Red coloured urine was also observed in females of the highest dose group. At necropsy adhesions were observed between the viscera and the peritoneum. The gastro-intestinal mucosa and parts of the liver close to the stomach appeared white or greyish in animals of the high dose group. In the lowest dose group no clinical signs indicating irritation were observed. This dose corresponded to a concentration of about 3% PAA, 4.5% H_2O_2 and 4% HOAc.

Cascieri and Freeman (1983a) observed mortality at all dose levels in males and in all but the 250 and 630 mg/kgbw doses in females. These data were not in accordance with the dose-response relationship and they were considered by the authors as indicative of the instability of the test material. The latter dose groups were tested at a later date than the preceding dose groups. The predominant clinical signs were decreased locomotion, rales, haematuria, abdominal distension, abdomino-genital staining, unthriftiness recumbacy, oral and nasal discharge. Gross necropsy of the decedents and the survivors included gross alteration of the stomach, liver and intestines.

Freeman (1987) reported that all animals died at 500 mg PAA/kgbw and one animal at 50 mg/kgbw. Predominant clinical signs were dyspnoea, oral discharge, chromorhinorrea and decreased locomotion. Gross lesions among descendants included mainly blood-filled stomachs and intestines. There were no gross internal alterations in any surviving rats.

A preliminary test with undiluted 40% PAA in Sprague-Dawley rats was aborted since all animals died from perforating ulcerations in the oesophagus and stomach at 0.5 ml/kgbw (226 mg/kgbw), the lowest dose tested (Degussa, 1977b; CoR 3a).

Several other studies are reported in the literature. Different values of LD_{50} (median dose expected to cause the death of 50% of the test animals) are cited but with a poor level of detail regarding the concentration and formulation of PAA used and the design of the study. This reduces their value for the toxicological evaluation of PAA (Tichácek 1972; Busch and Werner 1974; Merka and Urban, 1976; Reagan *et al*, 1983; all CoR 3a).

Evaluation

The acute oral toxicity data on the different PAA solutions tested do not show a consistent pattern that can be related to PAA dose or concentration, even when the composition appears to be similar. The test results also seem not related to the H_2O_2 concentration, but rather to the total composition of the tested formulation. The fact that the volume of administration was fixed or variable did not help to explain the differences seen in the results of the studies. Symptoms and pathological findings were similar in all studies and are consistent with the irritant/corrosive properties of the test material. Formulations containing less than 10% PAA seem to possess a low oral toxicity.

8.1.2 Dermal

Several dermal toxicity studies have been carried out in rats and rabbits with aqueous solutions of PAA at concentrations ranging from 0.89 to 11.6%. The most reliable dermal toxicity studies are summarised in Table 21. When indicated by the protocol, the PAA solutions were administered undiluted, adjusting the volume of administration according to the dose. The test concentrations were nominal, calculated from the basic PAA grade. In the most recent studies, the PAA quality was analysed and the concentration of components measured. The more recent studies were carried out in accordance with standard OECD/EU/US-EPA and international GLP guidelines.

Table 21: Acute Dermal Toxicity

Species (strain)	Sex	Composition (%) PAA	H_2O_2	HOAc	pH	Exposure conditions	LD_{50}[a] (mg/kgbw)	LD_{50}[a] (mg PAA/kgbw)	Effects	Reference	CoR[b]
Rat											
Sprague-Dawley	M+F	0.15	0.64[c]	NS	NS	24 h, occluded	> 2,000	> 3	No signs of toxicity, no pathological organ findings, no changes at site of contact	Freeman, 1991b	1a
Wistar	F	0.89	7.27	10.85	NS	24 h, occluded	> 2,000	> 17.8	No signs of toxicity, no pathological findings, white and red spots at the application site, encrustation in some animals 1 week after administration	Koopman, 1994	1a
Wistar	M	2	7	19	0.7	NS, presumably non-occlusive patch	> 12,000	> 240	No signs of toxicity, no pathological changes	Joakimson da Silva and Keiko s. Coimbra, 1990d	3a
Wistar	M	14[d]	23[d]	16[d]	0.5		> 12,000	> 1,680	No signs of toxicity, no pathological changes	Joakimson da Silva and Keiko s. Coimbra, 1990c	3a
Rabbit											
New Zealand Albino	M F M+F	4.89	19.72	10[e]	NS	24 h, semi-occlusive	1,280 1,040 1,147	62.6 50.9 56.1	Decreased activity, diarrhoea, nasal discharge, ptosis, salivation andslow gazing. No pathological changes attributable to the test substance. Local effects: moderate to severe erythema, slight to severe oedema, eschar formation	Kuhn, 1996c; Loera, 1996	1a

Table 21 continued

Species (strain)	Sex	Composition (%) PAA	H_2O_2	HOAc	pH	Exposure conditions	LD_{50}[a] (mg/kgbw)	LD_{50}[a] (mg PAA/kgbw)	Effects	Reference	CoR[b]
Rabbit											
New Zealand Albino	M	11.69	18.05	20[f]	NS	24 h, occlusive	1,912	223.5	Decreased activity, diarrhoea, nasal discharge, ptosis, salivation, slow gazing. No pathological changes attributable to the test substance. Local effects: moderate to severe erythema, slight to severe oedema, eschar formation	Kuhn, 1996d; Loera, 1996	1a
	F						1,990	232.6			
	M+F						1,957	228.8			
New Zealand White	M+F	17	22.9	NS	24 h, occlusive		> 200	> 34	No signs of toxicity. No pathological changes attributable to the test substance. Local effects: severe erythema, blanching of skin, eschar formation, exfoliation in 3 animals	Cascieri and Freeman, 1983b	1b

a Observation period: 14 days
b Code of reliability (Appendix B)
c Assumed value
d Dispersed (1:1) in vegetable oil
e From Solvay, 1997a
f From Solvay, 1997b
F Female
M Male
NS Not stated

Several other studies carried out in rats and mice are reported in the literature. Different values of LD_{50} are cited but with a poor level of details regarding the concentration and formulation of the PAA solution tested and the study design. The toxicological relevance of these studies is therefore questionable (Reagan and Becci, 1983; CoR 3a; Benes *et al*, 1966; CoR 4d; Kramer *et al*, 1987a; CoR 3a).

Evaluation

Overall, the dermal toxicity depends on the degree of skin damage caused by the different PAA solutions. Only Kuhn (1996c) reported signs of toxicity (nasal discharge) that could be attributed to systemic effects at the high dose levels. However, it is likely that these signs were caused by additional inhalation exposure in this particular study.

8.1.3 Inhalation

Various inhalation toxicity studies have been carried out in rats and mice with solutions containing up to 40% PAA. Details of the studies and the composition of the PAA solution are shown in Table 22. PAA was tested as vapour or aerosol. In most studies, no morbidity or mortality was seen.

Table 22: Acute Inhalation Toxicity

Species (strain)	Sex	Composition (%) PAA	H_2O_2	HOAc	pH	Duration (h)	LC_{50} (mg/m³)	LC_{50} (mg PAA/m³)	Reference	CoR[a]
Rat							**Aerosol**			
Wistar	M+F	15	NS	NS	NS	4	505 - 1,263	76 - 189	Terrell, 1986a	4a
Wistar	M	5.4	≥ 19	10	NS	4	NS	213[b]	Janssen and Van Doorn, 1994	1a
	F						NS	186[b]		
	M+F						4,080	204[b]		
Sprague-Dawley	M+F	4.5	27	16.7	NS	4	> 5,350	> 241	Dudek, 1984	1a
Sprague-Dawley	M+F	0.15[c]	0.67[c]	0.30[c]	NS	4	> 7,669	> 117[d]	Whitman, 1991	1d
Rat							**Vapour**			
Sprague-Dawley	M	35.5	6.8	39.3	NS	4		≈ 490[def]	Hutt and Kinney, 1985	1a
Wistar	M+F	5	20[g]	10[g]	NS	4	> 5,000	> 200[h]	Biffi, 1992a	2e
Wistar	M+F	5	20[g]	10[g]	NS	4	> 50,000	> 2,000[h]	Biffi, 1995	2e
Mouse										
CBA, NS		36-40[i]	NS[i]	NS[i]	NS	1	NS	1,334 - 5,404[f]	Krüger and Kruschinski, 1982	2a
						0.5	NS	4,171[f]		

a Code of reliability (Appendix B)
b Nominal concentrations calculated by the authors from aerosol composition, assuming 5% PAA content
c PAA 5%, diluted (1:33) in distilled water; H_2O_2 and HOAc concentrations from FMC, 1998a
d Measured concentrations
e Approximate Lethal Concentration
f Vapour/aerosol
g From Solvay, 1997a
h Calculated from partial vapour pressure of PAA in a 5% solution (Table 2)
i Inferred from other publications on the same compound
F Female
M Male
NS Not stated

Aerosol studies

Terrel (1986a) exposed rats to aerosol (or vapour, not clearly stated in the report) concentrations of PAA ranging from 18 to 2,138 mg/m^3. The animals were kept under observation for 14 days after the exposure. During the exposure the animals showed a range of clinical signs which consisted of blinking, foaming, gasping, nasal discharge, salivation, lachrymation, ptosis, laboured respiration, twitching, chewing motion, convulsions, staggering, cornea opacity or death depending on the concentration. Post-exposure clinical signs were laboured respiration, nasal discharge, gasping, lachrymation, haemorrhage from the eye, cornea opacity, blindness, staggering, loss of righting reflex, crusty appearance, piloerection or death depending on the dose. Gross necropsy of the animals that died during the observation period revealed alterations to the lungs and thymus, enteritis, swollen nose, congested nasal cavity and trachea, thickening of the oesophagus and larynx. Animals that were killed at the end of the observation period showed similar alterations. A more detailed evaluation of the study is not possible since only the summary is available.

Janssen and Van Doorn (1994) tested a 4.7 - 5.4% solution of PAA in rats exposed nose-only to aerosols containing measured concentrations of 87, 163, 185 and 267 mg PAA/m^3. The animals were observed for 14 days after exposure. Mortalities were observed only in the two highest dose groups. Clinical signs consisted of apathy, respiratory distress, reduced respiratory rates, decreased fear reaction, freezing and reduced locomotion activity. A number of clinical signs indicative of irritant effects of the product were noted. Surviving animals suffered from a temporary loss of body-weight. Animals that died during the observation period revealed increased lung weight and pulmonary oedema. No macroscopic alterations were seen at necropsy carried out at the end of the observation period.

In the study of Dudek (1984), none of the rats died during the study. All the animals showed irregular breathing and damp fur during the exposure. No macroscopic alterations were found at necropsy.

Whitman (1991) exposed rats whole-body to an aerosol / vapour (nominal concentration 66,171 mg/m^3, actually 7,669 mg/m^3) containing 117 mg PAA/m^3 and observed them for 14 days. A particle size analysis was attempted, but did not produce any valid results due to the extremely high (> 99%) water content of the test atmosphere and the volatility of the test material. No rats died during the study. Clinical signs observed during the exposure were decreased activity and closed eyes. After the exposure some animals showed ocular discharge that lasted for up to 8 days. At necropsy all animals appeared free from any test-related macroscopic alterations.

Janssen (1989a,b) exposed rats (Wistar, M and F) nose-only for 0.5, 1 and 1.5 hours to an aerosol nebulised from a solution containing 15% PAA (14% H_2O_2 and 28% HOAc). Two separate tests were carried out. In the first test, the animals were exposed for 15, 30 and 60 minutes (5 male rats per exposure period); in the second test another group was exposed for up to 90 minutes. The mean measured concentration of PAA in the first test ranged from 0.13 to 1.45 mg/l (130 - 1,450 mg/m^3), in the second test the measured concentration varied from 0.17 to 0.59 mg/l (170 - 590 mg/m^3). The animals were kept

under observation for 14 days after exposure. At necropsy, the organs of the respiratory tract as well as the head of the animal were removed and preserved for histopathological examination (the nasal cavities were also flushed with fixative). Two animals exposed to 590 mg/m^3 for 60 minutes were killed *in extremis* 24 hours after the exposure; mortality was also observed in the highest dose group exposed for 60 minutes in the first test. Clinical signs consisted of noisy breathing, sniffing, sneezing, nasal discharge and intensified grooming. The severity and time of disappearance of the clinical signs increased with the exposure level and duration. No clinical signs persisted until the end of the observation period. Macroscopic examination of animals that died or were killed *in extremis* during the observation period revealed alteration to the respiratory tract (red mucosa of internal nares and trachea, blood in trachea and red lungs), while gas was found in the gastro-intestinal tract; the latter was attributed to air swallowed during the exposure. Histopathology of the upper respiratory tract revealed tissue damage limited to the anterior parts of the nasal cavity in the area where the epithelial lining changes from respiratory to olfactory epithelium. Histopathology of the lungs revealed blood and alveolar macrophages in one animal and hyperplasia and metaplasia in two others. No alterations were found in the animals that were killed at the end of the observation period. No LC_{50} values were calculated in this study.

Benes *et al* (1966; CoR 4b as cited by Heinze et al, 1982) performed acute inhalation studies in rats (strain and sex not stated). Exposure to aerosols containing 7.2, 72, or 237.6 mg PAA /m^3 for 4 hours resulted in signs of restlessness in the low dose group. Additional signs in the mid-dose group consisted of lachrymation and laboured breathing. In the high dose group lung oedema was observed and one animal died (group size not reported).

Vapour / aerosol studies

Hutt and Kinney (1985) administered a vapour/aerosol atmosphere to groups of 6 male Sprague-Dawley rats. The animals were exposed nose-only for 4 hours to PAA concentrations varying from 260 to 670 mg/m^3. The test atmosphere was sampled and PAA concentrations analysed by iodometric titration. After the exposure the animals were kept under observation for 14 days. During the exposure the animals showed moderate red nasal discharge and did not exhibit a normal startle response. Rats exposed to 490 mg/m^3 had laboured breathing. Two rats exposed to 490 mg/m^3 and one rat exposed to 670 mg/m^3 died, 1 and 2 days respectively after the exposure. One to 4 days after cessation of exposure all animals showed lung noise, laboured breathing or gasping and nasal and ocular discharge. At lethal concentrations some rats had diarrhoea, hunched posture, wet or stained perineum and discoloured fur.

Biffi (1992a, 1995) carried out two different acute inhalation toxicity studies with a solution of 5% PAA containing 20% H_2O_2 and 10% HOAc. (Assuming the vapour phase contained 2% H_2O_2, 4% PAA and 9% HOAc, the respective partial pressures were 0.4, 0.3 and 0.8 hPa). Rats were exposed whole-body to a vapour with a nominal concentration of 5,000 mg/m^3 (limit test) and 50,000 mg/m^3. No mortality was seen. Clinical signs consisted of dyspnoea, piloerection and hyperaemia of nasal mucosa. Body weight gain was not affected. No alterations were found at necropsy after the 14-day observation period.

Krüger and Kruschinski (1982) studied the influence of fog density, i.e. the amount of liquid in 1 m^3 of air, on the concentration of PAA aerosol and vapour when aerosols were generated from solutions of different concentrations. Aerosols with droplet size ranging from 0.6 to 4 µm diameter, the majority between 1.5 and 2 µm (i.e. in the respirable range), were generated in a volume of 0.138 m^3. Groups of 10 CBA mice (sex not stated) were exposed to aerosols generated from diluted PAA solutions (1 to 23%; content of H_2O_2 and HOAc not stated) yielding fog densities of 7.25, 14.5, 29, 58 and 116 ml/m^3 for 1 hour. The post-exposure observation period lasted 47 hours. When the exposure time was held constant the lethal concentration was dependent on the fog density. A 50% death rate was reported for a 3.6% PAA solution (corresponding to a LC_{50} of 1,334 mg PAA/m^3) at a fog density of 116 ml/m^3 and an 18.5% PAA solution (corresponding to an LC_{50} of 5,404 mg PAA/m^3) at a fog density of 7.25 ml/m^3. In a second experiment, a 30-min LC_{50} of 4,171 mg/m^3 was obtained with aerosols created from 4, 5, and 8% PAA solutions with a fog density of 116 ml/m^3. According to the authors the LC_{50} was not related to the concentration of PAA expressed in mg/m^3. Furthermore, the aerosol was probably not stable over the experimental period and some PAA may have volatilised into the vapour phase, which would have complicated the determination of the actual concentration of PAA in the aerosols.

The same authors (Krüger and Kruschinski, 1982) exposed groups of 3 CBA mice (sex not stated) in closed chambers to atmospheres saturated with vapour/aerosol from PAA solutions of 5, 17, 20 and 40% PAA. The concentrations of PAA in the vapour phase were calculated using an equation derived from experimental determinations of PAA vapour equilibrium concentrations over open PAA solutions of different concentrations at different temperatures. Death of the animals occurred after inhalation of 3,800 mg PAA /m^3 for 1 hour or 260 mg/m^3 for 20 hours.

Other acute inhalation studies are reported in the literature. The lack of details regarding the study protocol and the experimental conditions prevents their use in a meaningful evaluation of the inhalation toxicity of PAA in experimental animals (Tichácek, 1972; Merka and Urban, 1976; Spiegelberger *et al*, 1984; all CoR 3a).

Evaluation

The available acute inhalation studies with aerosols and vapour derived from different PAA solutions suffered from the difficulty of generating and maintaining a stable atmosphere of PAA, and accurate measurement of the composition of the test atmosphere and particle size of the aerosol. The resulting LC_{50} values should therefore be treated with circumspection.

A common finding of those studies was local irritation of the respiratory tract, which seems more pronounced with PAA aerosols than vapours.

8.1.4 Intravenous

In mice, an intravenous LD_{50} of 17.86 mg/kgbw was reported (composition and concentration of PAA solution not specified) (Li *et al*, 1988; CoR 4). Gloxhuber and Kästner (1983; CoR 2c), testing a formulation containing 4.6% PAA, 29.4% H_2O_2 and 7.4% HOAc in CF1 mice, determined an LD_{50} value of 212 mg PAA/kgbw.

8.1.5 Summary and evaluation

The acute toxicity of PAA has been studied in experimental animals. The oral, dermal and inhalation routes are the most relevant routes of administration for health hazard assessment.

PAA is of moderate acute toxicity via the oral route. The acute oral toxicity of PAA formulations is dependent on the composition (i.e. the content of PAA, H_2O_2 and HOAc) and the concentration of the applied test solution. PAA formulations containing less than 10% of PAA are usually of low oral toxicity.

The acute dermal toxicity of PAA formulations is relatively low, depending on the applied concentration and presence of local irritation.

The available acute inhalation toxicity studies in rats and mice with aerosols and vapours derived from different PAA formulations suffer from difficulties in achieving and measuring constant concentrations due to the instability of the test substance itself and the aerosol droplets. Consequently LC_{50} values derived from such studies show a wide variation. The main effect in all studies was local irritation of the respiratory tract.

The predominant effect of PAA in all acute toxicity studies is local irritation at the site of contact, the extent of which depends on the concentration and the composition of the applied test solution.

8.2 Skin, Respiratory Tract and Eye Irritation, Sensitisation

8.2.1 Skin irritation

Rabbits

An overview of the available skin irritation studies in rabbits and composition of the PAA formulation tested is presented in Table 23.

Table 23: Skin Irritation Studies in Rabbits

Concentration applied[a] (% PAA)	Composition (%) PAA	H_2O_2	HOAc	Dilution	Exposure duration	Result	Reference	CoR[b]
40	36-40	< 5	45	None	4 h	Corrosive	Janssen and Pot, 1987	2b
17	17	23	16	None	4 h	Corrosive	Cascieri and Freeman, 1983c	1a
15	15	15	30	None	4 h	Corrosive	Janssen and Pot, 1987	2b
15	14-15	22-23	16	None	4 h	Corrosive	Degussa, 1982b	1b
15	14-15	22-23	16	None	3 min	Corrosive	Degussa, 1990b	1a
10	10	< 5	25	None	3 min	Corrosive	Degussa, 1988a	1a
5	20[c]	10[c]	NS	1:4	24 h	Corrosive	Biffi, 1992b	2b
5	5	20	10	None	4 h	Corrosive	Janssen and Pot, 1987	2b
5	5	24-25	4-5	None	45 min	Corrosive	Degussa, 1988b	1a
5	5	24-25	4-5	None	3 min	Moderate to severe irritant	Degussa, 1988b	1a
3.87	15.5	22	15	1:4	1 h	Corrosive	Van Beek, 1980	2e
3.87	15.5	22	15	1:4	3 min	Not irritant	Van Beek, 1980	2e
3.4	34	7.5	40	1:10	24 h	Corrosive	Duprat *et al*, 1974	2e
0.35	14	23	16	1:40	24 h	Not irritant (slight erythema)	Joakimson da Silva and Keiko s. Coimbra, 1990e	2e
0.34	34	7.5	40	1:100	24 h	Slight irritant	Duprat *et al*, 1974	2e
0.20	2	7	19	1:9	24 h	Not irritant (slight erythema)	Joakimson da Silva and Keiko s. Coimbra, 1990f	2e
0.17	34	7.5	40	1:200	24 h	Slight irritant	Duprat *et al*, 1974	1d
0.15	5-6	22-23	10-11	1:33	4 h	Not irritant	Freeman, 1991c	1a
0.034	34	7.5	40	1:1,000	24 h	Not irritant	Duprat *et al*, 1974	1d

a Sample volume for all tests: 0.5 ml
b Code of Reliability (Appendix B)
c From Solvay, 1997a
NS Not Stated

PAA solutions of 40% (Janssen and Pot, 1987), 17% (Cascieri and Freeman, 1983c), 15% (Degussa, 1982b; Janssen and Pot, 1987) and 5% (Janssen and Pot, 1987; Biffi, 1992b) were found to be corrosive to rabbit skin. The test solutions were applied at a volume of 0.5 ml for 4 hours using standard skin irritation protocols (Draize Test).

Exposure of the skin of one animal to 0.5 ml PAA 15% for 3 minutes under occlusive conditions resulted in white to yellowish discoloration of the application site and deepening of the treated skin area. Severe erythema was observed at the border of the application site and slight oedema was reported. Microscopic examination revealed

complete coagulation necrosis of the epidermis and upper third of the corium including skin adnexae. The damage developed within 1 hour. It was concluded that 15% PAA was corrosive after 3 minutes of occlusive exposure (Degussa, 1990b).

After exposure of 3 rabbits to 10% PAA for 3 minutes under occlusive conditions whitening of the skin was observed 1 hour after removal of the patch. After 24 hours severe damage of the skin developed with necrosis up to 5 mm in depth (Degussa, 1988a).

Groups of 6 male New Zealand white rabbits were exposed to PAA 5% for 24 hours under occlusive conditions. The patches were removed 24 hours after the application and the skin was washed using saline solution. The alterations were scored using the Draize method, from 1 to 7 days after exposure. The medium score was 4.00, i.e. PAA was extremely irritant (Biffi, 1992b).

Groups of 3 rabbits were exposed to PAA 5% for 3 or 45 minutes under occlusive conditions. After the 3 minutes exposure period, moderate to severe erythema and very slight to slight oedema (primary irritation index 3.3) were observed. The effects were completely reversible within 14 days. Exposure for 45 minutes resulted in corrosive effects. For humane reasons the animals were killed after two days (Degussa, 1988b). An *in vitro* skin corrosion study using Corrositex Continuous Time Monitor Assay was also conducted with 5% PAA. The results indicate that a 5% solution is corrosive according to the US Department of Transport (DOT) Packing Group II classification system (Nims, 1996a).

A 3.4% test solution (from 3.4% PAA, diluted 1: 10) was corrosive when applied to rabbit skin for 24 hours in a volume of 0.5 ml (Duprat *et al*, 1974). A 3.87% (diluted) PAA solution was placed in contact with the skin of rabbits for 3 minutes (4 animals) or 60 minutes (6 animals). There was no skin reaction other than slight erythema following the 3-min exposure. Severe skin reactions were noted in animals exposed for 60 minutes to the final concentration of 3.87% PAA, indicating a corrosive response (Van Beek, 1980).

Duprat *et al* (1974) reported slight irritation after exposure of rabbit skin to 0.34% or 0.17% test solutions for 24 hours. Joakimson da Silva and Keiko s. Coimbra (1990e,f) found no skin irritation after exposure to a 0.20% solution or 0.35% solution for 24 hours under an occlusive patch.

PAA was evaluated in rabbits in the Draize test. Solutions of 0.15% PAA were in contact with the skin for 4 hours under occlusive wrap. No irritation was noted at any site (Freeman, 1991c). Exposure of rabbits to 0.034% had no effect on the skin other than reversible enlargement of scars in scarified skin areas (Duprat *et al*, 1974).

Guinea pigs

Bulnes *et al* (1982a; CoR 3c) exposed the depilated skin of 20 guinea pigs to dressings impregnated with 1 or 3% PAA (further composition not stated) solutions for up to 5 hours. Animals exposed to 3% for 2 hours or more developed an acute dermatitis. No irritation was noted after exposure to 1% for up to 5 hours under the conditions of the experiment. In another study, Bulnes *et al* (1982b; CoR 3c) exposed guinea pigs via cage humidification to 1% or 3% PAA solution for a single exposure. Skin tissue was saved

24, 48 and 72 hours after exposure for histopathological evaluation. Animals exposed to 1% or 3% solutions had no changes to skin sections compared to untreated control animals. Neither of these studies (Bulnes *et al*, 1982a,b) are appropriate for evaluation of skin irritation because the study design is not a standard protocol for this end point.

Kramer *et al* (1987a; CoR 2c) attempted simulation of skin disinfection with PAA in surgical hand disinfection, using guinea pigs. They found no irritation in guinea pigs after 5 consecutive applications (presumably 5 minutes each time) of 0.5% PAA (diluted from equilibrium PAA 40%, 14% H_2O_2 and 27% HOAc). Moderate erythema was noted when 0.5% PAA was applied for 5 minutes after soaping, brushing and washing of the animal skin (3 x 3 min). Focal necrosis and eschar formation was observed after soaping, brushing and washing (2 x 3 min) and subsequent application of 0.5% PAA for 5 minutes. Soaping, brushing and washing alone led to mild erythema after 3 x 3 min and moderate to severe erythema after 2 x 3 min.

8.2.2 Eye irritation

An overview of the available eye irritation studies in rabbits and composition of the PAA formulation tested is presented in Table 24.

Table 24: Eye Irritation Studies in Rabbits

Concentration applied[a] (% PAA)	Composition (%) PAA	H_2O_2	HOAc	Dilution	Exposure duration (h)	Result	Reference	CoR[b]
17	17	23	16		4	Corrosive	Cascieri and Freeman, 1983d	1b
5	20[c]	10[c]	NS		24	Corrosive	Biffi, 1992c	2b
3.4	34	7.5	40	1:10	24	Corrosive	Duprat *et al*, 1974	2e
0.35	14	23	16	1:40	24	Corrosive	Joakimson da Silva and Keiko s. Coimbra, 1990g	2e
0.34	34	7.5	40	1:100	24	Severe irritation	Duprat *et al*, 1974	2e
0.22	2	7	19	1:9	24	Severe irritation	Joakimson da Silva and Keiko s. Coimbra, 1990h	2e
0.15	5-6	22-23	10-11	1:33	4	Mild irritation	Freeman, 1991d	1a
0.034	34	7.5	40	1:1,000	24	Very slight irritation	Duprat *et al*, 1974	2e

[a] Sample volume for all tests: 0.1 ml
[b] Code of reliability (Appendix B)
[c] From Solvay, 1997a
NS Not Stated

PAA was corrosive or severely irritant to the rabbit eye at concentrations of 0.2% and higher (Duprat *et al*, 1974; Joakimson da Silva and Keiko s. Coimbra, 1990g,h).

Cascieri and Freeman (1983d) tested 17% PAA in rabbit eyes and found that it was extremely irritant to washed and unwashed eyes. An *in vitro* test was performed with 5% PAA using the Bovine Corneal Opacity and Permeability test. A classification of severe irritant was determined (Nims, 1996b).

Groups of 6 male New Zealand white rabbits were exposed to PAA 5%. The product was instilled into the conjunctival sac at the dose of 0.1 ml/animal. The eyes were then observed from 1 hour to 7 days after exposure. The alterations to the cornea, iris and conjunctiva were scored using the Draize method. The index of ocular irritation was 75.00 at 1 hour and 90.00 from 24 hours up to 7 days. The alterations had not resolved after 7 days. Based on the Draize scale the author concluded that PAA was irritant (Biffi, 1992c). A more appropriate evaluation would be to consider this solution as corrosive. Duprat *et al* (1974) found maximal irritation at 3.4% PAA and extreme irritation at 0.34%, both with severe irreversible corneal opacity (at 0.34% only 2 of 6 animals) and severe conjunctivitis, ulceration and iritis. A diluted solution of 0.35% PAA was maximally irritant (Joakimson da Silva and Keiko s. Coimbra, 1990g). A diluted solution of 0.2% was severely irritant to rabbit eyes (Joakimson da Silva and Keiko s. Coimbra, 1990h). When a solution of 0.15% PAA was evaluated in rabbit eyes it was found to be mildly irritant (Freeman, 1991d; CoR 1a). Similarly, a 0.034% solution caused no effects other than slight conjunctivitis during the first 24 hours after exposure (Duprat *et al*, 1974).

8.2.3 Respiratory tract irritation

Janssen (1989c; CoR 1a) nebulised a 15% PAA (14% H_2O_2, 28% HOAc) solution into an exposure chamber for 25 minutes. Male Wistar rats were exposed (nose-only) to the aerosol at concentrations ranging from 9.5 to 40.3 mg PAA/m^3 (3.7 to 14.3 mg H_2O_2/m^3; HOAc not measured) and their respiration rate was monitored. The RD_{50}, referring to a concentration of PAA inducing a 50% reduction of respiratory rate, was calculated to be 21.5 to 24.1 mg/m^3. Reduction of respiratory rate occurred at levels from 5 to 10 mg PAA/m^3. After termination of exposure the respiratory rates returned to normal and the animals recovered fully within 3 days. No other clinical signs and no histopathological changes were observed.

The same author (Janssen, 1990; CoR 1a) exposed male Wistar rats to aerosol concentrations ranging from 221 to 487.5 mg PAA/m^3 (8.45 to 63.05 mg H_2O_2/m^3; HOAc not measured), generated from a 15% PAA (14% H_2O_2, 28% HOAc) formulation. Recovery was complete in the lowest dose group while respiratory rates were still depressed after 24 hours in one animal of the mid-dose (299 to 331.5 mg PAA/m^3) and 2 animals of the high dose group (435.5 to 487.5 mg PAA/m^3). Microscopic examination of the nose, trachea and lungs revealed necrosis in the anterior part of the nose while no treatment-related effects were observed in the trachea and lungs. The RD_{50} in this study was determined to be less than 299 mg PAA/m^3.

Guinea pigs exposed by inhalation to aerosol atmospheres (concentration not reported), generated from 1 to 3% PAA formulations (further composition not stated), for 3 days showed eye irritation and coughing. Histopathological examination of the animals 24, 48 or 72 hours after exposure to the 3% solution showed indications of irritation of the respiratory tract mucosa. No effects were noted following exposure to the 1% solution (Bulnes *et al*, 1982b; CoR 3a). This study did not include sufficient detail for further evaluation to be made.

Spraying cattle in closed stables with 0.4 - 1.6% PAA solutions induced coughing and moderate lachrymation and salivation (Zrunek, 1966; CoR 4c as cited in Kretzschmar *et al*, 1972).

8.2.4 Skin sensitisation

In skin sensitisation tests performed with diluted solutions of 14% PAA (23% H_2O_2 and 16% HOAc) and 2% PAA (containing 2% PAA, 7% H_2O_2 and 19% HOAc) administered intradermallly to guinea pigs, no evidence of sensitisation was found (Joakimson da Silva and Keiko s. Coimbra, 1990i,j; CoR 3a). However, PAA was diluted (1 : 1,000) in saline and probably degraded during the test.

A skin sensitisation study using the Bühler method was conducted on short-haired albino guinea pigs to determine if a 5% PAA (20% H_2O_2 and 10% HOAc) formulation could induce dermal sensitisation (Kuhn, 1996e; CoR 1a). The animals were treated (1 x /wk) with 0.4 ml of a 10% solution of the test compound in deionised water for 3 weeks. After a 2-wk rest period, the animals were challenged at a virgin test site with an application of 0.4 ml of a 7% solution of the test substance. After the challenge, a very faint erythema was observed in both the control and the treated group and, therefore, 5% PAA was not considered to have elicited a sensitising reaction in guinea pigs.
A similar study was conducted with 12% PAA (20% H_2O_2 and 20% HOAc) (Kuhn, 1996f; CoR 1a). In this case the animals were challenged with 0.4 ml of a 0.5% solution of the test substance in deionised water. The results showed that 12% PAA did not elicit a sensitising reaction in guinea pigs.

The Bühler method for skin sensitisation was also used with 0.15% PAA (5-6% PAA, 22-23% H_2O_2, 10-11% HOAc) (Freeman, 1991e; CoR 1a). Groups of 10 male and 10 female guinea pigs were treated with 0.3 ml of a diluted (1 : 33) test solution of PAA in contact with the skin for 6 hours. This treatment was repeated once a week for 3 weeks. Fourteen days after the third treatment the animals were challenged at a virgin site. No irritation or sensitisation reactions were noted.

A solution of 5% PAA (20% PAA, 10% H_2O_2, HOAc not stated; diluted with distilled water) was tested in guinea pigs (20 females) using the Magnusson and Kligman protocol to investigate the ability of the test material to produce skin sensitisation. The test solution (5% PAA) was administered during the induction phase by intradermal injection (0.1 ml/animal) and topical application (0.5 ml/animal). Twenty-one days after induction,

the test solution was administered by percutaneous injection (0.5 ml/animal) to challenge the animals. A second group of control animals was treated with the vehicle alone during the induction phase and then challenged with the test material by the same procedure above (Biffi, 1992d; CoR 3b). The authors considered the test material to be moderately sensitising. The study is, however, poorly reported and does not follow GLP guidelines. In particular, the results were not divided into control and treated animals. There were 3/10 animals responding with grade 1 reported in the first table and 5/10 responding with grade 1 reported in the second table. Not knowing which corresponds to the control and which to the treated animals makes it difficult to understand the author's conclusion of moderately sensitising. This study is deficient and does not allow a valid conclusion to be drawn on the sensitising potential of PAA.

8.2.5 Summary and evaluation

PAA should be considered as corrosive at concentrations of 10% and higher when applied to the skin of rabbits. PAA was also corrosive to rabbit skin at concentrations of 3-5% if contact lasted 1 hour or longer; contact for 3 minutes resulted in less severe responses. Concentrations of less than 1% PAA were only slightly irritant or not irritant, depending on the length of exposure of the skin.

PAA was corrosive at concentrations of 0.35% and greater when tested in the rabbit eye. Slight or no eye irritation was found at concentrations of 0.15% or less PAA. Evidence of respiratory irritation could be detected above 5 mg/m^3 in rats. The RD_{50} for respiratory irritation is 21-24 mg/m^3.

No skin sensitisation was observed in two Bühler tests in guinea pigs with different formulations of PAA. In one guinea pig maximisation test a positive result was claimed, but the report does not permit critical evaluation of the results.

8.3 Repeated Dose Toxicity

8.3.1 Oral

The available oral toxicity studies with PAA are summarised in Table 25. PAA was administered in the diet or drinking water of the animals.

Table 25: Toxicity following Repeated Oral Dosage

Route of administration, species, strain	Number of animals/ group, sex	Composition (%) PAA	H_2O_2	HOAc	Concentration	Dose (mg PAA/kgbw/d)	Duration (d)	Results LOAEL	NOAEL[a] (mg/kgbw/d)	Main effects	Remarks	Reference	CoR[b]
Diet					**(mg PAA/kg food)**								
Rat, Wistar	10 M	38	14[c]	27[c]	0, 429, 859, 1,718, 3,435 and 6,870	0, 60, 120, 240, 480, 960	5	NS	960	From 480 mg/kgbw, statistically non-significant reduction in food consumption and body-weight gain	Dose levels questionable because of gas formation in food, indicating instability of PAA in the diet	Krüger *et al*, 1977	3
Rat, Wistar	20 M	38	14[c]	27[c]	NS	0, 6, 21, 420	28	21	6	Decrease of serum alkaline phosphatase levels. Unclear if truly treatment related.	Dose levels questionable because of gas formation in food, indicating instability of PAA in the diet .No histopathology performe	Krüger *et al*, 1977	3
Pig, "Läufer"	NS	38	14[c]	27[c]	NS, presumably 1,400[d]	NS	5	NS	NS	No effects (behavioural, clinical signs)	Dose levels uncertain. No histopathology performed	Krüger *et al*, 1977	3
Drinking water					**(mg PAA/l water)**								
Rat, BD IX	10 M	40	14[c]	27[c]	0, 3.1, 6.2, 12.5, 25, 50, 100, 200	NS	7	NS	NS	Reduced water consumption, but no influence on body weight, growth, reproduction, histopathology of liver, lung, spleen, kidney and gastro-intestinal tract	Reportedly 200 mg/l was without effects, but due to instability at the test compound, concentrations were reduced by 50 - 60% after 1 day and 75% after 4 days	Juhr *et al*, 1978	2

Table 25 continued

Route of administration, species, strain	Number of animals/ group, sex	Composition (%) PAA	H_2O_2	HOAc	Concentration	Dose (mg PAA/kgbw/d)	Duration (d)	Results LOAEL	NOAEL[a] (mg/kgbw/d)	Main effects	Remarks	Reference	CoR[b]
Rat , BD IX	NS, M	40	14[c]	27[c]	200	NS	10 months	NS	NS	No influence on body weight, growth, reproduction, histopathology of liver, lung, spleen, kidney and gastro-intestinal tract.	Reportedly 200 mg/l was without effects, but due to instability of the test compound, concentrations were reduced by 50 - 60% after 1 day and 75% after 4 days	Juhr *et al*, 1977, 1978	3
Mouse, NMRI and C3Hf Gerbil Guinea pig, Pirbright white Golden hamster, Ha: AURA	NS, M, F	40	14[c]	27[c]	200	NS	10 months	NS	NS	No influence on body weight, growth, reproduction, histopathology of liver, lung, spleen, kidney and gastro-intestinal tract.	Reportedly 200 mg/l was without effects, but due to instability of the test compound, concentrations were reduced by 50 - 60% after 1 day and 75% after 4 days	Juhr *et al*, 1977, 1978	3
Rat, Wistar	12, M	36-40	NS	NS	0, 1, 10, 50	0.13 - 0.15, 1.3 - 1.5, 6.5 - 7.6[e]	28	0.13 - 0.15	NS	Elevated haemoglobin levels, increased spleen weights, increase in haemosiderin in spleen. At 0.13 - 0.15 mg/kgbw/d: cloudy swelling of liver, congestion of kidney medulla.		Veger *et al*, 1977	2

a No-observed adverse effect level
b Code of reliability (Appendix B)
c From other publications by the same authors
d Highest concentration in the diet was 10 x that used for disinfection of pigpens. Food changed daily
e Based on reported average body weight of 217 g and water consumption between 28 and 33 ml
F Female
M Male
NS Not Stated

Dietary studies

In none of the dietary studies of Krüger *et al* (1977) were details given concerning the stability of PAA in the diet, apart from the observation of an increased feed volume and oxygen formation indicating decomposition of the test substance. The authors performed some further testing in order to evaluate the degradation of PAA under specific conditions. When 1,400 mg PAA was added to 1 kg of feed, only 10% of the amount of PAA could be detected in the feed directly after mixing with PAA. The stability of PAA was dependent on the water content of the diet. The higher the water content in the food, the less rapid was PAA degradation. PAA stability was greater in water than in food. Based on this indication of decomposition, the doses that the rats or pigs received should be regarded as nominal only and the results should not be used for hazard assessment.

Drinking water

Rats received drinking water containing 3.1 to 200 mg PAA/l for one week. The concentration was determined daily by photometric analysis after reaction with potassium iodide. At higher dilutions yielding concentrations of 12.5 mg/l or lower, the PAA had almost disappeared within 2 days. Contamination by saliva to aqueous PAA solutions may have further reduced the PAA content. Animal water consumption was reduced by 12-19% at 200 mg/l and by 4% at 6.2 mg PAA/l. No effect on water consumption was found at 3.1 mg/l (Juhr *et al*, 1978).

The same authors briefly reported on the toxic effects of PAA administered in the drinking water of rats, mice, hamsters, gerbils and guinea pigs at a single concentration of 200 mg PAA/l for 10 months. The tests were designed to evaluate possible adverse effects of a concentration of PAA that would be used in disinfection of drinking water of farm animals. Water bottles were changed every week. The breeding capacity and health status of the animals were observed continuously. At regular intervals (not specified) interim kills were performed, the animals were autopsied and underwent pathological and histopathological examination. No changes were seen on growth, reproduction and histology of liver, kidney, spleen, lung and intestines. No further details were given (Juhr *et al*, 1977, 1978).

Drinking water containing 0.1% PAA administered to rats for 7 weeks did not results in any toxicological change (Benes *et al*, 1966; CoR 4b as cited in Kramer, 1982).

Rats received 1, 10 and 50 mg PAA/l in distilled water for 4 weeks (Veger *et al*, 1977). Three control groups were included in the study, one received distilled water only; the other two groups received distilled water with chlorine in concentrations of 1 and 10 mg/l respectively. Fresh test solutions were prepared daily and water consumption was recorded. Six animals per group were killed immediately after the end of the exposure period while the other half was kept for a recovery period of another 4 weeks. Clinical signs were recorded twice a week. Haematology and organ weight data (lungs, heart, liver, kidneys, adrenals, and stomach) were obtained from all animals after termination of the study. In the recovery group organ histopathology of the low- and mid-dose group animals was evaluated. Water consumption was significantly reduced in all dose groups compared to the water only control group. In the chlorinated water groups, water consumption was also lower than in the water only control group, but the difference

was not statistically significant. No differences in body weight and body-weight gain were observed between the groups. Haemoglobin levels were elevated in all dose groups compared to water only controls. An increase in haemoglobin levels was also reported in the high chlorine control group. In the lower-chlorinated water group a decrease in haemoglobin levels was observed. The number of leukocytes and differential blood counts were not different between the groups. In the PAA dose groups and the lower-chlorinated water rats, spleen weights were increased significantly compared to controls. All other organ weights (heart, liver, adrenals, stomach, and lungs) were not different from controls. Histopathology at week 8 did not reveal any significant differences from controls in the low dose group. In all dose groups treated with PAA an increase of haemosiderin in the red matter of the spleen was reported. In the 10 mg/l dose groups of both PAA and chlorine, changes in spleen (cloudy swelling of the white pulp), the liver (cloudy swelling) and congestion of the kidney medulla were observed in the majority of the treated animals. The increase in blood haemoglobin levels and haemosiderin in spleen of the animals treated with PAA (low doses only) were considered to be related to an increased absorption of iron due to acidic pH of the drinking water. (This conclusion is not supported by experience with other acids. As the iron uptake is receptor-regulated it seems doubtful that it could be substantially influenced by the pH. It is possible that the haematological changes could be related to the decreased drinking water consumption of the animals.) The LOAEL with regard to haematological changes was 1 mg PAA/l (0.13-0.15 mg/kgbw). Liver and kidney changes were observed in the 10 mg/l (1.3 to 1.5 mg/kgbw) and higher dose groups, thus a no-observed adverse effect level (NOAEL) for liver and kidney effects of 0.13 - 0.15 mg PAA/kgbw could be derived from this study. In the opinion of the Task Force the effects on liver and kidney could well be an artefact of the experimental procedures and hence should be viewed with caution.

8.3.2 Dermal

The available dermal toxicity studies on PAA are summarised in Table 26, including details of the study protocol and results.

Table 26: Toxicity following Repeated Open Dermal Application

Number of animals/ group, sex	Composition (%) PAA	H_2O_2	HOAc	Concentration (%)	(mg PAA/l)	Dose (mg PAA/kgbw)	Frequency, duration	Main Effects	Remarks	Reference	CoR[a]
Guinea pig											
20, M, F	40	14	27	0.3	1,200	0, 3.84[b]	2 x /d, 5 d/wk, 28 d	Skin: slight skin irritation reduced body-weight gain from day 20, slight evelvation of liver enzymes and LDH[c], slight decrease of liver weights, no histopathological findings.	Control and treated animals had pneumonia, more severe in treated	Kramer *et al*, 1982	2e
20, M, F	40	14	27	0.3	1,200	0, 3.84[b]	2 x /d, 5 d/wk, 90 d	Slight skin irritation and reduced body-weight gain from day 44, white blood cell count increased, slight elevation of liver enzymes and LDH, increased relative kidney and spleen weights, histopathological changes in liver and kidneys	Control and treated animals had pneumonia, more severe in treated	Kramer *et al*, 1982	2e
Rabbit											
28, F	40	14	27	0.5	2,000	1[d]	3 x /wk, 12 months	Skin: atrophy and vacuolar degeneration of hair follicles	Only skin was examined (1 animal after 1d, 1,2,3 wk, 2 animals every manth from month 1 to 12)	Müller *et al*, 1988	2e
Pig											
5, F	40 NS[f]	14	27	NS	15,000 15,000[f]	113.6[e]	1 x / 2 d, 120 d	Skin: inflammation, hair loss, and hyper-parakeratosis. No systemic effects		Busch and Werner, 1974	4e

a Code of reliability (Appendix B)
b Applied as 0.16 ml/100 gbw = 1.92 mg/kgbw, assuming a density of 1 mg/ml
c Lactate dehydrogenase
d 1 ml of the test solution was applied; the dose was calculated assuming an adult rabbit of 2 kgbw and density of the test solution 1 mg/ml
e Reported as 250 ml/33 kgbw, assuming a density of the test solution of 1 mg/ml
f Pure (distilled) PAA
F Female
M Male
NS Not Stated

In the 28-day study of Kramer *et al* (1982) with dermal application of diluted PAA in guinea pigs, water consumption and clinical signs were recorded daily. Body weight and heart action were checked twice weekly at the beginning of the experiment and weekly thereafter. At the end of the study haematological and clinical chemistry parameters were determined and organ weights recorded. The following organs were examined macroscopically and microscopically: liver, lungs, kidneys, adrenals, pancreas, heart, brain, spleen and skin. Fourteen animals showed slight skin irritation with reduced intensity from day 25 of dosing. A number of animals of the control group also showed transient slight erythema. No differences in water intake were observed between treated and control animals. A reduction in body-weight gain was observed in the treated animals compared to controls from day 20. Body weight gain returned to normal in the post-exposure observation period (40 days) within 10 days. Heart rate was elevated in both control and exposed animals, but to a slightly greater extent in the exposure group. Relative liver weights were slightly decreased. Liver enzyme levels and lactate dehydrogenase (LDH) levels were slightly elevated in the treated animals. No macroscopic changes were seen. No characteristic histopathological findings were observed. Pneumonia was observed in all animals including controls with an increased severity in the treated animals. According to the authors this could be due to an infection that was possibly aggravated by inhalation of PAA vapours originating from the treated skin. As the animals in this study were suffering from infection, observed effects could have been secondary to the infectious disease. It follows that no reliable conclusions on possible systemic effects of PAA after dermal application can be drawn from this study.

Kramer *et al* (1982) performed a 90-day study in guinea pigs using an otherwise identical protocol to that described above. The clinical findings were identical to those of the 28-day study, except that the reduction in body-weight gain began later, from day 44. Relative liver weights were not reduced, but an increase in kidney and spleen weights relative to body weight was observed in treated animals compared to controls. Haematological effects were confined to an increase in white blood cells of the treated animals. Liver enzyme levels and LDH levels were slightly elevated in the treated animals. In 7 of 9 animals some greyish yellow areas were reported on the liver surface. A number of animals showed focal liver cell necrosis (periportal) and fatty hepatocytes in the liver. Cell infiltration was seen in the Glisson triangle and swelling and slight sectional proliferation of the Kupffer cells. Pneumonia was observed in all animals including controls with an increased severity in the treated animals. According to the authors this could be due to an infection that was possibly aggravated by inhalation of PAA vapours originating from the treated skin. In the kidneys of the test animals, but not of controls, interstitial lymphocyte infiltration were observed in the glomeruli (Kramer *et al*, 1982). As all the animals in this study were infected, the observed effects could have been secondary to the infectious disease. Accordingly, no reliable conclusions on possible systemic effects of PAA after dermal application can be drawn from this study.

Busch and Werner (1974) applied a 1.5% PAA solution to the skin of pigs. The solution was applied to the whole back of the animals using a sponge. Clinical signs were recorded daily. Body weight determinations and haematological examinations were performed every 20 days. The animals showed signs of salivation, lachrymation and increased respiratory rate within 10 to 15 min after application, probably due to inhalation of PAA

that evaporated from the skin. Transient skin irritation was observed immediately after application of the test substance but was reversible within 10 to 15 min. After 20 days the skin showed signs of hyperkeratosis, parakeratosis, hair loss and signs of inflammation (cellular infiltration up to the corium). Gains in body weight were comparable to controls throughout the observation period. Haematological and clinical chemistry examinations did not reveal any treatment-related effect. The kidney function of the treated animals (phenol red test) was similar to that of controls.

8.3.3 Inhalation

The available studies on possible toxic effects of repeated exposure to PAA by inhalation are summarised in Table 27. The test compounds was administered as a vapour or aerosol. No analytical determination of the concentration of PAA in the test atmosphere was performed in any of the studies. The nominal concentration of the test atmosphere was calculated from the amount of PAA used for aerosol or vapour generation and the chamber volume. In some cases aerosol droplet sizes were measured.

Table 27: Repeated Dose Studies in Mice and Guinea Pigs by Inhalation

Number of animals/ group, sex	Composition (%) PAA	H_2O_2	HOAc	Concentration Solution (%)	Atmosphere (mg PAA/m^3)	Vapour or aerosol, particle size	Frequency, duration	Results (mg/m^3) LOAEC	NOAEC[a]	Main effects	Remarks	Reference	CoR[b]
Mouse[c]													
40, F	40[d]	14[d]	27[d]	0.39, 1.56, 6.25	0, 70, 281, 1,125	Aerosol, 0.5-8 µm	5, 10, 15 min/d for 29 d	1,125	281	Acute effects during and immediately after exposure: respiratory distress, eye irritation. Decreased body-weight gain, increased mortality (15 min exposure group), increased red/white blood cell count, haemoglobin, haematocrit, lung inflammation (pneumonia)	No analytical determination of atmospheric concentration of PAA	Heinze *et al*, 1981	2e
40, NS	40[d]	14[d]	27[d]	2.06, 7.8, 16.1	0, 280, 1,125, 2,250	Vapour, NS	5, 10, 15 min/d for 29 d	2,250	1,125	Laboured breathing, eye irritation, increased mortality, decreased body-weight gain. Increased red/white blood cell count, haemoglobin, haematocrit, inflammation of the lung	No analytical determination of atmospheric concentration of PAA	Heinze *et al*, 1982	2e
40, NS	40[d]	14[d]	27[d]	0.39, 1.56, 6.25	0, 70, 280, 1,125	Aerosol, 0.5-8 µm	5, 10, 15 min/d for 29 d	1,125	280	Laboured breathing, eye irritation, increased mortality, decreased body-weight gain. Increased red/white blood cell count, haemoglobin, haematocrit, inflammation of the lung	No analytical determination of atmospheric concentration of PAA	Heinze *et al*, 1982	2e

Table 27 continued

Number of animals/ group, sex	Compasition (%) PAA	H_2O_2	HOAc	Concentration Solution (%)	Atmosphere (mg PAA/m^3)	Vapour or aerosol, particle size	Frequency, duration	Results (mg/m^3) LOAEC	NOAEC[a]	Main effects	Remarks	Reference	CoR[b]
10, NS	36-40[d]	NS	NS	NS	0, 70, 140	Aerosol, 0.5 µm (MMAD[e] 1.6 µm)	3 x 1 h/wk for 28 d	70		Respiratory distress during exposure, small inflammatory foci in the lungs.	No data on analytical determination of PAA, limited reporting	Merka and Urban, 1976	3a
20 or 60, NS	40[d]	14[d]	27[d]	1, 1.5	0, 186, 280	Aerosol, NS	2 x 30 min/d for 90 d	186		Inflammatory changes in the lung, liver granuloma and lymphocyte infiltration.	No analytical determination of atmospheric concentration of PAA, liver granuloma could be related to infection	Heinze and Nattermann, 1984	2e
Guinea pig[c]													
20, NS	40[d]	14[d]	27[d]	1, 1.5	0, 186, 280	Aerosol, NS	2 x 30 min/d for 90 d	186		Decreased body-weight gain, increased ALAT[f] levels, inflammatory changes in the lung, granuloma, lymphocyte infiltration and increased amount of lipid droplets in the liver.	No analytical determination of atmospheric concentration of PAA, liver granuloma could be related to infection	Heinze and Nattermann, 1984	2e

a No observed adverse effect concentration
b Code of reliability (Appendix B)
c Strain not stated
d Inferred from other publications on the same product
e Mass median aerodynamic diameter
f Alanine aminotransferase
F Female
M Male
NS Not Stated

Heinze *et al* (1981) exposed mice to PAA aerosols by whole-body exposure; control groups received either no treatment or water aerosol for 10 min/d. Interim kills were performed on days 1, 2, 3, 4, 5, 8, 16, and 22. In all PAA-treated groups, excitement followed by lethargy was observed during exposure, an effect that was dose-related. After exposure, signs of respiratory distress were observed for several hours in the highest dose group. These effects were independent of the daily duration of exposure. Signs of eye irritation were also observed in some animals. Compared to both control groups, mortality and decreased body-weight gain was noted in the 1,125 mg/m^3 group exposed for 15 min/d. A significant decrease in body weight was also observed in the active (water aerosol) control group compared to the passive control (no treatment) group. Increased erythrocyte count, haematocrit, haemoglobin content and white blood cells were observed at the high dose group, but no exposure-duration relationship was evident. Changes in leukocyte and lymphocyte counts did not follow a consistent pattern and were not clearly attributable to treatment. Histopathological changes in the lungs (pneumonia) were noted mainly at the 1,125 mg PAA/m^3 dose and related to the duration of exposure. Other organs were not examined. The changes in blood parameters were attributed to the lung damage (compensatory changes). A NOAEL for inflammatory changes in the lung of 281 mg PAA/m^3 can be derived from this study.

In two other studies (Heinze *et al*, 1982) mice were exposed (with different frequency) to PAA vapours or aerosols by whole-body exposure; passive (no aerosol) and active (water aerosol) controls were also used. Deaths occurred in the high-dose groups at 2,250 mg PAA/m^3 as vapour and 1,125 mg PAA/m^3 as aerosol respectively. In all treated groups, there was excitement followed by lethargy during the inhalation period, while lethargy persisted after exposure in the high-dose groups (vapour and aerosol). Evidence of respiratory distress and marked inflammation of the eye were noted in many animals of the high-dose aerosol group. Decreased body-weight gain was noted in the high-dose vapour/aerosol groups for all treatment durations. The observed increases in erythrocyte count, haemoglobin content, haematocrit and white blood cell count were considered to be related to exposure at 1,125 mg PAA/m^3 aerosol and 2,250 mg/m^3 vapour, but in this latter group changes were less severe. In the high-dose aerosol exposure group the gastro-intestinal tract was found to be distended and had a foamy appearance. Inflammatory changes in the lungs were found to be significant at the high-dose vapour/aerosol groups; these changes increased with duration of exposure. No histopathological changes were observed in the liver and kidneys. The authors concluded that all effects observed were due to the irritant effect of PAA as similar findings were reported following exposure to lactic acid, HOAc aerosols or sulphur dioxide gas. The overall NOAEL based on irritant responses was 1,125 mg PAA/m^3 vapour or 280 mg PAA/m^3 aerosol, both for exposures of up to 15 min/d.

In the study of Merka and Urban (1976) in mice, signs of respiratory distress were observed in the animals during exposure; these effects disappeared after cessation of exposure. Gains in body weight of exposed animals were reduced compared to untreated controls. In mice killed after 14 days of exposure the only histopathological findings were mild morphological changes in the lung. No other organs (unspecified, but presumed to be heart, liver, spleen, kidneys as for an acute study reported in the same paper) were affected. Isolated small foci of inflammation in the lungs were seen after 4 weeks of exposure.

Heinze and Nattermann (1984) exposed mice to PAA aerosols and included additional groups of animals that were treated with different drugs in order to study their influence on PAA toxicity. Control groups received no treatment or water aerosol with and without drugs. Body-weight gain in all groups was similar to controls. Haematology and clinical serum chemistry parameters also did not differ significantly between the groups. Histopathological examination of the lungs revealed an increased incidence and severity of inflammatory changes (thickening of alveolar walls, epithelial cell proliferation, infiltration by eosinophils and neutrophils) in treated animals compared to controls. Epithelial cell tumours were observed in the lungs of 3 test animals of the low dose group only and one control mouse. Since these tumours were not observed in the higher dose group, they were not considered to be due to PAA treatment. In addition the number of control animals in which lungs were examined was less than the number of test animals examined. Examination of the livers of the test animals after 30 and 90 days of treatment revealed an increase in lymphocyte infiltration and granuloma compared to controls. The size of the granuloma increased after 90 days of treatment. Follow up studies of the livers of the animals indicated that bacterial infection could have been the reason for the observed changes. It is not clear from the report if the histopathology of organs other than lungs, liver and kidneys was examined.

In a similar study (Heinze and Nattermann, 1984) guinea pigs were exposed to PAA aerosols, as well as additional groups of animals treated with different drugs to study their influence on PAA toxicity. Control groups received no treatment or water aerosol with and without drugs. Body-weight gain in the treated groups was decreased compared with controls. Haematology studies revealed no significant treatment-related differences in white blood cell count, erythrocyte count, haemoglobin and serum proteins, except for a slight increase in γ-globulin in treated compared with control animals. Serum liver enzyme values of asparagine aminotransferase (ASAT) were not different from controls, but alanine aminotransferase (ALAT) levels were significantly higher in the treated animals compared to controls. Histopathological examination of the lungs revealed an increased incidence and severity of inflammatory changes (thickening of alveolar walls, epithelial cell proliferation, infiltration by eosinophils and neutrophils) in treated animals compared with controls. Examination of the livers of the test animals revealed a slight increase in lymphocyte infiltration and granuloma compared to controls from day 60 of treatment as well as an increase in lipid droplets. Changes in the liver and in γ-globulin were possibly related to bacterial infections in the animals. It is not clear from the report if the histopathology of organs other than lungs, liver and kidneys was examined.

One of 10 rats died after inhalation for 4 days of vapours from a 3% PAA solution (Polakova, 1968; CoR 4c as quoted in Krüger and Kruschinski, 1982). No deaths were observed after exposure of rats for 28 days to PAA vapours from a 1% solution. The only sign noted was transient restlessness at the beginning of the treatment (Benes *et al*, 1966; CoR 4b as cited in Krüger and Kruschinski, 1982).

Benes *et al* (1966; CoR 4b as cited in Heinze *et al*, 1982 and Krüger and Kruschinski, 1982) exposed rats to 0, 7.2 and 72 mg/m^3 PAA aerosol for 1 h/d, during 24 exposures in 28 days. Reduced body weight and clinical signs (restlessness, eye discharge and respiratory distress) were reported in the 72 mg/m^3 group. In the 7.2 mg/m^3 group signs of excitement, but not irritation or other clinical signs, were observed.

8.3.4 Other studies

Pigs (5) and calves (15) were exposed for 1 h/d to 0 and 50 mg PAA/m^3 aerosol for 14 days. The aerosol (droplet size 0.5 to 6 µm) consisted of 2 ml/m^3 of diluted (6.25%) equilibrium PAA 40% (14% H_2O_2 and 27% HOAc). Simultaneously, animals infected with *Chamydiae* were treated to study the effect of PAA aerosols on bacterial infections. In the context of this report, only the results for non-infected animals are of relevance. Clinical observations in pigs and calves consisted of increased lachrymation, salivation, nasal discharge and cough in the first 3 to 5 days. Additionally, pigs showed signs of laboured breathing and vomiting. The effects were less pronounced after further exposures. At the end of the 86-day test period, treated pigs had decreased body-weight gain compared to untreated controls. In calves no effect on body-weight gain was observed. An increased pulse and respiratory rate was observed in exposed calves. Haematological changes (decreased red blood cell counts and haemoglobin levels) were noted. These effects were transient and adaptation occurred during treatment. Acute lung inflammation was also reported to affect both control and treated calves (Heinze *et al*, 1979).

Groups of 5 mice were exposed (1 h/d) to 50 mg PAA/m^3 aerosol (droplet size 0.5 to 6 µm) for 14 days. Some animals were immunised, while others were infected with a virus. PAA exposure did not influence the immune reaction and generation of antibodies (Heinze *et al*, 1979).

8.3.5 Summary and evaluation

A number of publications on the toxicity of PAA after repeated oral, dermal or inhalation exposure in different animal species have been reviewed.

There are deficiencies in the reporting of the available repeat-dose toxicity studies, including uncertainties regarding the nature, concentration and the stability of the test substance, the limited amount of doses tested and limited reporting on histopathology. Furthermore in a number of studies the test animals suffered from infectious diseases and it remains unclear to what extent the reported effects can be attributed only to the administration of PAA. In spite of those limitations, a number of conclusions may be drawn from the studies.

The reduced food or water consumption observed in some of the oral studies may well be related to the unpalatability due to the odour and irritant properties of PAA. No treatment-related changes were observed in a drinking water study in rats, mice, golden hamsters, gerbils and guinea pigs receiving up to 200 mg PAA/l water for 10 months. However, the stability of PAA in drinking water varied and was not sufficient during these studies to inspire confidence in the lack of findings.

Only one study reported an increase in haemoglobin levels and haemosiderin deposition in the spleen of rats receiving PAA in drinking water for 28 days from 1 mg PAA/l corresponding to a dose of about 0.15 mg/kgbw. As these effects have not been reported in other studies even at higher dose levels and as the methodology was not sufficiently

described, these results may not be related to the test substance. In the same study, effects on kidney, liver and spleen were reported at doses from 10 mg PAA/l (1.5 mg/kgbw); these could well be an artefact of the experimental procedures and should thus be treated with circumspection.

Repeated dermal exposure of pigs to a 1.5% PAA solution for 120 days resulted in irritant effects to the skin including hair loss, hyper- and parakeratosis as well as signs of inflammation. No systemic effects were observed. In guinea pigs exposed to a 0.3% solution of PAA (corresponding to 3.84 mg/kgbw/d) twice daily for 90 days, transient slight skin erythema was observed. A reversible reduction of body-weight gain was also reported. A slight increase in numbers of white blood cells and of liver enzyme levels were reported in the treated group. An increase in relative kidney and spleen weights and changes in liver (focal liver cell necrosis) and kidneys (lymphocyte infiltration) were observed in the treated animals. As pneumonia was reported for both treated and control animals the effects observed could be a consequence of the infectious disease, rather than treatment with PAA.

Effects seen in repeated-dose inhalation studies are mostly attributable to the irritant properties of the test substance. The single exposure periods however, were relatively short (5 min to a maximum of 1 hour per exposure).

A NOAEL of 280 mg PAA/m^3 for aerosols or 1,125 mg/m^3 for PAA vapours was derived for mice exposed up to 15 min/d for 29 days.

Subchronic inhalation studies using PAA aerosols in different species (pigs, calves and mice exposed for 1 h/d) showed restlessness, irritation of the respiratory tract, lung damage and related transient blood parameter changes from 50 mg PAA/m^3. No effect or very slight irritation only was found at 7.2 mg PAA/m^3.

Inflammatory changes of the lung and the liver were reported in mice and guinea pigs exposed (2 x 30 min/d) to PAA aerosols of 186 or 280 mg/m^3 for 90 days. It remains unclear if these effects were treatment related or attributable to an infection in the animals. In all, the predominant effects arising from oral, dermal or inhalation exposure to PAA seem to be related to local irritation at the site of contact. However, systemic effects on liver, kidney and perhaps spleen cannot be ruled out from the limited studies available. Clear no-adverse effect levels cannot be derived from the available studies.

8.4 Genetic Toxicity

8.4.1 Gene mutation *in vitro*

The available studies on possible gene mutation activity of PAA *in vitro* are presented in Table 28.

Table 28: In Vitro Genetic Toxicity Assays

Test system	Test organism, strain	Composition (%) PAA	H_2O_2	HOAc	Dose (PAA)	Metabolic activation	Result[a]	Reference	CoR[b]
Spot-test	*Salmonella typhimurium* TA 1535, TA 1536, TA 1537,TA 1538	35-37	8-9	36-38	10 µg/plate	No	-ve[c]	Agnet *et al*, 1977	3a
	Wild strain LT-2	36	8.5	37	10 µg/plate	No	+ve[d]	Agnet *et al*, 1977	3a
	Wild strain LT-2	36	8.5	37	10 µg/plate	No	-ve[e]	Agnet *et al*, 1977	3a
	TA 1978	36[f]	8.5[f]	37[f]	6 µg/plate	No	+ve[d]	Dorange *et al*, 1974	3a
	TA 1978	36[f]	8.5[f]	37[f]	6 µg/plate	No	-ve[e]	Dorange *et al*, 1974	3a
Gene conversion/ mitotic recombination	*Saccharomyces cerevisiae* Strain D7	36[g]	8.5[g]	37[g]	0 - 40 µg/ml	No	-ve	Dorange *et al*, 1974	3a
Reversion-assay (Ames test)	*S. typhimurium* TA 1978	36	8.5	37	0 - 40 µg/ml	No	+ve[g]	Agnet *et al*, 1977	3a
	TA 98, TA 100	9	NS	NS	50 µg/plate	Yes	-ve[g]	Yamaguchi and Yamashita, 1980	4e
	TA 98, TA 100, TA 102, TA 1535, TA 1537, TA 1538	4.5	25.5	6.7	7 - 4,576 µg/plate	Yes / No	-ve[g]	Wallat, 1984a	1d
	TA 97, TA 98, TA 100, TA 1535	40	NS	NS	0.3 - 200 µg/plate	Yes / No	-ve[g]	Zeiger *et al*, 1988	2e
Unscheduled DNA[h] synthesis	Human lung fibroblasts, WI-38 CCL75	31[i] 42[i]	4.7 5.5	NS NS	0.2 - 32 mg/ml	No	-ve[g]	Coppinger *et al*, 1983	1d
DNA repair assay	Human lung fibroblasts, WI-38 CCL75				4 - 32 µg/ml	No	-ve[g]	Coppinger *et al*, 1983	1d
Chromosomal aberration	Human lymphocytes	5.17	20[i]	10[i]	0.25 - 5 mg/ml	Yes / No	-ve +ve[k]	Phillips, 1994b	1b

a -ve, negative; +ve, positive
b Code of reliability (Appendix B)
c His-reversion
d Resistance towards potassium chlorate (with LT-2 combined with resistance towards 2-desoxy-D-galactoside)
e Resistance towards ethionine
f Inferred from Agnet *et al*, 1977
g Test was conducted up to cytotoxic concentration
h Deoxyribonucleic acid
i Measured
j Inferred from Blowers, 1994a, 1995
k At highest, cytotoxic doses
NS Not Stated
ND Not Determined

In bacteria and yeast

Several studies on bacterial gene mutation tests in which PAA was assayed using the Ames method have been reported. In a number of tests possible toxic or detoxifying effects were investigated in the presence and absence of the so-called S9 metabolic activation system (supernatant of centrifuged 9,000 x g liver homogenate) containing the microsome and cytosol fractions usually derived from rats previously treated with microsomal enzyme inducing compounds such as phenobarbital or Aroclor.

A diluted equilibrium PAA solution was tested in the spot test using different strains of *Salmonella typhimurium* and different selection for mutants. No mutagenic effects were observed using the strains TA 1535, TA 1536, TA 1537, TA 1538. With strain TA 1978 and the wild strain LT-2, respectively, resistance towards ethionine was not found. When selecting the two strains for mutants resistant to potassium chlorate and 2-deoxy-D-galactose, the authors claimed to have observed an induction of mutants after treatment with PAA at 6-10 µg PAA/plate, compared to the untreated control (Dorange *et al*, 1974; Agnet *et al*, 1977). Judging from the limited data presented in the reports the effect is quite small (not quantified).

The same authors also tested PAA in the Ames test with *S. typhimurium* strain TA 1978 up to 40 µg PAA/ml without metabolic activation. An increase in mutation frequency above threefold appears to have been seen only in concentrations that reduced bacterial survival far below 50% (> 15 µg PAA/ml) (Agnet *et al*, 1977). Detailed information on the induced mutation frequencies of treated and untreated samples is not given.

Dorange *et al* (1974) also reported that treatment of the yeast *Saccharomyces cerevisiae* strain D7 with diluted equilibrium PAA, failed to stimulate mitotic recombination, gene conversion or homo-allelic reversion in yeast strain D7. No details of the results were reported.

When a solution of 9% PAA in HOAc (not further specified) was tested in *S. typhimurium* TA 98 and TA 100 in the presence of S9 mix, no mutagenic activity was found. Data on the results without S9 mix were not explicitly given (Yamaguchi and Yamashita, 1980). An evaluation of the concentration-activity relationship is not possible, as only one concentration, 50 µg/plate (probably of the formulation) was tested.

It is generally known that peroxides are highly toxic especially to repair-deficient *S. typhimurium* strains. *S. typhimurium* TA 102 that is not repair-deficient has been suggested as the strain of choice for this type of test substance (Berglin and Carlson, 1986). Therefore, strain TA 102 was included in another reversion-assay with PAA. In strain TA 102, PAA up to cytotoxic concentrations produced only a slight increase of reverted colonies (up to 30%) and the test substance was judged to be non-mutagenic. Total inhibition was achieved in concentrations exceeding 183 and 915 µg PAA/plate (depending on the strain and activation system). With regard to cytotoxicity no marked differences, i.e. reduced sensitivity, were observed in strain TA 102 (Wallat, 1984a). The concentrations that were reached in this assay were relatively high compared with the results presented by other authors.

Equilibrium PAA (40%) proved to be negative in the standard *S. typhimurium* reversion assay at concentrations of 0.3 to 200 µg PAA/plate. The highest concentration was chosen after toxicity testing prior to the actual test and represents the dose that elicited toxicity or a dose immediately below (half-log dose intervals). In addition to rat liver S9 mix, material from hamster tissues was also used as a metabolic system. With both protocols PAA was found to be devoid of mutagenic activity (Zeiger *et al*, 1988).

DNA repair in cultured mammalian cells

The possible induction of UDS by PAA (40% nominal) was investigated in human diploid foetal lung cells. Ethyl methane sulphonate, N-methyl-N'-nitro-N-nitrosoguanidine (MNNG), and 4-nitroquinoline-1-oxide were used in preliminary experiments to assure the appropriateness of the test system to show UDS and DNA repair. MNNG was used as positive control in both the UDS and DNA repair assay (Table 28). Cells incubated with PAA for 4 hours did not reveal a consistent dose-related increase of UDS using liquid scintillation counting (duplicate experiments). Slightly, but statistically significantly elevated rates of UDS were reported at 8 and 16 µg PAA/l in the first experiment and at 16 and 32 µg/l in the second experiment. The increase never exceeded 1.6 times the solvent control, which were reported to be within the variability of the test system. Therefore, the results did not meet the criteria for a positive response, i.e. 2-fold increase above controls. The authors explained the slight increase by a possible oxidation of hydroxyurea, which is used in this test system. No statistically significant increase of UDS compared to solvent (water) controls was detected in a second (triplicate) experimental series using autoradiography (a more sensitive technique that does not require hydroxyurea). In this assay 32 µg PAA/ml was clearly cytotoxic (50% survival). Conflicting results were obtained; the first experiment with PAA indicated a possible positive response. However, repeated testing with the same lot of PAA showed negative results (Coppinger *et al*, 1983).

Using the same test system and controls, a DNA repair assay (three independent experiments) was conducted. Cells incubated with PAA were assessed by equilibrium ultra-centrifugation of density-labelled DNA. The assay was negative at all dose levels. At the highest concentration normal DNA replication was considerably reduced (Coppinger *et al*, 1983).

In conclusion, PAA was negative in UDS and DNA repair assays in human lung fibroblasts when tested up to cytotoxic concentrations.

Chromosomal aberrations in cultured mammalian cells

Two independent experiments on the potential of PAA to induce structural chromosomal aberrations in human lymphocytes were conducted with equilibrium PAA (5.17%). Cells were treated at 0.25, 0.5, 1.0, 2.0 and 4.0 mg PAA/ml for 20 hours in the first experiment and with 0.25, 0.5, 0.75, 1.0 and 1.5 mg/ml in the second experiment. Treatment in the presence of S9 mix was carried out at 0.31, 0.63, 1.25, 2.5 and 5 mg/ml in both experiments and was limited to 3 hours. Cells were arrested in metaphase and harvested 20 and 44 hours after the start of treatment. Two hundred metaphases at each dose level were examined for structural chromosome aberrations. Cyclophosphamide (with activation) and Mitomycin C (without activation) served as positive controls (Table 28).

In the absence of S9 mix, 4 and 2 mg PAA/ml reduced the mitotic index of the cells to below 25% of the control in the test, chromosome analysis was conducted at the next three lowest concentrations and in the control. In the test with S9 mix, the highest concentration of PAA reduced the mitotic index to 69% and chromosome analysis was therefore conducted on the three highest concentrations and the controls. Without S9 mix there was a statistically significant and reproducible increase in the number of aberrant metaphases at 1.0 and 1.5 mg/ml. With metabolic activation, a concentration of 5 mg/ml was clastogenic. Effects observed were mainly deletions. Both in the 1.5 mg/ml (without S9) and 5 mg/ml (with S9) replicate, one single chromatid exchange was observed. Under the conditions employed, S9 mix reduced both cytotoxicity and mutagenicity. In summary, PAA revealed positive results only in the highest, moderately cytotoxic doses, which reduced the mitotic index to 44.5 - 63% without S9 mix and to 61 - 69% with S9 mix. The author concluded that PAA caused chromosomal damage in cultured human lymphocytes (Phillips, 1994b). It is speculated that the cytotoxicity and genotoxicity exerted by PAA is a result of the same mechanism at the cellular level, e.g. production of reactive oxygen species which are not detoxified at higher concentrations.

8.4.2 Gene mutation *in vivo*

The available *in vivo* studies on possible gene mutation of PAA are summarised in Table 29.

Table 29: In Vivo Genetic Toxicity Assays

Test	Route of application	Composition (%) PAA	H_2O_2	HOAc	Dose (mg PAA/kgbw)	Result[a]	Reference	CoR
Chromosomal aberration, mouse	Topical Intraperitoneal Intraperitoneal	40	5[b]	45[b]	0, 5[c] 0, 50[d] 0, 5[e]	+ve[b]	Paldy *et al*, 1984	3b
Micronucleus test, mouse	Oral, gavage	4.5	26.7	6.7	0, 400 -1,600	-ve	Wallat, 1984b	1b
Micronucleus test, mouse	Oral, gavage	5.17[f]	20	10	0, 8 - 150	-ve	Blowers, 1994a	1b
Unscheduled DNA synthesis, rat	Oral, gavage	5.17	20	0	0, 330, 1,000	-ve	Blowers, 1994b	1b

a -ve, negative; +ve, positive
b Assumed value
c 0.1 ml equilibrium PAA 40%
d 2 ml of 0.5% solution in distilled water
e 1 ml of 0.1% solution in distilled water
f Blowers (1995) confirmed that 15.17% was a typing error

Chromosomal aberration and micronucleus induction in mammals

In a bone marrow chromosome aberration test in mice (male and female, unspecified strain), PAA was found to cause chromosome mutations after topical or intraperitoneal (i.p.) application. The authors recommend further in-depth investigations (Paldy *et al*, 1984) (Table 29). Insufficient detail was reported in this study and the chromosome analysis conducted does not comply with the relevant OECD guideline 475. Only 200 mitoses/group were evaluated compared to the evaluation of at least 100 metaphases per animal required by the OECD guideline and the data are not specified separately for each animal. No information is given on cytotoxicity to the bone marrow. Given the small number of analysed metaphases per animal and dose group, the numbers of aberrations recorded do not show a convincing dose dependency in the i.p. treated groups. Only one dose was applied epicutaneously and only two by i.p. administration. The results obtained are surprisingly similar, independent of the treatment regime and dose.

In a micronucleus test conducted with equilibrium PAA (4.5%), the test solution was administered by gavage to groups of 7 male and 7 female CF21/W68 mice. The animals received two doses of 200, 400, and 800 mg PAA/kgbw/d at 0 and 24 hours. Six hours after the second administration the animals were killed. Cyclophosphamide served as a positive control. The femoral bone marrow was removed and examined for the incidence of micronuclei in polychromatic erythrocytes, the proportion of polychromatic erythrocytes in the erythrocyte population and the incidence of micronuclei in normochromatic erythrocytes. Dose-dependent clinical signs of toxicity were observed in all groups. No mortalities were recorded within the time frame of the investigation and no increased incidences of micronuclei were found. General bone marrow toxicity was detected as the inhibition of proliferation in the erythropoiesis since the ratio of normochromatic versus polychromatic erythrocytes was increased in the highest dose group (Wallat, 1984b). The samples were collected 6 hours after the last or 30 hours after the first administration, whereas current standard guidelines require the samples to be collected once within time interval of 18 to 24 hours.

In a mouse micronucleus test with equilibrium PAA (5.17%), groups of 15 male and 15 female CD-1 mice were given single oral doses by gavage. Positive control groups of males and females were given a single oral dose of 100 mg/kgbw cyclophosphamide to confirm that the system was capable of detecting the effects of a known genotoxin. Five males and 5 females from each group were killed at 24, 48 or 72 hours after treatment and bone-marrow smears prepared for each time point. There were no significant differences in the frequency of micronuclei in polychromatic or normochromatic erythrocytes between mice treated with PAA and the untreated controls. This was true for all doses of PAA tested, all three sampling times and both sexes of mice. PAA did not induce a dose-related decrease in the proportion of polychromatic erythrocytes, indicating a lack of toxicity to the bone marrow. No clinical signs were reported (Blowers, 1994a, 1995). It is not clear from this study whether PAA actually reached the target organ. In the light of this, the significance of the negative results obtained are questionable. In preliminary studies the highest dose tested (150 mg/kgbw) had been found to be the maximum tolerated dose in both sexes of mice. In the main study the highest dose of PAA had no effect on body-weight gain.

Primary DNA repair after in vivo treatment

An *in vivo / ex vivo* UDS assay (Table 29) was conducted in groups of 6 male F344 rats receiving doses of equilibrium PAA (5.17%) at 330 or 1,000 mg PAA/kgbw by gavage, the maximum dose causing no observable toxicity as determined in a preliminary toxicity study. A positive response with controls receiving 2-acetylaminofluorene and nitrosodimethylamine confirmed the validity of the assay. From each treatment group, 2 animals were killed after 2 hours and 4 animals were killed after 16 hours, and hepatocytes were isolated. No significant increases in UDS (measured as net grain increase) were observed in both treated groups at either time. It was concluded that the tested PAA formulation was not genotoxic under the conditions of the study (Blowers, 1994b). Information on the type of toxicity observed at higher doses, which could confirm bioavailability, is not given in the report.

8.4.3 Summary and evaluation

Limited information is available on effects of PAA on DNA and its potential to induce gene and chromosome mutations both *in vitro* and *in vivo*. Considering the paucity of reliable data, a final reliable evaluation of the mutagenic potential of PAA can hardly be achieved (DFG, 1999b). Several bacterial tests are available, but these are of limited value because PAA is a biocide and exerts its cytotoxic effects in these systems at low concentrations. Cytotoxicity in most cases was diminished by the addition of an exogenous metabolic system. In the strain TA 102, considered to be most sensitive with regard to mutagenicity, only a slight response was detected, that was not statistically significant.

The results of two DNA repair tests in human foetal lung cells did not indicate that PAA had a genotoxic potential. In the *in vitro* chromosome aberration test, positive findings were obtained only in concentrations that produced cytotoxicity. A common mechanism for cytotoxicity and genotoxicity could be at play, e.g. relating to insufficient detoxification of developing reactive oxygen species at high doses.

In one adequate *in vivo* study, PAA did not produce micronuclei. Another study failed to prove that PAA had actually reached the target organ. In this study the doses may have been too low to produce clinical signs of toxicity and cytotoxicity in the target organ.

In an *in vivo / ex vivo* UDS assay in rats, PAA did not show genotoxic potential. The highest dose was chosen to produce no toxicity and, as in the micronucleus tests, bioavailability of PAA at the target organ was not verified. However, after oral treatment it is more likely that a considerable amount of PAA reaches the liver after absorption in the gastro-intestinal tract via the portal vein.

8.5 Chronic Toxicity and Carcinogenicity

8.5.1 Chronic toxicity

No data are available.

8.5.2 Carcinogenicity

No data are available.

8.5.3 Tumour initiation-promotion

Bock *et al* (1975) reported diluted equilibrium PAA 40% (5% H_2O_2, 40% HOAc) to be a skin tumour promoter and a weak initiator in mice. The results of the experiments are summarised in Table 30.

Table 30: Initiation- Promotion Study with PAA (40%) on the Skin of Mice
(Bock et al, 1975)

Initiation with DMBA[a]	Concentration[b]	Solvent	Duration of treatment (wk)	Incidence	
				Skin tumour (non-invasive)	Skin cancer (invasive)
Yes	3%	Water	66	24/30	5/30
Yes	1%	Water	66	8/30	1/30
Yes	0.3%	Water	66	2/30	0/30
Yes	0%	None	66	0/30	0/30
Yes	2%[c]	Water	56	2/30	0/30
Yes	1%[c]	Acetone	56	2/30	0/30
No	2%	Water	52	3/30[d]	0/30[d]
No	2%	Acetone	52	NA[e]	NA[e]
No	1%	Acetone	52	0/30	0/30
No	0%	None	66	0/30	0/30

[a] 7,12-Dimethylbenz[*a*]anthracene, 1 x 125 µg in 0.25 ml acetone, 3 weeks prior to treatment
[b] Related to formulation or active substance (not stated)
[c] "Decomposed"
[d] After first 26 weeks of treatment
[e] Not applicable, because all animals died early in the experiment

The clipped dorsal skin of 3 groups of 30 female ICR Swiss mice was painted once with 7,12-dimethylbenz[*a*]anthracene (DMBA) in acetone. After 3 weeks, the mice were treated (5 x 0.2 ml/wk) with 0.3%, 1% or 3% PAA solutions for 66 weeks. The authors reported that a pilot study had indicated that 4% "aqueous PAA" would be excessively lethal. (It is not clearly stated in the paper if the given concentrations relate to the formulation or active substance. If the latter were so, the test solutions contained 1,200, 4,000 or 12,000 mg PAA/l). Two other groups of 30 mice pre-treated with DMBA were painted (5 x 0.2 ml/wk) with "decomposed PAA" solutions (2% in water and 1% in acetone) for 56 weeks. PAA was "decomposed" by passing the product through a screen made of a precious metal acting as catalyst. After this procedure, peroxy compounds could not be detected iodometrically in the solution (detection limit not specified). Three additional groups of 30 mice each were not treated with DMBA, but received (5 x 0.2 ml/wk) 2% PAA in water or 1-2% PAA in acetone for 52 weeks. The mice were examined weekly and the number and distribution of tumours were noted. A lesion was classified as a skin tumour if it was at least 1 mm in diameter and if it persisted on the skin for at least 3 successive weeks.

After initiation with DMBA, a solution of PAA in water exhibited a dose-dependent tumour-promoting activity at concentrations of 3% and 1%, respectively, but not at 0.3% (Table 30). After DMBA pre-treatment both the 2% "decomposed PAA" in water and the 1% "decomposed PAA" in acetone produced 2/30 tumours (7%) after 56 weeks. Without DMBA pre-treatment, application of 2% PAA in water produced tumours in 3/30 (10%) of the animals after 26 weeks. Subsequent treatment for another 26 weeks failed to increase the tumour rate. No tumours were recorded after treatment with PAA in acetone. With regard to toxicity of PAA in acetone, an extraordinarily steep dose-response curve was obtained. At 2% PAA all animals died early in the experiment, whereas 1% was reported to be well-tolerated, as were PAA solutions of up to 3% in water. Skin irritation resulting from the treatment with PAA was mentioned but not specified as to the extent and expected differences between the dose and control groups.

The observed tumours were further classified by the authors as "skin cancers" if they were capable of invading tissues below the *panniculus carnosus*. The tumours induced by PAA in water alone were classified as non-invasive, but not explicitly specified as benign. It should be noted that the applied tumour classification does not correspond to current standards of tumour classification (Greaves and Barsoum, 1990).

This initiation-promotion study suffers from deficiencies in experimental design and reporting of results. An irritation threshold was not determined and the concentration of PAA used was apparently irritant. As only one dose of PAA in water was used, no dose-response analysis can be made. Furthermore, the negative control mice do not appear to have been treated in the same manner as the other groups. In particular, in the negative controls, the two solvents (water and acetone) do not seem to have been applied and it is not clear whether the hair was clipped.

Tumour generation ceased in the second phase of the experiment with PAA in water only; after the first 26 weeks 3/30 (10%) tumours were found, but this number did not increase over the next 26 weeks of treatment. With regard to historical data on tumour

incidence in Swiss mice, Bock *et al* claim that only one skin tumour was found in thousands of negative controls painted with acetone for up to 1.5 years. After treatment with DMBA followed by acetone or water only, the authors reported a historical incidence of 5.4% tumours in this strain. According to Ingram and Grasso (1991) the general scientific consensus is that up to an incidence of 10%, there is no carcinogenic activity induced in mouse skin by irritant substances. The effect is thought to be due to an enhancement of spontaneous tumour incidence. In this context it is difficult to evaluate the relevance of the observed 10% incidence of skin tumours with vehicle alone in a single dose group.

8.5.4 Summary and evaluation

No chronic toxicity or carcinogenicity studies have been conducted with PAA.

In one study, PAA acted as a tumour promoter in mouse skin after DMBA initiation. It is likely that this is due to chronic irritation caused by PAA treatment. The data are insufficient to identify PAA as an initiator, i.e. a complete carcinogen.

The German MAK Commission[a] has classified PAA in category 3 for its carcinogenicity (i.e. substances which give rise to concern because of possible carcinogenic effects in humans, but which cannot be finally evaluated because of insufficient information), and states that a 40% PAA solution causes very severe inflammation and corrosion of the skin (DFG, 1999b). However, the "Ausschuß für Gefahrstoffe (AGS)", the official OEL setting committee in Germany, concluded that the available data on PAA do not allow for a final conclusion to be made with regard to its carcinogenicity, mutagenicity or toxicity to reproduction. Therefore, the AGS considered classification of PAA for those endpoints inappropriate; an OEL was not established (TRGS, 1997).

In conclusion, in the only available initiation-promotion study, which suffers from a number of experimental and reporting deficiencies, the observed effects represent an effect secondary to local irritation, rather than indicating a carcinogenic potential for PAA.

8.6 Reproductive Toxicity and Teratogenicity

8.6.1 Fertility

The breeding data from a specific-pathogen-free BD IX rat colony (77 animals, 67 controls) receiving PAA in their drinking water (200 PAA mg/l) over several generations (not specified) did not differ from those of the control group. Litter sizes and weights at weaning were similar to controls. No further details are given in the publication (Juhr *et al*, 1978) (CoR 4e).

Breeding pairs of NMRI and C3Hf mice, gerbils and Pirbright white guinea pigs were given drinking water containing 200 mg PAA/l *ad libitum* for 10 months. Drinking water

[a] Sentatskomission zur Prüfung gesundheitsschädlicher Arbeitsstoffe

was renewed every week. Breeding capacity was observed continuously. Growth and outcome of breeding was similar to known historical stock data. No further details are given (Juhr *et al*, 1978; CoR 4e).

Sperm head morphology

The sperm head morphology test is an *in vivo* test for evaluating the potential of a chemical to induce abnormalities to the heads of sperm. The test has the potential to identify chemicals that induce spermatogenic dysfunction and, possibly, heritable mutations. The relationship of positive results in this test to carcinogenic or mutagenic potential is not clear. No clear evidence is obtained from the test model whether alterations in sperm morphology are due to cytotoxicity or to a clastogenic effect. In addition, the validity of this test in assessing reproductive toxicity has not been established. The genetic consequences of fertilisation by sperm affected by chemical treatment during spermatogenesis remain unclear; embryonic death or transmission of genetic aberrations to live-born progeny are possibilities (Wyrobek *et al*, 1983). These authors found that all murine germ-cell mutagens tested also induce sperm-shape abnormalities in mice. Therefore, it is critical that the sperm head morphology test be stringently conducted so that the results can be properly interpreted.

A sperm head morphology test was conducted with PAA (40%, 14% H_2O_2, 27% HOAc), applied as a 0.1% solution of the formulation in distilled water. ICR mice (10 animals/group) were administered (0.2 ml i.p.) a dose of 2.6 mg PAA/kgbw/d for 5 days. Positive and negative controls were included in the study. Animals were killed 36 days after the first treatment, and spermatozoa were collected from the left and right epididymis of each animal. Spermatozoa (200/animal) were examined for abnormalities. The results showed that a dose of 2.6 mg PAA/kgbw doubled the incidence of sperm head abnormalities. When the dose was reduced to 1.3 mg/kgbw, no increase in anomalies was seen (Koch *et al*, 1989; CoR 3b). This study is deficient with regard to the proper conduct of the test in that a pure, colony bred mice strain was used, whereas hybrid strains are recommended (Wyrobek *et al*, 1983). Hybrid strains have a lower and more stable spontaneous incidence of abnormal sperm than pure inbred strains. The paper does not state that the epidydimes were minced, washed and filtered before sperm smears were prepared, steps necessary to ensure good quality sperm for evaluation. It is also not stated whether the smears were read "blind" to ensure lack of bias. The results of the test do not meet the criteria for a positive response of PAA because statistically significant results were not found at two consecutive dose levels. Thus, insufficient evidence was provided to conclude that PAA caused abnormal sperm heads. In addition, the i.p. route of exposure is not a route relevant to human exposure of PAA.

Subsequent to the i.p. study, the same group of investigators conducted a sperm head test following dermal exposure to PAA, a route more relevant to human exposure. Groups of ICR mice received twice daily dermal applications of 0.1 ml of 0.5% or 5.0% PAA (formulation above) dissolved in distilled water, for 28 days. Controls received water only. (The corresponding doses are estimated to be 0, 11.8 and 118 mg/kgbw/d). The backs of the mice were depilated prior to application. The mice were killed 36 days after the first application, the epididymides removed and smears of sperm prepared. The skin of animals exposed to 5.0% PAA had marked necrosis after 3 days. The results of

this test were positive, i.e. PAA caused abnormalities at both doses (Kramer *et al*, 1991; CoR 3b). The study has the same deficiencies as that of Koch *et al* (1989) in using inbred mice and in preparation and reading of sperm samples. In addition, a positive control was omitted.

The relevance of the findings in the two sperm head anomaly tests (Koch *et al*, 1989; Kramer *et al*, 1991) to the potential mutagenicity and clastogenicity of PAA is not clear. The two tests did not meet the scientific criteria for valid assays (Wyrobek *et al*, 1983).

8.6.2 Developmental toxicity

In a teratogenicity study with ICR mice, the animals (5-10/group) were exposed (2 x/d) by inhalation to nominal concentrations of 20 and 100 mg PAA/m^3 throughout gestation. The atmospheres were generated from a 1% or 5% dilution of PAA (40%, H_2O_2 14%, HOAc 27%). The authors reported a statistically significant retardation of foetal growth (body length and weight) at 100 mg PAA/m^3, but no retardation at 20 mg/m^3. No exposure related skeletal anomalies were observed. The health status of the dams was not reported (Kramer *et al* 1990; CoR 3a,b). Exposure to a level of 100 mg PAA/m^3 would have been expected also to produce maternal toxicity. Because of uncertainty about the exposure levels and limited reporting, a reliable conclusion cannot be drawn from this study.

8.6.3 Evaluation

No reliable conclusion can be drawn from the data regarding reproductive and developmental toxicity of PAA because the available studies are inadequate, poorly conducted or not relevant to these endpoints.

8.7 Other Studies

Laub *et al* (1990) studied the effects of PAA-containing disinfectants on Langerhans cells of the epidermis of guinea pigs. Equilibrium PAA (formulation presumably 40% PAA, 14% H_2O_2 and 27% HOAc) and a mixture of 10% PAA and 75% glyceroltriacetate were diluted with water yielding test solutions of 0.2% (2,000 mg PAA/l) of the formulation and 0.1% (1,000 mg PAA/l) of the mixture. The pH (5.6) was adjusted with acetate buffer. The test solutions were applied (1 x 50 µl/d) to the right ears of groups of 3 white guinea pigs (inbred strain) for 1, 7 or 14 days. The animals were killed and the epidermis of both ears (the left one was untreated and served as control) was isolated, fixed and cut into ultra-fine slices and mounted on slides. Langerhans cells were counted after staining with adenosine-triphosphatase (ATPase) stain. A time-dependent decrease in Langerhans cells was observed in the treated ears compared to the control ears for both preparations. When acetate buffered solutions were used the reduction of Langerhans cells was less pronounced. The authors speculated that the reduction of Langerhans cells in the epidermis after topical application of PAA solutions could alter the immunological defence capacity of the treated skin.

The effect on oral mucosa of long-term exposure to PAA was studied in a group of 8 rabbits exposed (1 - 8 h/d, 4 d/wk) via an "oral tank" to a 0.2% PAA solution (2,000 mg PAA/l) prepared from 40% PAA (formulation above) for 11 months. The oral tanks, made of Piacryl, were modelled to fit the oral cavity of the individual animals and slowly released the test substance into the animal's mouth (see Müller *et al*, 1978 for details). One control group of 16 animals received water via the oral tank, while another group of 10 rabbits remained untreated. The animals were regularly monitored for alterations of the oral mucosa over the whole test period. Histopathological evaluation of the oral mucosa was performed at the end of the study. Results indicated only epithelial thickening (free from dysplasia and reversible at the end of the exposure period) and inflammation of the oral mucosa. This effect was more pronounced in the PAA treated group compared with the water treated group (Müller *et al*, 1980). The test conditions are highly artificial and could have resulted in mechanical irritation of the mucous membranes of the mouth and in forced drinking.

One ml of a 0.2% PAA solution (2,000 mg PAA/l), freshly prepared from 40% PAA (formulation above) was applied (3 x/wk) to the oral or vaginal mucosa of groups of 1 or 2 rabbits for up to 12 months. Histology of the oral mucosa revealed isolated nuclear oedema in the mucosal epithelium and increased epithelial desquamation of the superficial layers of the epithelium beginning with the eighth month. No increase in mitotic rate or dysplasia was observed in animals treated for up to 12 months. In the vaginal mucosa slight focal oedema with circumscribed nuclear oedema and slight sub-epithelial fibrosis was observed after 12 months. The mucosal epithelium was unaffected (Müller *et al*, 1988).

8.7.1 Neurotoxicity

Possible neurotoxic effects of PAA vapours (nominal concentration 10 mg PAA/m^3) were studied in two behavioural tests (open field and maze trials) with mice and rats. In the first test, male and female ICR mice (10 animals/group) were exposed (10 min/d, whole-body) for 28 days to vapours evolving from 1 ml of equilibrium PAA 36-40% (containing 14% H_2O_2 and 27% HOAc) in a 23 litres desiccator. Water served as the control substance. The open field test was conducted for 10 minutes at the same time of day prior to the first exposure and after 18 and 28 days of exposure. The test was conducted immediately after exposure to the test substance. At day 18, an increase in activity was observed in the treated mice compared to controls with regard to field changeover, erect posture and jumping. No increase in tail drumming or grooming was observed. After 28 days of exposure, activity was significantly depressed compared with controls in respect of field changeover, erect posture and jumping, but there was increased grooming, probably to remove PAA from the fur. Body-weight gain was initially retarded, but subsequently recovered fully (Kramer *et al*, 1993; CoR 3b). It is likely that the observed effects were secondary to irritation.

In the second test, following a 5-day training phase in a maze, Wistar rats (number and sex not stated) were exposed using the same test conditions as for mice above. Four separate test series were conducted. The maze trial was conducted on days 7, 14, 21, and

28 with exposure taking place after passage through the maze on these days. For the control animals the arrival time was shortened and the number of errors reduced proportional to the length of the experiment. This was considered an expression of the learning capacity of the animals. In the animals exposed to PAA, arrival times were extended and did not get shorter with time. The number of errors did not decrease significantly in the tests. (No individual data were given in the paper.) The authors concluded that the effects observed in the animals were indicative of a possible neurotoxic effect of PAA (Kramer *et al*, 1993; CoR 3b). However, as the exposures were scheduled after the behavioural test it is possible that the delay of the animals was due to a learning effect associated with avoidance of the discomfort of exposure to an irritant vapour.

Evaluation

The protocols do not meet the standards for neurotoxicity evaluation by various regulatory authorities and hence the two experiments are not sufficiently standardised to enable firm conclusions to be drawn. The behavioural effects reported in the publication are likely to be secondary to the irritant properties of PAA. Clarification of the findings could only be obtained from studies which included appropriate control exposures with another known irritant using standard methods.

9. EFFECTS ON HUMANS

9.1 Acute and Subchronic Toxicity

No data are available.

9.2 Irritation

9.2.1 Skin irritation

The available data on skin irritation in humans related to PAA are presented below (Table 31).

Table 31: Skin Tolerance Testing in Humans with PAA Solutions

Concentration (% PAA)	Composition PAA	H_2O_2	HOAc	Dilution (%)	Effects	Reference
0.5	40	14	27	1.25	Dermatosis when used with soap and water for 7 days	Kramer *et al*, 1987a
0.5	40	14	27	1.25	Irritation	Mücke, 1970
< 0.5	40	14	27	1.25	No effects	Kretzschmar *et al*, 1972
0.4	NS	NS	NS	NS	No effects	Schröder, 1982
0.35					Irritation[a]	French, 1993
0.2	40	14	27	0.5	No effects	Mücke, 1970
0.2					No effects	Pazdiora and Kubiček, 1967
0.2	40	14	27	0.5	Rough skin and slippery feel for 1-2 days	Kretzschmar *et al*, 1972
0.1	1	7	10	10	No effects[a]	Baldry, 1992

[a] In eczema-prone patients

Kramer *et al* (1987a) reported immediate erythema formation in 3 of 15 surgeons using 0.5% PAA solution for hand disinfection repeatedly over a day. The procedure involved soaping, brushing, washing for 3 minutes followed by hand disinfection for 5 minutes and approximately 5 further hand disinfections of 5 minutes during the working day between different operations. In 6 of 15 surgeons, hand dermatosis developed after 7 days of using PAA disinfecting solutions.

Subjects using a wash solution of 0.5% PAA to disinfect hands reported irritation to the skin, whereas those using a more dilute solution (0.2% PAA) did not. Long-term use of 0.2% PAA solution for disinfection of hands did not result in any adverse effects on skin (Mücke, 1970).

Tolerance to 0.4% PAA was found in humans. This article provides no further information (Schröder, 1982).

Surgeons using 0.2% PAA for 3 minutes, followed by washing with soap, did not experience intolerance. A burning sensation was experienced only when small wounds were present. Concentrations of up to 0.5% PAA did not damage the skin of the hand (Pazdiora and Kubiček, 1967).

Skin desquamation was noted for 1 to 2 days after hand disinfection with 0.2% PAA. Rough skin was reported the day after treatment in 2 of 10 subjects. The roughness disappeared during continued treatment. Subjects also reported a slightly slippery feeling for 1 to 2 days when hands were washed with 0.2% PAA (Kretzschmar *et al*, 1972).

At concentrations of 0.35% PAA, 7 out of 56 eczema-prone patients showed irritation responses (French, 1993). Use of lower concentrations (0.1% PAA and less) under occlusive wrap was not associated with significant irritation in 122 eczema-prone patients in a clinical skin irritation study (Baldry, 1992). Higher concentration levels were not tested. A double-blind primary skin irritation study was conducted with various concentrations of PAA in petrolatum on 10 subjects. The test material was prepared in petrolatum and 0.2 ml applied under a band aid for 24 hours. The goal of the study was to determine the concentration of PAA that could be tolerated for 4 days (continuous exposure) without causing substantial skin damage. The criteria for a positive finding was a grade of less than 2 on a scale of 0 to 5 (highest) in 5 of 10 subjects. A grade 2 response corresponded to "intense redness/erythema". A concentration of 2% PAA in petrolatum was found to be the maximum concentration tested which met these criteria (Robinson, 1984).

9.2.2 Eye irritation

A solution of 0.1% PAA was applied with compresses to the eyelids for 5 to 10 minutes in 4 subjects. A slight burning sensation was felt which disappeared during the application (Kretzschmar, 1972). Ocular irritation was not reported, probably because PAA was applied to the eyelid.

9.2.3 Respiratory irritation

Respiratory effects or symptoms reported at different atmospheric concentrations of PAA are given in Table 32.

Table 32: Atmospheric PAA Concentrations and Reported Effects or Symptoms

Concentration (mg/m^3)	Effects or symptoms	Reference
7.0 H_2O_2[a]	Lachrymation, extreme discomfort and irritation of nasal membranes	Fraser and Thorbinson, 1986
2.8 - 4.2 H_2O_2[b]	Extreme discomfort	
1.4 - 2.8 H_2O_2[c]	Tolerable discomfort	
0.7 H_2O_2[d]	No discomfort	
0.9 - 1.2[e]	Not immediately irritant, but unpleasant for an extended period.	McDonagh, 1997
0.4 - 0.5[f]	Tolerable and not unpleasant	
< 0.7 PAA	No appreciable odour was detected	Harvey, 1992
< 0.3 PAA[g]	No symptoms of runny eyes or nose	Simms, 1995
< 0.15 PAA	Odour threshold lower than, but probably not much lower than, 0.15 mg/m^3	Ancker and Zetterberg, 1997

[a] Reported as 5 ppm H_2O_2 (Section 5.2.2)
[b] Reported as 2.0 - 3.0 ppm H_2O_2
[c] Reported as 1.0 - 2.0 ppm H_2O_2
[d] Reported as 0.5 ppm H_2O_2
[e] Reported as 0.3 - 0.4 ppm
[f] Reported as 0.13 - 0.17 ppm
[g] Reported as < 0.15 mg/m^3 H_2O_2

Fraser and Thorbinson (1986) reported lachrymation and extreme discomfort following exposure to 7.0 mg/m^3 total active oxygen compounds in an aerosol consisting of PAA and H_2O_2 (Section 5.2.2) for only 3 minutes. Extreme discomfort, but no lachrymation was reported for exposures of 3.5 - 4.2 mg/m^3 for about 5 minutes and for 2.8 mg/m^3 for up to 10 minutes. Exposure to 2.8 mg/m^3 for 4 minutes caused unbearable irritation, but was tolerated for 2 minutes of a 5-minute exposure.

McDonagh (1997) reported that exposure to PAA vapour at 0.9 - 1.2 mg/m^3 (0.28 - 0.38 ppm) was not immediately irritant, but would have been considered "unpleasant" for an extended time period. A vapour concentration of 0.4 - 0.5 mg PAA/m^3 (0.13 - 0.16 ppm) was tolerable and not unpleasant for up to 3 hours.

Exposure to PAA aerosols at a concentration of 1.5 ppm (4.74 mg/m^3) for 15 to 20 minutes caused discomfort to mucous membranes. Lower respiratory effects were not reported even after exposure to 5 ppm PAA, although upper respiratory effects were reported (Fraser and Thorbinson, 1986).

Schaffernicht and Müller (1998) conducted an investigation of 45 workplaces (150 workers) at a university hospital (Section 5.2.2). For an 8-hour time period the concentrations ranged from less than 0.005 mg PAA/m^3 (detection limit) up to 1.84 mg/m^3. Of the measured values recorded, 60% were less than 0.1 mg/m^3 and 5% exceeded 1.0 mg/m^3. The employees reported irritation around the eyes and of the nasal and pharyngeal mucous membranes, as well as reddening and itching of the skin on the hands and face.

In the same study, Müller and Schaffernicht (1998) investigated whether the concentrations observed in the 45 workplaces in the university hospital were likely to result in damage of the teeth and gingivae. The dental status of the persons exposed to a workplace concentration of > 0.4 mg PAA/m^3 was examined. The study included a test group and a control group of 26 females of the same age group with approximately the same oral hygiene status. The findings were based on three criteria: oral hygiene, condition of the gingivae, and the condition of the dental enamel. The only significant difference between the test and control groups was in the sulcus bleeding index according to Mühlemann and Son, indicating gingivitis in the front teeth area. Otherwise, no significant differences were found between the test and the control groups. The authors concluded that a damaging effect of PAA fumes on the gingivae probably could arise from low levels of exposure.

A concentration of 4.6 mg PAA/m^3 was used in intensive care rooms for short-term disinfection purposes. No symptoms were reported by clinical staff or patients other than a slight acidic odour (Dworschak and Linde, 1976).

Tichácek (1966 as cited in Kretzschmar, 1972) described irritant effects in humans exposed to aerosol application of 0.8% PAA solution in a closed room. Effects included lachrymation, increased nasal secretions, mucous membrane irritation and temporary loss of smell. No further details were provided.

9.3 Sensitisation

There are no cases of skin sensitisation reported by the German network of dermatological clinics (Informationsverbund Dermatologischer Kliniken) (IVDK, 1999).

9.4 Evaluation

When used as a hand wash solution, concentrations of 0.5% PAA caused skin irritation in humans, but not if the concentration of the wash solution was 0.2% PAA or lower. A solution of 0.1% PAA applied to the eyelids caused only a slight burning sensation.

Data from topical skin applications or ocular exposure in humans are in agreement with the information from animal studies (Section 8.2). Although the concentrations tested were not identical, both humans and rabbits showed similar sensitivity in that < 0.2% PAA was not irritant to skin and < 0.1% was not irritant to the eyes.

Exposure to atmospheric concentrations of 0.5 mg PAA/m^3 (0.16 ppm) or lower seem to be well tolerated by humans. Concentrations up to 1.2 mg/m^3 (0.38 ppm) were not immediately irritant but unpleasant after exposure for an extended time period.

10. FIRST AID AND SAFE HANDLING ADVICE

10.1 First Aid

Liquid and mist are corrosive and can cause burns, direct contact could cause irreversible damage to the eyes including blindness and/or irreversible destruction of skin tissue. Vapour / mist will irritate the nose, throat and lungs, but will usually subside when exposure ceases. The severity of the effects depends on the concentration and dose.

10.1.1 Skin and eye injuries

Eye contact: Immediately flush with water for at least 15 minutes, lifting the upper and lower eyelids intermittently. Continue flushing until further treatment. See medical doctor or ophthalmologist immediately.

Skin contact: Immediately flush with plenty of water while removing contaminated clothing and /or shoes. Thoroughly wash with water. See medical doctor if there is persistant irritation or if there are burns.

10.1.2 Inhalation

- The patient should be taken into fresh air and should rest in a seated posture.
- If breathing discomfort occurs and persists after cessation of exposure, see a medical doctor.
- If breathing has stopped, artificial respiration should be administered until qualified medical personnel are able to take over.

10.1.3 Ingestion

- Do not induce vomiting.
- If the subject is conscious, flush mouth with water, give 1 to 2 glasses of water to drink.
- Never give anything by mouth to an unconscious person but provide classical resuscitation measures.
- See a medical doctor immediately or take subject to a hospital.

10.2 Safe Handling

10.2.1 Handling and safety at work

- Operate in well ventilated area, do not breathe vapours
- Provide mechanical local exhaust ventilation
- No eating, drinking, smoking in work area
- Use adequate personal protective equipment (PPE) (below)
- Never return unused material to original container

- Avoid contamination of product
- Avoid contact with skin, eyes and clothing
- Wash face and hands after handling product
- Provide emergency showers and eye wash stations

Personal protective equipment

- Respiratory protection :
  - In case of emissions of vapours and aerosols, use suitable respiratory protection.
  - In case of large uncontrolled emissions, positive pressure self-contained breathing apparatus should be used.
- Hands - Wear suitable gloves made from materials with acceptable penetration times, e.g. butylrubber, polychloroprene, fluororubber
- Eyes - Use chemical proof goggles, full face shield or full face mask
- Body - Wear acid proof protective clothing., e.g. apron and boots made of butylrubber if risk of splashing.

10.2.2 Storage

- Store in vented containers in a clean, cool, dry, well-ventilated area
- Store away from reducing agents, fuels, non-compatible materials e.g., alkalis, reducing agents, metallic salts, combustibles and other oxidising agents.
- Keep away from direct sun light, heat sources and sources of ignition
- Keep in original package, keep closed, Use first in first out

10.3 Management of Spillage and Waste

10.3.1 Spills and waste

- Evacuate and isolate the hazard area, approach release from upwind
- Use adequate PPE (Section 10.2.1)
- Stop leak / contain spill (if this can be done safely)
- Dilute spilled material with large quantities of water or mix with an inert material such as sand or earth
- Do not seal waste material, do not use textiles, tissues, saw dust or combustible materials to clean spill
- Remove endangered containers to safe place, if this can be done safely
- Never return spilled material to original container
- Keep non-compatible materials away from spill
- Dispose of spilled material in accordance with all country, state and local regulations
- Immediately notify appropriate authorities

10.3.2 Fire-fighting measures

During a fire, PAA could begin to decompose releasing oxygen gas, which can support combustion of flammable materials. If decomposition occurs, a pressure burst may occur if the container is not properly vented. To fight the fire:

- Approach from upwind
- Use proper personal protective equipment such as an acid resistant over suit and a positive pressure self contained breathing apparatus
- Bring persons to safety, evacuate all non-essential personnel
- Use large quantities of water spray to fight the fire and to keep fire-exposed containers cool

Refer to the local authorities for disposal of PAA. For further and more detailed safety instructions, contact your PAA supplier.

For bulk storage spillage, an emergency plan should be worked out in conjunction with the supplier and the competent authority, if applicable.

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APPENDIX A. SPECIAL ABBREVIATIONS

ABTS	2,2´-Azino-*bis*-(3-ethyl-benzo-thiazoline)-6-sulphonate
ADS	2-((-3(2-(4-amino-2-(methhylsulphanyl)phenyl)-1-diazenyl)phenyl) sulphonyl)-1-ethanol
ALAT	Alanine aminotransferase
ASAT	Asparagine aminotransferase
DMBA	7,12-Dimethylbenz[*a*]anthracene
DNA	Dexoyribonucleic acid
DOC	Dissolved organic carbon
DOT	Department of Transport
DPD	N,N'-diethyl-*p*-phenylendiamine
EC_{50}	Median concentration expected to have an effect in 50% of the test organisms
EINECS	European inventory of existing commercial chemical substances
FTIR	Fourier transform infrared (spectroscopy)
GLP	(Principles of) good laboratory practice
GSH	Glutathione
H_2O_2	Hydrogen peroxide
HOAc	Acetic acid
HPLC	High performance liquid chromatography
i.p.	Intraperitoneal
IBC	Intermediate bulk container
IUPAC	International Union of Pure and Applied Chemistry
LC_{50}	Median concentration expected to cause the death of 50% of the test organisms
LD_{50}	Median dose expected to cause the death of 50% of the test animals
LDH	Lactate dehydrogenase
MTS	Methyl *p*-tolyl sulphide
MTSO	Methyl *p*-tolyl sulphoxide
NOAEL	No-observed adverse effect level
NOEC	No-observed effect concentration
OEL	Occupational exposure limit value
PAA	Peracetic acid
ppbv	Parts per billion by volume
PPE	Personal protective equipment
RD_{50}	Concentration inducing a 50% reduction of respiratory rate
RQflex	Reflectometer quality flexible (test strips)
SADT	Self-accelerating decomposition temperature
TAED	*Tetra*-acetyl ethylenediamine
TCF	Total chlorine free
TWA	Time-weighted average
UDS	Unscheduled DNA synthesis
U	Activity unit (of enzymes)

APPENDIX B. CRITERIA FOR RELIABILITY CATEGORIES

Adapted from Klimisch et al (1997)

Code of reliability (CoR)	Category of reliability
1	**Reliable without restriction**
1a	GLP guideline study (OECD, EC, EPA, FDA, etc.)
1b	Comparable to guideline study
1c	Test procedure in accordance with national standard methods (AFNOR, DIN, etc...)
1d	Test procedure in accordance with generally accepted scientific standards and described in sufficient detail
2	**Reliable with restrictions**
2a	Guideline study without detailed documentation
2b	Guideline study with acceptable restrictions
2c	Comparable to guideline study with acceptable restrictions
2d	Test procedure in accordance with national standard methods with acceptable restrictions
2e	Study well documented, meets generally accepted scientific principles, acceptable for assessment
2f	Accepted calculation method
2g	Data from handbook or collection of data
3	**Not reliable**
3a	Documentation insufficient for assessment
3b	Significant methodological deficiencies
3c	Unsuitable test system
4	**Not assignable**
4a	Abstract
4b	Secondary literature
4c	Original reference not yet available
4d	Original reference not translated (e.g. Russian)
4e	Documentation insufficient for assessment

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No. 4	Hepatocarcinogenesis in Laboratory Rodents: Relevance for Man
No. 5	Identification and Assessment of the Effects of Chemicals on Reproduction and Development (Reproductive Toxicology)
No. 6	Acute Toxicity Tests, LD50 (LC50) Determinations and Alternatives
No. 7	Recommendations for the Harmonisation of International Guidelines for Toxicity Studies
No. 8	Structure-Activity Relationships in Toxicology and Ecotoxicology: An Assessment (Summary)
No. 9	Assessment of Mutagenicity of Industrial and Plant Protection Chemicals
No. 10	Identification of Immunotoxic Effects of Chemicals and Assessment of their Relevance to Man
No. 11	Eye Irritation Testing
No. 12	Alternative Approaches for the Assessment of Reproductive Toxicity (with emphasis on embryotoxicity/teratogenicity)
No. 13	DNA and Protein Adducts: Evaluation of their Use in Exposure Monitoring and Risk Assessment
No. 14	Skin Sensitisation Testing
No. 15	Skin Irritation
No. 16	Early Indicators of Non-Genotoxic Carcinogenesis
No. 17	Hepatic Peroxisome Proliferation
No. 18	Evaluation of the Neurotoxic Potential of Chemicals
No. 19	Respiratory Allergy
No. 20	Percutaneous Absorption
No. 21	Immunotoxicity: Hazard Identification and Risk Characterisation
No. 22	Evaluation of Chemicals for Oculotoxicity
No. 23	Receptor Mediated Mechanisms in Chemical Carcinogenesis
No. 24	Risk Assessment for Carcinogens
No. 25	Practical Concepts for Dose Selection in Chronic Toxicity and Carcinogenicity Studies in Rodents
No. 26	Aquatic Toxicity Testing of Sparingly Soluble Volatile and Unstable Substances
No. 27	Aneuploidy
No. 28	Threshold-Mediated Mutagens - Mutation Research Special Issue
No. 29	Skin Sensitisation Testing for the Purpose of Hazard Identification and Risk Assessment

Technical Reports

No.	Title
No. 1	Assessment of Data on the Effects of Formaldehyde on Humans
No. 2	The Mutagenic and Carcinogenic Potential of Formaldehyde
No. 3	Assessment of Test Methods for Photodegradation of Chemicals in the Environment
No. 4	The Toxicology of Ethylene Glycol Monoalkyl Ethers and its Relevance to Man
No. 5	Toxicity of Ethylene Oxide and its Relevance to Man
No. 6	Formaldehyde Toxicology: An Up-Dating of ECETOC Technical Reports 1 and 2
No. 7	Experimental Assessment of the Phototransformation of Chemicals in the Atmosphere
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No. 9	Assessment of Reverse-Phase Chromatographic Methods for Determining Partition Coefficients
No. 10	Considerations Regarding the Extrapolation of Biological Data in Deriving Occupational Exposure Limits

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No. 12 The Phototransformation of Chemicals in Water: Results of a Ring-Test
No. 13 The EEC 6th Amendment: A Guide to Risk Evaluation for Effects on the Environment
No. 14 The EEC 6th Amendment: A Guide to Risk Evaluation for Effects on Human Health
No. 15 The Use of Physical-Chemical Properties in the 6th Amendment and their Required Precision, Accuracy and Limiting Values
No. 16 A Review of Recent Literature on the Toxicology of Benzene
No. 17 The Toxicology of Glycol Ethers and its Relevance to Man: An Up-Dating of ECETOC Technical Report No. 4
No. 18 Harmonisation of Ready Biodegradability Tests
No. 19 An Assessment of Occurrence and Effects of Dialkyl-o-Phthalates in the Environment
No. 20 Biodegradation Tests for Poorly-Soluble Compounds
No. 21 Guide to the Classification of Carcinogens, Mutagens, and Teratogens under the 6th Amendment
No. 22 Classification of Dangerous Substances and Pesticides in the EEC Directives. A Proposed Revision of Criteria for Inhalational Toxicity
No. 23 Evaluation of the Toxicity of Substances to be Assessed for Biodegradability
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No. 25 Evaluation of Fish Tainting
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No. 30 Existing Chemicals: Literature Reviews and Evaluations (Fifth Edition) (No longer available)
No. 31 The Mutagenicity and Carcinogenicity of Vinyl Chloride: A Historical Review and Assessment
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No. 48 Eye Irritation: Reference Chemicals Data Bank (Second Edition)
No. 49 Exposure of Man to Dioxins: A Perspective on Industrial Waste Incineration
No. 50 Estimating Environmental Concentrations of Chemicals using Fate and Exposure Models
No. 51 Environmental Hazard Assessment of Substances
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No. 53 DHTDMAC: Aquatic and Terrestrial Hazard Assessment (CAS No. 61789-80-8)

No. 54 Assessment of the Biodegradation of Chemicals in the Marine Environment
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No. 69 Toxicology of Man-Made Organic Fibres
No. 70 Chronic Neurotoxicity of Solvents
No. 71 Inventory of Critical Reviews on Chemicals (Only available to ECETOC members)
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No. 20 Tris-/Bis-/Mono-(2 ethylhexyl) Phosphate
No. 21 Tris-(2-Butoxyethyl)-Phosphate (CAS:78-51-3)

No. 22 Hydrogen Peroxide (CAS: 7722-84-1)
No. 23 Polycarboxylate Polymers as Used in Detergents
No. 24 Pentafluoroethane (HFC-125) (CAS: 354-33-6)
No. 25 1-Chloro-1,2,2,2-tetrafluoroethane (HCFC 124) (CAS No. 2837-89-0)
No. 26 Linear Polydimethylsiloxanes (CAS No. 63148-62-9)
No. 27 n-Butyl Acrylate (CAS No. 141-32-2)
No. 28 Ethyl Acrylate (CAS No. 140-88-5)
No. 29 1,1-Dichloro-1-Fluoroethane (HCFC-141b) (CAS No. 1717-00-6)
No. 30 Methyl Methacrylate (CAS No. 80-62-6)
No. 31 1,1,1,2-Tetrafluoroethane (HFC-134a) (CAS No. 811-97-2)
No. 32 Difluoromethane (HFC-32) (CAS No. 75-10-5)
No. 33 1,1-Dichloro-2,2,2-Trifluoroethane (HCFC-123) (CAS No. 306-83-2)
No. 34 Acrylic Acid (CAS No. 79-10-7)
No. 35 Methacrylic Acid (CAS No. 79-41-4)
No. 36 n-Butyl Methacrylate; Isobutyl Methacrylate (CAS No. 97-88-1) (CAS No. 97-86-9)
No. 37 Methyl Acrylate (CAS No. 96-33-3)
No. 38 Monochloroacetic Acid (CAS No. 79-11-8) and its Sodium Salt (CAS No. 3926-62-3)
No. 39 Tetrachloroethylene (CAS No. 127-18-4)
No. 40 Peracetic Acid (CAS No. 79-21-0) and its Equilibrium Solutions

Special Reports

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No. 9	Styrene Criteria Document
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No. 11	Ecotoxicology of some Inorganic Borates
No. 12	1,3-Butadiene OEL Criteria Document (Second Edition) (CAS No. 106-99-0)
No. 13	Occupational Exposure Limits for Hydrocarbon Solvents
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No. 15	Examination of a Proposed Skin Notation Strategy
No. 16	GREAT-ER User Manual

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No. 33	Environmental Oestrogens: A Compendium of Test Methods
No. 34	The Challenge Posed by Endocrine-disrupting Chemicals
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No. 36	Comments on OECD Draft Detailed Review Paper: Appraisal of Test Methods for Sex-Hormone Disrupting Chemicals
No. 37	EC Classification of Eye Irritancy
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No. 39	Screening and Testing Methods for Ecotoxicological Effects of Potential Endocrine Disrupters: Response to the EDSTAC Recommendations and a Proposed Alternative Approach
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