

NORTHWEST HORTICULTURAL COUNCIL

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February 5, 2008

Mr. Mark Bradley
Associate Deputy Administrator
USDA/AMS/TM/NOP
Room 4008-South, Ag Stop 0268
1400 Independence Avenue, SW.
Washington, DC 20250

Re: Petition to Use Ethylene for Ripening Organic Pears

Dear Mr. Bradley:

In accordance with the guidelines posted in the Federal Register on January 18, 2007, the Northwest Horticultural Council (NHC) and the Pear Bureau Northwest (PBN), both non-profit organizations, have provided the following petition to approve the use of ethylene for ripening organic pears. The NHC represents the growers and shippers of deciduous tree fruit in Washington, Oregon and Idaho. The PBN is a marketing organization that promotes, advertises and develops markets for fresh pears grown in Washington and Oregon. These states represent 84% of all fresh pears grown in the United States and 94% of all winter pears. Sixty-five percent of national organic pear production occurs in these states. They also account for 92% of America's fresh pear exports. We believe this petition is justified since ethylene is a naturally occurring substance consistent with the principles of organic production and has been accepted by the organic governing boards of a wide number of countries. In addition, ethylene is already approved for use by the National Organic Standards Board for ripening other organic fruits.

We appreciate the opportunity to work with the NOSB as it reviews this documentation and formulates an opinion.

Two copies are enclosed for your review. We are happy to answer any questions that may help clarify our document.

Below please find the official contact information:

Deborah Carter, Technical Issues Manager
Northwest Horticultural Council
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Sincerely,

NORTHWEST HORTICULTURAL COUNCIL



Deborah Carter
Technical Issues Manager

cc: Ms. Valerie Frances, NOSB
Mr. Kevin Moffitt, Pear Bureau Northwest
Mr. Don Gibson, NHC, Science Advisory Committee

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NATIONAL
ORGANIC PROGRAM
2008 FEB -7 A 9 09

Petition to Use Ethylene for Ripening Organic Pears

To

National Organic Program

National Organic Standards Board

From

Northwest Horticultural Council

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and

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February 2008

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Petition to Use Ethylene for Ripening Organic Pears
Prepared by Northwest Horticultural Council for the Pear Bureau Northwest
February 2008

Petition: Inclusion of the following annotation to section 205.605(b):
“for the post harvest ripening of pears”.

205.605(b)-Synthetic substance allowed in organic crop production.

1. Chemical Information

- Chemical Name: Ethylene, also known as ethene, olefiant gas
- CAS Number: 74-85-1
- UN 1962/UN 1938

2. Manufacturer’s name:

Ethylene can be generated by several known methods:

- Ethylene generators in which a catalytic process to produce ethylene from a solution containing ethyl alcohol is used.
- Ethylene cartridges containing pure ethylene can be released and circulated in a room (usually used for citrus degreening).
- Ethylene (sometimes containing 5% nitrogen to reduce explosion potential) in cylinders is released in the room.
- Plant products are the largest producers of ethylene. It is given off naturally by ripening fruit. This process has not been adopted commercially due to potential problems with pathogens and insects.

There are multiple manufacturers including:

- Catalytic Generators, LLC
1185 Pineridge Road
Norfolk, VA 23502
800-446-8100 (toll free)
757-855-0191 (Office)
757-855-4155 (Fax)
<http://www.catalyticgenerators.com>
Trade name: Ethy-Gen
- Livingston Group, Inc.
4768 Hermitage Road
Virginia Beach, VA 23445
757-460-3115 (Office)
757-460-0391 (Fax)
Trade Name: Nature-Ripe

- Praxair Distribution, Inc.
39 Old Ridgebury Road
Danbury, CT 06810-5113
800-PRAXAIR or 716-879-4077 (Office)
800-772-9985 or 716-879-2040 (Fax)
Name: Ethylene

3. Intended use:

Ethylene is a natural plant hormone and has been used for degreening and ripening fruit, including mangoes, bananas, citrus, avocados, tomatoes and pears.^{1, 2, 3, 4, 5} It currently is approved to ripen organic tropical fruit, bananas and degreening organic citrus. It is our petition that ethylene be approved for the post harvest ripening of organic pears.

4. Crop/Application Rate and Process/Mode of Action

- **Crop:** Organic pears (*Pyrus communis*), including all varieties of pears produced in the United States. Pears are climacteric but most often do not produce enough ethylene without a period of cold storage and/or treatment with ethylene gas.
- **Application Rate and Process.**^{6, 7, 8} In order to ripen pear fruit with the best eating quality, pears should be harvested at optimum maturity but unripe. Immature pears are more susceptible to physiologic disorders and have a shorter storage life.⁹ Pears that ripen on the tree develop mealy texture and poor flavor. Since pears are relatively fragile and temperature sensitive, they are carefully stored in either conventional air storage for short term or controlled atmosphere storage for longer term with the temperature set to 30-32° F (-1 - 0°C) and a 90-95% relative humidity (to prevent shrivel). Before ethylene is introduced to trigger the ripening process, the stacked boxed fruit is allowed to come to an internal temperature of 60-70 °F (15.5-20°C). 100 ppm of ethylene gas is introduced along with good air circulation between and through boxes to ensure

¹ *Ethylene use in the Ripening of Organic Bananas*, Briefing Paper 10/10/2001, <http://soilassociation.org/web/sa/saweb.nsf/>.

² Ritenour, M.A. and Brecht, J.K., Presentation, *Ethylene Treatments for Ripening and Degreening*, IRREC, University of Florida.

³ Burg, S.P. and Burg, E.A., *Role of Ethylene in Fruit Ripening*, Department of Physiology, University of Miami School of Medicine, 1961.

⁴ Sargent, S., *Ripening Tomatoes with Ethylene*, VC-29, Department of Horticultural Sciences, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, 2000.

⁵ Ritenour, M., et. al., *Recommendations for Degreening Florida Fresh Citrus Fruits*, Cir 1170, Department of Horticultural Sciences, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida, 2003.

⁶ **Pear Handling Manual**, Pear Bureau Northwest, Milwaukie, OR, www.usapears.com, 2004.

⁷ Mitcham, B. et al., *Optimum Procedures for Ripening Pears*, **Management of Fruit Ripening**, Series #20 Reprint, Postharvest Technology Research and Information Center, UC Davis, pp 65-70.

⁸ Villalobos, M. et. al., **Pear Ripening**, Department of Plant Sciences, University of California, Davis, 36pp.

⁹ Chen, P., *Pear*, Mid-Columbia Agricultural Research and Extension Center, Oregon State University.

the fruit ripens evenly. The ripening room is vented every 12- 24 hours to prevent the accumulation of excess carbon dioxide (which slows ripening). The ripening process may take 24-48 hours depending on the maturity of the fruit; 24 hours for later season fruit that has been stored for two or months and 48 hours for early season fruit. Firmness and temperature readings are checked daily. The minimal fruit firmness for safe shipment and distribution should not be lower than 12 lbs (54N). After the desired firmness is achieved, the pulp temperature is rapidly reduced to 32°F (0°C) to slow ripening as pears will continue to ripen once triggered.

The following table provides guideline for ripening different variety of pears.

Table1. Pear pressures in pounds by variety (lbs)

	Bartlett	Anjou	Bosc	Comice	Seckel	Forelle
Initiate ripening if over	13	12	12	12	12	12
Do not ripen if under	12	10	10	10	10	10

Ethylene sensitivity for the induction of ripening varies depending on the pear cultivar⁹:

Anjou	Least sensitive
Bosc and Comice	Moderately sensitive
Bartlett	Most sensitive

- Mode of Action: Although the mode of action is not clearly understood, it is well documented that ethylene triggers the ripening of fruit. It is thought that exogenously supplied ethylene triggers ethylene production within the plant. Ethylene is biosynthesized by a series of reactions from the precursor, methionine, to S-adenosylmethionine (SAM) to 1-aminocyclopropane-1-carboxylic acid (ACC) (the ethylene production limiting step by way of ACC synthase) and finally to ethylene. It has been noted that not all ACC found in tissues is converted to ethylene. Some converts to N-malonyl ACC which accumulates in the tissue. Since not all ACC converts to ethylene, this action prevents overproduction of ethylene. Environmental conditions, physical and chemical injury and simply the developmental stage all can trigger ethylene biosynthesis.¹⁰ It is reported that ethylene is responsible for triggering the genes that 1) enhance the rise in respiration rates, 2) autocatalyze ethylene production within the plant, 3) initiate chlorophyll degradation, 4) cause pigment synthesis 5)

¹⁰ Taiz, L. and Zeiger, E., **Plant Physiology**, Benjamin/Cummings Publishing Company, 1991, Chapter 19, Ethylene and Abscisic Acid, p 473-489.

convert starch to sugars 6) produce aromatic volatiles and 7) increase the activity of cell wall degrading enzymes (abscission).^{11, 12, 13}

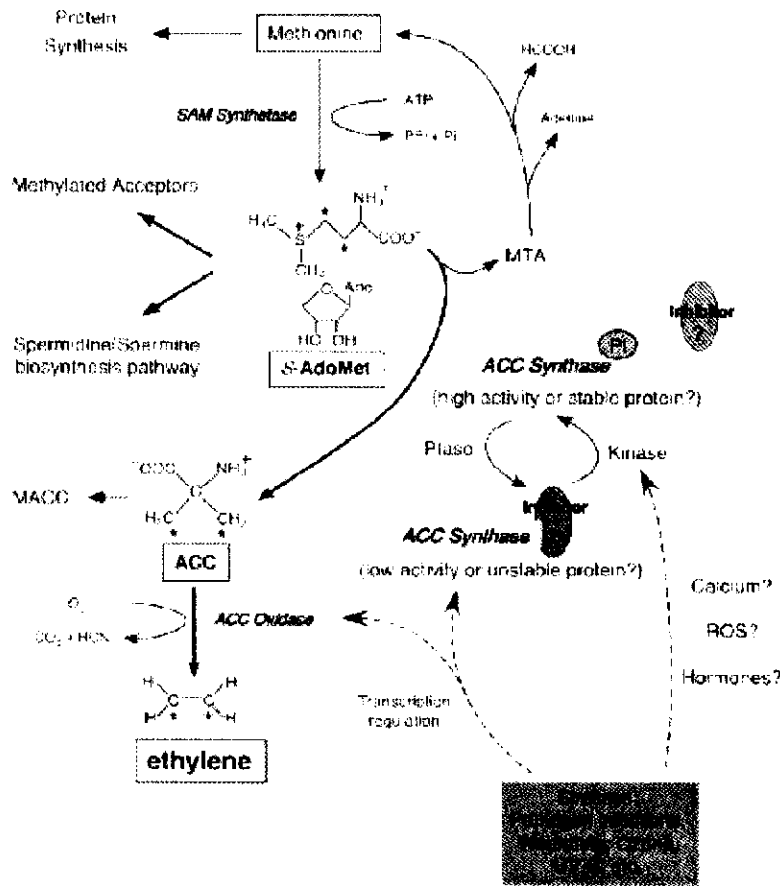


Figure 1. Biosynthetic Pathway and Regulation of Ethylene.

¹⁴Courtesy of Wang, Li and Ecker, *Ethylene Biosynthesis and Signaling Networks*, 2002.

It has been proposed and chemical evidence has shown that ethylene binds to copper-containing protein that may cause ethylene oxidation. The mode of action *may* be connected to its oxidation and conversion into ethylene oxide and ethylene glycol. This hypothesis has not been verified. But we do know that ripening, one of the most complex processes regulated by ethylene, is a series of gene expressions regulating softening of cell walls, color and flavor changes.^{15,16,17}

¹¹ Koning, R., *Fruit Ripening*, Plant Physiology Information Website, http://plantphys.info/plants_human/fruitgrowripe.htm, 1994.

¹² Ethylene, <http://www.plant-hormones.info/ethylene.htm>

¹³ Koslanund, R., et al., *Paw Paw [Asinaina triloba (L.) Dunal] Fruit Ripening. I. Ethylene Biosynthesis Production*, Journal of American Society of Horticultural Science, 2005, 130 (4), pp 638-642.

¹⁴ Wang, K. et al., *Ethylene Biosynthesis and Signaling Networks*, The Plant Cell, 2002, S131-S151.

¹⁵ Yamamoto, M. et al., *The Synthesis of Ethylene in Melon Fruit During the Early Stage of Ripening*, Plant Cell Physiology, 1995, 36 (4) pp 591-596.

¹⁶ Chaves, A.L.S. and Celso de Mello-Farias, P. *Ethylene and Fruit Ripening: From Illumination Gas to the Control of Gene Expression, More than a Century of Discoveries*, Review Article, Genetics and Molecular Biology, 2006, 29 (3) pp 508-515.

5. Source

Ethylene is a gas made as a pyrolysis product of hydrocarbons from natural gas liquids or current crude oil.¹⁸ The hydrocarbons are steam-cracked by briefly heating to high temperatures 1380-1742°F (750-950°C) to produce a mixture of smaller molecular weight hydrocarbons. Repeated distillation separates ethylene out. Carbon dioxide and hydrogen sulfide are subsequently removed. The cracked gas is dried and cryogenically treated. The cold cracked gas stream then goes to a demethanizing tower. Ethylene is removed from the top of the tower while ethane coming from the bottom is recycled to be cracked again. In many plants heat recovered from the cracked gas is used to produce high pressure steam which drives the compression turbines and the ethylene refrigeration compressors.¹⁹

Ethylene gas can also be produced by catalytic generators in situ. Ethyl alcohol is dehydrated by heat over various solid acid catalysts at atmospheric pressure producing ethylene in the presence of water vapor. The company, Catalytic Generators, has supplied documentation that their source of ethanol from Grain Processing Corporation is from non-GMO corn and is therefore, in compliance with NOSB standards. (Attachment 1, Fax from Grain Processing Corporation)

6. and 7. Reviews of Ethylene for Organic Fruit and Information regarding, EPA, FDA, National and International Agencies.

Domestic:

Ethylene is registered by the U.S. Environmental Protection Agency (EPA) as a pesticide plant growth regulator (PGR). In the 1990's, the EPA reported that ethylene "naturally occurs and had a nontoxic mode of action in controlling target pests (EPA 1992). The EPA has designated ethylene as a biorational²⁰ pesticide.²¹ The EPA does not require a maximum residue tolerance when used as a PGR on fruits and vegetables (40CFR180.1016) and it did not require additional ecological testing during its reregistration process. In 1995, the National Organics Standards Board (NOSB) reviewed the use of ethylene for ripening post harvest fruit, specifically bananas. After an overwhelming majority vote to approve the annotation for ripening tropical fruit, a motion for a 5-year phase-out failed: 9 against, 3 for and 1 abstention.

¹⁷ Stotz, H., Horticulture 405, *Fruit Quality, Lecture on Ethylene*, Oregon State University, (2004).

¹⁸ [Http://en.wikipedia.org/wiki/ethylene](http://en.wikipedia.org/wiki/ethylene)

¹⁹ Ethylene Processing, NOSB, Materials Database, November 1999, 8pp.

²⁰ The term "biorational" refers to being of natural origin and having limited or no adverse effects on the environment or beneficial organisms. (Ware, G.W., 1989, *The Pesticide Book*, 3rd edition., Thomas Publications, Fresno, Calif.) The EPA considers biorational materials to have different modes of action than conventional or traditional substances, with greater selectivity and considerably lower risks to humans, wildlife and the environment.

²¹ EPA RED Facts, Ethylene, EPA-738-F-92-012, September 1992.

In 1999 the NOSB approved the use of ethylene for post harvest ripening of tropical fruit and the degreening of citrus.²² Ethylene from generators has been registered with the U.S. EPA since 1978 for ripening bananas, tomatoes and tobacco. In 1998 it was approved for use on avocados, citrus, melons, tomatoes, tobacco, pears and papayas as Ethy-Gen II.

International:

Clearly the use of ethylene on organic crops has international approval.

- **International Federation of Organic Agricultural Movements (IFOAM)**
The IFOAM Basic Standards for Organic Production and Processing, 2002, states under Section 6.3.6 that ethylene is permitted for ripening organic fruit.²³
- **Codex Alimentarius Commission** reviewed a petition in April/May 2007 from New Zealand to allow ethylene to be used on organic kiwi and other tropical fruit.²⁴ Although no final decision has been reached at this time, approval for this petition was expressed by the following countries:
 - **Costa Rica** indicated that ethylene is a non-toxic substance obtained from ripened fruit and its use in organic production does not conflict with organic principles.
 - **European Community** supports the use of ethylene on kiwis and bananas but not all tropical fruit as New Zealand proposed.
 - **Guatemala** supports the use of ethylene to ripen kiwis, plantain, bananas and other tropical fruit. Ethylene is already allowed under the Organic Agriculture Technical Manual, approved by Ministerial Agreement 1317-2002-Organic Agriculture Regulations.
 - **Japan** supports ethylene use to ripen organic kiwis and bananas. They indicated that ethylene is a natural substance which ripens fruit by acting as a plant hormone, also stating that it is produced by fruit.
 - **Panama**, through the General Directorate of Standards and Industrial Technology of the Minister of Trade and Industry, had no objection to the use of ethylene as it is a natural substance produced by plant species.
 - **Peru** states that under Article 57, Technical Regulation for Organic Products approved by D.S. No. 044-2006-AG, published 14.07.2006, ethylene gas is allowed for ripening only when it is essential to do so and supported its use on kiwi.
 - **Philippines** supports ethylene's use for ripening kiwi, bananas and other tropical fruit as 1) it is a natural post harvest processing technique, 2) it is a natural occurring gas, 3) it is considered a safe and

²² <http://www.ams.usda.gov/nop/NOSBNationalListDatabase> Processing, NOSB Processing Materials Decision, June 2001, Item 41 and 41, page 3 of 9.

²³ IFOAM Basic Standards for Organic Production and Processing, approved IFOAM General Assembly, Victoria, Canada, August 2002, p. 31.

²⁴ Codex Alimentarius Commission, Joint FAO/WHO Food Standards Program, 35th Session, Ottawa, Canada, April 30-May 4, 2007, *Guidelines for the Production, Processing, Labeling and Marketing of Organically Produced Foods: Proposed Draft Amendment: Addition of Ethylene (CL2006/48-FL)*. Step 3 comments.

permissible processing aid and 4) there is no evidence of having adverse effect on health, presents no toxicity issues and dissipates quickly.

- **Thailand** supports the use of use of ethylene to ripen kiwi and other tropical fruit as it is also used to ripen bananas.
- **United States** did not object to the consideration of ethylene as an addition to the Annex 2 list as a post harvest ripening aid.
- **IFOAM** supports the inclusion of ethylene in Codex Organic Guidelines. IFOAM has permitted the use of ethylene gas for ripening fruits including tropical fruits.

Ethylene for ripening organic fruits has also already been approved by the following (Attachments 2-5):

- Canada- Organic Production Systems Permitted Substance Lists CAN/CGSB-32.311-2006.
- European Commission-Council Regulation EEC No. 2092/91, June 1991.
- New Zealand-NZFSA Standard OP3, Appendix 2, NZFSA Technical Rules for Organic Production, November 2006, Version 6.
- National List Regulatory Text, The National Organic Program, <http://www.ams.usda.gov/NOP/NOP/standards/ListReg.html>.

8. Labels and EPA Registration Numbers (Attachments 6-9)

- Banana Gas 32- EPA Reg. 10330-12, Praxair, Inc.
- Ethy-Gen, EPA No. 374331, Catalytic Generators
- Ethylene, (CAS 74-85-1), Praxair, Inc.
- Livingston's NatureRipe, EPA No. 47893-3, Livingston Group, Inc.

9. Physical Properties²⁵

C₂H₄ (CH₂=CH₂), colorless, flammable gas which exists in nature but is also synthetic with a slightly sweet odor.

Molecular Weight: 28.05

Specific Volume: 13.8 cf/lb

Flammability limits: 13.1-32% in air

Toxicity: Asphyxiant

Compatibility: Non-corrosive

Use Profile: The U.S. EPA has registered ethylene as a plant growth regulator. It is used commercially as a flower producing agent on pineapple and a ripening aid for fruits and vegetables. It is normally known as a plant hormone.²⁶

History: Ethylene for fruit ripening has a long history which was first described in the Bible as "gashing figs". This operation stresses the fruit by causing external

²⁵ Ethylene Gas, <http://mindfully.org/Plastic/Ethylene-Gas.htm>

²⁶ Oetiker, J. and Yang, S., *The Role Of Ethylene In Fruit Ripening*, *ISHS Acta Horticulturae*, 398: Post Harvest Physiology of Fruits, Kyoto, Japan, 1995.

injury which triggers ethylene production resulting in ripening. In the 1920's it was discovered by accident that ethylene was the actual cause of degreening citrus fruit after it was warmed with kerosene heaters. A decade later ethylene was found to be produced by plants. This same chemical structure was verified to be the same ethylene generated by heaters. In December 1971 the EPA registered a pesticide product containing ethylene.

The following table provides conditions for the post harvest ripening of various produce with ethylene.

Ripening Conditions for Post Harvest-Ripened Fruit

Fruit	Exposure time to 100 ppm Ethylene (Hours)	Ripening temperatures (F)/(C)
Avocado	8-48	59-68 (15-20 C)
Banana	24-48	58-65 (14-18 C)
Kiwi	12-24	54-77 (12-25 C)
Mango	24-48	68-77 (20-25 C)
Pear	24-48	68-77 (20-25 C)
Tomato	24-48	65-68 (18-20 C)

Kader, A., Ripening and Conditioning Fruit, presentation UC Davis.²⁷

Chemical Reactions:

Ethylene oxidizes to ethylene oxide and ultimately to ethylene glycol. Ethylene also degrades by going to ethylene oxide to oxalic acid to carbon dioxide. Ethylene is explosive at high temperatures and a concentration of approximately 20,000 ppm.

Toxicity and Environmental Persistence

The EPA RED states that “ethylene is a naturally occurring volatile gas, regarded as a biorational pesticide due to its low toxicity. The EPA finds that the registered uses of ethylene do not pose an unreasonable risk to the environment”.²⁰

Environmental Impact of its Use/Manufacture

No adverse impact on the environment is expected by ethylene's manufacture or use. No literature was identified indicating adverse impact.

Effects on Human Health

The EPA RED regulatory report concludes “all registered products containing the active ingredient ethylene are not likely to cause unreasonable adverse effects in people or the environment”.²¹ Ethylene occurs endogenously in mammals and has been identified in human exhaled breath. The concentration of endogenous ethylene in the blood is 0.097nmol/L. Ethylene at concentrations of 80-90% in oxygen has

²⁷ Kader, A., Ripening and Conditioning Fruit, Presented at University of California Davis, June 2007.

been used as a clinical anesthetic without related toxicity. It is reported that recovery from ethylene anesthetic is rapid. Ethylene has low blood solubility. Therefore, its uptake into the body is low; it is excreted rapidly and does not accumulate.²⁸ This report also states that 2-3% of inhaled ethylene is metabolized to ethylene oxide while the remaining is exhaled unchanged. PMRA has reported that a rat inhalation study shows no evidence of acute toxicity, oncogenicity or genotoxicity.

It is unlikely that there is a direct chemical interaction between ethylene and biological media since it is rapidly excreted from the lungs.

- **Carcinogenicity Class:** IARC: Group 3. No carcinogenic effects were found after inhalation of 300 to 3000 ppm ethylene.
- **Acute Toxicity:** There was no change in mice behavior after administration of 150 ppm of ethylene.
- **Repeated Exposure:** Accumulation is unlikely because of rapid excretion from the body.
- **Long-term Toxicity:** Rats dosed for 6 months showed no abnormalities in behavior, body weight, phagocytic activity or cholinesterase anal condition reflex activity.²⁵

Effects on Soil Organisms, Crops and Livestock

Ethylene for the purpose of ripening pears is not used in an outdoor environment so no effect is expected or documented in the literature.

10. Safety Information

11.

Material Safety Data Sheets can be found in Appendix A.

- **Hazards**
Fire and explosion are two of the hazards of ethylene gas whether from cartridges, cylinders or ethanol based solutions used in ethylene generators. The other potential hazard is asphyxiation. Oxygen deficiency in a room occurs during treatments.

The USDA National Toxicology Program (NTP) as part of the NIEHS does not classify ethylene as a carcinogen.²⁹ (Attachment 10) Neither Health Canada's Pest Management Regulatory Agency nor the NTP established an acute reference dose (ARfD) for ethylene since it is unlikely to present an acute hazard.

11/12. Research Information and Petition Justification

Why should ethylene be permitted?

- Ethylene improves the over all quality of pears. Cold storage induction of ethylene production is not always the answer. Maintaining fruit in cold

²⁸ Proposed Regulatory Decision Document PRDD 2001-04, *Ethylene-Eco Sprout Guard*, Canadian Pest Management Regulatory Agency, October 2001.

²⁹ National Toxicology Program, Ethylene, Human Toxicity Excerpts, [Http://ntp.niehs.nih.gov](http://ntp.niehs.nih.gov)

storage is a means by which pears can be held and ripened. Allen proposed in 1932 that Anjou pears do not ripen evenly without exposure to cold storage or ethylene.³⁰ Anjous are particularly problematic as 60 days of chilling at 30.2°F (-1°C) is required to generate normal ripening.³¹ Therefore, they cannot be immediately marketed after harvest. Chen et al. preconditioned Anjou pears without ethylene and determined that from immediately after harvest up to 4 weeks storage only trace amounts of ethylene were produced during a 15 day ripening period. This study indicates that Anjou pears are incapable of ripening normally.³² Kupferman determined that commercially packed Anjous shipped before November did not ripen properly after 7 days at room temperature.³³ Therefore, consumers could not obtain desirable eating quality Anjous in September and October each year. Without the use of ethylene, this conclusion can also be drawn for organic pears.

Pears are usually ripened in a mature green state and post-harvest chilling stimulates the endogenous production of ethylene. It is well documented that ethylene production provides the impetus that allows pears to ripen to their optimum texture.^{27, 34, 35} Some cultivars will ripen slowly and satisfactorily at temperatures below 50°F (10°C) but below 54°F (12°C) ethylene is produced very slowly.³⁶ Agar et al., reported that exposing freshly harvested and non-chilled Bartletts to 24 hours of exogenous ethylene stimulated the activity of ACC-S and ACC-O which resulted in higher ethylene production by the fruit resulting in (1) increased uniform ripening, (2) increased rate of ripening and (3) decreased firmness regardless of maturity, growing region or season.³⁷ Sugar and Basile report similar findings with mature Comice pears.³⁵ If pears are held too long at low non-ripening temperatures, they will fail to achieve full quality. For example, Bartletts will not ripen below 54°F (12°C) and maximum storage life is achieved at 30.2°F (-1°C). Chilling injury as a result of improper controlled atmospheric storage can cause severe physiologic disorders to occur in pears. These disorders include core breakdown, neck breakdown and superficial scald.^{38, 39} Scald control is usually accomplished chemically and is not in compliance with organic production.

³⁰ Allen, F., *Physical and Chemical Changes in the Ripening of Deciduous Fruits*, **Hilgardia**, 1932, 6, pp 331-441.

³¹ Chen, P., *Ethylene and Anjou Pears*, 16th Annual Post Harvest Conference, Yakima, WA, March 2000, pp 14-15.

³² Chen, P. et al., *Precondition of D'Anjou Pears for Early Marketing by Ethylene Treatment*, **Journal of Food Quality**, 1996, 19 pp 375-390.

³³ Kupferman, E., *Anjou Pear Quality: 1. Fruit Quality*, **Tree Fruit Post Harvest Journal**, 5, pp 3-10, 1994.

³⁴ Hansen, E. et al., *Commercial Handling and Storage Practices for Winter Pears*, Oregon State University, Ag Experiment Station, Special Report 550, 1779.

³⁵ Sugar, D. et al., **Hort. Technology**, *Ethylene Treatment Promotes Early Ripening Capacity in Mature Comice Pears*, March 2006 16(1).

³⁶ Truter, A. and Combrink, J., *Ethylene Levels in Commercial CA and Low-Ethylene CA Storage of Golden Delicious, Starking and Granny Smith Apples and Packham Triumph Pears*, **Tree Fruit Post Harvest Journal**, October 1993, 4(30), pp 14-18.

³⁷ Agar, I.T. et al., *Exogenous Ethylene Accelerates Ripening Response in Bartlett Pears Regardless of Maturity or Growing Region*, **Post Harvest Biology and Technology**, October 1999, 17 (2), pp 67-78.

³⁸ Childers, N. F., **Modern Fruit Science**, Horticultural Publications, New Brunswick, NJ, 1976, pp71-82 and pp 320-322.

- The chemical structure of ethylene is the same whether produced naturally or synthetically. The plant recognizes the chemical structure of ethylene (C₂H₄).

A study by Hansen in 1932, following ripening changes for Bartlett and Anjou pears that were treated with exogenous ethylene indicated:⁴⁰

- Ethylene increased sugar concentrations in fruit.
- Ethylene was effective in increasing the rate of starch hydrolysis.
- Ethylene rapidly increased the amount of soluble pectin which results in softening fruit.
- Ethylene increased respiratory activity of fruit.

He states: “The initiation of these chemical ripening processes could be brought about by early ethylene treatment of pears picked at immature stage, long before the fruit had naturally developed to the period where ripening would normally occur. In addition, the reactions occurring in the presence of ethylene were identical to the changes that are observed to take place in mature fruit ripened naturally under normal conditions.”

The statement that synthetic and natural ethylene are recognized by the plant as being equivalent is further documented in research by Chen et al³² and Wang.⁴¹ Both looked at Anjou pears ripened with and without exogenous ethylene. Wang determined that fully mature fruit had an internal ethylene concentration of 0.94 ppm and that ethylene must be at 0.46 ppm before the climacteric develops. During climacteric development internal ethylene peaked at approximately 41 ppm in 11 days. Chen’s test protocol included harvesting mature fruit, storing in 30.2°F(-1°C) air for 0, 2, 4, 6 and 8 weeks, preconditioning fruit with 100 ppm ethylene or no ethylene for 3 days, and then keeping fruit at room temperature for a period of 15 days. The following figure by Chen indicates that exogenous ethylene speeds the rate of ripening but after a 15 day period, the amount of ethylene measured in the fruit was essentially equivalent (7-8 ppm ethylene).

³⁹ Sugar, D., *Post Harvest Physiology and Pathology of Pears*, **ISHA Acta Horticulturae 596: VIII International Symposium on Pears**, Bologna, IT, 2002.

⁴⁰ Hansen E., *The Effect of Ethylene on Certain Chemical Changes Associated with the Ripening of Pears*, **Plant Physiology**, January, 14 (1) 1939, 145-161.

⁴¹ Wang C. and Mellenthin, W., *Internal Ethylene Levels during Ripening and Climacteric in Anjou Pears*, **Plant Physiology**, 1972 50, 311-312.

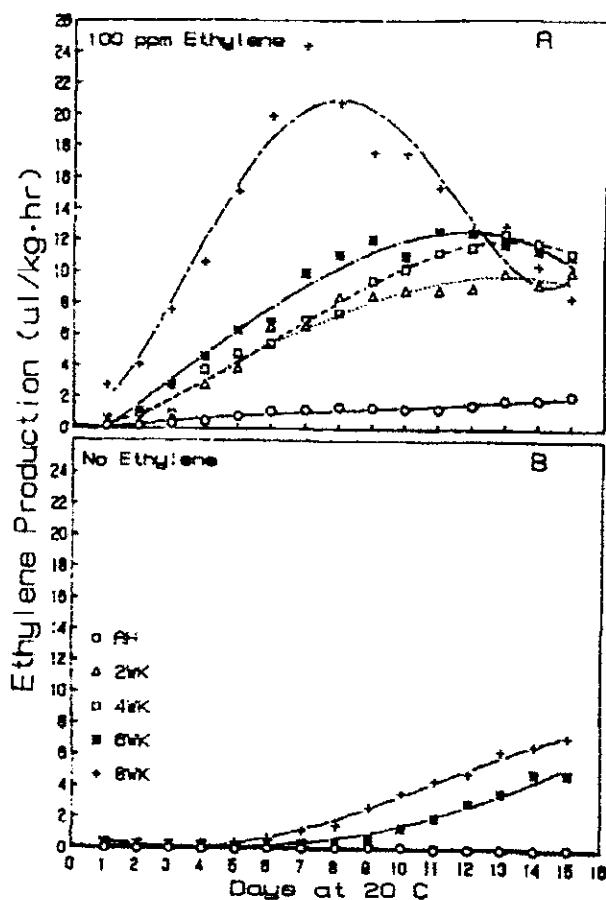


Figure 2. Changes in ethylene production of ethylene preconditioned (A) and non-ethylene preconditioned (B) Anjou pears at 20C
³² Courtesy of Chen, Journal of Food Quality, 1996.

- Exogenously applied ethylene causes no adverse effect on fruit biological processes.

Hansen and Hartman in 1937 reported that in the variety of pears tested (Bosc, Anjou and Comice) there is a gradual shift toward a period of maximum respiration. After that point ethylene is no longer effective during the remaining life stages of the fruit. They state: "While external factors such as changes in temperature do retard or accelerate the rate at which this increase in respiration takes place, the general trend followed appears to be controlled primarily by internal factors inherent in the fruit".⁴² They conclude that the decrease in the effect from ethylene treatment appears to be associated with the natural increase in the respiratory activity of the fruit after picking.

⁴² Hansen, E. and Hartman, H., *Effect of Ethylene and Certain Metabolic Gases upon Respiration and Ripening of Pears Before and After Cold Storage*", *Plant Physiology*, (1937) April, 12 (2), pp 441-454.

McMurchie et al report that ripening induced by exogenous ethylene is “qualitatively identical” with that which occurs naturally.⁴³

- Ethylene biosynthesis can be self-limiting. In other words, Hiwasa et al. reports that ethylene’s ‘biosynthetic pathway is subject to both positive and negative feedback regulation. And that in pear fruit, ethylene biosynthesis has a positive feedback during ripening.’⁴⁴ Campbell and Labovitch have reported that ethylene acts as its personal feedback regulator of its own biosynthesis particularly in response to wounding.⁴⁵ Ethylene biosynthesis begins to increase rapidly 20-30 minutes after wounding, peaks at 40-60 minutes then starts to decline. It has been proposed that there are two systems for regulating ethylene biosynthesis: (1) respiration is increased dramatically when first exposed to ethylene and (2) after respiration is stimulated, additional ethylene has no stimulatory effect. Kays states that “above a threshold level of ethylene, the respiratory increase is independent of the concentration of ethylene to which the fruit is exposed.”⁴⁶
- There is no health risk associated with the exogenous application of ethylene to fruit. A paper presented by Chace in 1934, *Health Problems Connected with Ethylene Treatment of Fruits*, is commonly cited as to why ethylene should not be used on fruit.⁴⁷ However, this paper notes:

“The changes produced by ethylene are solely those which have been brought about by nature in somewhat longer time and less uniformly. ... We have never encountered a change which is not a natural one.”

“...it could be conceived that danger might come from impurities in the gas absorbed by the fruit and carried to the consumer in this way. Impurities common in ethylene amount to about 2%... Traces of carbon dioxide, propane acetylene and acetone also occur. All are probably quite harmless in the dilutions in which they occur.”

In the last 64 years no additional evidence has been presented that documents the presence of the impurities in ethylene treated fruit.

⁴³ McMurchie, E.J., et al., *Treatment of Fruit with Propylene Gives Information about the Biogenesis of Ethylene*, *Nature*, (1972) 237 (5352), pp 235-236.

⁴⁴ Hiwasa, K. et al., *Ethylene is Required for Both the Initiation and Progression of Softening in Pear (Pyrus communis L.) Fruit*, *Journal of Experimental Biology*, 2003, 54 (383) pp 771-779.

⁴⁵ Campbell A. and Labovitch, J., *Induction and Regulation of Ethylene Biosynthesis by Pectic Oligomers in Cultured Pear Cells*, *Plant Physiology*, (1991) 97, pp 699-705.

⁴⁶ Kays, S.J., *Post Physiology of Perishable Plant Products*, Van Nostrand Reinhold, 1991, pp 229-230.

⁴⁷ Chace, E. *Health Problems Connected with Ethylene Treatments of Fruits*, presented at the Food and Nutrition Section of the American Public Health Association at the 63rd Annual Meeting in Pasadena, CA, 1934.

Available Organic Materials

While ethylene generated from other ripening fruits such as cherimoya, papaya, passion fruit and sapote and decomposing fruit have been suggested in the past as a means of ripening fruit organically, it is not commercially practical for the following reasons:

- Even very high natural producers of ethylene (tropical fruits) produce at the average concentration of 100 microliters of ethylene per hour at 20°C. (Fading blossoms of *Vanda* orchids have been noted to produce as high as 3400 microliters per kilogram per hour.^{41, 48} Generating and maintaining a predictable/steady amount over the 24-48 hour period at lower temperatures could be laborious, challenging and practically impossible.
- Ripening fruits often become a harbor for a variety of pests and insects. Softer fruit (which would be used to produce higher amounts of ethylene) make the desired fruit more vulnerable to damage and subsequent infestation during handling and transport. Chemically controlling some of these pests would not be within organic principles. Irradiation has been shown to work for disinfestation of tropical fruit and has been suggested as a means to control pests but research has shown that pears do not tolerate irradiation as abnormal ripening can occur. It has been proposed that irradiation affects the ethylene receptors on pears prohibiting their initiation of ripening. Irradiation has never been recommended for pears.

Summary:

Ethylene should be approved for ripening organic pears because:

- Ethylene is consistent with the principles of organic production and has been accepted by a wide number of countries and organic product governing agencies.
- Ethylene is necessary to ripen early season pears. Consumers miss out on high quality organic pears during 2 months in the winter.
- Ethylene has no negative impact on the environment or human and animal health.
- Available organic alternatives to ethylene are unacceptable.
- Multiple international organizations have assessed the risk of ethylene and the importance of using ethylene in ripening organic crops and have approved its use.
- Ethylene is already approved for use on other fruits such as tropical fruits, including bananas.

⁴⁸ Kader, A. and Kasmire, R., *Effects of Ethylene on Horticultural Commodities during Post Harvest Handling*, *Produce Marketing Almanac Supplement*, 1984, pp 5-7.

Appendix A

Appendix (A)

1. Grain Processing Corporation Fax- GMO Declaration
2. Canadian –Organic Production Systems Permitted Substances Lists
3. European Commission- Council Regulation on Organic Products and Foodstuff
4. New Zealand Food Safety Authority Standard OP3, Appendix 2, NZFSA Technical Rules for Organic Production
5. USDA National Organic Program, National List-Regulatory Text
6. U.S. EPA Banana Gas -32 Label and MSDS
7. U.S. EPA Ethy-Gen II Label and MSDS
8. Livingston Group Nature-Ripe Label and MSDS
9. Praxair Ethylene MSDS
10. National Institute of Health, NIEHS, National Toxicology Program, Ethylene

Attachment 1

Grain Processing Corporation
1600 Oregon Street
Muscatine, Iowa 52761
563-264-4773

GPC facsimile transmittal

To: Greg Aikens Fax:

From: Rick Miller, VP-Alcohol Products Date: 7/27/2007

Re: GMO declaration Pages: 1

CC:

Urgent For Review Please Comment Please Reply Please Recycle

You have inquired about the GMO status of our ethyl alcohol. We can clearly state that neither our 190 proof nor anhydrous ethyl alcohol contains any GMO material. We have tested this not only in our own laboratory, but have also tested same in an outside laboratory (Hanse Analytik of Bremen, Germany). In all cases, no genetically modified plant DNA was detected. It is important to note that even if any GMO is present in corn used to manufacture ethyl alcohol, the distillation process will not volatilize any protein, and therefore we can unequivocally state that none of GPC's ethyl alcohol contains GMO.

You have also inquired about the use of GMO corn events in our process to produce ethyl alcohol. GPC will only accept those GMO corn events that are approved by the USDA, the EPA, the FDA, and the European Union (EU). StarLink™ is not approved by any of the above organizations and is not fit for use by GPC. To accomplish this, we have done the following:

1. A direct letter has been sent to our corn suppliers stating that GPC will accept only those events approved by the USDA/EPA/FDA/EU.
2. All corn purchasing contracts state GPC will accept only events approved by the above organizations.
3. At our material unloading area, a sign has been posted that states GPC accepts only those events approved by the above organizations.
4. All corn delivered to our elevator is tested by the lateral flow ELISA procedure. Any corn that tests positive for presence of StarLink™ is rejected. GPC will continue to test for StarLink™ until we are assured that material has been removed from the food supply chain.
5. Our procedures have been reviewed by the USDA and comply with all of their recommendations.

Should you have further questions, please call your GPC account representative, or myself at 563-264-4265.

Attachment 2



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of Canada

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du Canada

Canadian General
Standards Board

Office des normes
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CAN/CGSB-32.311-2006

Supersedes part of CAN/CGSB-32.310-99

Organic Production Systems Permitted Substances Lists

ICS 67.040

National Standard of Canada

Canada

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NATIONAL STANDARD OF CANADA

CAN/CGSB-32.311-2006

Supersedes part of CAN/CGSB-32.310-99

ORGANIC PRODUCTION SYSTEMS
PERMITTED SUBSTANCES LISTS

Prepared by the
Canadian General Standards Board 

Approved by the
Standards Council of Canada 

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CANADIAN GENERAL STANDARDS BOARD

ORGANIC PRODUCTION SYSTEMS
PERMITTED SUBSTANCES LISTS

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CANADIAN GENERAL STANDARDS BOARD

ORGANIC PRODUCTION SYSTEMS
PERMITTED SUBSTANCES LISTS

1. SCOPE
 - 1.1. This standard¹ provides additional information to CAN/CGSB-32.310, *Organic Production Systems — General Principles and Management Standards*. It consists of requirements for adding or amending permitted substances in the following lists, organized by category of use.
 - 1.2. Quantities and dimensions in this standard are given in metric units with yard/pound equivalents, mostly obtained through soft conversion, given in parentheses. The metric units shall be regarded as official in the event of dispute or unforeseen difficulty arising from the conversion.
2. REFERENCED PUBLICATIONS
 - 2.1. The following publications are referenced in this standard:
 - 2.1.1. Canadian General Standards Board (CGSB)
CAN/CGSB-32.310 — *Organic Production Systems — General Principles and Management Standards*.
 - 2.1.2. Health Canada
Food and Drugs Act (R.S. 1985, c. F-27).
 - 2.1.3. Canadian Food Inspection Agency (CFIA)
Feeds Regulations, 1983 (SOR/83-593).
3. REQUIREMENTS FOR ADDING OR AMENDING SUBSTANCES IN THE LISTS
 - 3.1. Section 11 of CAN/CGSB-32.310 outlines the requirements for adding or amending substances in the lists.
4. PERMITTED SUBSTANCES LISTS FOR CROP PRODUCTION
 - 4.1. Classification — Crop production substances are classified according to the following uses and applications:
 - a. Soil Amendments are substances applied to the soil to improve fertility and tilth and to correct soil problems. Fertilizers, plant foods and soil amendments are primarily used for their plant nutrient content and may be applied to the soil or to the foliage of plants.
 - b. Crop Production Aids and Materials are substances used in conjunction with other substances, which may or may not be directly applied to the crop or soil, or substances used to control diseases or pests. Examples include
 - i. adjuvants, equipment cleaners, insect traps and plastic mulch
 - ii. vertebrate animal pest management substances
 - iii. plant disease management substances
 - iv. insect pest management (invertebrates), mites, molluscs and crustacean substances
 - v. nematode management substances.
 - c. Weed Management

¹ References throughout this document to "this standard" refer to CAN/CGSB-32.311, *Organic Production Systems — Permitted Substances Lists*.

Attachment 3

1991R2092 — EN — 06.05.2006 — 026.001 — 1

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COUNCIL REGULATION (EEC) No 2092/91

of 24 June 1991

on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs

(OJ L 198, 22.7.1991, p. 1)

Amended by:

	No	page	date
► <u>M1</u> Commission Regulation (EEC) No 1535/92 of 15 June 1992	L 162	15	16.6.1992
► <u>M2</u> Council Regulation (EEC) No 2083/92 of 14 July 1992	L 208	15	24.7.1992
► <u>M3</u> Commission Regulation (EEC) No 207/93 of 29 January 1993	L 25	5	2.2.1993
► <u>M4</u> Commission Regulation (EEC) No 2608/93 of 23 September 1993	L 239	10	24.9.1993
► <u>M5</u> Commission Regulation (EC) No 468/94 of 2 March 1994	L 59	1	3.3.1994
► <u>M6</u> Council Regulation (EC) No 1468/94 of 20 June 1994	L 159	11	28.6.1994
► <u>M7</u> Commission Regulation (EC) No 2381/94 of 30 September 1994	L 255	84	1.10.1994
► <u>M8</u> Commission Regulation (EC) No 1201/95 of 29 May 1995	L 119	9	30.5.1995
► <u>M9</u> Commission Regulation (EC) No 1202/95 of 29 May 1995	L 119	11	30.5.1995
► <u>M10</u> Council Regulation (EC) No 1935/95 of 22 June 1995	L 186	1	5.8.1995
► <u>M11</u> Commission Regulation (EC) No 418/96 of 7 March 1996	L 59	10	8.3.1996
► <u>M12</u> Commission Regulation (EC) No 1488/97 of 29 July 1997	L 202	12	30.7.1997
► <u>M13</u> Commission Regulation (EC) No 1900/98 of 4 September 1998	L 247	6	5.9.1998
► <u>M14</u> Commission Regulation (EC) No 330/1999 of 12 February 1999	L 40	23	13.2.1999
► <u>M15</u> Council Regulation (EC) No 1804/1999 of 19 July 1999	L 222	1	24.8.1999
► <u>M16</u> Commission Regulation (EC) No 331/2000 of 17 December 1999	L 48	1	19.2.2000
► <u>M17</u> Commission Regulation (EC) No 1073/2000 of 19 May 2000	L 119	27	20.5.2000
► <u>M18</u> Commission Regulation (EC) No 1437/2000 of 30 June 2000	L 161	62	1.7.2000
► <u>M19</u> Commission Regulation (EC) No 2020/2000 of 25 September 2000	L 241	39	26.9.2000
► <u>M20</u> Commission Regulation (EC) No 436/2001 of 2 March 2001	L 63	16	3.3.2001
► <u>M21</u> Commission Regulation (EC) No 2491/2001 of 19 December 2001	L 337	9	20.12.2001
► <u>M22</u> Commission Regulation (EC) No 473/2002 of 15 March 2002	L 75	21	16.3.2002
► <u>M23</u> Commission Regulation (EC) No 223/2003 of 5 February 2003	L 31	3	6.2.2003
► <u>M24</u> Commission Regulation (EC) No 599/2003 of 1 April 2003	L 85	15	2.4.2003
► <u>M25</u> Council Regulation (EC) No 806/2003 of 14 April 2003	L 122	1	16.5.2003
► <u>M26</u> Commission Regulation (EC) No 2277/2003 of 22 December 2003	L 336	68	23.12.2003
► <u>M27</u> amended by Commission Regulation (EC) No 779/2004 of 26 April 2004	L 123	63	27.4.2004
► <u>M28</u> Council Regulation (EC) No 392/2004 of 24 February 2004	L 65	1	3.3.2004
► <u>M29</u> Commission Regulation (EC) No 746/2004 of 22 April 2004	L 122	10	26.4.2004
► <u>M30</u> Commission Regulation (EC) No 1481/2004 of 19 August 2004	L 272	11	20.8.2004
► <u>M31</u> Commission Regulation (EC) No 2254/2004 of 27 December 2004	L 385	20	29.12.2004
► <u>M32</u> Commission Regulation (EC) No 1294/2005 of 5 August 2005	L 205	16	6.8.2005
► <u>M33</u> Commission Regulation (EC) No 1318/2005 of 11 August 2005	L 210	11	12.8.2005
► <u>M34</u> Commission Regulation (EC) No 1336/2005 of 12 August 2005	L 211	11	13.8.2005
► <u>M35</u> Council Regulation (EC) No 1567/2005 of 20 September 2005	L 252	1	28.9.2005

▷ <u>M36</u>	Commission Regulation (EC) No 1916/2005 of 24 November 2005	L 307	10	25.11.2005
▷ <u>M37</u>	Commission Regulation (EC) No 592/2006 of 12 April 2006	L 104	13	13.4.2006
▷ <u>M38</u>	Commission Regulation (EC) No 699/2006 of 5 May 2006	L 121	36	6.5.2006

Amended by:

▷ <u>A1</u>	Act of Accession of Austria, Sweden and Finland (adapted by Council Decision 95/1/EC, Euratom, ECSC)	C 241 L 1	21 1	29.8.1994 1.1.1995
▷ <u>A2</u>	Act concerning the conditions of accession of the Czech Republic, the Republic of Estonia, the Republic of Cyprus, the Republic of Latvia, the Republic of Lithuania, the Republic of Hungary, the Republic of Malta, the Republic of Poland, the Republic of Slovenia and the Slovak Republic and the adjustments to the Treaties on which the European Union is founded	L 236	33	23.9.2003

Corrected by:

- ▷ C1 Corrigendum, OJ L 021 , 28.1.1995, p. 21 (2381/1994)
- ▷ C2 Corrigendum, OJ L 344 , 20.11.2004, p. 40 (746/2004)

VE

COUNCIL REGULATION (EEC) No 2092/91

of 24 June 1991

on organic production of agricultural products and indications referring thereto on agricultural products and foodstuffs

THE COUNCIL OF THE EUROPEAN COMMUNITIES,

Having regard to the Treaty establishing the European Economic Community, and in particular Article 43 thereof,

Having regard to the proposal from the Commission ⁽¹⁾,

Having regard to the opinion of the European Parliament ⁽²⁾,

Having regard to the opinion of the Economic and Social Committee ⁽³⁾,

Whereas demand from consumers for organically produced agricultural products and foodstuffs is increasing; whereas a new market for agricultural products is thus being created by this phenomenon;

Whereas the market price for such products is higher, while the way in which they are produced involves less intensive use of land; whereas, therefore, in the context of the reorientation of the common agricultural policy, this type of production may contribute towards the attainment of a better balance between supply of, and demand for, agricultural products, the protection of the environment and the conservation of the countryside;

Whereas, in response to the rising demand, agricultural products and foodstuffs are being placed on the market with indications stating or implying to purchasers that they have been produced organically or without the use of synthetic chemicals;

Whereas some Member States have already adopted rules and inspection arrangements for the use of such indications;

Whereas a framework of Community rules on production, labelling and inspection will enable organic farming to be protected in so far as it will ensure conditions of fair competition between the producers of products bearing such indications and give the market for organic products a more distinctive profile by ensuring transparency at all stages of production and processing, thereby improving the credibility of such products in the eyes of consumers;

Whereas organic production methods constitute a specific form of production at farm level; whereas, consequently, it should be provided that, on the labelling of processed products, indications referring to organic production methods should relate to the ingredients obtained by such methods;

Whereas, for the implementation of the arrangements concerned, provision should be made for flexible procedures whereby certain technical details or measures may be amended, amplified or further defined in order to take account of experience gained; whereas, within a suitable period, this Regulation will be supplemented by equivalent rules covering livestock production;

Whereas, in the interests of the producers and purchasers of products bearing indications referring to organic production methods, the minimum principles which must be complied with in order for products to be presented with such indications should be laid down;

Whereas organic production methods entail significant restrictions on the use of fertilizers and pesticides which may have detrimental effects on the environment or result in the presence of residues in agricultural produce; whereas, in this context, practices accepted in the Community when this Regulation is adopted must be complied with in accordance with codes of practice followed in the Community when this Regulation

⁽¹⁾ OJ No C 4, 9. 1. 1990, p. 4; and

OJ No C 101, 18. 4. 1991, p. 13.

⁽²⁾ OJ No C 186, 22. 4. 1991, p. 27.

⁽³⁾ OJ No C 182, 23. 7. 1990, p. 12.

▼BE

is adopted; whereas, moreover, in the future, the principles governing the authorization of products which may be used in this type of farming must be established;

Whereas, moreover, organic farming involves varied cultivation practices and limited use of non-synthetic fertilizers and conditioners of low solubility; whereas these practices should be specified and conditions for the use of certain non-synthetic products laid down;

Whereas the procedures laid down make possible, if this appears necessary, the addition to Annex I of more specific provisions aimed at avoiding the presence of certain residues of synthetic chemicals from sources other than agriculture (environmental contamination) in the products obtained by such production methods;

Whereas, to ensure compliance with the rules on production, all stages of production and marketing should normally be subject to inspection;

Whereas all operators producing, preparing, importing or marketing products bearing indications referring to organic production methods must be subject to a regular inspection system, meeting minimum Community requirements and carried out by designated inspection authorities and/or by approved and supervised bodies; whereas provision should be made for a Community indication of inspection to appear on the labelling of the products concerned,

HAS ADOPTED THIS REGULATION:

Scope

▼MES

Article 1

1. This Regulation shall apply to the following products, where such products bear, or are intended to bear, indications referring to the organic production method:

- (a) unprocessed agricultural crop products; also livestock and unprocessed livestock products, to the extent that principles of production and specific inspection rules for them are introduced in Annexes I and III;
- (b) processed agricultural crop and livestock products intended for human consumption prepared essentially from one or more ingredients of plant and/or animal origin;
- (c) feedingstuffs, compound feedingstuffs and feed materials not covered under subparagraph (a) as from the entry into force of this Regulation referred to in paragraph 3.

2. By way of derogation from paragraph 1, where the detailed production rules are not laid down in Annex I for certain animal species, the rules provided for labelling in Article 5 and for the inspections in Articles 8 and 9 shall apply for these species and the products therefrom, with the exception of aquaculture and aquaculture products. Pending the inclusion of detailed production rules, national rules or in the absence thereof private standards accepted or recognised by the Member States shall apply.

3. The Commission shall, not later than 24 August 2001, propose a regulation in accordance with the procedure in Article 14 providing for labelling requirements as well as inspection requirements and precautionary measures for products mentioned in paragraph (1)(c), as far as these requirements are related to the organic production method.

Pending the adoption of the Regulation referred to in the first subparagraph for the products mentioned in paragraph (1)(c), national rules in conformity with Community law or, in the absence thereof, private standards accepted or recognised by the Member States shall apply.

▼M28

Article 2

For the purposes of this Regulation a product shall be regarded as bearing indications referring to the organic production method where, in the labelling, advertising material or commercial documents, such a product, its ingredients or feed materials are described in terms suggesting to the purchaser that the product, its ingredients or feed materials have been obtained in accordance with the rules of production laid down in Article 6. In particular, the following terms or their usual derivatives (such as bio, eco etc.) or diminutives, alone or combined, shall be regarded as indications referring to the organic production method throughout the Community and in any Community language, unless they are not applied to agricultural products in foodstuffs or feeding-stuffs or clearly have no connection with this method of production:

— in Spanish:	ecológico,
— in Danish:	økologisk,
— in German:	ökologisch, biologisch,
— in Greek:	βιολογικό,
— in English:	organic,
— in French:	biologique,
— in Italian:	biologico,
— in Dutch:	biologisch,
— in Portuguese:	biológico,
— in Finnish:	luonnonmukainen,
— in Swedish:	ekologisk.

▼M15

Article 3

This Regulation shall apply without prejudice to other Community provisions or national provisions, in conformity with Community law, concerning products specified in Article 1, such as provisions governing the production, preparation, marketing, labelling and inspection, including legislation in foodstuffs and animal nutrition.

▼B

Definitions

Article 4

For the purpose of this Regulation:

1. 'labelling' shall mean any words, particulars, trade marks, brand names, pictorial matter or symbols on any packaging, document, notice, label, board or collar accompanying or referring to a product specified in Article 1;

▼M14

2. 'production' shall mean the operations on the agricultural holding involved in producing, packaging and initially labelling as products of organic production agricultural products produced on that holding;

▼M15

3. 'preparation' shall mean the operations of preserving and/or processing of agricultural products (including slaughter and cutting for livestock products), and also packaging and/or alterations made to the labelling concerning the presentation of the organic production method of the fresh, preserved and/or processed products;

▼M22

IIIa Preparations to be surface-spread between cultivated plants

Name	Description, compositional requirements, conditions for use
Iron (III) orthophosphate	Molluscicide

▼M12

IV. Other substances from traditional use in organic farming

▼M22

Name	Description, compositional requirements, conditions for use
Copper in the form of copper hydroxide, copper oxychloride, (tribasic) copper sulphate, cuprous oxide	<p>Fungicide</p> <p>Until 31 December 2005 up to a maximum of 8 kg copper per hectare per year, and from 1 January 2006 up to 6 kg copper per ha per year, without prejudice to a more limited quantity if laid down under the specific terms of the general legislation on plant protection products in the Member State where the product is to be used</p> <p>For perennial crops, Member States may, by derogation to the previous paragraph, provide that the maximum levels apply as follows:</p> <ul style="list-style-type: none"> — the total maximum quantity used from 23 March 2002 until 31 December 2006 shall not exceed 38 kg copper per ha — from 1 January 2007, the maximum quantity which may be used each year per ha shall be calculated by subtracting the quantities actually used in the 4 preceding years from, respectively, 36, 34, 32 and 30 kg copper for the years 2007, 2008, 2009 and 2010 and following years <p>Need recognised by the inspection body or inspection authority</p>
(*) Ethylene	<p>Degreening of bananas, kiwis and kakis; Flower induction of pineapple</p> <p>Need recognised by the inspection body or inspection authority</p>
Fatty acid potassium salt (soft soap)	Insecticide
(*) Potassium alum (Kalinite)	Prevention of ripening of bananas
Lime sulphur (calcium polysulphide)	<p>Fungicide, insecticide, acaricide;</p> <p>need recognised by the inspection body or inspection authority.</p>
Paraffin oil	Insecticide, acaricide

▼M33

▼M12

▼M17

▼M12

Attachment 4

New Zealand Food Safety Authority
PO Box 2835, Wellington, New Zealand

NZFSA Standard OP3, Appendix Two:

*NZFSA Technical Rules for
Organic Production*

November 2006 Version Six

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RULES OF ORGANIC PRODUCTION

1.0 INTRODUCTION

- 1.1 Originally issued in draft form as an extract (with MAF/NZFSA comments) in July 2000 from the relevant EU Regulation, and subsequently amended to incorporate United States National Organic Standard requirements, this document describes the scope and rules of production applying to NZFSA standards for giving official assurances of organic production to importing countries. It includes details of requirements for complying with NZFSA Standards OP1, OP2, and OP3.
 - 1.2 It has been updated to take account of New Zealand law, for instance on food safety or animal welfare, other related standards and definitions, local production patterns and the like, rather than relying almost exclusively on the EU and US sources. This also takes into account that other markets are likely to seek official assurances of organic production from NZFSA as the relevant New Zealand Government agency.
 - 1.3 The *Rules* are envisaged as the Third Party Agency's (TPA) main reference point for what is required of organic production. In the absence of a New Zealand national standard it will be the yardstick against which the TPA will undertake verification and put forward a recommendation on official assurances on organic products intended for export under the NZFSA programme.
 - 1.4 In many instances organic production methods already in existence in New Zealand may be compatible with the overseas requirements. TPAs may designate a standard of production already in existence in New Zealand to verify against. In these instances an independent review of the designated standard against the *Rules* will be required.
 - 1.5 TPAs need to be fully conversant with the details of the *Rules* relevant to the style of organic production they are verifying.
 - 1.6 Entry into organic production involves a transition or conversion period from "conventional" to an organic system, and verification of this conversion process also forms a part of the requirements to be met.
 - 1.7 These are the minimum requirements for organic production, and operators may choose to adopt higher standards.
- Interpretations and/or changes to this document will be co-ordinated by NZFSA, on recommendation from the Organic Technical Committee. NZFSA interpretations may be added where clarification of the rules is required.
- 1.8 Proposals for dispensation will be accepted by NZFSA, provided it can be demonstrated to NZFSA's satisfaction that the required outcomes will be achieved.

- 1.9 Some organic products may not need an official organic assurance in order to gain access into an overseas market covered by this programme e.g. organic salt.

II. Micro-organisms used for biological pest control

Name	Description; composition requirements; conditions for use
Micro-organisms (bacteria, viruses and fungi) e.g. <i>Bacillus thuringensis</i> , <i>Granulosis virus</i> , etc.	Not genetically modified

III. Substances to be used in traps and/or dispensers

General conditions:

- the traps and/or dispensers must prevent the penetration of the substances in the environment and prevent contact of the substances with the crops under cultivation.
- the traps must be collected after use and disposed of safely.

Name	Description; composition requirements; conditions for use
Diammonium phosphate	Attractant; Only in traps
Pheromones	Attractant, sexual behaviour disrupter Only in traps and dispensers.

IV. Other substances from traditional use in organic farming

Name	Description; compositional requirements; conditions for use
Copper in the form of copper hydroxide, copper oxychloride, (tribasic) copper sulphate, cuprous oxide	Fungicide; Until 31 December 2005 up to a maximum of 8 kg copper per hectare per year, and from 1 January 2006 up to 6 kg copper per ha per year, without prejudice to a more limited quantity if laid down under the specific terms of the general legislation on plant protection products in the country where the product is to be used; For perennial crops, operators may, by derogation to the previous paragraph, provide that the maximum levels apply as follows: <ul style="list-style-type: none"> - the total maximum quantity used from 23 March 2002 until 31 December 2006 shall not exceed 38 kg copper per ha - from 1 January 2007, the maximum quantity which may be used each year per ha shall be calculated by subtracting the quantities actually used in the 4 preceding years from, respectively, 36, 34, 32, and 30 kg copper for the years 2007, 2008, 2009 and 2010 and following years Need recognised by the TPA.
Ethylene	Degreening bananas and early season kiwifruit
Lime sulphur (calcium polysulphide)	Fungicide, insecticide, acaricide;

WMS
JADA'S

The National Organic Program

National List -- Regulatory Text

Subpart G - Administrative

The National List of Allowed and Prohibited Substances

§ 205.600 Evaluation criteria for allowed and prohibited substances, methods, and ingredients.

The following criteria will be utilized in the evaluation of substances or ingredients for the organic production and handling sections of the National List:

(a) Synthetic and nonsynthetic substances considered for inclusion on or deletion from the National List of allowed and prohibited substances will be evaluated using the criteria specified in the Act (7 U.S.C. 6517 and 6518).

(b) In addition to the criteria set forth in the Act, any synthetic substance used as a processing aid or adjuvant will be evaluated against the following criteria:

(1) The substance cannot be produced from a natural source and there are no organic substitutes;

(2) The substance's manufacture, use, and disposal do not have adverse effects on the environment and are done in a manner compatible with organic handling;

(3) The nutritional quality of the food is maintained when the substance is used, and the substance, itself, or its breakdown products do not have an adverse effect on human health as defined by applicable Federal regulations;

(4) The substance's primary use is not as a preservative or to recreate or improve flavors, colors, textures, or nutritive value lost during processing, except where the replacement of nutrients is required by law;

(5) The substance is listed as generally recognized as safe (GRAS) by Food and Drug Administration (FDA) when used in accordance with FDA's good manufacturing practices (GMP) and contains no residues of heavy metals or other contaminants in excess of tolerances set by FDA; and

(6) The substance is essential for the handling of organically produced agricultural products.

(c) Nonsynthetics used in organic processing will be evaluated using the criteria specified in the Act (7 U.S.C. 6517 and 6518).

§ 205.601 Synthetic substances allowed for use in organic crop production.

In accordance with restrictions specified in this section, the following synthetic substances may be used in organic crop production: Provided, That, use of such substances do not contribute to contamination of crops, soil, or water. Substances allowed by this section, except disinfectants and sanitizers in paragraph (a) and those substances in paragraphs (c), (j), (k), and (l) of this section, may only be used when the provisions set forth in § 205.206 (a) through (d) prove insufficient to prevent or control the target pest.

(a) As algicide, disinfectants, and sanitizer, including irrigation system cleaning systems.

(1) Alcohols.

(i) Ethanol.

(ii) Isopropanol.

(2) Chlorine materials - Except, That, residual chlorine levels in the water shall not exceed the maximum residual disinfectant limit under the Safe Drinking Water Act.

(i) Calcium hypochlorite.

(ii) Chlorine dioxide.

(iii) Sodium hypochlorite.

(3) Copper sulfate--for use as an algicide in aquatic rice systems, is limited to one application per field during any 24-month period. Application rates are limited to those which do not increase baseline soil test values for copper over a timeframe agreed upon by the producer and accredited certifying agent.

(4) Hydrogen peroxide.

(5) Ozone gas--for use as an irrigation system cleaner only.

(6) Peracetic acid--for use in disinfecting equipment, seed, and asexually propagated planting material.

(7) Soap-based algicide/demossers.

(b) As herbicides, weed barriers, as applicable.

(1) Herbicides, soap-based - for use in farmstead maintenance (roadways, ditches, right of ways, building perimeters) and ornamental crops.

(2) Mulches.

(i) Newspaper or other recycled paper, without glossy or colored inks.

(ii) Plastic mulch and covers (petroleum-based other than polyvinyl chloride (PVC)).

(c) As compost feedstocks.

Newspapers or other recycled paper, without glossy or colored inks.

(d) As animal repellents.

Soaps, ammonium - for use as a large animal repellent only, no contact with soil or edible portion of crop.

(e) As insecticides (including acaricides or mite control).

(1) Ammonium carbonate - for use as bait in insect traps only, no direct contact with crop or soil.

(2) Boric acid - structural pest control, no direct contact with organic food or crops.

(3) Copper Sulfate - for use as tadpole shrimp control in aquatic rice production, is limited to

one application per field during any 24-month period. Application rates are limited to levels which do not increase baseline soil test values for copper over a timeframe agreed upon by the producer and accredited certifying agent.

(4) Elemental sulfur.

(5) Lime sulfur - including calcium polysulfide.

(6) Oils, horticultural - narrow range oils as dormant, suffocating, and summer oils..

(7) Soaps, insecticidal.

(8) Sticky traps/barriers.

(f) As insect management. Pheromones.

(g) As rodenticides.

(1) Sulfur dioxide - underground rodent control only (smoke bombs).

(2) Vitamin D3.

(h) As slug or snail bait - None.

(i) As plant disease control.

(1) Coppers, fixed - copper hydroxide, copper oxide, copper oxychloride, includes products exempted from EPA tolerance, Provided, That, copper-based materials must be used in a manner that minimizes accumulation in the soil and shall not be used as herbicides.

(2) Copper sulfate - Substance must be used in a manner that minimizes accumulation of copper in the soil.

(3) Hydrated lime.

(4) Hydrogen peroxide.

(5) Lime sulfur.

(6) Oils, horticultural, narrow range oils as dormant, suffocating, and summer oils.

(7) Peracetic acid - for use to control fire blight bacteria.

(8) Potassium bicarbonate.

(9) Elemental sulfur.

(10) Streptomycin, for fire blight control in apples and pears only.

(11) Tetracycline (oxytetracycline calcium complex), for fire blight control only.

(j) As plant or soil amendments.

(1) Aquatic plant extracts (other than hydrolyzed) - Extraction process is limited to the use of potassium hydroxide or sodium hydroxide; solvent amount used is limited to that amount necessary for extraction.

- (2) Elemental sulfur.
- (3) Humic acids - naturally occurring deposits, water and alkali extracts only.
- (4) Lignin sulfonate - chelating agent, dust suppressant, floatation agent.
- (5) Magnesium sulfate - allowed with a documented soil deficiency.
- (6) Micronutrients - not to be used as a defoliant, herbicide, or desiccant. Those made from nitrates or chlorides are not allowed. Soil deficiency must be documented by testing.
 - (i) Soluble boron products.
 - (ii) Sulfates, carbonates, oxides, or silicates of zinc, copper, iron, manganese, molybdenum, selenium, and cobalt.
- (7) Liquid fish products - can be pH adjusted with sulfuric, citric or phosphoric acid. The amount of acid used shall not exceed the minimum needed to lower the pH to 3.5.
- (8) Vitamins, B1, C, and E.
- (k) As plant growth regulators. Ethylene gas - for regulation of pineapple flowering.
- (l) As floating agents in postharvest handling.
 - (1) Lignin sulfonate.
 - (2) Sodium silicate - for tree fruit and fiber processing.
- (m) As synthetic inert ingredients as classified by the Environmental Protection Agency (EPA), for use with nonsynthetic substances or synthetic substances listed in this section and used as an active pesticide ingredient in accordance with any limitations on the use of such substances.
 - (1) EPA List 4 - Inerts of Minimal Concern.
 - (2) EPA List 3 - Inerts of unknown toxicity - for use only in passive pheromone dispensers.
- (n)-(z) [Reserved]

[65 FR 80656, Dec. 21, 2000, as amended at 68 FR 61992, Oct. 31, 2003]

§ 205.602 Nonsynthetic substances prohibited for use in organic crop production.

The following nonsynthetic substances may not be used in organic crop production:

- (a) Ash from manure burning.
- (b) Arsenic.
- (c) Calcium chloride, brine process is natural and prohibited for use except as a foliar spray to treat a physiological disorder associated with calcium uptake.
- (d) Lead salts.
- (e) Potassium chloride – unless derived from a mined source and applied in a manner that

minimizes chloride accumulation in the soil.

(f) Sodium fluoaluminate (mined).

(g) Sodium nitrate - unless use is restricted to no more than 20% of the crop's total nitrogen requirement; use in spirulina production is unrestricted until October 21, 2005.

(h) Strychnine.

(i) Tobacco dust (nicotine sulfate).

(j)-(z) [Reserved]

[65 FR 80657, Dec. 21, 2000, as amended at 68 FR 61992, Oct. 31, 2003]

§ 205.603 Synthetic substances allowed for use in organic livestock production.

In accordance with restrictions specified in this section the following synthetic substances may be used in organic livestock production:

(a) As disinfectants, sanitizer, and medical treatments as applicable.

(1) Alcohols.

(i) Ethanol-disinfectant and sanitizer only, prohibited as a feed additive.

(ii) Isopropanol-disinfectant only.

(2) Aspirin-approved for health care use to reduce inflammation.

(3) Biologics-Vaccines.

(4) Chlorhexidine - Allowed for surgical procedures conducted by a veterinarian. Allowed for use as a teat dip when alternative germicidal agents and/or physical barriers have lost their effectiveness.

(5) Chlorine materials - disinfecting and sanitizing facilities and equipment. Residual chlorine levels in the water shall not exceed the maximum residual disinfectant limit under the Safe Drinking Water Act.

(i) Calcium hypochlorite.

(ii) Chlorine dioxide.

(iii) Sodium hypochlorite.

(6) Electrolytes-without antibiotics.

(7) Glucose.

(8) Glycerine - Allowed as a livestock teat dip, must be produced through the hydrolysis of fats or oils.

(9) Hydrogen peroxide.

(10) Iodine.

(11) Magnesium sulfate.

(12) Oxytocin - use in postparturition therapeutic applications.

(13) Paraciticides. Ivermectin - prohibited in slaughter stock, allowed in emergency treatment for dairy and breeder stock when organic system plan-approved preventive management does not prevent infestation. Milk or milk products from a treated animal cannot be labeled as provided for in subpart D of this part for 90 days following treatment. In breeder stock, treatment cannot occur during the last third of gestation if the progeny will be sold as organic and must not be used during the lactation period for breeding stock.

(14) Phosphoric acid - allowed as an equipment cleaner, Provided, That, no direct contact with organically managed livestock or land occurs.

(b) As topical treatment, external parasiticide or local anesthetic as applicable.

(1) Copper sulfate.

(2) Iodine.

(3) Lidocaine - as a local anesthetic. Use requires a withdrawal period of 90 days after administering to livestock intended for slaughter and 7 days after administering to dairy animals.

(4) Lime, hydrated - as an external pest control, not permitted to cauterize physical alterations or deodorize animal wastes.

(5) Mineral oil - for topical use and as a lubricant.

(6) Procaine - as a local anesthetic, use requires a withdrawal period of 90 days after administering to livestock intended for slaughter and 7 days after administering to dairy animals.

(c) As feed supplements - Milk replacers without antibiotics, as emergency use only, no nonmilk products or products from BST treated animals.

(d) As feed additives.

(1) DL - Methionine, DL-Methionine - hydroxy analog, and DL-Methionine - hydroxy analog calcium (CAS#-59-51-8; 63-68-3; 348-67-4) - for use only in organic poultry production until October 1, 2008.

(2) Trace minerals, used for enrichment or fortification when FDA approved.

(3) Vitamins, used for enrichment or fortification when FDA approved.

(e) As synthetic inert ingredients as classified by the Environmental Protection Agency (EPA), for use with nonsynthetic substances or a synthetic substances listed in this section and used as an active pesticide ingredient in accordance with any limitations on the use of such substances.

(1) EPA List 4 - Inerts of Minimal Concern.

(f)-(z) [Reserved]

[65 FR 80657, Dec. 21, 2000, as amended at 68 FR 61992, Oct. 31, 2003; 70 FR 61219, Oct. 21, 2005]

§ 205.604 Nonsynthetic substances prohibited for use in organic livestock production.

The following nonsynthetic substances may not be used in organic livestock production:

(a) Strychnine.

(b)-(z) [Reserved]

§ 205.605 Nonagricultural (nonorganic) substances allowed as ingredients in or on processed products labeled as "organic" or "made with organic (specified ingredients or food groups(s))."

The following nonagricultural substances may be used as ingredients in or on processed products labeled as "organic" or "made with organic (specified ingredients or food group(s))" only in accordance with any restrictions specified in this section.

(a) Nonsynthetics allowed:

Acids (Alginic; Citric - produced by microbial fermentation of carbohydrate substances; and Lactic).

Agar-agar.

Animal enzymes – (Rennet - animals derived; Catalase – bovine liver; Animal lipase; Pancreatin; Pepsin; and Trypsin).

Bentonite.

Calcium carbonate.

Calcium chloride.

Calcium sulfate - mined.

Carageenan.

Colors, nonsynthetic sources only.

Dairy cultures.

Diatomaceous earth - food filtering aid only.

Enzymes--must be derived from edible, nontoxic plants, nonpathogenic fungi, or nonpathogenic bacteria.

Flavors, nonsynthetic sources only and must not be produced using synthetic solvents and carrier systems or any artificial preservative.

Glucono delta-lactone – production by the oxidation of D-glucose with bromine water is prohibited.

Kaolin.

Magnesium sulfate, nonsynthetic sources only.

Nitrogen - oil-free grades.

Oxygen--oil-free grades.

Perlite--for use only as a filter aid in food processing.

Potassium chloride.

Potassium iodide.

Sodium bicarbonate.

Sodium carbonate.

Tartaric acid.

Waxes - nonsynthetic (Carnauba wax; and Wood resin).

Yeast - nonsynthetic, growth on petrochemical substrate and sulfite waste liquor is prohibited (Autolysate; Bakers; Brewers; Nutritional; and Smoked - nonsynthetic smoke flavoring process must be documented).

(b) Synthetics allowed:

Alginates.

Ammonium bicarbonate - for use only as a leavening agent.

Ammonium carbonate - for use only as a leavening agent.

Ascorbic acid.

Calcium citrate.

Calcium hydroxide.

Calcium phosphates (monobasic, dibasic, and tribasic).

Carbon dioxide.

Cellulose - for use in regenerative casings, as an anti-caking agent (non-chlorine bleached) and filtering aid.

Chlorine materials - disinfecting and sanitizing food contact surfaces, Except, That, residual chlorine levels in the water shall not exceed the maximum residual disinfectant limit under the Safe Drinking Water Act (Calcium hypochlorite; Chlorine dioxide; and Sodium hypochlorite).

Ethylene - allowed for postharvest ripening of tropical fruit and degreening of citrus.

Ferrous sulfate - for iron enrichment or fortification of foods when required by regulation or recommended (independent organization).

Glycerides (mono and di) - for use only in drum drying of food.

Glycerin - produced by hydrolysis of fats and oils.

Hydrogen peroxide.

Lecithin - bleached.

Magnesium carbonate - for use only in agricultural products labeled "made with organic (specified ingredients or food group(s))," prohibited in agricultural products labeled "organic."

Magnesium chloride - derived from sea water.

Magnesium stearate - for use only in agricultural products labeled "made with organic (specified ingredients or food group(s))," prohibited in agricultural products labeled "organic."

Nutrient vitamins and minerals, in accordance with 21 CFR 104.20, Nutritional Quality Guidelines For Foods.

Ozone.

Pectin (low-methoxy).

Phosphoric acid - cleaning of food-contact surfaces and equipment only.

Potassium acid tartrate.

Potassium tartrate made from tartaric acid.

Potassium carbonate.

Potassium citrate.

Potassium hydroxide - prohibited for use in lye peeling of fruits and vegetables except when used for peeling peaches during the Individually Quick Frozen (IQF) production process.

Potassium iodide - for use only in agricultural products labeled "made with organic (specified ingredients or food group(s))," prohibited in agricultural products labeled "organic."

Potassium phosphate - for use only in agricultural products labeled "made with organic (specified ingredients or food group(s))," prohibited in agricultural products labeled "organic."

Silicon dioxide.

Sodium citrate.

Sodium hydroxide - prohibited for use in lye peeling of fruits and vegetables.

Sodium phosphates - for use only in dairy foods.

Sulfur dioxide - for use only in wine labeled "made with organic grapes," Provided, That, total sulfite concentration does not exceed 100 ppm.

Tartaric acid.

Tocopherols - derived from vegetable oil when rosemary extracts are not a suitable alternative.

Xanthan gum.

(c)-(z) [Reserved]

[65 FR 80657, Dec. 21, 2000, as amended at 68 FR 61993, Oct. 31, 2003, and 68 FR 62217, Nov 3, 2003]

§ 205.606 Nonorganically produced agricultural products allowed as ingredients in or on processed products labeled as "organic."

Only the following nonorganically produced agricultural products may be used as ingredients in or on processed products labeled as "organic," only in accordance with any restrictions specified in this section, and only when the product is not commercially available in organic form.

(a) Cornstarch (native).

(b) Gums - water extracted only (arabic, guar, locust bean, carob bean).

(c) Kelp - for use only as a thickener and dietary supplement.

(d) Lecithin - unbleached.

(e) Pectin (high-methoxy).

§ 205.607 Amending the National List.

(a) Any person may petition the National Organic Standard Board for the purpose of having a substance evaluated by the Board for recommendation to the Secretary for inclusion on or deletion from the National List in accordance with the Act.

(b) A person petitioning for amendment of the National List should request a copy of the petition procedures from the USDA at the address in § 205.607(c).

(c) A petition to amend the National List must be submitted to: Program Manager, USDA/AMS/TMP/NOP, 1400 Independence Ave., SW., Room 4008-So., Ag Stop 0268, Washington, DC 20250.

[65 FR 80656, Dec. 21, 2000, as amended at 68 FR 61992, Oct. 31, 2003]



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Reg # 10330-12

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

AUG 2 1995

OFFICE OF
PREVENTION, PESTICIDES AND
TOXIC SUBSTANCES

Mr. A. G. Vilkas
Praxair, Inc.
39 Old Ridgeway Road
Danbury, CT 06810-5113

Dear Mr. Vilkas,

Subject: Reregistration
Banana Gas 32
EPA Registration No. 10330-12
Your Submission Dated January 9, 1995

We have reviewed your draft labeling submitted for the reregistration of ethylene, which was revised per our letter of December 29, 1994. In addition, we have received the faxed copy of your "collar" label, which deletes the word "warning", to comply with regulations requiring only one signal word on pesticide labeling.

Therefore, the labeling referred to above, submitted in compliance with the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), as amended, is acceptable. A stamped copy is enclosed for your records. Five (5) copies of the final printed labels must be submitted prior to releasing the product for shipment.

Sincerely,

Janet L. Andersen
Janet L. Andersen, Ph.D.
Acting Director
Biopesticides and Pollution
Prevention Division
(7501W)

Enclosure

Attachment 6

DANGER: HIGH PRESSURE LIQUID AND GAS MIXTURE. HARMFUL IF INHALED. CAN CAUSE RAPID SUFFOCATION. MAY CAUSE FROSTBITE. CAN INCREASE RESPIRATION AND HEART RATE. MAY CAUSE NERVOUS SYSTEM DAMAGE. MAY CAUSE DIZZINESS AND DROWSINESS.

BANANA GAS 32

FRUIT RIPENING OR DEGREENING GAS MIXTURE

Active Ingredient: Ethylene.....6.3%
CAS: 74-85-1

Inert Ingredient: Carbon Dioxide.....93.7%
CAS: 124-38-9

ACCEPTED
8/2/95
Under the Federal Insecticide, Fungicide, and Rodenticide Act, as amended, for the pesticide registered under EPA Reg. No. 103.20-12

Keep Out Of the Reach Of Children Total 100.0%

DANGER!

STATEMENTS OF PRACTICAL TREATMENT

- IF IN EYES: Flush with plenty of water. Call a physician
- IF ON SKIN: Wash with plenty of soap and water. Get medical attention.
- IF INHALED: Remove victim to fresh air. If not breathing, give artificial respiration. Get medical attention.

PRECAUTIONARY STATEMENTS:

HAZARDS TO HUMANS AND DOMESTIC ANIMALS

DANGER!

Liquefied or pressurized gas can cause frost burns. Do not get in eyes or on skin. Wear long-sleeved shirt, long pants, boots, goggles and chemical resistant gloves while handling cylinders or any application equipment under pressure. Harmful if inhaled. Avoid breathing vapors. Do not enter unventilated treatment areas unless wearing a respirator approved by NIOSH/MSHA for this use.

PHYSICAL OR CHEMICAL HAZARDS

Contents under pressure. Keep away from fire, sparks and heated surfaces. Do not puncture or incinerate container. Exposure to temperature above 130 F may cause bursting. Use with equipment rated for cylinder pressure. Close valve when not in use and when empty. Cylinder temperature should not exceed 125F(52C). Use in accordance with tag attached to cylinder valve and Praxair Form MSDS L-4818(MSDS).

NOTE: Reverse flow into cylinder may cause rupture. Always use a back flow preventive device in piping.

LEAK: Evacuate area and keep personnel upwind. Use self-contained breathing apparatus and protective clothing, and shut off leak if without risk.

TIV: 5000ppm Carbon Dioxide (ACGIH 1994)

IN CASE OF EMERGENCY: Call 1-800-645-4633

FOR AGRICULTURAL AND INDUSTRIAL USE ONLY.

DOT/IMO Shipping Name: Compressed Gas, N.C.S. (Ethylene, Carbon Dioxide) UN1956

EPA Reg. No. 10330-12

EPA Est.No. 10330-

BATCH

Praxair, Inc.
Danbury, CT 06810-5113

PRAXAIR

Do not remove this label.

SCB-10600(2794)
1/95

Read the attached Directions for Use tag before using this product.

496

DO NOT DETACH THIS FOOTLET

BANANA GAS-32

ACTIVE INGREDIENT: ETHYLENE - 0.3%

INERT INGREDIENT: CARBON DIOXIDE 99.7%

BANGEN, HIGH PRESSURE, LIQUIFIED GAS, NONFLAMMABLE, APPROXIMATE PRESSURE WHEN FULL 130 PSIG AT 70°F.

DIRECTIONS FOR USE

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

CAN CAUSE RAPID SUPERHEATING DUE TO OXYGEN DEFICIENCY. Store and use with adequate ventilation. Do not enter places where used until adequately ventilated. Use with caution rates for cylinder pressure. Keep valve closed when not in use and when empty. In case of spill or leak, shut off leak, if without risk. Move leaking assembly to ventilated area, if without risk, or ventilate area of leak. If exposed to fire, move cylinder away from fire, if without risk. Observe good cylinder safety practices. The contents are nonflammable. Use only in accordance with directions given on this label and the safety instructions listed on the inside cover. See current Praxair, Inc. Material Safety Data Sheet, Form 1-4318 for additional safety information.

GENERAL PRECAUTIONS

1. Cylinders should be stored in a well-ventilated area. Do not enter places where used until adequately ventilated. Can cause rapid suffocation due to oxygen deficiency.
2. Use any metal connections and piping capable of withstanding a working pressure of 2,000 pounds per square inch.
3. CYLINDERS MUST BE SECURED IN AN UPRIGHT POSITION WHEN DISCHARGING.
4. CYLINDER VALVE OUTLET CONNECTION IS GAA 320 (RIGHT-HAND THREAD). USE A SPECIAL BANANA GAS-32 regulator.

STORAGE AND DISPOSAL

Return cylinders to supplier. Store and use with adequate ventilation. Cylinders should be stored in a well-ventilated area.

DIRECTIONS FOR USE

Before starting the treatment, it is necessary to determine the cubic content of the room by multiplying the length by the

width by the height. No allowance is made for the space occupied by the fruit. For instance, a room 20 feet long, 10 feet wide and 10 feet high contains 2,000 cubic feet.

Banana Gas-32 is introduced into the room in accurately measured quantities at regular intervals of time. The gas should be introduced from the cylinder through a regulator with a flowmeter calibrated for measuring flow in cubic feet per hour of Banana Gas-32. The gas then flows to the smothering rooms through metal pipes.

BANANAS - Each application should use a flow rate of 0.8 cubic feet per hour of Banana Gas-32 for a 2,000 cubic foot room. For each additional 1,000 cubic feet of space, increase the flow by 0.2 cubic feet per hour. Optimum flow rate should be determined by the banana grower based on trial and error with differences being made for whether the room is night or heating. Exposure time is 24 hours.

TOMATOES - Use a flow rate of 10 cubic feet per hour of Banana Gas-32 for each 2,000 cubic foot of space. The exposure time is 4 hours. The recommended humidity is 80-90 percent. Ventilate the tomato production room for 24 minutes after 6 hours of exposure. If necessary, re-gas the following day for an additional 6 hours.

PORTABLE BANANA GAS-32 PACKAGE

The Portable Banana Gas-32 Package has been developed for those customers who normally use only 1 to 2 gallons of ethylening gas per year. The package consists of a cylinder of the ethylening gas and a special regulator.

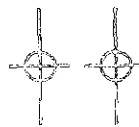
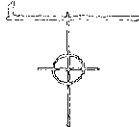
The Portable Banana Gas-32 Package consists of the following:

1. A cylinder of Banana Gas-32, 60 lbs. net weight.
2. A cylinder head cap for portability and ease of handling.
3. A special regulator-flowmeter.

OPERATING INSTRUCTIONS

1. Place the cylinder of Banana Gas-32 on the cylinder head cap and secure with the safety screw.
2. Attach the regulator-flowmeter to the cylinder valve. **NOTE: ENSURE THAT THE WASHER PROVIDED IS PLACED BETWEEN THE CYLINDER VALVE AND REGULATOR CONNECTION. TIGHTEN THE CONNECTION BUT WITH A SUITABLE WRISTEEN.**
3. Turn the knob on flowmeter clockwise to off.
4. Open cylinder valve slowly to the full open position. First pressure gauge should read between 60 to 1,000 psig.
5. Turn regulator adjusting screw clockwise until safety pressure gauge reads 16 psig, i.e., needle is now between the two red lines.

praxair.com Labeling



Praxair, Inc.

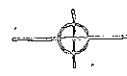
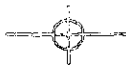
Danbury, CT 06810-5118

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PRAXAIR

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- Turn red knob on flowmeter counterclockwise until the small ball in the flow tube corresponds to the setting recommended. See Directions For Use.
- When not in use, turn the gas supply off by closing the cylinder valve first and then closing the flowmeter valve using the red knob.

BANANA GAS-32 PACKAGE

The Stationary Banana Gas-32 Manifold allows from 2 to 8 opening or degreasing rooms to be gassed from one cylinder of Banana Gas-32 at the same time. A single cylinder supplies gas to individual panel mounted flowmeters that are piped to the opening or degreasing room using 1/4-inch copper tubing.

The Stationary Banana Gas-32 Manifold consists of the following:

1. A cylinder of Banana Gas-32.
2. A cylinder wall mounting bracket.
3. A special Banana Gas-32 regulator.
4. A ready-to-install, factory-assembled flowmeter panel with flowmeters.

Piping: 1/4-inch copper tubing to rooms not included.

OPERATING INSTRUCTIONS

1. Secure cylinder of Banana Gas-32 to 1/2" cylinder wall mounting bracket.
2. Attach regulator to the cylinder valve.

NOTE: ENSURE THAT THE WASHER PROVIDED IS PLACED BETWEEN THE CYLINDER VALVE AND REGULATOR CONNECTION. TIGHTEN THE CONNECTION NUT WITH A SUITABLE WRENCH.

3. Turn the regulator adjustment handle counterclockwise until it rotates freely.
4. Turn red knob on flowmeter clockwise to 0.
5. Open cylinder valve slowly to the 1/4 turn position. Inlet pressure gauge should read between 500 to 7,000 psig.
6. Turn regulator adjusting screw clockwise until delivery pressure gauge reads 15 psig. I.e., needle is now between the two red lines.
7. Turn red knob on flowmeter counterclockwise until the small ball in the flow tube corresponds to the setting recommended. See Directions For Use.

When not in use, turn the gas supply off by closing the cylinder valve first and then closing the flowmeter valve using the red knob.

Gassing of the opening or degreasing room is accomplished by using the individual flowmeter piped to the room to be gassed and setting the recommended flow rate for that room.

NOTE: WHEN CYLINDER PRESSURE GAUGE REACHES 500 POUNDS OR LESS (NEEDLE IN THE RED ZONE OF THE GAUGE) REPLACE CYLINDER WITH A NEW CYLINDER OF BANANA GAS-32.

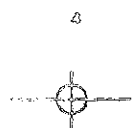
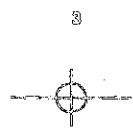
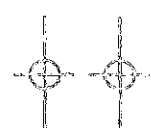
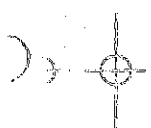
Flowmeter panel is designed for use on less than five (5) stations per panel and, because of space, additional flowmeter stations may easily be needed to meet future requirements, up to five (5) stations.

DANGER
High Pressure, Nonflammable, Liquefied Gas
BANANA GAS-32

Recommended Storage: To be used in air in a lightly enclosed treatment room. Do not open or degrease until time is ready to fill for market.

FLOWMETER	CYLN. PRESS. (PSI)	DELIV. PRESS. (PSI)	TEMP. (°F)	INLET PRESS. (PSI)	DELIV. PRESS. (PSI)	TYPE OF ROOM
BANANAS	50 - 7000	15	70°F	15-20	15	Lightly enclosed degreasing
REGULATORS	15	1000	70°F	15-20	15	Lightly enclosed degreasing (Use only on room tank)

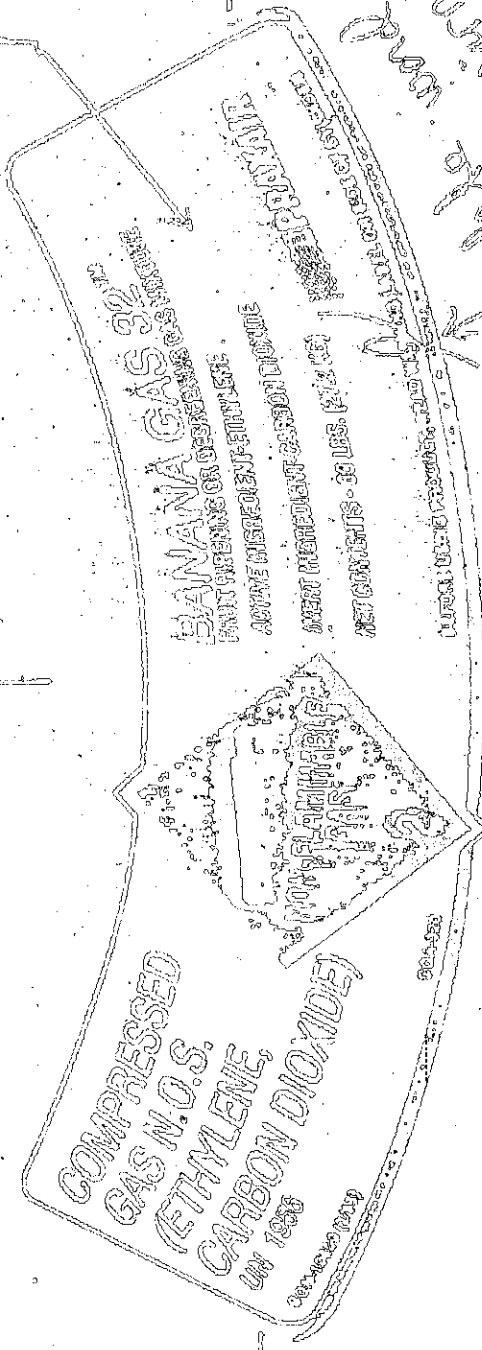
Use of Banana Gas-32 for fruit spraying is covered by U.S. Patent 2,334,010



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Product: Compressed gases, n.o.s. P-4818-G
(carbon dioxide, ethylene)

Date: December 2006

Praxair Material Safety Data Sheet

1. Chemical Product and Company Identification

Product Name: Compressed gases, n.o.s. (carbon dioxide, ethylene) (MSDS No. P-4818-G)	Trade Names: Banana Gas 32™ Gas Mixture
Chemical Name: Mixture of ethylene and carbon dioxide	Synonyms: Fruit-ripening gas, degreening gas
Chemical Family: Not applicable.	Product Grades: Not applicable.
Telephone: Emergencies: 1-800-645-4633* CITEMTREC: 1-800-424-9300* Routine: 1-800-PRAXAIR	Company Name: Praxair, Inc. 39 Old Ridgebury Road Danbury, CT 06810-5113

**Call emergency numbers 24 hours a day only for spills, leaks, fire, exposure, or accidents involving this product. For routine information, contact your supplier, Praxair sales representative, or call 1-800-PRAXAIR (1-800-772-9247).*

2. Hazards Identification

EMERGENCY OVERVIEW

DANGER! High-pressure liquid and gas mixture.
Harmful if inhaled.

Can cause rapid suffocation.
May cause frostbite.

May increase respiration and heart rate.
May cause nervous system damage.
May cause dizziness and drowsiness.

Self-contained breathing apparatus and protective clothing
may be required by rescue workers.

Under ambient conditions, this is a colorless gas with a sweet odor.

OSHA REGULATORY STATUS: The components of this mixture are considered hazardous by the OSHA Hazard Communications Standard (29 CFR 1910.1200).

POTENTIAL HEALTH EFFECTS:

Effects of a Single (Acute) Overexposure

Inhalation. Asphyxiant. Effects are due to lack of oxygen. The carbon dioxide component is also physiologically active, affecting circulation and breathing. Moderate concentrations may cause headache, drowsiness, dizziness, stinging of the nose and throat, excitation, rapid breathing, excess salivation, vomiting, and unconsciousness. Lack of oxygen can kill.

Skin Contact. No harm expected from vapor; cold gas, or liquid or solid carbon dioxide may cause severe frostbite.

Product: Compressed gases, n.o.s. P-4818-G
(carbon dioxide, ethylene)

Date: December 2006

Swallowing. An unlikely route of exposure. This product is a gas at normal temperature and pressure.

Eye Contact. Vapor may sting; cold gas, or liquid or solid carbon dioxide may cause severe frostbite.

Effects of Repeated (Chronic) Overexposure. No harm expected.

Other Effects of Overexposure. May damage retinal ganglion cells and central nervous system.

Medical Conditions Aggravated by Overexposure. The toxicology and the physical and chemical properties of the mixture components suggest that overexposure is unlikely to aggravate existing medical conditions.

CARCINOGENICITY: The components of this mixture are not listed by NTP or OSHA. The IARC lists ethylene as Group 3, unclassifiable as to carcinogenicity to humans.

POTENTIAL ENVIRONMENTAL EFFECTS: For further information, see section 12, Ecological Information.

3. Composition/Information on Ingredients

See section 16 for important information about mixtures.

COMPONENT	CAS NUMBER	CONCENTRATION
Ethylene	74-85-1	6.3%
Carbon Dioxide	124-38-9	Balance

4. First Aid Measures

INHALATION: Remove to fresh air. If not breathing, give artificial respiration, preferably mouth-to-mouth. If breathing is difficult, qualified personnel may give oxygen. Call a physician.

SKIN CONTACT: Wash with plenty of soap and water. For exposure to cold vapor or solid, immediately warm frostbite area with warm water not to exceed 105°F (41°C). In case of massive exposure, remove contaminated clothing while showering with warm water. Call a physician.

SWALLOWING: An unlikely route of exposure. This product is a gas at normal temperature and pressure.

EYE CONTACT: Immediately flush eyes thoroughly with warm water for at least 15 minutes. Hold the eyelids open and away from the eyeballs to ensure that all surfaces are flushed thoroughly. See a physician, preferably an ophthalmologist, immediately.

NOTES TO PHYSICIAN: There is no specific antidote. Treatment of overexposure should be directed at the control of symptoms and the clinical condition of the patient.

5. Fire Fighting Measures

FLAMMABLE PROPERTIES: This mixture cannot catch fire. Contact with flammable materials may cause fire or explosion.

SUITABLE EXTINGUISHING MEDIA: Use media appropriate for surrounding fire.

Product: Compressed gases, n.o.s. P-4818-G
(carbon dioxide, ethylene)

Date: December 2006

PRODUCTS OF COMBUSTION: Not applicable. See section 10 for decomposition products.

PROTECTION OF FIREFIGHTERS: DANGER! High-pressure liquid and gas mixture. Evacuate all personnel from danger area. Immediately deluge cylinders with water from maximum distance until cool; then move them away from fire area if without risk. Use self-contained breathing apparatus and protective clothing where needed. On-site fire brigades must comply with OSHA 29 CFR 1910.156.

Specific Physical and Chemical Hazards. Heat of fire can build pressure in cylinder and cause it to rupture. No part of cylinder should be subjected to a temperature higher than 125°F (52°C). Cylinders are equipped with a pressure relief device. (Exceptions may exist where authorized by DOT.)

Protective Equipment and Precautions for Firefighters. Firefighters should wear self-contained breathing apparatus and full fire-fighting turnout gear.

6. Accidental Release Measures

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:

DANGER! High-pressure liquid and gas mixture.

Personal Precautions. Evacuate all personnel from danger area. Use self-contained breathing apparatus where needed. Shut off leak if without risk. Ventilate area of leak or move cylinder to a well-ventilated area. Test for sufficient oxygen, especially in confined spaces, before allowing reentry.

Environmental Precautions. Prevent waste from contaminating the surrounding environment. Keep personnel away. Discard any product, residue, disposable container, or liner in an environmentally acceptable manner, in full compliance with federal, state, and local regulations. If necessary, call your local supplier for assistance.

7. Handling and Storage

PRECAUTIONS TO BE TAKEN IN HANDLING: *Gas can cause rapid suffocation due to oxygen deficiency.* Store and use with adequate ventilation at all times. This mixture is heavier than air. It tends to accumulate near the floor of an enclosed space, displacing air and pushing it upward. This creates an oxygen-deficient atmosphere near the floor. Ventilate space before entry. Verify sufficient oxygen concentration. *Protect cylinders from damage.* Use a suitable hand truck to move cylinders; do not drag, roll, slide, or drop. *Never attempt to lift a cylinder by its cap;* the cap is intended solely to protect the valve. Never insert an object (e.g., wrench, screwdriver, pry bar) into cap openings; doing so may damage the valve and cause a leak. Use an adjustable strap wrench to remove over-tight or rusted caps. *Open valve slowly.* If valve is hard to open, discontinue use and contact your supplier. Close cylinder valve after each use; keep closed even when empty. For other precautions in using this mixture, see section 16.

PRECAUTIONS TO BE TAKEN IN STORAGE: Store and use with adequate ventilation. *Firmly secure cylinders upright to keep them from falling or being knocked over.* Screw valve protection cap firmly in place by hand. Store only where temperature will not exceed 125°F (52°C). *Store full and empty cylinders separately.* Use a first-in, first-out inventory system to prevent storing full cylinders for long periods.

Product: Compressed gases, n.o.s. P-4818-G
(carbon dioxide, ethylene)

Date: December 2006

RECOMMENDED PUBLICATIONS: For further information on storage, handling, and use, see Praxair publication P-14-153, *Guidelines for Handling Gas Cylinders and Containers*. Obtain from your local supplier.

8. Exposure Controls/Personal Protection

COMPONENT	OSHA PEL	ACGIH TLV-TWA (2006)
Ethylene	Simple asphyxiant	200 ppm
Carbon Dioxide	5000 ppm	5000 ppm

TLV-TWAs should be used as a guide in the control of health hazards and not as fine lines between safe and dangerous concentrations.

IDLH = 40,000 ppm (carbon dioxide)

ENGINEERING CONTROLS:

Local Exhaust. Use a local exhaust system, if necessary, to keep the concentration of carbon dioxide below all applicable exposure limits in the worker's breathing zone.

Mechanical (General). Under certain conditions, general exhaust ventilation may be acceptable to keep carbon dioxide below all applicable exposure limits.

Special. None

Other. None

PERSONAL PROTECTIVE EQUIPMENT:

Skin Protection. Wear work gloves when handling cylinders; insulated neoprene gloves when working with product. Metatarsal shoes for container handling; high-top shoes are preferred. Protective clothing where needed. Cuffless trousers should be worn outside the shoes. Select in accordance with OSHA 29 CFR 1910.132 and 1910.133. Regardless of protective equipment, never touch live electrical parts.

Eye/Face Protection. Wear safety glasses when handling cylinders; add a full face shield when working with product. Select in accordance with OSHA 29 CFR 1910.133.

Respiratory Protection. None required under normal use. If use may result in an oxygen-deficient atmosphere or may generate hazardous concentrations of gases or fumes, an air-supplied respirator must be used. Respiratory protection must conform to OSHA 29 CFR 1910.134. Select per OSHA 29 CFR 1910.134 and ANSI Z88.2.

9. Physical and Chemical Properties

APPEARANCE:	Colorless gas
ODOR:	Sweet
ODOR THRESHOLD:	Not available.
PHYSICAL STATE:	Gas at normal temperature and pressure
pH:	Not applicable.
MELTING POINT at 1 atm:	Not available.
BOILING POINT at 1 atm:	Not available.
FLASH POINT (test method):	Not applicable.
EVAPORATION RATE (Butyl Acetate = 1):	Not available.
FLAMMABILITY:	Nonflammable

Product: Compressed gases, n.o.s.
(carbon dioxide, ethylene)

P-4818-G

Date: December 2006

FLAMMABLE LIMITS IN AIR, % by volume:	LOWER: Not applicable.	UPPER: Not applicable.
VAPOR PRESSURE at 68°F (20°C):	830 psig (5723 kPa)	
VAPOR DENSITY at 70°F (21.1°C) and 1 atm:	0.112 lb/ft ³ (1.79 kg/m ³) (calculated)	
SPECIFIC GRAVITY (H ₂ O = 1):	Not available.	
SPECIFIC GRAVITY (Air = 1) at 70°F (21.1°C) and 1 atm:	1.49 (calculated)	
SOLUBILITY IN WATER 68°F (20°C):	Slight	
PARTITION COEFFICIENT: n-octanol/water:	Not available.	
AUTOIGNITION TEMPERATURE:	Not applicable.	
DECOMPOSITION TEMPERATURE:	Not available.	
PERCENT VOLATILES BY VOLUME:	100	
MOLECULAR WEIGHT:	Not available.	
MOLECULAR FORMULA:	Mixture of C ₂ H ₄ & CO ₂	

10. Stability and Reactivity

CHEMICAL STABILITY: Unstable Stable

CONDITIONS TO AVOID: None known.

INCOMPATIBLE MATERIALS: None known.

HAZARDOUS DECOMPOSITION PRODUCTS: None known. Thermal decomposition of ethylene may produce CO or additional CO₂.

POSSIBILITY OF HAZARDOUS REACTIONS: May Occur Will Not Occur

Product: Compressed gases, n.o.s. P-4818-G
(carbon dioxide, ethylene)

Date: December 2006

11. Toxicological Information

ACUTE DOSE EFFECTS: Carbon dioxide is an asphyxiant. It initially stimulates respiration and then causes respiratory depression. High concentrations result in narcosis. Symptoms in humans are as follows:

EFFECT:	CONCENTRATION:
Breathing rate increases slightly.	1%
Breathing rate increases to 50% above normal level. Prolonged exposure can cause headache, tiredness.	2%
Breathing increases to twice normal rate and becomes labored. Weak narcotic effect. Impaired hearing, headache, increased blood pressure and pulse rate.	3%
Breathing increases to approximately four times normal rate, symptoms of intoxication become evident, and slight choking may be felt.	4 - 5%
Characteristic sharp odor noticeable. Very labored breathing, headache, visual impairment, and ringing in the ears. Judgment may be impaired, followed within minutes by loss of consciousness.	5 - 10%
Unconsciousness occurs more rapidly above 10% level. Prolonged exposure to high concentrations may eventually result in death from asphyxiation.	10 - 100%

TERATOGENIC EFFECTS: A single study has shown an increase in heart defects in rats exposed to 6% carbon dioxide in air for 24 hours at different times during gestation. There is no evidence that carbon dioxide is teratogenic in humans.

12. Ecological Information

ECOTOXICITY: No known effects.

OTHER ADVERSE EFFECTS: No adverse ecological effects expected. This mixture does not contain any Class I or Class II ozone-depleting chemicals.

13. Disposal Considerations

WASTE DISPOSAL METHOD: Do not attempt to dispose of residual or unused quantities. Return cylinder to supplier.

14. Transport Information

DOT/IMO SHIPPING NAME: Compressed gases, n.o.s. (carbon dioxide, ethylene)			
HAZARD CLASS: 2.2	PACKING GROUP/Zone: NA*	IDENTIFICATION NUMBER: UN1956	PRODUCT RQ: None
SHIPPING LABEL(s): NONFLAMMABLE GAS			
PLACARD (when required): NONFLAMMABLE GAS			
*NA - Not applicable.			

Product: Compressed gases, n.o.s. P-4818-C
(carbon dioxide, ethylene)

Date: December 2006

SPECIAL SHIPPING INFORMATION: Cylinders should be transported in a secure position, in a well-ventilated vehicle. Cylinders transported in an enclosed, nonventilated compartment of a vehicle can present serious safety hazards.

Shipment of compressed gas cylinders that have been filled without the owner's consent is a violation of federal law [49 CFR 173.301(b)].

MARINE POLLUTANTS: None of the components of this mixture are listed as marine pollutants by DOT.

15. Regulatory Information

The following selected regulatory requirements may apply to this product. Not all such requirements are identified. Users of this product are solely responsible for compliance with all applicable federal, state, and local regulations.

U.S. FEDERAL REGULATIONS:

EPA (ENVIRONMENTAL PROTECTION AGENCY)

CERCLA: COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT OF 1980 (40 CFR Parts 117 and 302):

Reportable Quantity (RQ): None

SARA: SUPERFUND AMENDMENT AND REAUTHORIZATION ACT:

SECTIONS 302/304: Require emergency planning based on Threshold Planning Quantity (TPQ) and release reporting based on Reportable Quantities (RQ) of Extremely Hazardous Substances (EHS) (40 CFR Part 355):

TPQ: None

EHS RQ (40 CFR 355): None

SECTIONS 311/312: Require submission of MSDSs and reporting of chemical inventories with identification of EPA hazard categories. The hazard categories for this product are as follows:

IMMEDIATE: No

PRESSURE: Yes

DELAYED: Yes

REACTIVITY: No

FIRE: No

SECTION 313: Requires submission of annual reports of release of toxic chemicals that appear in 40 CFR Part 372.

Ethylene and mixtures is subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA) and 40CFR Part 372.

40 CFR 68: RISK MANAGEMENT PROGRAM FOR CHEMICAL ACCIDENTAL RELEASE PREVENTION: Requires development and implementation of risk management programs at facilities that manufacture, use, store, or otherwise handle regulated substances in quantities that exceed specified thresholds.

Ethylene is listed as a regulated substance in quantities 10,000 lb (4536 kg) or greater.

TSCA: TOXIC SUBSTANCES CONTROL ACT: The components of this mixture are listed on the TSCA inventory.

Product: Compressed gases, n.o.s. P-4818-G
(carbon dioxide, ethylene)

Date: December 2006

OSHA: OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION:

29 CFR 1910.119: PROCESS SAFETY MANAGEMENT OF HIGHLY HAZARDOUS CHEMICALS: Requires facilities to develop a process safety management program based on Threshold Quantities (TQ) of highly hazardous chemicals.

Neither carbon dioxide nor ethylene is listed in Appendix A as a highly hazardous chemical. However, any process that involves a flammable gas on site in one location in quantities of 10,000 lb (4536 kg) or greater is covered under this regulation unless the gas is used as a fuel.

STATE REGULATIONS:

CALIFORNIA: Neither component of this mixture is listed by California under the SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT OF 1986 (Proposition 65).

PENNSYLVANIA: This mixture is subject to the PENNSYLVANIA WORKER AND COMMUNITY RIGHT-TO-KNOW ACT (35 P.S. Sections 7301-7320).

16. Other Information

Be sure to read and understand all labels and instructions supplied with all containers of this product.

OTHER HAZARDOUS CONDITIONS OF HANDLING, STORAGE, AND USE: *High-pressure liquid and gas.* Use piping and equipment adequately designed to withstand pressures to be encountered. *Prevent reverse flow.* Reverse flow into cylinder may cause rupture. Use a check valve or other backflow prevention device in any line or piping from the cylinder. *Never work on a pressurized system.* If there is a leak, close the cylinder valve. Blow the system down in a safe and environmentally sound manner in compliance with all federal, state, and local laws; then repair the leak. *Never place a compressed gas cylinder where it may become part of an electrical circuit.*

Mixtures. When you mix two or more gases or liquefied gases, you can create additional, unexpected hazards. Obtain and evaluate the safety information for each component before you produce the mixture. Consult an industrial hygienist or other trained person when you evaluate the end product. Remember, gases and liquids have properties that can cause serious injury or death.

HAZARD RATING SYSTEMS:

NFPA RATINGS:

HEALTH = 2
FLAMMABILITY = 0
INSTABILITY = 0
SPECIAL = None

HMIS RATINGS:

HEALTH = 1
FLAMMABILITY = 0
PHYSICAL HAZARD = 3

STANDARD VALVE CONNECTIONS FOR U.S. AND CANADA:

THREADED: 0-3000 psig CGA-320
PIN-INDEXED YOKE: 0-3000 psig Not applicable.
ULTRA-HIGH-INTEGRITY CONNECTION: Not applicable.

Use the proper CGA connections. DO NOT USE ADAPTERS. Additional limited-standard connections may apply. See CGA pamphlet V-1 listed below.

Ask your supplier about free Praxair safety literature as referred to in this MSDS and on the label for this product. Further information can be found in the following materials published by

Product: Compressed gases, n.o.s. P-4818-G
(carbon dioxide, ethylene)

Date: December 2006

The Compressed Gas Association, Inc. (CGA), 4221 Walney Road, 5th Floor, Chantilly, VA
20151-2923, Telephone (703) 788-2700, <http://www.cganet.com/Publication.asp>.

- AV-1 *Safe Handling and Storage of Compressed Gases*
- SB-2 *Oxygen-Deficient Atmospheres*
- P-1 *Safe Handling of Compressed Gases in Containers*
- V-1 *Compressed Gas Cylinder Valve Inlet and Outlet Connections*
- V-7 *Standard Method of Determining Cylinder Valve Outlet Connections for Industrial Gas Mixtures*
- *Handbook of Compressed Gases, Fourth Edition*

Praxair asks users of this product to study this MSDS and become aware of product hazards and safety information. To promote safe use of this product, a user should (1) notify employees, agents, and contractors of the information in this MSDS and of any other known product hazards and safety information, (2) furnish this information to each purchaser of the product, and (3) ask each purchaser to notify its employees and customers of the product hazards and safety information.

Product: Compressed gases, n.o.s. P-4818-G
(carbon dioxide, ethylene)

Date: December 2006

The opinions expressed herein are those of qualified experts within Praxair, Inc. We believe that the information contained herein is current as of the date of this Material Safety Data Sheet. Since the use of this information and the conditions of use of the product are not within the control of Praxair, Inc., it is the user's obligation to determine the conditions of safe use of the product.

Praxair MSDSs are furnished on sale or delivery by Praxair or the independent distributors and suppliers who package and sell our products. To obtain current MSDSs for these products, contact your Praxair sales representative or local distributor or supplier, or download from www.praxair.com. If you have questions regarding Praxair MSDSs, would like the form number and date of the latest MSDS, or would like the names of the Praxair suppliers in your area, phone or write the Praxair Call Center (Phone: 1-800-PRAXAIR; Address: Praxair Call Center, Praxair, Inc., PO Box 44, Tonawanda, NY 14151-0044).

Praxair, the *Flowing Airstream* design, and *Banana Gas 32* are trademarks or registered trademarks of Praxair Technology, Inc. in the United States and/or other countries.



Praxair, Inc.
39 Old Ridgebury Road
Danbury, CT 06810-5113

Attachment 7

ETHY-GEN® II
CONCENTRATE

ONLY FOR USE WITH A CATALYTIC GENERATOR TO PRODUCE ETHYLENE TO ACCELERATE RIPENING OF:

Avocados, Bananas, Citrus Fruit, Melons, Papayas, Pears, Tomatoes and Tobacco

ACTIVE INGREDIENT

Ethanol 90.00%

OTHER INGREDIENTS 10.00%

TOTAL 100.00%

KEEP OUT OF REACH OF CHILDREN
CAUTION
NOT INTENDED FOR
HUMAN CONSUMPTION

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 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 further 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 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.
Have the product container or label with you when calling a poison control center or doctor, or going for treatment. For additional information in case of emergency call toll free, 800-424-9300.	

Mfg. By: CATALYTIC GENERATORS, LLC.
1185 Pineridge Road
Norfolk, VA 23502
(757) 855-0191

EPA Reg. No. 37433-1

EPA Est. No. 37433-VA-1

Net Contents - 32 Ounces - One (1) U.S. Quart

PHYSICAL AND CHEMICAL HAZARDS
FLAMMABLE. Keep away from heat and open flames.

PRECAUTIONARY STATEMENTS

Hazards to Humans and Domestic Animals
Caution. Prolonged or frequently repeated skin contact may cause allergic reaction in some individuals

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Handlers and users must wear:

- o Long-sleeved shirt and long pants
- o Shoes and socks

STORAGE AND DISPOSAL

Do not contaminate water, food, or feed by storage or disposal.
PESTICIDE STORAGE-Store in dry locked storage area, at temperatures below 125°F.

PESTICIDE DISPOSAL: Wastes resulting from the use of this product may be disposed of on site or at an approved waste disposal facility.

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.

DIRECTIONS FOR USE

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

Avocados, Bananas, Citrus Fruit, Melons, Papayas, Pears and Tomatoes. Use in a Catalytic Generator the first 24 hours of ripening period. One (1) quart used as directed in 4,000 to 10,000 cubic feet ripening room produces ethylene concentrations varying from 4 to 1,200 P.P.M. over a period 12-48 hours. One (1) pint used as directed in 1,500 to 6,000 cubic feet ripening room produces ethylene concentrations varying from 5 to 500 P.P.M. over a period of 6-24 hours.

Tobacco (Flue-Cured). Use in a Catalytic Generator immediately after filling curing system. Two (2) quarts used as directed in 1,500 to 2,500 cubic feet curing system produces ethylene concentrations varying from 15 to 300 P.P.M. over a period of 12 - 24 hours. Use additional two (2) quarts of ETHY-GEN® II as required.

USE PRECAUTIONS

Anyone using this product in any other type curing system or room size should contact us prior to use. The ripening room or curing system should be reasonably air-tight, all vents and doors closed, cracks or holes in walls and doors should be repaired or covered over. Do not use in enclosures less than 1,500 cubic feet.

WARRANTY

To the extent allowable by state law, seller's liability for breach of warranty, express or implied, in connection with the sale or lease of this product shall be limited to repairs or replacement at seller's expense of the defective product, and in no case shall seller be liable for incidental or consequential damages.

IMPORTANT NOTICE

Use of any other product other than ETHY-GEN® II CONCENTRATE may damage the catalytic generator supplied by Catalytic Generators, LLC. Also, use of other products in the generator may produce harmful by-products.

NOTE

Degreening citrus requires 1 to 5 P.P.M. of ethylene. Excess may cause damage.



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**MATERIAL SAFETY
DATA SHEET**



Section 1: Company and Product Identification and Use	
PRODUCT NAME:	Ethy-Gen® II Ripening Concentrate
PRODUCT USE:	Fruit Ripening, Tobacco and Citrus Degreasing in Commercial Ripening Rooms; For Industry Use Only.
MANUFACTURER:	Catalytic Generators, LLC 1185 Pineridge Road Norfolk, VA 23502-2095 U.S.A.
EMERGENCY TELEPHONE:	CHEMTREC: (800) 424-9300 (North America) or (703) 527-3887
PREPARED BY:	Catalytic Generators, LLC
TELEPHONE:	(757) 855-0191
PREPARATION DATE:	August 2006

Section 2: Hazardous Ingredients				
Hazardous Ingredient	%	CAS Number	LD ₅₀ of Ingredient	LC ₅₀ of Ingredient
Ethanol	60 - 100	64-17-5	Rat (Oral) 7060 mg/kg	Rat (Inhalation) 20,000 ppm, 10 hour
Ethyl Acetate	1 - 5	141-78-6	Rat (Oral) 5620 mg/kg	Rat (Inhalation) 200 mg/l, 1 hour
Isopropyl Alcohol	1 - 5	67-63-0	Rat (Oral) 5045 mg/kg	Rat (Inhalation) 16,000 ppm, 8 hour

Section 3: Hazards Identification	
EMERGENCY OVERVIEW:	<p>Hazards: Warning! Flammable Liquid. Can burn with little or no visible flame. May be irritating to the eyes and upper respiratory tract. May affect the central nervous system.</p> <p>Appearance: Clear / Transparent Liquid</p> <p>Odor: Fruity / Sweet</p> <div style="text-align: right;">   </div>
Potential Health Effects	
ROUTES OF ENTRY:	Skin Contact / Eye Contact / Inhalation / Ingestion
EFFECTS OF ACUTE EXPOSURE TO PRODUCT:	May cause eye and upper respiratory tract irritation. Short-term overexposure above 1,000 ppm by the inhalation route may cause central nervous system (CNS) effects such as headache and irritation of eyes, nose and throat. If continued for more than an hour additional CNS effects may occur such as: dizziness, drowsiness, loss of appetite, and an inability to concentrate. Gastrointestinal (stomach) effects may occur with symptoms such as nausea and vomiting.
SKIN:	Defatting of the skin with irritation, dryness and cracking.

Emergency Numbers: 800.424.9300 CHEMTREC, 24 hrs/day
 703.527.3887 Outside USA, collect calls accepted, 24 hrs/day

EYE:	Eye exposure generally causes transient pain, irritation, and reflex lid closure. A foreignbody sensation may persist for one to two days. Vapors produce transient stinging and tearing, but no apparent adverse effects. Transiently impaired perception of color may occur with acute ingestion or chronic alcoholism.
EFFECTS OF CHRONIC EXPOSURE TO PRODUCT:	Long-term exposure can cause loss of appetite, weight loss, nervousness, memory loss, mental retardation and liver damage. May cause dermatitis by defatting the skin from prolonged or repeated contact. Alcoholic beverages are carcinogenic to humans. Ethanol is a developmental toxin and various effects have been associated with ethanol intake. Examples of chronic ethanol abuse effects include physical dependence, malnutrition, amnesia, dementia, somnolence, cardiac myopathy, hepatotoxicity, GI bleeding and pancreatitis. Combined exposure to ethanol and certain other chemicals may result in increased toxic effects.

Section 4: First Aid Measures	
INGESTION:	<ul style="list-style-type: none"> o Call a poison control center or doctor immediately for treatment advice. o Have person sip a glass of water if able to swallow. o Do not induce vomiting unless told to do so by a poison control center or doctor. o Do not give anything by mouth to an unconscious person.
INHALATION:	<ul style="list-style-type: none"> o Move person to fresh air. o If person is not breathing, call 911 or an ambulance, then give artificial respiration, preferably mouth-to-mouth if possible. o Call a poison control center or doctor for further treatment advice.
EYE CONTACT:	<ul style="list-style-type: none"> o 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. o Call a poison control center or doctor for treatment advice.
SKIN CONTACT:	<ul style="list-style-type: none"> o Take off contaminated clothing. o Rinse skin immediately with plenty of water for 15-20 minutes. o Call a poison control center or doctor for treatment advice.

Section 5: Fire Fighting Measures	
FLAMMABILITY:	Yes, under conditions of heat, sparks, open flames, contact with oxidizing materials.
MEANS OF EXTINCTION:	Alcohol foam, CO ₂ , dry chemical. Cool exposed containers with water. Water may be ineffective on fire.
FLASHPOINT AND METHOD:	12°C (53.6°F), Closed Cup
UPPER FLAMMABLE LIMIT:	14.0% by volume
LOWER FLAMMABLE LIMIT:	3.5% by volume
AUTO-IGNITION TEMPERATURE:	Determined not to have an auto-ignition temperature below 400°C (752°F)
EXPLOSION DATA:	Insensitive to impact. Unlikely to accumulate a static charge. Flashback along vapor trail may occur. Vapor may explode if ignited in an enclosed area.

Emergency Numbers: 800.424.9300 CHEMTREC, 24 hrs/day
 703.527.3887 Outside USA, collect calls accepted, 24 hrs/day

HAZARDOUS COMBUSTION PRODUCTS:	Burning can produce Carbon Monoxide (CO; highly toxic if inhaled) and/or Carbon Dioxide (CO ₂ ; in sufficient concentrations can act as an asphyxiant).		
NFPA:	Health: 1	Fire: 3	Reactivity: 0

Section 6: Accidental Release Measures	
LEAK AND SPILL PROCEDURES:	Assure adequate ventilation in leak or spill area. Remove all sources of heat or ignition. Depending upon the nature and size of the release, responders may need to be HAZWOPER trained. Responders must be provided with appropriate respiratory protection and protective clothing. If necessary, use water spray or alcohol-resistant foam to reduce vapors. Contain and recover the liquid, where possible. Do not flush to sewer. Absorb liquid onto a compatible absorbent material; handle as a flammable material. Containerize spill cleanup residues to prevent release of vapors, prevent contact with heat, sparks, open flames, and oxidizing materials.

Section 7: Handling and Storage	
HANDLING PROCEDURES:	Avoid contact with sparks, open flames, and oxidizing materials. Do not smoke while using this product. When transferring product from a metal container, ensure that container is grounded.
STORAGE PROCEDURES:	Protect container from physical damage. Store in a dry locked storage area at temperatures below 125° F (52° C). Do not contaminate water, food or feed by storage or disposal.
NOTE:	The ethylene generated by the use of this product is a simple asphyxiant and is flammable. The Lower Explosive Limit of ethylene is 2.7% (27,000 ppm).

Section 8: Exposure Control / Personal Protection			
EXPOSURE LIMITS	Ethanol	Ethyl Acetate	Isopropyl Alcohol
OSHA PEL:	1,000 PPM	400 PPM	400 PPM
ACGIH TLV:	1,000 PPM	400 PPM	500 PPM
ENGINEERING CONTROLS:	Use in well ventilated area. When necessary, a system of local or general exhaust is recommended to keep employee exposures below allowable exposure limits. When transferring product from a metal container, ensure that container is grounded.		
PERSONAL PROTECTIVE EQUIPMENT:	<p>Protective Gloves: Use chemical-resistant gloves such as rubber, neoprene or vinyl. Do not use PVA gloves.</p> <p>Eye Protection: Use chemical safety goggles. Provide and maintain eyewash in the work area. Do not wear contact lenses when working with this material.</p> <p>Protective Clothing: Wear long-sleeved shirt, long pants, socks and shoes.</p> <p>Respiratory Protection: Under normal conditions, the use of this product should not require respiratory protection. If allowable exposure limits are exceeded, a NIOSH/MSHA approved cartridge respirator can be worn up to the maximum use concentration specified by the respirator manufacturer. For atmospheres that are immediately dangerous to life and health (IDLH) or for unknown atmospheres, use only a self-contained breathing apparatus operating in an approved positive-pressure mode.</p>		

Emergency Numbers: 800.424.9300 CHEMTREC, 24 hrs/day
 703.527.3887 Outside USA, collect calls accepted, 24 hrs/day

Section 9: Physical and Chemical Properties			
PHYSICAL STATE:	Liquid	ODOR AND APPEARANCE:	Clear with Fruity Odor
ODOR THRESHOLD:	N. Av.	SPECIFIC GRAVITY:	0.793 @ 20°C (68°F)
VAPOR DENSITY:	1.59	VAPOR PRESSURE:	44.6 mmHg @ 20°C (68°F)
EVAPORATION RATE:	1.7	BOILING POINT:	78.3°C (173°F)
pH:	N. App.	FREEZING POINT:	-114.1°C (-173.4°F)
VISCOSITY:	1.49 @ 20°C (68°F)		
COEFFICIENT OF WATER / OIL DISTRIBUTION:			-0.31

Section 10: Stability and Reactivity	
CHEMICAL STABILITY:	Yes
INCOMPATIBILITY WITH OTHER SUBSTANCES:	Yes, contact with acetyl chloride or other strong oxidizing agents may result in a violent reaction
REACTIVITY:	Does not react with air, water or other common materials
HAZARDOUS DECOMPOSITION PRODUCTS:	Not expected to decompose under normal conditions

Section 11: Toxicological Properties	
This product has not been tested for toxicological properties; however, the ingredients have.	
<i>ETHANOL</i>	
ROUTES OF ENTRY:	Skin Contact / Eye Contact / Inhalation / Ingestion
EFFECTS OF ACUTE EXPOSURE TO PRODUCT:	May cause eye and upper respiratory tract irritation. Short-term overexposure above 1,000 ppm by the inhalation route may cause central nervous system (CNS) effects such as headache and irritation of eyes, nose and throat. If continued for more than an hour additional CNS effects may occur such as: dizziness, drowsiness, loss of appetite, and an inability to concentrate.
EFFECTS OF CHRONIC EXPOSURE TO PRODUCT:	Long-term exposure can also cause loss of appetite, weight loss, nervousness, memory loss, mental retardation and liver damage. May cause dermatitis by defatting the skin from prolonged or repeated contact. Alcoholic beverages are carcinogenic to humans. Ethanol is a developmental toxin and various effects have been associated with ethanol intake. Examples of chronic ethanol abuse effects include physical dependence, malnutrition, amnesia, dementia, somnolence, cardiac myopathy, hepatotoxicity, GI bleeding and pancreatitis. Combined exposure to ethanol and certain other chemicals may result in increased toxic effects.
EXPOSURE LIMITS:	OSHA PEL = 1000 PPM; ACGIH TLV = 1000 PPM
IRRITANCY:	Yes: Defatting of the skin with irritation, dryness and cracking. Eye exposure to Ethanol generally causes transient pain, irritation, and reflex lid closure. A foreignbody sensation may persist for one to two days. Vapors produce transient stinging and tearing, but no apparent adverse effects. Transiently impaired perception of color may occur with acute ingestion or chronic alcoholism.
SENSITIZATION:	Yes: weak skin sensitizing potential in a very small percentage of the population.

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Product Identifier: Ethy-Ger® II Ripening Concentrate
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CARCINOGENICITY:	No: The American Conference of Governmental Industrial Hygienists (ACGIH) list ethyl alcohol as an A4 - Not classifiable as a Human Carcinogen. EPA review of available literature indicates that carcinogenic effects are not expected from the industrial uses of ethanol.
REPRODUCTIVE TOXICITY:	No.
TERATOGENICITY:	Yes: Ethanol is generally recognized as a human developmental neurotoxicant (Rees et al. 1990). Jones and Smith (1973) and Jones et al. (1973) initially described Fetal Alcohol Syndrome that results from the effects of chronic maternal alcohol consumption on the fetus. The effects of this syndrome include altered prenatal growth and morphogenesis, characterized, in part, by severe growth retardation, mental retardation and microencephaly. Meyer and Riley (1986) extensively reviewed the behavioral teratology of alcohol and describe transient delays in development, such as age-dependent deficits in activity, delays in maturational indices (eye opening, incisor eruption), increased open field activity, and learning deficits. The effects listed here are generally associated with high (grams/day, oral) maternal consumption of ethanol. Given that OSHA has established the threshold limit value at 1000 ppm (10 hour, time weighted average), the human risk to ethanol exposure in an industrial environment appear to be minimal.
MUTAGENICITY:	Yes; 1 of 7 studies showed positive results (EPA Genetox Program, 1988, Rodent dominate lethal); 6 of 7 tests were negative.
SYNERGISTIC PRODUCTS:	Yes: Carbon Tetrachloride
ETHYL ACETATE	
ROUTES OF ENTRY:	Skin Contact / Eye Contact / Inhalation / Ingestion
EFFECTS OF ACUTE EXPOSURE TO PRODUCT:	Skins: Prolonged or repeated contact may dry skin and cause irritation. Symptoms of exposure may include: Drying, cracking or inflammation of skin. Eyes: Exposure to vapors and liquid May cause eye irritation. Symptoms of exposure may include: Eye irritation, burning sensation, pain, watering, and/or change of vision. Inhalation: May cause respiratory tract irritation. Symptoms of exposure may include: Nasal discharge, hoarseness, coughing, chest pain and breathing difficulty. Nausea, headache and/or dizziness. Ingestion: Symptoms of exposure may include: Central nervous system depression with nausea, headache and mental sluggishness.
EFFECTS OF CHRONIC EXPOSURE TO PRODUCT:	Defatting and dermatitis of skin; central nervous system depression; allergic skin reaction.
EXPOSURE LIMITS:	OSHA PEL = 400 PPM; ACGIH TLV = 400 PPM
IRRITANCY:	Irritating to eyes and respiratory passages at concentrations above 400 ppm.
SENSITIZATION:	Not Available
CARCINOGENICITY:	Not Available
REPRODUCTIVE TOXICITY:	Not Available
TERATOGENICITY:	Not Available
MUTAGENICITY:	In Vitro: Results were unclear. Ethyl acetate was negative in two Ames tests with Salmonella typhimurium and in a recombination assay with Bacillus subtilis. In the Sister Chromatid Exchange (SCE) assay with Chinese hamster ovary (CHO) cells, it was positive with activation and negative without

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	activation. In five separate tests for aneuploidy with <i>Saccharomyces cerevisiae</i> , it was positive four times. It was negative for chromosomal aberrations in CHO cells, but positive in Chinese hamster lung fibroblasts. In Vivo: Not Mutagenic: Ethyl acetate was negative in three separate micronucleus assays - mouse (i.p.), Chinese hamster (i.p.), and Chinese hamster (gavage).
SYNERGISTIC PRODUCTS:	Not Available
<i>ISOPROPYL ALCOHOL</i>	
ROUTES OF ENTRY:	Skin Contact / Eye Contact / Inhalation / Ingestion
EFFECTS OF ACUTE EXPOSURE TO PRODUCT:	The substance irritates the eyes and the respiratory tract. The substance may cause effects on the central nervous system, possibly resulting in depression, nausea, headache, dizziness, unconsciousness and coma. Aspiration of material into the lungs may cause chemical pneumonitis, which may be fatal. Ingestion may cause gastrointestinal irritation with nausea, vomiting and diarrhea. May cause kidney damage.
EFFECTS OF CHRONIC EXPOSURE TO PRODUCT:	Prolonged or repeated skin contact may cause defatting of the skin and dermatitis.
EXPOSURE LIMITS:	OSHA PEL = 400 PPM; ACGIH TLV = 500 PPM
IRRITANCY:	Eyes: Produces irritation, characterized by a burning sensation, redness, tearing, inflammation, and possible corneal injury. May cause transient corneal injury. Skin: May cause irritation with pain and stinging, especially if the skin is abraded. Isopropanol has a low potential to cause allergic skin reactions; however, rare cases of allergic contact dermatitis have been reported. May be absorbed through intact skin. Dermal absorption has been considered toxicologically insignificant.
SENSITIZATION:	No
CARCINOGENICITY:	No
REPRODUCTIVE TOXICITY:	No
TERATOGENICITY:	Limited information is available on the reproductive toxicity of isopropyl alcohol. In the rat, high maternally-toxic inhalation exposures were associated with reduced fetal weight and increased skeletal and visceral malformations
MUTAGENICITY:	No
SYNERGISTIC PRODUCTS:	Yes: Carbon Tetrachloride

(continued)

Emergency Numbers: 800.424.9300 CHEMTREC, 24 hrs/day
 703.527.3887 Outside USA, collect calls accepted, 24 hrs/day

Section 12: Ecological Information	
This product has not been tested for ecological impact; however, the ingredients have.	
AQUATIC TOXICITY:	<p>Ethanol: Ethanol has been shown to be practically non-toxic in tests. LC50 Rainbow Trout (<i>Salmo gairdneri</i>): 13,000 ppm. LC50 Fathead Minnow (<i>Pimephales promelas</i>): 14,200 ppm.</p> <p>Ethyl Acetate: Ethyl acetate exhibits low acute toxicity to aquatic organisms. Fish (<i>Salmo gairdneri</i>) 96-hr. LC50 = 230 ppm. Fish (<i>Pimephales promelas</i>) 96-hr. LC50 = 230 ppm. Crustacean (<i>Daphnia magna</i>) 48-hr. EC50 = 757 ppm. Mollusc (<i>Lymnea stagnalis</i>) 48-hr. EC50 = 1100 ppm.</p> <p>Isopropyl Alcohol: Isopropyl alcohol has been shown to be practically non-toxic in tests. LC50 Fathead Minnow (<i>Pimephales promelas</i>): 6,550 ppm. EC50 <i>Daphnia</i>: 2,280 ppm.</p>
ENVIRONMENTAL FATE:	<p>Ethanol: <i>Degradation:</i> When spilled on land, ethyl alcohol is apt to volatilize, biodegrade, and/or leach into the groundwater. It is anticipated, based on its physical properties, that water will serve as the terminal media. Based on these factors, it is anticipated that ethyl alcohol will neither absorb to soil nor bioconcentrate in aquatic organisms. Once in water, photolysis, hydrolysis, and biodegradation is anticipated to occur. <i>Bioaccumulation:</i> Not expected to occur.</p> <p>Ethyl Acetate: <i>Degradation:</i> Ethyl acetate was "readily biodegradable" when tested according to OECD Guideline 301D, Ready Biodegradability: Closed Bottle Test and had "100% degradation" when tested according to OECD Guideline 303A, "Simulation Test - Aerobic Sewage Treatment: Coupled Unit Test. Similar results were noted in numerous (at least 10) other tests for aerobic biodegradation. The BOD5/COD ratio was 0.81 when tested under aerobic conditions. A single test under anaerobic conditions indicated 100% degradation after 4 days. These data indicate that substantial biodegradation of ethyl acetate takes place rapidly under a variety of conditions. <i>Bioaccumulation:</i> Low potential to occur.</p> <p>Isopropyl Alcohol: Relatively biodegradable</p>

Section 13: Disposal Considerations	
WASTE DISPOSAL:	All packaging, labeling, transporting and disposal of recovered material should be performed in accordance with federal, state, and local laws and regulations.

Section 14: Transportation Information	
SPECIAL SHIPPING INFORMATION:	<p>Proper Shipping Name: FLAMMABLE LIQUID N.O.S. (CONTAINS ISOPROPYL ALCOHOL AND ETHANOL)</p> <p>DOT Class Hazard: 3</p> <p>UN ID: UN1993</p> <p>Packing Group: PGII</p> <p>Labels: Flammable Liquid</p> <p>Marine Pollutant: No</p>

Emergency Numbers: 800.424.9300 CHEMTREC, 24 hrs/day
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Product Identifier: Ethy-Gen® II Ripening Concentrate
Publish Date: August 2006

CATALYTIC
GENERATORS, LLC.

Section 15: Regulatory Information	
WHMIS:	Class B / 2; Class D / 2 / 3
OSHA:	Hazardous chemical
TSCA:	Listed
SARA 313:	Not listed
SARA 311 and 312:	Fire hazard and acute health hazard
TSCA:	Listed
CALIFORNIA PROP. 65:	Ethanol causes developmental toxicity (when in alcoholic beverages)
STATE:	Ingredients are found in following state right-to-know lists: California, New Jersey, Florida, Pennsylvania, Minnesota, Massachusetts.
CERCLA:	Not listed

Section 16: Other Information	
<p>All statements, technical information and recommendations on this MSDS are believed to be accurate and were obtained from sources currently available to us that we believe to be reliable. We make no warranty, express or implied, with respect to this information, since we have no control over the conditions or methods of handling, storage, use or disposal of this product. Also, the accuracy or completeness of the information is not guaranteed. Users should make their own investigations to determine the suitability of the information for their particular purposes and should know and comply with all applicable rules, regulations and laws relating to this product.</p>	
<p>For Industry Use Only</p>	
<p>Ethy-Gen® is a trademark of Catalytic Generators, L.L.C.</p>	

Emergency Numbers: 800.424.9300 CHEMTREC, 24 hrs/day
703.527.3887 Outside USA, collect calls accepted, 24 hrs/day

47893-3

Center panel

03/22/2005

1/3

LIVINGSTON'S
NATURE-RIPE™
ETHYLENE

Used in ripening rooms to accelerate the ripening of Avocados, Banana, Citrus Fruits (Grapefruit, Lemon, Orange, Tangerines), Mangoes, Melons, Honeydew Melons, Papayas, Peach, Pome Fruit (Pear), Persimmon, Pineapple, Tomato, Walnut (English/Black) and other Fruiting Vegetables. Also used as a high volume spray (dilute) in pressure sprayers to promote flowering of pineapple.

ACTIVE INGREDIENT:

Ethylene:-----	99.9%
Other Ingredients-----	00.1%
TOTAL:-----	100.0%

KEEP OUT OF REACH OF CHILDREN

FLAMMABLE GAS

KEEP AWAY FROM HEAT and FLAME

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. Call a poison control center or doctor for treatment advice.
IF ON 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 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 further 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 SIDE PANEL FOR PRECAUTIONARY STATEMENTS

SOLD BY:



LIVINGSTON
GROUP, INC.

4768 Hermitage Road
Virginia Beach, VA 23455 USA
Telephone: 757-460-3115
Facsimile: 757-460-0391

EPA REG. No. 47893-3
EPA EST. No. 069901-TX-01

NET CONTENTS
37 U.S. Pounds; 16.78 KG
(Unless Otherwise Marked Below)

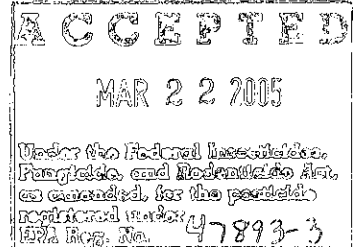
_____ 4 Pounds

_____ 10 Pounds

_____ 9 Pounds

_____ 30 Pounds

If other, write in here _____



Left panel

PRECAUTIONARY STATEMENT
Hazards to Humans and Domestic Animals

DANGER

Liquefied or pressurized gas can cause frost burns. Do not get in eyes or on skin. Harmful if inhaled. Avoid breathing vapors.

PERSONAL PROTECTIVE EQUIPMENT (PPE)

Wear long-sleeved shirt, long pants, boots, goggles, and chemical resistant gloves while handling cylinders or any application equipment under pressure. Do not enter unventilated treatment areas unless wearing a respirator approved by NIOSH/MSHA for this use. Follow the manufacturer's instructions for cleaning/maintaining PPE. If no such instructions for washables, use detergent and hot water. Keep and wash PPE separately from other laundry.

USER SAFETY RECOMMENDATIONS

Users should wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
Users should remove clothing/PPE immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
Users should 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

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 when disposing of equipment wash-water or rinsate.

PHYSICAL OR CHEMICAL HAZARDS

Extremely flammable. Contents under pressure. Keep away from fire, sparks, and heated surfaces. Do not puncture or incinerate container. Exposure to temperatures above 130 degrees Fahrenheit may cause bursting.

IMPORTANT NOTICE

This container is to be returned to Livingston Group, Inc. or its designated agent for refilling when empty. Unauthorized filling of this container is prohibited by Federal Law.

GENERAL INFORMATION

Plants produce ethylene to induce chlorophyll degradation and ripening. The exposure of Avocados, Banana, Citrus Fruits (Grapefruit, Lemon, Orange, Tangerines), Mangoes, Melons, Honeydew Melons, Papayas, Peach, Pome Fruit (Pear), Persimmon, Pineapple, Tomato, Walnut (English/Black) and other Fruiting Vegetables to LIVINGSTON'S NATURE-RIPE™ ethylene will result in a faster and more uniform breakdown of chlorophyll than if not treated. LIVINGSTON'S NATURE-RIPE™ is flammable in concentrations of 3.1 to 32 percent in air (31,000 to 320,000 parts per million).

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 requirement specific to your State or Tribe, consult the State or Tribe agency responsible for pesticide regulation.

AGRICULTURAL USE REQUIREMENTS

Use this product only in accordance with its labeling and with the Worker Protection Standards, 40 C.F.R. 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 the restricted-entry interval. The requirements in this box only apply to uses of this product that are covered by the Worker Protection Standard.
Do not enter or allow worker entry into treated areas during the restrictive entry interval (REI) of 12 hours.
Exception: If the product is soil-incorporated, the Worker Protection Standard, under certain circumstances, allows workers to enter the treated area if there will be no contact with anything that has been treated.
PPE required 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 are: coveralls, waterproof gloves, shoes plus socks, and protective eyewear.

Right panel

RIPENING APPLICATION

LIVINGSTON'S NATURE-RIPE™ ethylene is to be applied to the air of rooms designed for the ripening of fruits and vegetables listed maintaining proper humidity (minimum of 85% relative humidity) and complete air exchange of at least 2 times per 24 hour period.

LIVINGSTON'S NATURE-RIPE™ ethylene is used to ripen Avocados, Bananas, Citrus Fruits (Grapefruit, Lemon, Orange, Tangerines), Mangoes, Melons, Honeydew Melons, Papayas, Peach, Pome Fruit (Pear), Persimmon, Pineapple, Tomato, Walnut (English/Black) and other Fruiting Vegetables at normal room temperature, 68°F - 70°F (20°C - 21°C). Exposure of LIVINGSTON'S NATURE-RIPE™ ethylene is made until the desired coloring of the fruits and fruiting vegetables has occurred. Always use proper regulator firmly attached to cylinder to reduce the pressure of the gas in conjunction with a properly sized flow-meter and restricted orifice (fixed orifice) for each room to be treated to ensure proper flow not to exceed a rise of concentration of 42 parts per million per hour. Do not open cylinder valve without proper regulator attached firmly to the cylinder.

Do not allow tubing from cylinder to ripening room to pass through unventilated areas. Install flow-meter and restrictive orifice outside the ripening room in ventilated area to allow only the desired flow to enter the ripening room. Do not place cylinder inside ripening room.

To determine the amount of Livingston's Nature-Ripe™ ethylene required with air exchange: (1) calculate the cubic volume of the ripening room by multiplying the height X width X length, (2) calculate air exchange in cubic feet per minute by dividing room volume in cubic feet by total minutes required for 1 complete air exchange, (3) calculate ethylene flow rate in cubic feet per hour (CFH) using the CFM X desired ethylene concentration X 60.

Avocados, Banana, Citrus Fruits (Grapefruit, Lemon, Orange, Tangerines), Mangoes, Melons, Honeydew Melons, Papayas, Peach, Pome Fruit (Pear), Persimmon, Pineapple, Tomato, Walnut (English/Black) and other Fruiting Vegetables: Use 1/4 to 1 cubic feet of LIVINGSTON'S NATURE-RIPE™ ethylene per 1,000 cubic feet of room volume (empty) for a concentration of approximately 500 to 1,000 parts per million (PPM) at the end of a continuous 24-hour treatment in an air-tight room. Air must be exchanged to flush the room of carbon dioxide emitted by fruits or vegetables during ripening as a result of the fruit or fruiting vegetables' respiration. Have at least one complete air exchange every 12 hours in ripening rooms - more frequent air exchange is desirable.

Citrus: Apply 0.12 to 0.48 cubic feet of Livingston's Nature-Ripe™ ethylene per 24 hours per 1,000 cubic feet of room volume (empty) with complete air exchange 1 to 2 times per hour (24 to 48 times per 24 hours) to maintain 5 to 10 PPM. Do not expose ARIZONA and CALIFORNIA CITRUS to more than 5 PPM; do not exceed 0.24 cubic feet of LIVINGSTON'S NATURE-RIPE™ ethylene per 1,000 cubic feet of room volume (empty) per 24 hours with less than 2 air exchanges per hour (48 times per 24 hours).

Concentrations of LIVINGSTON'S NATURE-RIPE™ ethylene and carbon dioxide in ripening rooms may be monitored by using GasTec or similar tubes in pumps or electronic digital devices.

PINEAPPLE (FLOWER INDUCEMENT)

Use 1 to 2.5 lb. LIVINGSTON'S NATURE-RIPE™ ethylene applied in 500 to 1,600 gallons of water per acre. Use of China clay, activated carbon, or other suitable adsorbent in suspension in the water is preferred. Use sprayer at 15-20 psi to apply to plant foliage when the plant is mature. Retreat crop if plant characteristics (maturity, environmental and growing conditions) adversely affected the treatment's results.

ADDITIONAL INFORMATION

For additional information, contact local Agricultural Extension Office, Agricultural University or Livingston Group, Inc.

PESTICIDE STORAGE and DISPOSAL

Do not contaminate water, food or feed by storage or disposal.

STORAGE: Store cylinder and regulators in a safe and ventilated area, away from the weather, when not in use. CONTENTS UNDER PRESSURE. DO NOT MOVE OR STORE CYLINDER WITHOUT SAFETY CAP SECURELY IN PLACE. DO NOT STORE NEAR HEAT OR FLAME.

PESTICIDE DISPOSAL: Cylinder containing excess gas that cannot be held in proper storage for later use should be returned to the supplier.

CONTAINER DISPOSAL: Return empty cylinder for reuse.

WARRANTY

Seller makes no warranty, expressed or implied, concerning the use of this product other than as indicated on the label. Buyer assumes all risk of use and/or handling of this material when such use and/or handling is contrary to label instructions.

Attachment 8



LIVINGSTON GROUP INC.
Applied Ethylene Technology

4768 Hermitage Road
Virginia Beach, Virginia 23455
Telephone: 757-460-3115
Fax: 757-460-0397
E-Mail: Larry.Livingston@cox.net

MATERIAL SAFETY DATA SHEET

ETHYLENE, Compressed
DOT: UN 1962
Haz. Cl. Hazard Div. 2.1
Label: Flammable Gas

24-Hour Emergency Phone Numbers:
Livingston Group Inc. - 1-800-992-3893
Chemtrec - 1-800-424-9300

SECTION I - PRODUCT INFORMATION

Chemical Name: Ethylene
Common Name and Synonyms: Ethylene; Acetylene; Ethene; Etherin; Elayl; Ethylene Compressed; Livingston's Nature-Ripe™ ethylene; Livingston's Tobacco Curing Gas™
Chemical Family: Monoolefin; alkene
Formula: C₂H₄

SECTION II - HAZARDOUS INGREDIENTS

Material	Volume	CAS No.	1990-1991 ACGIH TLV LIMITS
Ethylene	99.9%	74-85-1	Simple Asphyxiant

Oxygen levels should be maintained at greater than 18 molar percent at normal atmospheric pressure.
OSHA 1989 TWA - None listed.

SECTION III - PHYSICAL DATA

Boiling Point (°F) = -154°F	Specific Gravity (Air=1): @70°F (21.1°C)=0.97
Vapor Pressure = @70°F*	% Volatile by Volume: 99
Vapor Density (Air=1) = 0.97 @ 70°F	Evaporation Rate (Butyl Acetate=1) UNKNOWN
Solubility in Water: Negligible	Appearance and Odor: Colorless Gas; Slightly Sweet Odor

* Above the critical temperature

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

FLASH POINT (METHOD USED): N/A (GAS)

Flammable Limits in Air
LEL = 3.1%; UEL = 32%

EXTINGUISHING MEDIA: Water, carbon dioxide, dry chemical

SPECIAL FIRE FIGHTING PROCEDURES:

Stop flow of gas. Cool exposed containers with water spray. If possible allow fire to burn itself out. Containers may rupture violently when heated by a fire. Vapors may travel a considerable distance to a source of ignition.

UNUSUAL FIRE AND EXPLOSION HAZARDS:

Mixtures of ethylene in air will burn or explode. Vapors are slightly lighter than air and may accumulate in upper portion of buildings. Fire fighters should wear self-contained breathing apparatus and other protective equipment.

SECTION V - HEALTH HAZARD DATA

Routes of Entry: Inhalation? Yes. Skin? Frostbite. Ingestion? No.

Carcinogenicity: NTP? No. IARC Monographs? No. OSHA? No.

EFFECTS OF OVEREXPOSURE:

Inhalation: Moderate concentrations excluding an adequate air supply cause dizziness, drowsiness and eventual unconsciousness. May act as an anesthetic.

Skin and Eye: Rapidly evaporating liquid may cause frostbite. Persons in ill health where such illness would be aggravated by exposure to ethylene should not be allowed to work with or handle this product.

EMERGENCY AND FIRST AID PROCEDURES:

If inhaled: Remove to fresh air. If breathing is difficult, administer artificial respiration with supplemental oxygen. Keep warm and at rest. Caution when entering contaminated area due to fire and explosion hazard. Safely ventilate area to less than LEL concentration.

Skin Contact: Flush affected areas with copious quantities of tepid (105-115F) water. Seek medical help for thermal injury.

SECTION VI – REACTIVITY DATA

Stability:	Stable
Conditions to avoid:	Heat, flame, and ignition sources
Incompatibility (Materials to avoid):	Chlorine, carbon tetrachloride, aluminum chloride, nitrogen dioxide, ozone, benzoyl peroxide, bromotrichloromethane, oxygen, and strong oxidizers.
Hazardous Decomposition Products:	None
Hazardous Polymerization:	Does not occur
Conditions to Avoid:	N/A

SECTION VII – SPILL OR LEAK PROCEDURES

STEPS TO BE TAKEN IN CASE MATERIAL IS RELEASED OR SPILLED:

Evacuate all personnel upwind and away from affected area. Stop leak if possible. Personnel involved in attempting to stop leak should use self-contained breathing apparatus and should have protective clothing for direct contact with liquid ethylene. Eliminate sources of ignition. Supply maximum ventilation with explosion proof equipment.

WASTE DISPOSAL METHOD:

Locate leaking containers in a remote downwind area outside and allow to vent to atmosphere. Incinerate gas by controlled burning in flare if possible. Follow Federal, State, or local regulations.

SECTION VIII – SPECIAL PROTECTION INFORMATION

RESPIRATORY PROTECTION: Self-contained breathing apparatus available in event of leak or spill.

VENTILATION: Use only in well ventilated areas.

PROTECTIVE GLOVES: PVC or rubber

EYE PROTECTION: Safety goggles or glasses

OTHER PROTECTIVE EQUIPMENT: Safety shoes and safety shower

SECTION IX – SPECIAL PRECAUTIONS

PRECAUTIONS TO BE TAKEN IN HANDLING AND STORING: Protect cylinders against physical damage. Store in cool, dry, well-ventilated area away from sources of heat and ignition and direct sunlight. Do not allow area where cylinders are stored to exceed 130°F. Isolate from oxidizers such as oxygen, chlorine, and fluorine. Use a check valve or trap in ethylene discharge line to prevent hazardous backflow. Post “No Smoking” or “No Open Flame” signs in storage or use area. Cylinders should be stored upright and be firmly secured to prevent falling or being knocked over. Electrical equipment should be non-sparking or explosion proof.

OTHER PRECAUTIONS: Use only DOT or ASME coded containers. Earth-ground and bond all lines and equipment associated with the ethylene system. Use a pressure reducing regulator when connecting cylinder to lower pressure piping or systems. Close valve after each use and when empty. Ethylene cylinders must not be recharged except by or with the consent of Livingston Group Inc. or its authorized agent. For more information refer to CGA Bulletin SB-2 “Oxygen Deficient Atmospheres” and CGA Pamphlet P-1 “Safe Handling of Compressed Gases in Containers” and NFPA Bulletin No. 58.

Ethylene is a toxic chemical subject to the reporting regulations of SARA, Title III, Section 313.

Ethylene used for agricultural purposes to ripen/degreen agricultural commodities is a pesticide and regulated by EPA under FIFRA-40 C.F.R. 152.15.

When used in accordance to the U.S. EPA label (U.S. EPA Reg. 47893-3) and in a manner so as to not exceed the lower 25 percent of the LEL (0.7750% or 7,750 PPM), explosion-proof equipment is not required.

Attachment 9

Product: Ethylene

P-4598-E

Date: December 2006

Praxair Material Safety Data Sheet

1. Chemical Product and Company Identification

Product Name: Ethylene (MSDS No. P-4598-E)	Trade Names: Ethylene
Chemical Name: Ethylene	Synonyms: Ethene, elayl, acetene, bicarburetted hydrogen, clefant gas, refrigerant gas R1150
Chemical Family: Alkene	Product Grades: 1.85, 2.5, Polymer -- 3.0, Research -- 5.0
Telephone: Emergencies: 1-800-645-4633* CHEMTREC: 1-800-424-9300* Routine: 1-800-PRAXAIR	Company Name: Praxair, Inc. 39 Old Ridgebury Road Danbury, CT 06810-5113

**Call emergency numbers 24 hours a day only for spills, leaks, fire, exposure, or accidents involving this product. For routine information, contact your supplier, Praxair sales representative, or call 1-800-PRAXAIR (1-800-772-9247).*

2. Hazards Identification

EMERGENCY OVERVIEW

DANGER! Flammable, high-pressure gas.

Can form explosive mixtures with air.

May cause frostbite.

May cause dizziness and drowsiness.

Self-contained breathing apparatus may be required by rescue workers.

Under ambient conditions, this is a gas with a faint, sweet, musty odor.

OSHA REGULATORY STATUS: This material is considered hazardous by the OSHA Hazard Communications Standard (29 CFR 1910.1200).

POTENTIAL HEALTH EFFECTS:

Effects of a Single (Acute) Overexposure

Inhalation. Asphyxiant. Effects are due to lack of oxygen. Moderate concentrations may cause headache, drowsiness, dizziness, excitation, excess salivation, vomiting, and unconsciousness. Lack of oxygen can kill.

Skin Contact. May cause frostbite.

Swallowing. An unlikely route of exposure. This product is a gas at normal temperature and pressure.

Eye Contact. May cause frostbite.

Effects of Repeated (Chronic) Overexposure. No harm expected.

Other Effects of Overexposure. Ethylene is an asphyxiant. Lack of oxygen can kill.

Medical Conditions Aggravated by Overexposure. The toxicology and the physical and chemical properties of ethylene suggest that overexposure is unlikely to aggravate existing medical conditions.

CARCINOGENICITY: Ethylene is not listed by NTP or OSHA. The IARC lists ethylene as Group 3, unclassifiable as to carcinogenicity to humans.

POTENTIAL ENVIRONMENTAL EFFECTS: For further information, see section 12, Ecological Information.

3. Composition/Information on Ingredients

See section 16 for important information about mixtures.

COMPONENT	CAS NUMBER	CONCENTRATION
Ethylene	74-85-1	>99%*

*The symbol > means "greater than."

4. First Aid Measures

INHALATION: Immediately remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, qualified personnel may give oxygen. Call a physician.

SKIN CONTACT: Wash skin with soap and water. In case of frostbite, get immediate medical attention.

SWALLOWING: An unlikely route of exposure. This product is a gas at normal temperature and pressure.

EYE CONTACT: Immediately flush eyes thoroughly with water for at least 15 minutes. Hold the eyelids open and away from the eyeballs to ensure that all surfaces are flushed thoroughly. Seek the advice of a physician, preferably an ophthalmologist, immediately.

NOTES TO PHYSICIAN: *There is no specific antidote. Treatment of overexposure should be directed at the control of symptoms and the clinical condition of the patient.*

5. Fire Fighting Measures

FLAMMABLE PROPERTIES: Spontaneously explosive when combined with chlorine in sunlight. Forms explosive mixtures with air and oxidizing agents.

SUITABLE EXTINGUISHING MEDIA: CO₂, dry chemicals, water spray, or fog.

PRODUCTS OF COMBUSTION: Thermal decomposition or burning produces CO/CO₂.

PROTECTION OF FIREFIGHTERS: DANGER! Flammable, high-pressure gas. Evacuate all personnel from danger area. Self-contained breathing apparatus may be required by rescue workers. Immediately spray cylinders with water from maximum distance until cool, taking care not to extinguish flames. Remove sources of ignition if without risk. Remove all cylinders from fire area if without risk; continue cooling water spray while moving cylinders. Do not extinguish any flames emitted from cylinders; stop flow of gas if without risk, or allow flames to burn out. If flames are accidentally extinguished, explosive reignition may occur. Take appropriate measures, e.g., total evacuation. Reapproach with extreme caution. On-site fire brigades must comply with OSHA 29 CFR 1910.156.

Specific Physical and Chemical Hazards. Heat of fire can build pressure in cylinder and cause it to rupture. No part of a cylinder should be subjected to a temperature higher than 125°F (52°C). Cylinders containing ethylene are equipped with pressure relief devices. (Exceptions may exist where authorized by DOT.) If venting or leaking product catches fire, do not extinguish flames. Flammable gas may spread from leak, creating an explosive reignition hazard. Vapors can be ignited by pilot lights, other flames, smoking, sparks, heaters, electrical equipment, static discharge, or other ignition sources at locations distant from product handling point. Explosive atmospheres may linger. Before entering area, especially confined areas, check atmosphere with an appropriate device.

Protective Equipment and Precautions for Firefighters. Firefighters should wear self-contained breathing apparatus and full fire-fighting turnout gear.

6. Accidental Release Measures

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:

DANGER! Flammable, high-pressure gas.

Personal Precautions. Immediately evacuate all personnel from danger area. Use self-contained breathing apparatus where needed. Remove all sources of ignition if without risk. Reduce vapors with fog or fine water spray. Shut off flow if without risk. Ventilate area or move cylinder to a well-ventilated area. Flammable vapors may spread from leak. Before entering area, especially confined areas, check atmosphere with an appropriate device.

Environmental Precautions. Prevent waste from contaminating the surrounding environment. Keep personnel away. Discard any product, residue, disposable container, or liner in an environmentally acceptable manner, in full compliance with federal, state, and local regulations. If necessary, call your local supplier for assistance.

7. Handling and Storage

PRECAUTIONS TO BE TAKEN IN HANDLING: *Protect cylinders from damage. Use a suitable hand truck to move cylinders; do not drag, roll, slide, or drop. Use only spark-proof tools and explosion-proof equipment. Leak check system with soapy water; never use a flame. Never attempt to lift a cylinder by its cap; the cap is intended solely to protect the valve. Never insert an object (e.g., wrench, screwdriver, pry bar) into cap openings; doing so may damage the valve and cause a leak. Use an adjustable strap wrench to remove over-tight or rusted caps. Open valve slowly. If valve is hard to open, discontinue use and contact your supplier. For other precautions in using ethylene, see section 16.*

PRECAUTIONS TO BE TAKEN IN STORAGE: Store and use with adequate ventilation. Separate cylinders containing ethylene from oxygen, chlorine, and other oxidizers by at least 20 ft (6.1 m), or use a barricade of noncombustible material. This barricade should be at least 5 ft (1.53 m) high and have a fire resistance rating of at least ½ hour. *Firmly secure cylinders upright to keep them from falling or being knocked over. Screw valve protection cap firmly in place by hand. Post "No Smoking or Open Flames" signs in storage and use areas. There must be no sources of ignition. All electrical equipment in storage areas must be explosion-proof. Storage areas must meet national electric codes for Class 1 hazardous areas. Store only where temperature will not exceed 125°F (52°C). Store full and empty cylinders separately. Use a first-in, first-out inventory system to prevent storing full cylinders for long periods.*

RECOMMENDED PUBLICATIONS: For further information on storage, handling, and use of this product, see NFPA 55, *Standard for the Storage, Use, and Handling of Compressed and Liquefied Gases in Portable Cylinders*, published by the National Fire Protection Association. See also Praxair publication P-14-153, *Guidelines for Handling Gas Cylinders and Containers*. Obtain from your local supplier.

8. Exposure Controls/Personal Protection

COMPONENT	OSHA PEL	ACGIH TLV-TWA (2005)
Ethylene	N.E.*	200 ppm

*N.E.—Not Established.

TLV-TWAs should be used as a guide in the control of health hazards and not as fine lines between safe and dangerous concentrations.

IDLH = Not available.

ENGINEERING CONTROLS:

Local Exhaust. An explosion-proof local exhaust system with sufficient air flow velocity is recommended.

Mechanical (General). Under certain conditions, general exhaust ventilation may be acceptable to keep ethylene below the exposure limit.

Special. Use only in a closed system.

Other. None

PERSONAL PROTECTIVE EQUIPMENT:

Skin Protection. Wear work gloves for cylinder handling.

Eye/Face Protection. Select in accordance with OSHA 29 CFR 1910.133.

Respiratory Protection. None required under normal use. An air-supplied respirator must be used in confined spaces. Respiratory protection must conform to OSHA 29 CFR 1910.134.

Select per OSHA 29 CFR 1910.134 and ANSI Z88.2.

9. Physical and Chemical Properties

APPEARANCE:	Colorless gas	
ODOR:	Faint, sweet, musty odor.	
ODOR THRESHOLD:	Not available.	
PHYSICAL STATE:	Gas at normal temperature and pressure	
pH:	Not applicable.	
MELTING POINT at 1 atm:	-272.45°F (-169.14°C)	
BOILING POINT at 1 atm:	-154.62°F (-103.68°C)	
FLASH POINT (test method):	-213°F (-136.1°C) TCC	
EVAPORATION RATE (Butyl Acetate = 1):	Not applicable.	
FLAMMABILITY:	Flammable	
FLAMMABLE LIMITS IN AIR, % by volume:	LOWER: 2.7%	UPPER: 36%
VAPOR PRESSURE at 68°F (20°C):	Not available.	
VAPOR DENSITY at 32°F (0°C) and 1 atm:	0.0787 lb/ft ³ (1.261 kg/m ³)	
SPECIFIC GRAVITY (H ₂ O = 1) at 19.4°F (-7°C):	Not applicable.	

SPECIFIC GRAVITY (Air = 1) at 32°F (0°C) and 1 atm:	0.978
SOLUBILITY IN WATER, vol/vol at 32°F (0°C) and 1 atm:	0.26
PARTITION COEFFICIENT, logKOW: n-octanol/water:	1.13
AUTOIGNITION TEMPERATURE:	842°F (450°C)
DECOMPOSITION TEMPERATURE:	Not available.
PERCENT VOLATILES BY VOLUME:	100
MOLECULAR WEIGHT:	28.05
MOLECULAR FORMULA:	C ₂ H ₄

10. Stability and Reactivity

CHEMICAL STABILITY: Unstable Stable

This material is stable shipped under and stored under an inert atmosphere.

CONDITIONS TO AVOID: Elevated temperature and pressure.

INCOMPATIBLE MATERIALS: Heat (reacts explosively with chlorine in sunlight or UV light), oxidizing agents, halogens, acids, aluminum chloride, halocarbons.

HAZARDOUS DECOMPOSITION PRODUCTS: Thermal decomposition or burning may produce CO/CO₂.

POSSIBILITY OF HAZARDOUS REACTIONS: May Occur Will Not Occur

Hazardous polymerization may occur at elevated temperature and pressure.

11. Toxicological Information

ACUTE DOSE EFFECTS: Ethylene is a simple asphyxiant.

STUDY RESULTS: None known.

12. Ecological Information

ECOTOXICITY: No known effects.

OTHER ADVERSE EFFECTS: Ethylene does not contain any Class I or Class II ozone-depleting chemicals.

13. Disposal Considerations

WASTE DISPOSAL METHOD: Do not attempt to dispose of residual or unused quantities. Return cylinder to supplier.

14. Transport Information

DOT/IMO SHIPPING NAME: Ethylene

HAZARD CLASS:	PACKING GROUP/Zone:	IDENTIFICATION NUMBER:	PRODUCT RQ:
2.1	NA	UN1962	None

SHIPPING LABEL(s): FLAMMABLE GAS

PLACARD (when required): FLAMMABLE GAS

SPECIAL SHIPPING INFORMATION: Cylinders should be transported in a secure position, in a well-ventilated vehicle. Cylinders transported in an enclosed, nonventilated compartment of a vehicle can present serious safety hazards.

Shipment of compressed gas cylinders that have been filled without the owner's consent is a violation of federal law [49 CFR 173.301(b)].

MARINE POLLUTANTS: Ethylene is not listed as a marine pollutant by DOT.

15. Regulatory Information

The following selected regulatory requirements may apply to this product. Not all such requirements are identified. Users of this product are solely responsible for compliance with all applicable federal, state, and local regulations.

U.S. FEDERAL REGULATIONS:

EPA (ENVIRONMENTAL PROTECTION AGENCY)

CERCLA: COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT OF 1980 (40 CFR Parts 117 and 302):

Reportable Quantity (RQ): e.g., None

SARA: SUPERFUND AMENDMENT AND REAUTHORIZATION ACT:

SECTIONS 302/304: Require emergency planning based on Threshold Planning Quantity (TPQ) and release reporting based on Reportable Quantities (RQ) of Extremely Hazardous Substances (EHS) (40 CFR Part 355):

TPQ: e.g., None

EHS RQ (40 CFR 355): e.g., None

SECTIONS 311/312: Require submission of MSDSs and reporting of chemical inventories with identification of EPA hazard categories. The hazard categories for this product are as follows:

IMMEDIATE: Yes

PRESSURE: Yes

DELAYED: No

REACTIVITY: No

FIRE: Yes

SECTION 313: Requires submission of annual reports of release of toxic chemicals that appear in 40 CFR Part 372.

Ethylene is subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 (SARA) and 40CFR Part 372.

40 CFR 68: RISK MANAGEMENT PROGRAM FOR CHEMICAL ACCIDENTAL RELEASE PREVENTION: Requires development and implementation of risk management programs at facilities that manufacture, use, store, or otherwise handle regulated substances in quantities that exceed specified thresholds.

Ethylene is listed as a regulated substance in quantities of 10,000 lb (4536 kg) or greater.

TSCA: TOXIC SUBSTANCES CONTROL ACT: Ethylene is listed on the TSCA inventory.

OSHA: OCCUPATIONAL SAFETY AND HEALTH ADMINISTRATION:

29 CFR 1910.119: PROCESS SAFETY MANAGEMENT OF HIGHLY HAZARDOUS CHEMICALS: Requires facilities to develop a process safety management program based on Threshold Quantities (TQ) of highly hazardous chemicals.

Ethylene is not listed in Appendix A as a highly hazardous chemical. However, any process that involves a flammable gas on site in one location in quantities of 10,000 lb (4536 kg) or greater is covered under this regulation unless the gas is used as a fuel.

STATE REGULATIONS:

CALIFORNIA: Ethylene is not listed by California under the SAFE DRINKING WATER AND TOXIC ENFORCEMENT ACT OF 1986 (Proposition 65).

PENNSYLVANIA: Ethylene is subject to the PENNSYLVANIA WORKER AND COMMUNITY RIGHT-TO-KNOW ACT (35 P.S. Sections 7301-7320).

16. Other Information

Be sure to read and understand all labels and instructions supplied with all containers of this product.

OTHER HAZARDOUS CONDITIONS OF HANDLING, STORAGE, AND USE: *Flammable, high-pressure gas.* Use piping and equipment adequately designed to withstand pressures to be encountered. Use a backflow prevention device in any piping. Use only in a closed system. *All piped ethylene systems and associated equipment must be grounded.* Electrical equipment must be non-sparking or explosion-proof. Keep away from heat, sparks, and open flame. *May cause frostbite.* Avoid contact with skin and eyes. *Gas can cause rapid suffocation due to oxygen deficiency.* Store and use with adequate ventilation at all times. Close cylinder valve after each use; keep closed even when empty. *Never work on a pressurized system.* If there is a leak, close the cylinder valve. Blow the system down in a safe and environmentally sound manner in compliance with all federal, state, and local laws; then repair the leak. *Never place a compressed gas cylinder where it may become part of an electrical circuit.*

NOTE: *Prior to using any plastics, confirm their compatibility with ethylene.*

Mixtures. When you mix two or more gases or liquefied gases, you can create additional, unexpected hazards. Obtain and evaluate the safety information for each component before you produce the mixture. Consult an industrial hygienist or other trained person when you evaluate the end product. Remember, gases and liquids have properties that can cause serious injury or death.

HAZARD RATING SYSTEMS:

NFPA RATINGS:

HEALTH = 2
FLAMMABILITY = 4
INSTABILITY = 2
SPECIAL = None

HMIS RATINGS:

HEALTH = 1
FLAMMABILITY = 4
PHYSICAL HAZARD = 3

STANDARD VALVE CONNECTIONS FOR U.S. AND CANADA:

THREADED: CGA-350
PIN-INDEXED YOKE: CGA-900
ULTRA-HIGH-INTEGRITY CONNECTION: Not applicable.

Use the proper CGA connections. DO NOT USE ADAPTERS. Additional limited-standard connections may apply. See CGA pamphlet V-1 listed below.

Ask your supplier about free Praxair safety literature as referred to in this MSDS and on the label for this product. Further information can be found in the following pamphlets published by the Compressed Gas Association, Inc. (CGA), 4221 Walney Road, 5th Floor, Chantilly, VA 20151-2923, Telephone (703) 788-2700, <http://www.cganet.com/Publication.asp>.

AV-1 *Safe Handling and Storage of Compressed Gases*
P-1 *Safe Handling of Compressed Gases in Containers*
SB-2 *Oxygen-Deficient Atmospheres*
V-1 *Compressed Gas Cylinder Valve Inlet and Outlet Connections*
— *Handbook of Compressed Gases, Fourth Edition*

Praxair asks users of this product to study this MSDS and become aware of product hazards and safety information. To promote safe use of this product, a user should (1) notify employees, agents, and contractors of the information in this MSDS and of any other known product hazards and safety information, (2) furnish this information to each purchaser of the product, and (3) ask each purchaser to notify its employees and customers of the product hazards and safety information.

The opinions expressed herein are those of qualified experts within Praxair, Inc. We believe that the information contained herein is current as of the date of this Material Safety Data Sheet. Since the use of this information and the conditions of use of the product are not within the control of Praxair, Inc., it is the user's obligation to determine the conditions of safe use of the product.

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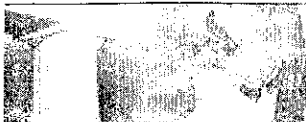
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CAS Registry Number: 74-85-1

Names (NTP)

- Ethylene
- Acetene

Selected information from two of the National Library of Medicine's databases: ChemIDPlus¹ and HSDB².

Structure



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Chemical Properties²

Color/Form	<ul style="list-style-type: none"> • COLORLESS GAS • MONOCLINIC PRISMS WHEN IT SOLIDIFIES AT -181 DEG C
Odor	<ul style="list-style-type: none"> • SWEET • Olefinic, hedonic tone: unpleasant to neutral
Taste	<ul style="list-style-type: none"> • SLIGHTLY SWEET
Boiling Point	<ul style="list-style-type: none"> • -102.4 DEG C @ 700 MM HG
Melting Point	<ul style="list-style-type: none"> • -169 DEG C

Molecular Weight	<ul style="list-style-type: none"> • 28.05
Corrosivity	<ul style="list-style-type: none"> • Ethylene is a noncorrosive gas.
Critical Temperature & Pressure	<ul style="list-style-type: none"> • CRITICAL TEMPERATURE: +9.6 DEG C; CRITICAL PRESSURE: 50.7 ATM
Density/Specific Gravity	<ul style="list-style-type: none"> • 567.37 kg/cu m (-103.8 deg C)
Disassociation Constants	<ul style="list-style-type: none"> • None found
Heat of Combustion	<ul style="list-style-type: none"> • -11,272 cal/g = -471.94x10⁵ J/kg
Heat of Vaporization	<ul style="list-style-type: none"> • 207.7 Btu/lb = 115.4 cal/g = 4.832x10⁵ J/kg
log P (octanol-water)	<ul style="list-style-type: none"> • Log Kow= 1.13
pH	<ul style="list-style-type: none"> • None found
Solubilities	<ul style="list-style-type: none"> • 1 VOL DISSOLVES IN ABOUT 4 VOL WATER @ 0 DEG C, IN ABOUT 9 VOL WATER @ 25 DEG C, IN ABOUT 0.5 VOL ALCOHOL @ 25 DEG C, IN ABOUT 0.05 VOL ETHER @ 15.5 DEG C • SOL IN ACETONE, BENZENE • 131 mg/l at 20 deg C; 256 cu cm/l at 0 deg C • Water solubility: 131 mg/l at 25 deg C
Spectral Properties	<ul style="list-style-type: none"> • MAX ABSORPTION (GAS): 161.5 NM (LOG E= 3.92) • INDEX OF REFRACTION: 1.363 @ 100 DEG C/D • IR: 1131 (Sadler Research Laboratories Prism Collection) • UV: 3-3 (Organic Electronic Spectral Data, Phillips et al, John Wiley & Sons, New York) • MASS: 4 (Atlas of Mass Spectral Data, John Wiley & Sons, New York)
Surface Tension	<ul style="list-style-type: none"> • 16 dynes/cm = 0.016 N/m at -104 deg C
Vapor Density	<ul style="list-style-type: none"> • 0.978 (AIR= 1)
Vapor Pressure	<ul style="list-style-type: none"> • Vapor pressure 4,040 kPa (-1.5 deg C)
Relative Evaporation Rate	<ul style="list-style-type: none"> • None found
Viscosity	<ul style="list-style-type: none"> • 0.01 mPa.s 20 deg C
Other Properties	<ul style="list-style-type: none"> • 1 mg/cu m = 0.86 ppm; 1 ppm = 1.17 mg/cu m • BURNS WITH A LUMINOUS FLAME • Specific gravity: 0.57 at -130.8 deg C • Latent heat of fusion 3.33 kj/mole (-169.4 deg C) • Latent heat of vaporization 13.6 kj/mole (-103.8 deg C) • Heat of formation 52.47 kj/mole (25 deg C) • Ionization potential 10.51 eV • Heat capacity, constant pressure: 1.516 J/g deg C; Heat capacity, constant volume: 1.220 J/g deg C

- | |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none">• Coefficient of thermal expansion 3.7×10^{-3} at 20 deg C• Heat of combustion 1,411 Kj/mole• POLYMERIZES @ HIGH PRESSURES• Henry's Law constant = 0.228 atm-cu m/mole at 25 deg C |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

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Uses²

- OXYETHYLENE WELDING & CUTTING METALS; MFR MUSTARD GAS AND MANY OTHER ORGANICS; MEDICATION: INHALATION ANESTHETIC
- REFRIGERANT
- PLANT GROWTH REGULATOR
- CHEM INT FOR ETHYLENE OXIDE, ETHYLENE DICHLORIDE, ETHYLBENZENE, ETHYL ALCOHOL, ACETALDEHYDE, LINEAR PRIMARY ALCOHOLS & VINYL ACETATE MONOMER; MONOMER FOR POLYETHYLENE
- Manufacture of ethyl chloride
- Raw material for anesthetics
- Cooling medium
- Solvent
- Manufacture of tetraethyl lead
- THE PRINCIPAL INDUSTRIAL USE OF ETHYLENE IS AS A "BUILDING BLOCK" FOR CHEMICAL RAW MATERIALS WHICH IN TURN ARE USED TO MFR A LARGE VARIETY OF SUBSTANCES AND PRODUCTS. SOME OF MAJOR CHEM & MATERIALS DERIVED FROM ETHYLENE ARE: VINYL CHLORIDE MONOMER OR 1,2-DICHLOROETHANE ... STYRENE MONOMER ... ACETALDEHYDE ...
- COMPRESSED GAS USED TO INITIATE DEGREENING & RIPENING OF BANANAS, CITRUS FRUITS, HONEYDEW MELONS, PEARS, & PINEAPPLES. APPLIED BEFORE HARVEST OF PINEAPPLES TO INDUCE FLOWERING.
- MEDICATION **QC REVIEWED**

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Superlist Classes¹

- Overall Carcinogenic Evaluation: Group 3
- TWA 200 ppm; Not classifiable as a human carcinogen

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Notes (Sources: NTP,HSDB,RTECS,MESH)¹

- None found

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Other Registry Numbers¹

- 33060-30-9
- 87701-64-2
- 87701-65-3

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- Acetene
- Bicarburretted hydrogen
- Elayl
- Ethene
- Etileno
- HSDB 168
- Liquid ethylene
- Olefiant gas

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¹ Source: the [National Library of Medicine's ChemIDPlus](#), 02/28/2006.

² Source: the [National Library of Medicine's Hazardous Substance Database](#), 02/28/2006.

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CAS Registry Number: 74-85-1

Names (NTP)

- Ethylene
- Acetene

Selected toxicity information from HSDB, one of the National Library of Medicine's databases. ¹

Human Toxicity Excerpts

- AFTER PROLONGED USE, THERE MAY BE MODERATE HYPERGLYCEMIA. POSTOPERATIVE NAUSEA & VOMITING OCCUR MORE FREQUENTLY AFTER ETHYLENE THAN AFTER NITROUS OXIDE BUT LESS FREQUENTLY THAN AFTER CYCLOPROPANE. UNPLEASANT AFTERTASTE IS OFTEN EXPERIENCED FOR A FEW HR FOLLOWING ETHYLENE ANESTHESIA. DIFFUSION HYPOXIA MAY OCCUR AT THE CONCLUSION OF ANESTHESIA ... [American Medical Association, Council on Drugs. AMA Drug Evaluations. 2nd ed. Acton, Mass.: Publishing Sciences Group, Inc., 1973., p. 227]**PEER REVIEWED**
- BECAUSE OF THE HIGH CONCEN OF ETHYLENE ... REQUIRED TO PRODUCE & MAINTAIN ANESTHESIA, CYANOSIS IS AN UNAVOIDABLE ACCOMPANIMENT OF ... /ITS/ USE. [Thienes, C., and T.J. Haley. Clinical Toxicology. 5th ed. Philadelphia: Lea and Febiger, 1972., p. 53]**PEER REVIEWED**
- BLOOD PRESSURE MAY RISE MODERATELY DURING INDUCTION & EARLY PHASE OF SURGICAL ANESTHESIA, BUT IT SOON RETURNS TO NORMAL & REMAINS THERE THROUGHOUT ANESTHESIA. CARDIAC ARRHYTHMIAS OCCUR INFREQUENTLY WHEN ETHYLENE IS USED, & CARDIOVASCULAR EFFECTS OF THE GAS ARE RELATIVELY BENIGN. [Goodman, L.S., and A. Gilman. (eds.) The Pharmacological Basis of Therapeutics. 5th ed. New York: Macmillan Publishing Co., Inc., 1975., p. 84]**PEER REVIEWED**
- Exposure at 37.5% for 15 min may result in marked memory disturbances. Humans exposed to as much as 50% ethylene in air, whereby the oxygen

availability is decreased to 10%, experienced a loss of consciousness, and death may follow. [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982., p. 3199]**PEER REVIEWED**

- ... Moderate concentration in air causes unconsciousness. [Fire Protection Guide to Hazardous Materials. 12 ed. Quincy, MA: National Fire Protection Association, 1997., p. 49-66]**QC REVIEWED**
- Vapors are anesthetic. [U.S. Coast Guard, Department of Transportation. CHRIS - Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984-5., p.]**PEER REVIEWED**

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Non-Human Toxicity Excerpts

- Treatment of rats with up to 500,000 ppm ethylene for 5 hours had no effects, however if the rats were pretreated with 500 mg/kg of Arochlor and exposed at 100,000 ppm ethylene, an increased serum glutamicpyruvic transaminase (SGPT) activity and centrolobular necrosis were observed. Similar effects were not evident with other enzyme inducers such as phenobarbital and 3-methyl cholanthrene. [American Conference of Governmental Industrial Hygienists, Inc. Documentation of the Threshold Limit Values and Biological Exposure Indices. 6th ed. Volumes I, II, III. Cincinnati, OH: ACGIH, 1991., p. 598]**PEER REVIEWED**
- Ethylene was not found to be mutagenic with or without S-9 activating system in Salmonella typhimurium strains TA98, TA1537, TA100, or TA1535. [American Conference of Governmental Industrial Hygienists, Inc. Documentation of the Threshold Limit Values and Biological Exposure Indices. 6th ed. Volumes I, II, III. Cincinnati, OH: ACGIH, 1991., p. 598]**PEER REVIEWED**
- Inhalation of ethylene by Sprague Dawley rats, in concentrations of 0, 300, 1000, 3000, or 10,000 ppm, 6 hours/day, 5 days/week for 14 weeks, caused no toxic effects. [American Conference of Governmental Industrial Hygienists, Inc. Documentation of the Threshold Limit Values and Biological Exposure Indices. 6th ed. Volumes I, II, III. Cincinnati, OH: ACGIH, 1991., p. 598]**PEER REVIEWED**
- A study of 0, 300, 1000, or 3000 ppm ethylene, 6 hours/day, 5 days/week for 106 weeks also yielded no chronic toxicologic or carcinogenic effects. [American Conference of Governmental Industrial Hygienists, Inc. Documentation of the Threshold Limit Values and Biological Exposure Indices. 6th ed. Volumes I, II, III. Cincinnati, OH: ACGIH, 1991., p. 598]**PEER REVIEWED**
- ... In dogs ... at 1.4% ethene was a fast acting anesthetic. It reached alveolar, arterial, brain, muscle, and CNS partial pressure in 2 to 8.2 min, even more rapidly than ethyl ether. [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982., p. 3199]**PEER REVIEWED**
- ... /Ethylene/ is a plant hormone, effective at concn as low as 0.06 mg/l. At higher concn, it may inhibit plant metabolism. [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982., p. 3199]**PEER REVIEWED**

- Ethylene showed no mutagenic properties toward *Escherichia coli* and several *Bacillus* species. [Clayton, G. D. and F. E. Clayton (eds.). *Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology*. 3rd ed. New York: John Wiley Sons, 1981-1982., p. 3199]**PEER REVIEWED**
- Various plants were exposed to different concentrations of ethylene, (0.002 - 40.0 ppm) resulting in causing numerous toxic responses. [Verschueren, K. *Handbook of Environmental Data of Organic Chemicals*. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983., p. 634-635]**PEER REVIEWED**
- The toxicity and oncogenicity of inhaled ethylene were determined in Fischer-344 rats. 960 were randomly divided into 4 groups of 120 animals of each sex and were exposed 6 hours/day, 5 days/week, for up to 24 months to concentrations of ethylene in the air of 0, 300, 1000, or 3000 ppm. The maximum tolerated dose was not used as concentrations above 3000 ppm were considered hazardous because of the risks associated with ethylene's explosive properties. The calculated time-weighted average concentrations for the 24 months of exposure were: 0, 301, 1003, and 3003 ppm, respectively. Randomly selected animals were necropsied and examined after 6, 12, and 18 months of exposure. A complete selection of tissues and organs from all animals in the control and 3000 ppm groups were examined for microscopic lesions. All animals were examined for clinical changes throughout the course of the 2 year study. Gross examination of rats dying during the study, or those that were sacrificed as scheduled, did not reveal any lesions attributable to ethylene exposure. Histologically, a variety of proliferative, degenerative, and inflammatory lesions were observed in both control and 3000 ppm groups. These lesions were typical of those seen in this strain of animal and were ... unrelated to ethylene exposure. [Hamm TE Jr et al; *Fundam Appl Toxicol* 4 (3): 473-8 (1984)]**PEER REVIEWED**
- Mixtures of aniline/ethylene/NOx were photolyzed in 22.7 cu m Teflon reaction chamber operated in a cyanic mode. Several minor products, including nitrobenzene, azobenzene, alpha-nitraniline, phenol and benzoic acid, were identified. The production of aerosol was also observed. The product mixtures were exposed to *Salmonella typhimurium* strains TA98 and TA100 both with and without metabolic activation. Exposures of the gas mixtures alone and the aerosol plus gas mixtures were performed. In addition, filters of the aerosol were collected, extracted, and used in a plate incorporation procedure with these strains. The results show the gas phase products from the irradiated mixture to be relatively nonmutagenic in the TA98 and TA100. This same result was found in the aerosol exposure, although the deposition into the media may have been low. However, extracts from the aerosol when directly incorporated into the medium show mutagenic activity for TA98. [Shepson PB et al; *J Environ Sci Health Part A* 20 (5): 503-519 (1985)]**PEER REVIEWED**
- Incubation of cut spurs of *Hippophae rhamnoides* in atmospheres containing 1 ml ethylene/l for 120 hr induced formation of abscission layer and complete abscission of ripe fruit within 1 week. Presence of leaves decreased the abscisic effect of C₂H₄. [Demenko VI et al; *Fiziol Rast (Moscow)* 33 (1): 188-94 (1986)]**PEER REVIEWED**
- Treating potato tubers with ethylene donors (Hydrel, Dihydrol or Camposan) inhibited the sprouting of the growth points and increased abscisic acid content of the meristem of the growth points and of the cortical parenchyma. However, abscisic acid content of the tubers increased less when Hydrel was used at growth-stimulating (0.05%) than at growth-inhibiting (0.5 and 1%)

concentrations. Abscisic acid concentration in the tubers decreased 90-120 days after the treatment resulting in active tuber sprouting after that time when 0.05% Hydrel was used, while when the high Hydrel concentrations were applied, the abscisic acid concentration remained still at a high level inhibiting the sprouting 120-150 days after treatment and even later. Thus, the increase in abscisic acid concentration resulting from treatment with ethylene donors was the main cause of inhibition of tuber sprouting. The other ethylene donors behaved similarly as Hydrel did also increasing the abscisic acid concentration in the tuber tissues. In the control tubers (treated with 0.05% ethylene donors) the abscisic acid decreased 210 days after the treatment to 0.08 ug/g fresh matter while in tubers treated at 0.5% concentration it remained at that time at a level 10-fold that in the control. A direct relation between the concentration of ethylene donors used for treatment and abscisic acid concentration in the tubers was found.

[Korableva NP et al; Fiziol Biokhim Mikrobiol 18 (1): 600-4 (1986)]

PEER REVIEWED

- ... Ethylene is not a cardiac sensitizer in the dog. [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982., p. 3199] **PEER REVIEWED**
- Male rats exposed to 10, 25 and 57x10⁺³ ppm for 4 hr showed increased serum pyruvate and liver weights. [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982., p. 3199]**PEER REVIEWED**
- ... Mice repeatedly exposed at minimal /CNS depressant/ concn showed no histopathological changes in kidneys, adrenals, hearts, or lungs. [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982., p. 3198]**PEER REVIEWED**
- ... Liver mitochondrial volume increased in rats treated with ethylene. [Clayton, G. D. and F. E. Clayton (eds.). Patty's Industrial Hygiene and Toxicology: Volume 2A, 2B, 2C: Toxicology. 3rd ed. New York: John Wiley Sons, 1981-1982., p. 3199]**PEER REVIEWED**
- Easter lilies (*Lilium longiflorum*) were treated with ethylene or ethephon at several development stages of flower buds. C₂H₄ hastened flower-bud opening. The earlier C₂H₄ treatment during the flower-bud development stages, the earlier flowering occurred. C₂H₄ or ethephon treatment decreased tepal length, but increased degenerated flower buds and distorted flowers. C₂H₄ also hastened flower senescence to result in earlier wilting and earlier dropping of flowers. [Lee JS, Roh SM; Han'guk Wonye Hakhoechi 26 (2): 145-9 (1985)]**PEER REVIEWED**
- Groups of male and female Sprague-Dawley rats, three to five days of age, were exposed by inhalation to 0 (5 male and 9 female rats) or 10,000 ppm (11,500 mg/cu m, 2 males and 10 females) ethylene (purity unspecified) for 8 hr per day on five days per week for three weeks. One week later, the rats received oral administrations of 10 mg/kg body weight Clophen A 50 (a mixture of polychlorinated biphenyls (not otherwise specified) by gavage twice a week for up to eight additional weeks (promotion), at which time the experiment was terminated and the livers were examined for ATPase-deficient foci. The number of ATPase-deficient foci in the, rats exposed to ethylene did not exceed the control values. In the same experiment, ethylene

oxide, administered as a positive control, produced a significant increase in the incidence of ATPase-deficient foci in females. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-PRESENT. (Multivolume work)., p. V60 53-4 (1994)]**PEER REVIEWED**

- Ethylene inhaled at a dose of 11.5 g/cu m (10,000 ppm) for 4 hr is acutely hepatotoxic to rats pretreated with the polychlorinated biphenyl Aroclor 1254 given orally at a dose of 300 umol/kg body wt once daily for 3 days. It is not acutely toxic without such pretreatment. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-PRESENT. (Multivolume work)., p. V19 163 (1979)]**PEER REVIEWED**
- Male Fischer 344 rats and male B6C3F1 mice (10/species/group) were exposed to ethylene 6 hr/day 5 days/week for 4 weeks. The ethylene target concentrations were 0, 40, 1000 and 3000 ppm. An ethylene oxide control group for each species was exposed under the same conditions at a target concentration of 200 ppm. Bone marrow was collected approximately 24 hr after the final exposure. Polychromatic erythrocyte (PCE) to normochromatic erythrocyte (NCE) ratios were determined and 2000 PCE/animal were scored for the presence of micronuclei. Ethylene did not produce statistically significant exposure related increases in the frequency of micronucleated PCE (MNPCE) in the bone marrow of either rats or mice when compared to air exposed control animals. ... [Vergnes JS, Pritts IM; Mutat Res 324 (3): 87-91 (1994)]**PEER REVIEWED**

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Human Toxicity Values

- None found

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Non-Human Toxicity Values

- None found

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Absorption, Distribution and Excretion

- ETHYLENE IS EXCRETED ALMOST QUANTITATIVELY IN THE EXHALED AIR & UNDERGOES LITTLE CHEMICAL CHANGE IN THE BODY. PARTITION COEFFICIENTS AT BODY TEMPERATURE: BLOOD:GAS= 0.15; HEART:BLOOD= 1.0; FAT:BLOOD= 6. BLOOD:AIR PARTITION RATIO= 0.14 AT 37 DEG C. [Goodman, L.S., and A. Gilman. (eds.) The Pharmacological Basis of Therapeutics. 5th ed. New York: Macmillan Publishing Co., Inc., 1975., p. 84]**PEER REVIEWED**

- GASES WITH LOW BLOOD/GAS SOLUBILITY LIKE ETHYLENE ARE RAPIDLY EXCRETED. [Doull, J., C.D. Klaassen, and M. D. Amdur (eds.). Casarett and Doull's Toxicology. 2nd ed. New York: Macmillan Publishing Co., 1980., p. 48]**PEER REVIEWED**
- ETHYLENE HAS BEEN DETERMINED IN EXPIRED AIR OF 2/8 HUMAN SUBJECTS AT RATE OF 0.91 & 120 UG/HR. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-PRESENT. (Multivolume work)., p. V19 161 (1979)]**PEER REVIEWED**
- ... EXCRETED IN URINE ... [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-PRESENT. (Multivolume work)., p. V19 163 (1979)]**PEER REVIEWED**
- The inhalation pharmacokinetics of ethylene have been investigated in human volunteers at atmospheric concentrations of up to 50 ppm (157.5 mg/cu m) by gas uptake in a closed spirometer system. The uptake, exhalation and metabolism of ethylene can be described by first-order kinetics. Uptake of ethylene into the body is low. Clearance due to uptake, which reflects the transfer rate of ethylene from the atmosphere into the body, was 25 l/hr for a man of 70 kg. This value represents only 5.6% of the experimentally obtained alveolar ventilation rate of 150 l/hr. The majority (94.4%) of ethylene inhaled into the lungs is exhaled again without becoming systemically available via the blood stream. Maximal accumulation of ethylene in the same man, determined as the thermodynamic partition coefficient whole body:air was 0.53. The concentration ratio at steady state was even smaller (0.33), owing to metabolic elimination. Clearance due to metabolism, in relation to the concentration in the atmosphere, was calculated to be 9.3 l/hr for a man of 70 kg. This indicates that at steady state about 36% of systemically available ethylene is eliminated metabolically and 64% is eliminated by exhalation as the unchanged substance, as can be calculated from the values of clearance of uptake and of clearance of metabolism. The biological half-life of ethylene was 0.65 hr. The alveolar retention of ethylene at steady state was calculated to be 2%. From theoretical considerations of the lung uptake of gases and vapors, it can be deduced that the low uptake rate of ethylene is due to its low solubility in blood: Ostwald's solubility coefficient for human blood at 37 deg C, 0.15. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-PRESENT. (Multivolume work)., p. V60 53 (1994)]**PEER REVIEWED**
- Four male CBA mice (average body weight, 31 g) were exposed together for 1 hr in a closed glass chamber (5.6 l) to (14)C-ethylene (22 mCi/mmol) in air at 17 ppm x hr (22.3 (mg/cu m) x hr, equivalent to about 1 mg/kg bw). Blood and organs from two mice were pooled 4 hr after the end of exposure. Radioactivity was about the same in kidney (0.16 uCi/g wet weight) and liver (0.14 uCi/g) but lower in testis (0.035 uCi/g), brain (0.02 uCi/g) and Hb (0.0094 uCi/g Hb). Urine was collected from the two other mice during 48 h, and blood was collected after 21 days. 5-(2-Hydroxyethyl)cysteine was identified as a metabolite of ethylene in urine (3% of (14)C in urine) by thin-layer chromatography. The radioactivity in Hb was 0.011 uCi/g Hb. These

data, together with those on specific hydroxyethyl derivatives at amino acid residues of Hb, indicated that ethylene was metabolized to ethylene oxide. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-PRESENT. (Multivolume work)., p. V60 55 (1994)]**PEER REVIEWED**

- In several experiments, disposition of (14)C-ethylene (free of (14)C-acetylene or greater than or equal to 97% pure) in male Fischer 344 rats (170-220 g) was determined over 36 hr following 5 hr exposures in a closed chamber (35 l) to 10,000 ppm (11,500 mg/cu m). In each experiment, up to four rats were exposed together in a single chamber. Within about 1 min after the end of exposure, animals were transferred to individual all-glass metabolism cages. Most of the eliminated (14)C was exhaled as ethylene (18 umol (504 ug) per rat exposed to acetylene-containing ethylene); smaller amounts were excreted in urine (2.7 umol ethylene equivalents/rat) and feces (0.4 umol) and exhaled as CO₂ (0.16 umol). Radioactivity was also found in blood (0.022 umol ethylene equivalents/ml), liver (0.047 umol ethylene equivalents/liver), gut (0.034 umol ethylene equivalents/gut) and kidney (0.006 umol ethylene equivalents/kidney). Pretreatment of animals with a mixture of polychlorinated biphenyls (Aroclor 1254; 500 mg/kg bw; single intraperitoneal injection five days before exposure) had no measurable influence on ethylene exhalation but resulted in a significant ($p < 0.05$) increase in exhaled (14)CO₂ (2.04 umol ethylene equivalents/rat) and of (14)C in urine (11.1 umol ethylene equivalents/rat) and in blood (0.044 umol ethylene equivalents/ml). The organ burden of (14)C was one to two orders of magnitude greater in Aroclor 1254-treated than in untreated animals. Radioactivity also became detectable in lungs, brain, fat, spleen, heart and skeletal muscle. The data were interpreted as indicating that the metabolism of ethylene can be stimulated by an inducer of the mixed-function oxidase system.[IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International Agency for Research on Cancer, 1972-PRESENT. (Multivolume work)., p. V60 55-6 (1994)]**PEER REVIEWED**

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Metabolism/Metabolites

- Dioxolane ... the aliphatic analog of the known cytochrome inhibitor, methylenedioxybenzene ... breaks down to ethylene and carbon dioxide. [The Royal Society of Chemistry. Foreign Compound Metabolism in Mammals. Volume 6: A Review of the Literature Published during 1978 and 1979. London: The Royal Society of Chemistry, 1981., p. 332]**PEER REVIEWED**
- Rat liver microsomal monooxygenases transform ethylene to oxirane. ... [Schmiedel G et al; Toxicol Lett 19 (3): 293-7 (1983)]**PEER REVIEWED**
- MALE CBA MICE EXPOSED TO AIR CONTAINING 19.6 MG/CU M ... (14)C-LABELED ETHYLENE METABOLIZED ETHYLENE TO ETHYLENE OXIDE, WHICH BINDS TO CELLULAR PROTEINS. [IARC. Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Man. Geneva: World Health Organization, International

Agency for Research on Cancer, 1972-PRESENT. (Multivolume work), p. V19 163 (1979)]**PEER REVIEWED**

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TSCA Test Submissions

- None found

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Footnotes

¹ Source: the [National Library of Medicine's Hazardous Substance Database](#), 02/28/2006.

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