evaporates very quickly displacing the air and causing a serious risk of suffocation when in confined areas. [Peer reviewed] [IPCS, CEC; International Chemical Safety Card on Propane. (November 2003). Available from http://www.inchem.org/documents/icsc/icsc/eics0319.htm as of October 11, 2006.]

Explosive Limits and Potential:

1. If gas were leaking into a house trailer & a source of ignition were present, an explosion would result when the concn reached 2.2%. ... propane cylinders for homes & trailers are equipped with fusible plugs. If fire is present, the plug melts at a designated temp, releasing a small vol of gas which burns slowly, thus preventing an explosion. [Peer reviewed] [Arena, J.M. and Drew, R.H. (eds.) Poisoning-Toxicology, Symptoms, Treatments. 5th ed. Springfield, IL: Charles C. Thomas Publisher, 1986., p. 832]
2. LOWER: 2.37, UPPER 9.5% BY VOLUME IN AIR. [Peer reviewed] [The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983., p. 1124]

HAZARDOUS REACTIONS ▲

Reactivities and Incompatibilities:

1. ... Can react vigorously with oxidizing materials. Explosive reaction with chlorine dioxide. [Peer reviewed] [Lewis, R.J. Sr. (ed) Sax's Dangerous Properties of Industrial Materials. 11th Edition. Wiley-Interscience, Wiley & Sons, Inc. Hoboken, NJ. 2004., p. 3060]
2. Heating barium peroxide under gaseous propane at ambient pressure caused a violent exothermic reaction which deformed the glass container. [Peer reviewed] [Bretherick, L. Handbook of Reactive Chemical Hazards. 4th ed. Boston, MA: Butterworth-Heinemann Ltd., 1990, p. 84]
3. The relationship between critical pressure and composition for self-ignition of chlorine-propane mixtures at 300 deg C was studied, and the tendency is minimal for 60:40 mixtures. Combustion is explosive under some conditions. [Peer reviewed] [Bretherick, L. Handbook of Reactive Chemical Hazards. 4th ed. Boston, MA: Butterworth-Heinemann Ltd., 1990, p. 1001]
4. Strong oxidizers. [Peer reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards & Other Databases CD-ROM. Department of Health & Human Services, Centers for Disease Prevention & Control. National Institute for Occupational Safety & Health. DHHS (NIOSH) Publication No. 2005-151 (2005), p.]

Decomposition:

At 650 deg C decomposes to ethylene and ethane [Peer reviewed] [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. 3181]

Other Hazardous Reactions:

1. As a result of flow, agitation, etc, electrostatic charges can be generated ... On loss of containment this liquid evaporates very quickly displacing the air and causing a serious risk of suffocation when in confined areas. [Peer reviewed] [IPCS, CEC; International Chemical Safety Card on Propane. (November 2003). Available from http://www.inchem.org/documents/icsc/icsc/eics0319.htm as of October 11, 2006.]
2. In a review of the use of various cryogenic liq for rapid freezing of biol specimens for cryo-sectioning, hazards attendant on the use of liq propane and similar cryogens are discussed. Upon evaporation, the vol of mixture with air within the explosive range may be 14,000 times that of the vol of original liq, and this may be a significant proportion of the free space in a confined work area. Precautions including the use of nitrogen blanketing, a fume cupboard, and adequate ventilation are discussed. [Peer reviewed] [Bretherick, L.

Handbook of Reactive Chemical Hazards. 4th ed. Boston, MA: Butterworth-Heinemann Ltd., 1990, p. 1550]

3. The practice of burning propane and kerosene to heat ... produces NOx in potentially toxic concentrations ... [Peer reviewed] [Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley & Sons. New York, N.Y. (2001)., p. 3:639]
4. Acute NO2 exposures have often been associated with ice-resurfacing machines (Zambonis) used in inadequately ventilated arenas. Exposures can be episodic and have led to incidences where 50 to >100 ice-hockey players, cheerleaders, and spectators experienced various respiratory symptoms (cough, chest pain, hemoptysis, shortness of breath) during or shortly after hockey games ... Air monitoring following these incidents has recorded NO2 concentrations of 1.0?3.5 ppm, often combined with carbon monoxide. Resurfacers produce varying amounts of NO2 depending on how they are powered; propane, gasoline, or diesel power produces increasing NO2 concentrations, respectively. [Peer reviewed] [Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley & Sons. New York, N.Y. (2001)., p. 3:643]
5. ... Contrary to popular opinion, propane-powered equipment may emit as much or more carbon monoxide than gasoline-fueled equipment ... [Peer reviewed] [Zenz, C., O.B. Dickerson, E.P. Horvath. Occupational Medicine. 3rd ed. St. Louis, MO., 1994, p. 451]

WARNING PROPERTIES ▲

Odor Threshold:

1. 5,000-20,000 PPM [Peer reviewed] [U.S. Coast Guard, Department of Transportation. CHRIS - Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984-5., p.]
2. WATER: 1.0 MG/L; AIR: 16,000 UL/L; ODOR SAFETY CLASS C; C= LESS THAN 50% OF DISTRACTED PERSONS PERCEIVE WARNING OF TLV. [Peer reviewed] [AMOORE JE, HAUTALA E; J APPL TOXICOL 3 (6): 272-90 (1983)]
3. Recognition threshold values: 36,000 mg/cu m; 22,000 mg/cu m; odor index at 20 deg C= 425 [Peer reviewed] [Verschueren, K. Handbook of Environmental Data on Organic Chemicals. Volumes 1-2. 4th ed. John Wiley & Sons. New York, NY. 2001, p. 1833]
4. Odor threshold 1800 mg/cu m (low), 36000 mg/cu m (high) [Peer reviewed] [Ruth JH; Am Ind Hyg Assoc J 47: A-142-51 (1986)]

Skin, Eye and Respiratory Irritations:

At concn up to 10% (100,000 ppm) ... propane caused no noticeable irritation to the eyes, nose, or resp tract. [Peer reviewed] [Snyder, R. (ed.) Ethyl Browning's Toxicity and Metabolism of Industrial Solvents. 2nd ed. Volume 1: Hydrocarbons. Amsterdam - New York - Oxford: Elsevier, 1987., p. 265]

PREVENTIVE MEASURES ▲

Protective Equipment and Clothing:

1. Personnel protection: ... Wear appropriate chemical protective gloves and goggles. [Peer reviewed] [Association of American Railroads; Bureau of Explosives. Emergency Handling of Hazardous Materials in Surface Transportation. Association of American Railroads, Pueblo, CO. 2005, p. 753]
2. Wear appropriate clothing to prevent skin freezing. [Peer reviewed] [Sittig, M. Handbook of Toxic and Hazardous Chemicals and Carcinogens, 1985. 2nd ed. Park Ridge, NJ: Noyes Data Corporation, 1985., p. 748]
3. ... face shield ... . [Peer reviewed] [ITII. Toxic and Hazarous Industrial Chemicals Safety

Manual. Tokyo, Japan: The International Technical Information Institute, 1982., p. 440]

4. Compressed gases may create low temperatures when they expand rapidly. Leaks and uses that allow rapid expansion may cause a frostbite hazard. Wear appropriate personal protective clothing to prevent the skin from becoming frozen. [Peer reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards & Other Databases CD-ROM. Department of Health & Human Services, Centers for Disease Prevention & Control. National Institute for Occupational Safety & Health. DHHS (NIOSH) Publication No. 2005-151 (2005), p.]
5. Wear appropriate eye protection to prevent eye contact with the liquid that could result in burns or tissue damage from frostbite. [Peer reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards & Other Databases CD-ROM. Department of Health & Human Services, Centers for Disease Prevention & Control. National Institute for Occupational Safety & Health. DHHS (NIOSH) Publication No. 2005-151 (2005), p.]
6. Quick drench facilities and/or eyewash fountains should be provided within the immediate work area for emergency use where there is any possibility of exposure to liquids that are extremely cold or rapidly evaporating. [Peer reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards & Other Databases CD-ROM. Department of Health & Human Services, Centers for Disease Prevention & Control. National Institute for Occupational Safety & Health. DHHS (NIOSH) Publication No. 2005-151 (2005), p.]
7. Respirator Recommendations: Up to 2,100 ppm: (Assigned Protection Factor = 10) Any supplied-air respirator./(Assigned Protection Factor = 50) Any self-contained breathing apparatus with a full facepiece. [Peer reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards & Other Databases CD-ROM. Department of Health & Human Services, Centers for Disease Prevention & Control. National Institute for Occupational Safety & Health. DHHS (NIOSH) Publication No. 2005-151 (2005), p.]
8. Respirator Recommendations: Emergency or planned entry into unknown concentrations or IDLH conditions: (Assigned Protection Factor = 10,000) Any self-contained breathing apparatus that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode./(Assigned Protection Factor = 10,000) Any supplied-air respirator that has a full facepiece and is operated in a pressure-demand or other positive-pressure mode in combination with an auxiliary self-contained positive-pressure breathing apparatus. [Peer reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards & Other Databases CD-ROM. Department of Health & Human Services, Centers for Disease Prevention & Control. National Institute for Occupational Safety & Health. DHHS (NIOSH) Publication No. 2005-151 (2005), p.]
9. Respirator Recommendations: Escape: Any appropriate escape-type, self-contained breathing apparatus. [Peer reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards & Other Databases CD-ROM. Department of Health & Human Services, Centers for Disease Prevention & Control. National Institute for Occupational Safety & Health. DHHS (NIOSH) Publication No. 2005-151 (2005), p.]
10. Cold-insulating gloves. [Peer reviewed] [IPCS, CEC; International Chemical Safety Card on Propane. (November 2003). Available from http://www.inchem.org/documents/icsc/icsc/eics0319.htm as of October 11, 2006.]

Other Preventative Measures:

1. When a filling, storage & dispatch depot is being selected, consideration must be given to the safety of both the site & the environment. Pump rooms, filling machinery ... must be located in fire resistant buildings with roofs of light construction. Doors & other closures should open outwards from the building. The premises should be adequately ventilated & a system of lighting with flameproof electrical switches should be installed. /gases & air, compressed/ [Peer reviewed] [International Labour Office. Encyclopedia of Occupational Health and Safety. Vols. I&II. Geneva, Switzerland: International Labour Office, 1983., p. 947]
2. If material is not on fire and not involved in fire: Keep sparks, flames, and other sources of ignition away. Keep material out of water sources and sewers. Attempt to stop leak if without undue personnel hazard. Use water spray to knock down vapors. [Peer reviewed]

[Association of American Railroads; Bureau of Explosives. Emergency Handling of Hazardous Materials in Surface Transportation. Association of American Railroads, Pueblo, CO. 2005, p. 753]

3. Work clothing that becomes wet should be immediately removed due to its flammability hazard (ie, for liquids with a flash point <100 deg F). [Peer reviewed] [NIOSH. NIOSH Pocket Guide to Chemical Hazards & Other Databases CD-ROM. Department of Health & Human Services, Centers for Disease Prevention & Control. National Institute for Occupational Safety & Health. DHHS (NIOSH) Publication No. 2005-151 (2005), p.]
4. Evacuation: If material leaking (not on fire) consider evacuation from downwind area based on amt of material spilled, location and weather conditions. [Peer reviewed] [Association of American Railroads; Bureau of Explosives. Emergency Handling of Hazardous Materials in Surface Transportation. Association of American Railroads, Pueblo, CO. 2005, p. 753]
5. Personnel protection: Avoid breathing vapors. Keep upwind. ... Do not handle broken packages unless wearing appropriate personal protective equipment. Approach fire with caution. [Peer reviewed] [Association of American Railroads; Bureau of Explosives. Emergency Handling of Hazardous Materials in Surface Transportation. Association of American Railroads, Pueblo, CO. 2005, p. 753]
6. NO open flames, NO sparks, and NO smoking ... Closed system, ventilation, explosion-proof electrical equipment and lighting. Prevent build-up of electrostatic charges (eg, by grounding) if in liquid state. Use non-sparking handtools ... [Peer reviewed] [IPCS, CEC; International Chemical Safety Card on Propane. (November 2003). Available from http://www.inchem.org/documents/icsc/icsc/eics0319.htm as of October 11, 2006.]
7. ... As of April 1, 2002, many state and local jurisdictions will require that all propane gas tanks being refilled for consumers to use with their barbecue grills must have a new ... over-fill prevention device ... Some safety tips to reduce the risk of fire or explosion with gas grills /are/: Check grill hoses for cracking, brittleness, holes, and leaks. Make sure there are no sharp bends in the hose or tubing. Move gas hoses as far away as possible from hot surfaces and dripping hot grease. Always keep propane gas containers upright. Never store a spare gas container under or near the grill or indoors. Never store or use flammable liquids, like gasoline, near the grill. Never keep a filled container in a hot car or car trunk. Heat will cause the gas pressure to increase, which may open the relief valve and allow gas to escape. Make sure your spark ignitor is consistently generating a spark to create a flame and burn the propane gas. If the flame is not visible, the heavier-than-air propane gas may be escaping and could explode. Never bring the propane tank into the house. [Peer reviewed] [U.S. Consumer Product Safety Commission; NEWS from CPSC: New, Safer Propane Tank for Barbecue Grills Helps to Avoid Gas Leaks (March 22, 2002). Available from: http://www.cpsc.gov/cpscpub/prerel/prhtml02/02127.html as of October 11, 2006.]
8. SRP: Local exhaust ventilation should be applied wherever there is an incidence of point source emissions or dispersion of regulated contaminants in the work area. Ventilation control of the contaminant as close to its point of generation is both the most economical and safest method to minimize personnel exposure to airborne contaminants. [Peer reviewed]
9. SRP: Contaminated protective clothing should be segregated in such a manner so that there is no direct personal contact by personnel who handle, dispose, or clean the clothing. Quality assurance to ascertain the completeness of the cleaning procedures should be implemented before the decontaminated protective clothing is returned for reuse by the workers. Contaminated clothing should not be taken home at end of shift, but should remain at employee's place of work for cleaning. [Peer reviewed]

OTHER SAFETY AND HANDLING ▲

Shipment Methods and Regulations:

1. No person may /transport,/ offer or accept a hazardous material for transportation in commerce unless that person is registered in conformance ... and the hazardous material is properly classed, described, packaged, marked, labeled, and in condition for shipment as required or authorized by ... /the hazardous materials regulations (49 CFR 171-177)./ [Peer reviewed] [49 CFR 171.2; U.S. National Archives and Records Administration's Electronic Code of Federal Regulations. Available from: http://www.gpoaccess.gov/ecfr/ as of February 15, 2006]
2. The International Air Transport Association (IATA) Dangerous Goods Regulations are published by the IATA Dangerous Goods Board pursuant to IATA Resolutions 618 and 619 and constitute a manual of industry carrier regulations to be followed by all IATA Member airlines when transporting hazardous materials. [Peer reviewed] [International Air Transport Association. Dangerous Goods Regulations. 47th Edition. Montreal, Quebec Canada. 2006., p. 243, 236]
3. The International Maritime Dangerous Goods Code lays down basic principles for transporting hazardous chemicals. Detailed recommendations for individual substances and a number of recommendations for good practice are included in the classes dealing with such substances. A general index of technical names has also been compiled. This index should always be consulted when attempting to locate the appropriate procedures to be used when shipping any substance or article. [Peer reviewed] [International Maritime Organization. International Maritime Dangerous Goods Code. London, UK. 2004., p. 44, 96]

Storage Conditions:

1. COMPRESSED GASES MAY BE STORED IN THE OPEN ONLY IF THEY ARE ADEQUATELY PROTECTED FROM THE WEATHER & DIRECT SUNLIGHT. STORAGE AREAS SHOULD BE LOCATED AT A SAFE DISTANCE FROM OCCUPIED PREMISES & NEIGHBORING DWELLINGS. /GASES & AIR, COMPRESSED/ [Peer reviewed] [International Labour Office. Encyclopedia of Occupational Health and Safety. Vols. I&II. Geneva, Switzerland: International Labour Office, 1983., p. 947]
2. Storage temp: ambient; venting: safety relief [Peer reviewed] [U.S. Coast Guard, Department of Transportation. CHRIS - Hazardous Chemical Data. Volume II. Washington, D.C.: U.S. Government Printing Office, 1984-5., p.]
3. Store cylinder outdoors without direct sunlight or heat radiation and with adequate ventilation. Provide electrical equipment with spark resistant construction. [Peer reviewed] [ITII. Toxic and Hazarous Industrial Chemicals Safety Manual. Tokyo, Japan: The International Technical Information Institute, 1982., p. 440]
4. Four main types of storage are used: high pressure storage aboveground, low pressure refrigerated storage aboveground, frozen earth storage, and underground cavern storage. 1) Aboveground pressure storage tanks are usually designed for a 1720 kPa (250 psi) working pressure ... 2) Refrigerated, aboveground storage tanks usually are designed for a few kPa (psi) of pressure. They must be coupled with refrigeration systems to cool the product ... to a temp equal to the product's boiling point @ the operating pressure of the tanks. Vapors are generally recondensed by refrigeration and returned to the tanks. 3) In frozen earth storage of propane, the walls and bottom of a pit in the ground are frozen and a dome is constructed over the pit. The pressure in the storage cavern is maintained @ nearly atmospheric pressure by refrigeration systems that cool the product to its boiling point @ storage pressure. Heat leaks into the cavity and vaporizes some of the propane; the vapor that is formed is compressed, cooled, and returned to the pit as liquid by the refrigeration system. ... 4) Underground storage caverns, which operate @ approx formation temp and @ the corresponding /liquified petrolem gas (LPG)/ vapor pressure ... must be of sufficient depth to develop an overburden pressure greater than the vapor pressure of the stored liquid. Mined storage caverns are about 60-152 m deep, whereas salt formation caverns may be from 106-1524 m deep ... [Peer reviewed] [Kirk-Othmer Encyclopedia of Chemical Technology. 3rd ed., Volumes 1-26. New York, NY: John Wiley and Sons, 1978-1984., p. 14(81) 393]

5. Fireproof. Cool. [Peer reviewed] [IPCS, CEC; International Chemical Safety Card on Propane. (November 2003). Available from http://www.inchem.org/documents/icsc/icsc/eics0319.htm as of October 11, 2006.]

Cleanup Methods:

1. Evacuate danger area! Consult an expert! Remove all ignition sources. Ventilation. NEVER direct water jet on liquid. (Extra personal protection: self-contained breathing apparatus.) ... Check oxygen content before entering area. Turn leaking cylinder with the leak up to prevent escape of gas in liquid state. [Peer reviewed] [IPCS, CEC; International Chemical Safety Card on Propane. (November 2003). Available from http://www.inchem.org/documents/icsc/icsc/eics0319.htm as of October 11, 2006.]
2. 1) Remove all ignition sources. 2) Ventilate area of leak. 3) Stop flow of gas. If source of leak is a cylinder & the leak cannot be stopped in place, remove the leaking cylinder to a safe place in the open air, & repair the leak or allow the cylinder to empty. [Peer reviewed] [Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) Publication No. 81-123 (3 VOLS). Washington, DC: U.S. Government Printing Office, Jan. 1981., p. 3]

Disposal Methods:

1. SRP: The most favorable course of action is to use an alternative chemical product with less inherent propensity for occupational exposure or environmental contamination. Recycle any unused portion of the material for its approved use or return it to the manufacturer or supplier. Ultimate disposal of the chemical must consider: the material's impact on air quality; potential migration in soil or water; effects on animal, aquatic, and plant life; and conformance with environmental and public health regulations. [Peer reviewed]
2. Propane may be disposed of by burning at a safe location or in a suitable combustion chamber. [Peer reviewed] [Mackison, F. W., R. S. Stricoff, and L. J. Partridge, Jr. (eds.). NIOSH/OSHA - Occupational Health Guidelines for Chemical Hazards. DHHS(NIOSH) Publication No. 81-123 (3 VOLS). Washington, DC: U.S. Government Printing Office, Jan. 1981., p. 3]

5.0 TOXICITY/BIOMEDICAL EFFECTS

SUMMARY ▲

Antidote and Emergency Treatment:

1. Basic treatment: Establish a patent airway (oropharyngeal or nasopharyngeal airway, if needed). Suction if necessary. Watch for signs of respiratory insufficiency and assist ventilations if necessary. Administer oxygen by nonrebreather mask at 10 to 15 L/min. Monitor for pulmonary edema and treat if necessary ... . Anticipate seizures and treat if necessary ... . For eye contamination, flush eyes immediately with water. Irrigate each eye continuously with 0.9% saline (NS) during transport ... . Do not use emetics. For ingestion, rinse mouth and administer 5 ml/kg up to 200 ml of water for dilution if the patient can swallow, has a strong gag reflex, and does not drool. Administer activated charcoal ... . Treat frostbite with rapid rewarming techniques ... ./Aliphatic hydrocarbons and related compounds/ [Peer reviewed] [Currance, P.L. Clements, B., Bronstein, A.C. (Eds).; Emergency Care For Hazardous Materials Exposure. 3Rd edition, Elsevier Mosby, St. Louis, MO 2005, p. 241-2]
2. Advanced treatment: Consider orotracheal or nasotracheal intubation for airway control in the patient who is unconscious, has severe pulmonary edema, or is in severe respiratory distress. Positive-pressure ventilation techniques with a bag-valve-mask device may be beneficial. Consider drug therapy for pulmonary edema ... . Monitor cardiac rhythm and

treat arrhythmias as necessary ... . Start IV administration of D5W /SRP: 'To keep open', minimal flow rate/. Use 0.9% saline (NS) or lactated Ringer's (LR) if signs of hypovolemia are present. For hypotension with signs of hypovolemia, administer fluid cautiously.Watch for signs of fluid overload ... . Treat seizures with diazepam or lorazepam ... . Use proparacaine hydrochloride to assist eye irrigation ... . /Aliphatic hydrocarbons and related compounds/ [Peer reviewed] [Currance, P.L. Clements, B., Bronstein, A.C. (Eds).; Emergency Care For Hazardous Materials Exposure. 3Rd edition, Elsevier Mosby, St. Louis, MO 2005, p. 242]

3. ON FROSTBITE: rinse with plenty of water, do NOT remove clothes. Refer for medical attention ... /For eyes:/ First rinse with plenty of water for several minutes (remove contact lenses if easily possible), then take to a doctor. [Peer reviewed] [IPCS, CEC; International Chemical Safety Card on Propane. (November 2003). Available from http://www.inchem.org/documents/icsc/icsc/eics0319.htm as of October 11, 2006.]

Medical Surveillance:

Consider the points of attack /central nervous system/ in preplacement and periodic physical examinations. [Peer reviewed] [Sittig, M. Handbook of Toxic and Hazardous Chemicals and Carcinogens, 1985. 2nd ed. Park Ridge, NJ: Noyes Data Corporation, 1985., p. 748]

TOXICITY EXCERPTS ▲

Human Toxicity Excerpts:

1. /HUMAN EXPOSURE STUDIES/ Eight adult volunteers of both sexes were exposed to isobutane, propane, or mixtures of the two gases (250 to 1,000 ppm for 1, 5, and 10 min and 1, 2, and 8 hr/day for 1 day or 2 wk) in a controlled environmental chamber for the purpose of monitoring their physiological responses. No untoward subjective responses were reported during or following these exposures. No abnormal physiological responses were observed in any volunteer. No cardiac abnormalities related to exposure were recorded. Serial computerized spirometric measurements revealed no pulmonary function abnormalities. [Peer reviewed] [STEWART RD ET AL; US NTIS PB REP ISS PB-279205: 1-95 (1977)]
2. /HUMAN EXPOSURE STUDIES/ Acute exposures to propane 250, 500, or 1,000 ppm for periods of 1 min to 8 hr did not produce any untoward physiological effects as determined by serial EKGs and continuous monitoring of modified V5 by telemetry during exposure. [Peer reviewed] [STEWART RD ET AL; ENVIRON HEALTH PERSPECT 26: 275-85 (1978)]
3. /HUMAN EXPOSURE STUDIES/ Human exposures to propane were consistent with the model predictions for /central nervous system depression/ onset and speed of action. Humans exposed at 1,000 ppm (0.1%) propane for 10 minutes did not experience any CNS symptoms, while those exposed at 100,000 ppm (10%) experienced distinct vertigo in 2 minutes. These data indicated that the onset of /CNS depression/ for propane exposures occurred at a concentration between 1,000 and 100,000 ppm (eg, possibly at 47,000 ppm as predicted by the model) and occurs quickly (under 15 minutes). [Peer reviewed] [American Conference of Governmental Industrial Hygienists. Documentation of the TLV's and BEI's with Other World Wide Occupational Exposure Values. CD-ROM Cincinnati, OH 45240-1634 2005., p. 5]
4. /SIGNS AND SYMPTOMS/ Propane is an anesthetic and is nonirritating to the eyes, nose, or throat. Direct skin or mucous membrane contact with liquefied propane causes burns and frostbite. [Peer reviewed] [Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley & Sons. New York, N.Y. (2001)., p. 4:11]
5. /SIGNS AND SYMPTOMS/ 'Burn-like' propane thermal injury is produced by evaporative

heat loss causing damage to vital structures. Acute appearance is that of heat burn with progressive vascular compromise. Histopathologic study demonstrates epidermal and derma necrosis followed by vascular thrombosis. [Peer reviewed] [European Chemicals Bureau; IUCLID Dataset, Propane (74-98-6) (2000 CD-ROM edition). Available from the database query page: http://ecb.jrc.it/esis/esis.php as of October 13, 2006.]

6. /SIGNS AND SYMPTOMS/ On loss of containment this liquid evaporates very quickly displacing the air and causing a serious risk of suffocation when in confined areas ... Rapid evaporation of the liquid may cause frostbite ... High concentrations in the air cause a deficiency of oxygen with the risk of /drowsiness,/ unconsciousness or death. [Peer reviewed] [IPCS, CEC; International Chemical Safety Card on Propane. (November 2003). Available from http://www.inchem.org/documents/icsc/icsc/eics0319.htm as of October 11, 2006.]
7. /CASE REPORTS/ Tissue damage due to direct contact of liquid propane with the integument is extremely rare. Only five such cases have been described in the literature. /The authors/ report the case of a girl who sustained a full-thickness skin necrosis of 14.5 % of her body surface area. There is little agreement about the optimal treatment of these injuries in previous reports. The pathophysiological mechanism suggests a freezing injury. The treatment, however, should be analogous to that of third-degree burns. PubMed Abstract [Peer reviewed] [Muehlberger T et al; Chirurg 72 (11): 1373-5 (2001)]
8. /CASE REPORTS/ ... / A case is reported of a/ man exposed ... to propane from a leaking tank in an automobile. He exhibited colicky pains, became stupefied, disoriented and excited, pupils of his eyes narrowed, and he exhibited marked salivation. He recovered, but suffered from retrograde amnesia. No propane concn was reported. [Peer reviewed] [American Conference of Governmental Industrial Hygienists. Documentation of the Threshold Limit Values for Substances in Workroom Air. Third Edition, 1971. Cincinnati, Ohio: American Conference of Governmental Industrial Hygienists, 1971. (Plus supplements to 1979), p. 215]
9. /CASE REPORTS/ ... 5 /female/ workers ... were exposed to propane when the gas escaped through improper pipe fittings. Headache, numbness, a 'chilly feeling' and vomiting were reported ... . [Peer reviewed] [American Conference of Governmental Industrial Hygienists. Documentation of the Threshold Limit Values for Substances in Workroom Air. Third Edition, 1971. Cincinnati, Ohio: American Conference of Governmental Industrial Hygienists, 1971. (Plus supplements to 1979), p. 215]
10. /CASE REPORTS/ A 25-year-old male committed suicide by inducing asphyxia using a combination of plastic bag suffocation and propane-gas inhalation. Autopsy finding were consistent with a hypoxic event, and blood brain, and lung tissue tested positive for propane by gas chromatography, Propane, while possessing some /CNS depressant/ properties, causes death primarily by displacing oxygen in the atmosphere with resultant asphyxia. [Peer reviewed] [European Chemicals Bureau; IUCLID Dataset, Propane (74-98-6) (2000 CD-ROM edition). Available from the database query page: http://ecb.jrc.it/esis/esis.php as of October 13, 2006.]
11. /CASE REPORTS/ Two unusual suicides of a 19-year-old white man and a 47-year-old white man, involving propane inhalation and plastic bag suffocation, are described. The special characteristics of propane gas as an asphyxiant agent are discussed, as well as its effect on the human body. The discussion emphasizes the postmortem examination and the collection of samples for toxicologic analysis. PubMed Abstract [Peer reviewed] [Fonseca CA et al; Am J Forensic Med Pathol 23 (2): 167-9 (2002)]
12. /CASE REPORTS/ A very rare case of non-fatal acute massive rhabdomyolysis caused by unintentional prolonged inhalation of liquid gas (consisting of butane and propane) in a previously healthy adult is presented. The immediate diagnosis and intensive symptomatic

therapy prevented any other severe complications of rhabdomyolysis, and the patient made a complete recovery without any sequelae. PubMed Abstract [Peer reviewed] [Frangides CY et al; Eur J Emerg Med 10 (1): 44-6 (2003)]

13. /CASE REPORTS/ Toxic hepatitis due to anesthetic gas inhalation has been well documented, but hepatitis caused by inhalation of non-halogenated hydrocarbons has not been reported. /The authors/ present an acute case of occupational hepatitis due to chronic inhalation of propane and butane gases. PubMed Abstract [Peer reviewed] [Aydin Y, Ozcakar L; Int J Clin Pract 57 (6): 546 (2003)]
14. /CASE REPORTS/ ... /This/ case report describes an adult male who inhaled propane for recreational purposes. Initially, he achieved short-lived euphoria and hallucinations. He compensated for the developing tolerance by increasing the dosage, finally consuming 5 L of fluid propane daily. Getting such quantities was facilitated by his occupational access to propane. Since he abused the propane in an apartment house, he also exposed third parties to the danger of explosion. Clinical examination revealed disturbances in orientation, restricted perceptivity and concentration, reduced mnemonic performance, and psychomotor agitation. All these symptoms diminished during a 6-month follow-up. The relationship of his organic mental disorder to the abuse of propane was not clear, since he had also abused alcohol. PubMed Abstract [Peer reviewed] [Grosse K, Grosse J; Nervenarzt 71 (1): 50-3 (2000)]
15. /SURVEILLANCE/ ...To describe patterns of inhalant abuse in New Zealand and discuss management... calls to the National Poisons Centre (NPC) from January 1, 2003 to December 31, 2004 were analysed. In addition, deaths following inhalational abuse were identified from the Institute of Environmental Science and Research Limited (ESR) database for 2001 and 2002 and available data for 2003. ... Seventy calls were classified as relating to inhalational abuse incidents. In abusers whose age was known, 83% were between 11 and 20 years, and 61% were male. Over half (44/70) of the calls involved abuse of propane or butane, either alone or in combination with a synthetic pyrethroid. ESR coronial data identified 11 inhalant abuse related deaths, most commonly attributed to cardiac effects. 73% of deaths were in teenagers and all but one fatality involved propane and/or butane. /The authors concluded that/ inhalant abuse is a persisting problem in New Zealand. NPC and ESR data demonstrate that teenagers are more likely to abuse inhalants than other age groups and butane and propane are the inhalants of choice. Acute management can be difficult, with significant mortality and morbidity. Continued education and other preventive measures are essential to help curb an extremely dangerous practice. PubMed Abstract [Peer reviewed] [Beasley M et al; N Z Med J. 119 (1233): U1952 (2006)]
16. /OTHER TOXICITY INFORMATION/ May be /CNS depressant/ ... In high concn. [Peer reviewed] [The Merck Index. 10th ed. Rahway, New Jersey: Merck Co., Inc., 1983., p. 1124]
17. /OTHER TOXICITY INFORMATION/ Alleged or suspected cases of 'bottled gas intoxication' are more likely due to some overlooked source of carbon monoxide. [Peer reviewed] [Gosselin, R.E., R.P. Smith, H.C. Hodge. Clinical Toxicology of Commercial Products. 5th ed. Baltimore: Williams and Wilkins, 1984., p. II-150]
18. /OTHER TOXICITY INFORMATION/ Volatile substance abuse (VSA) is believed to be widespread. The Toxic Exposure Surveillance System (TESS) of the American Association of Poison Control Systems offers an opportunity to evaluate the epidemiology of volatile substance abuse using a data set that captures data from a large geographic area covering a wide-ranging group of socioeconomic strata, ethnic groups, and demographics. To utilize this potential /the authors/ analyzed a data set of TESS for the 6-year period of 1996 through 2001 involving all cases of intentional inhalational abuse of

nonpharmaceutical substances. Over the study period there was a mean annual decline of 9% of reported VSA with an overall decline of 37% from 1996 to 2001. Volatile substance abuse was reported primarily in children, with 6,358 cases (54%) in children 13-19 yr and 1,803 (15%) cases in children 6-12 yr. Fifty-two cases were reported in children < 5 or = 5 yr. A total of 2,330 (20%) VSA cases had a serious outcome, defined as either moderate effect (n = 2,000), major effect (n = 267), or death (n = 63). The top five categories of substances abused were gasoline (41%), paint (13%), propane/butane (6%), air fresheners (6%), and formalin (5%). Three categories were responsible for the majority of deaths: gasoline (45%), air fresheners (26%), and propane/butane (11%). While there was a decline in reported cases, there was no decline in major outcomes or fatalities... PubMed Abstract [Peer reviewed] [Spiller HA; Am J Drug Alcohol Abuse 30 (1): 155-65 (2004) henry.spiller@nortonhealthcare.org]

Non-Human Toxicity Excerpts:

1. /LABORATORY ANIMALS: Acute Exposure/ Animal inhalation studies indicate a gas concn of 89% to be below the anesthetic level but to depress the blood pressure of cats. [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. 3181]
2. /LABORATORY ANIMALS: Acute Exposure/ ... The effects of propane /were studied/ in guinea pigs exposed to 24,000-29,000 ppm and 47,000-55,000 ppm propane for periods of 5, 30, 60, and 120 min; at the lower concn, irregular breathing was observed and at the higher concn, tremors were evident during the first 5 min of exposure. Stupor was commonly observed in the animals exposed for longer periods of time (up to 2 hr). All animals recovered from the propane exposure and there were no pathological signs of organ toxicity at necropsy. In these studies, a /CNS depressant/ ... effect for propane was not seen until exposure levels were about 50,000 ppm. In contrast, /other studies showed/ n-butane caused anesthesia in mice within 1 min at 22,000 ppm and caused death in dogs at 20,000-25,000 ppm. Therefore, propane is much less toxic than its next higher homolog, n-butane. [Snyder, R. (ed.) Ethyl Browning's Toxicity and Metabolism of Industrial Solvents. 2nd ed. Volume 1: Hydrocarbons. Amsterdam - New York - Oxford: Elsevier, 1987., p. 263]
3. /LABORATORY ANIMALS: Acute Exposure/ Propane is a simple asphyxiant like methane and ethane ... In dogs, 1% propane causes hemodynamic changes, whereas 3.3% decreases inotropism of the heart; a decrease in mean aortic pressure, stroke volume, and cardiac output; and increase in pulmonary vascular resistance. In primates, 10% induces some myocardial effects, whereas exposure to 20% causes aggravation of these parameters and respiratory depression. [Bingham, E.; Cohrssen, B.; Powell, C.H.; Patty's Toxicology Volumes 1-9 5th ed. John Wiley & Sons. New York, N.Y. (2001)., p. 4:10]
4. /LABORATORY ANIMALS: Acute Exposure/ Guinea pigs showed sniffing & chewing movement at 2.2 to 5.5%, with a rapidly reversible effect upon cessation of exposure ... [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. 3181]
5. /LABORATORY ANIMALS: Acute Exposure/ Mildly anesthetic in cats at 93%. [Gosselin, R.E., R.P. Smith, H.C. Hodge. Clinical Toxicology of Commercial Products. 5th ed. Baltimore: Williams and Wilkins, 1984., p. II-150]
6. /LABORATORY ANIMALS: Acute Exposure/ Propane has been shown to be moderately irritating to the skin of rabbits, but not to the skin of mice. [Snyder, R. (ed.) Ethyl Browning's Toxicity and Metabolism of Industrial Solvents. 2nd ed. Volume 1: Hydrocarbons. Amsterdam - New York - Oxford: Elsevier, 1987., p. 264]
7. /LABORATORY ANIMALS: Acute Exposure/ Group of 6 male or 6 female Alderley Park rats were used /in a propane inhalation study/. CNS-depression was observed. Recovery from non-lethal exposure was very rapid; affected animal appeared to be normal within 10 min. LC50 was >1464 mg/L/15 min. [European Chemicals Bureau; IUCLID Dataset,

Propane (74-98-6) (2000 CD-ROM edition). Available from the database query page: http://ecb.jrc.it/esis/esis.php as of October 12, 2006.]

8. /LABORATORY ANIMALS: Acute Exposure/ Mouse ... exposure to 20% (ca 366 mg/L) sensitized heart to epinephrine. Exposure to 10 to 20% (ca 183 to 366 mg/L) resulted in bronchoconstriction and respiratory depression. [European Chemicals Bureau; IUCLID Dataset, Propane (74-98-6) (2000 CD-ROM edition). Available from the database query page: http://ecb.jrc.it/esis/esis.php as of October 13, 2006.]
9. /LABORATORY ANIMALS: Acute Exposure/ The anesthetic potency of the test substance was assessed in 5 rats. Thus, the rats were exposed by inhalation ot the test substance and the minimal anesthetic concn (MAC) was determined. Anesthesia was defined by absence of movement in response to tail clamp or electric stimulation and the inspired concn just permitting and preventing movements were averaged to give an estimate of MAC ... The MAC of propane was 0.94+/- 0.12 atm. /Propane purity > 97%/ [European Chemicals Bureau; IUCLID Dataset, Propane (74-98-6) (2000 CD-ROM edition). Available from the database query page: http://ecb.jrc.it/esis/esis.php as of October 13, 2006.]
10. /LABORATORY ANIMALS: Acute Exposure/ /In guinea pig/ ... exposure to 5% (ca 91.5 mg/L) for 1 hr resulted in stupor. [European Chemicals Bureau; IUCLID Dataset, Propane (74-98-6) (2000 CD-ROM edition). Available from the database query page: http://ecb.jrc.it/esis/esis.php as of October 13, 2006.]
11. /LABORATORY ANIMALS: Acute Exposure/ Groups of 3 anesthetized rhesus monkeys (Macaca mulatta) were exposed to 10 and 20% (ca 183 and 366 mg/L, respectively) for 5 and 15 min, respectively. Heart rate, myocardial contractility and blood pressure were unaffected. A substance-related bronchoconstriction and respiratory depression were observed. [European Chemicals Bureau; IUCLID Dataset, Propane (74-98-6) (2000 CD-ROM edition). Available from the database query page: http://ecb.jrc.it/esis/esis.php as of October 13, 2006.]
12. /LABORATORY ANIMALS: Acute Exposure/ Ventricular fibrillation and death occurred in some animals. In another study, dogs exposed to propane at 100,000 and 200,000 ppm for 5 minutes produced cardiac arrhythmias or multiple ventricular beats 17% and 58% of the time, respectively. Cardiac arrhythmia did not occur in dogs at 5000 ppm propane. Additionally, a 5-minute exposure to 18% propane (by volume) with concurrent epinephrine administration induced cardiac arrhythmia in 50% of exposed dogs (i.e., the EC50). A similar effect occurred in mice at 10% concentration. [American Conference of Governmental Industrial Hygienists. Documentation of the TLV's and BEI's with Other World Wide Occupational Exposure Values. CD-ROM Cincinnati, OH 45240-1634 2005., p. 4]
13. /LABORATORY ANIMALS: Acute Exposure/ Propane caused early respiratory depression in the monkey. The depression of breathing was the only toxic endpoint in monkeys when exposed at 100,000 to 200,000 ppm (10%-20%) propane for 15 minutes. Guinea pigs exposed to propane concentrations between 24,000 and 29,000 ppm (24%-29%)or 47,000 and 55,000 ppm (47%-55%) for 5 to 120 minutes developed irregular breathing at lower concentrations and tremors at the highest concentrations. The effects were reversible upon cessation of exposure, and there were no pathological organ changes in these animals at necropsy. Blood pressure changes were reported in dogs after exposure at 25,000 ppm (2.5%) propane. Effects on blood pressure, heart stroke rate/volume, and pulmonary vascular resistance were also reported after exposures at 33,000 ppm (3.3%). [American Conference of Governmental Industrial Hygienists. Documentation of the TLV's and BEI's with Other World Wide Occupational Exposure Values. CD-ROM Cincinnati, OH 45240-1634 2005., p. 4]
14. /LABORATORY ANIMALS: Subchronic or Prechronic Exposure/ Subchronic inhalation studies have been conducted in which monkeys were exposed to approx 750 ppm propane for 90 consecutive days with no toxicity or abnormalities observed. ... Similar inhalation studies /were also conducted/ in monkeys except that the product tested was an aerosol spray deodorant containing a mixture of propane and isobutane in a concn of 65% by wt. In

these studies, all animals survived and showed no changes in behavior, body wt, hematology, blood chemistry, urinalysis, electrocardiogram, and pulmonary function. Gross microscopic examination revealed no evidence of organ toxicity. [Snyder, R. (ed.) Ethyl Browning's Toxicity and Metabolism of Industrial Solvents. 2nd ed. Volume 1: Hydrocarbons. Amsterdam - New York - Oxford: Elsevier, 1987., p. 263]

15. /LABORATORY ANIMALS: Subchronic or Prechronic Exposure/ Monkeys were exposed at 750 ppm propane via inhalation for 90 days. No abnormalities were noted. [American Conference of Governmental Industrial Hygienists. Documentation of the TLV's and BEI's with Other World Wide Occupational Exposure Values. CD-ROM Cincinnati, OH 45240-1634 2005., p. 4]
16. /LABORATORY ANIMALS: Developmental or Reproductive Toxicity/ ... Pregnant mice /were exposed/ on the 8th day for 1 hr to 5-8% concn of fuel-gas. In addition to 85% methane most natural gases contain small amounts of ethane, propane & butane. Abnormalities of the fetal brains were found to result in brain hernia & hydrocephalus. [Shepard, T.H. Catalog of Teratogenic Agents. 5th ed. Baltimore, MD: The Johns Hopkins University Press, 1986., p. 936]
17. /LABORATORY ANIMALS: Neurotoxicity/ Groups of either 6 male or 6 female rats were exposed for 15 minutes in ... whole body inhalation chambers ... Propane caused CNS depression. Signs of intoxication were slight ataxia, loss of righting reflex, loss of movement, /SRP: CNS depression/, shallow respiration and death eventually from respiratory depression. Recovery from a non-lethal exposure was rapid and the rats appeared normal within 10 minutes. Where death occurred, it was during exposure, never afterwards. The calculated EC50 and LC50 values with 95% confidence limits, expressed as concentrations in air are as follows: EC50 (CNS depression, 10 min) 280,000 (220,000 to 350,000) ppm (504,996 (396,783 to 631,245) mg/cu m); LC50 (15 min) >800,000 ppm (1,442,847 mg/cu m). [EPA/Office of Pollution Prevention and Toxics; High Production Volume (HPV) Challenge Program's Robust Summaries and Test Plans. Available from: http://cfpub.epa.gov/hpv-s/ on Petroleum gases as of October 12, 2006.]
18. /GENOTOXICITY/ The mutagenic activity of propane has been evaluated using the Ames Salmonella typhimurium system at various vapor concn with and without a metabolic activating system. Propane was not mutagenic. [Snyder, R. (ed.) Ethyl Browning's Toxicity and Metabolism of Industrial Solvents. 2nd ed. Volume 1: Hydrocarbons. Amsterdam - New York - Oxford: Elsevier, 1987., p. 265]
19. /GENOTOXICITY/ ... /Propane reduced the viable cell count in Escherichia coli and produced biochemical mutations ... [European Chemicals Bureau; IUCLID Dataset, Propane (74-98-6) (2000 CD-ROM edition). Available from the database query page: http://ecb.jrc.it/esis/esis.php as of October 13, 2006.]
20. /GENOTOXICITY/ Propane gas showed no mutagenic activity when tested in the Ames assay at concentrations up to 500,000 ppm (50% volume). [American Conference of Governmental Industrial Hygienists. Documentation of the TLV's and BEI's with Other World Wide Occupational Exposure Values. CD-ROM Cincinnati, OH 45240-1634 2005., p. 4]

TOXICITY VALUES ▲

Non-Human Toxicity Values:

1. EC50 Rat inhalation 280,000 (95% confidence limit: 220,000 to 350,000) ppm, 504,996 (95% confidence limit: 396,783 to 631,245) mg/cu m)/10 min; Effects: CNS depression [Peer reviewed] [EPA/Office of Pollution Prevention and Toxics; High Production Volume (HPV) Challenge Program's Robust Summaries and Test Plans. Available from: http://cfpub.epa.gov/hpv-s/ on Petroleum gases as of October 12, 2006.]
2. LC50 Rat inhalation >800,000 ppm (1,442,847 mg/cu m)/15 min [Peer reviewed] [EPA/Office of Pollution Prevention and Toxics; High Production Volume (HPV) Challenge

Program's Robust Summaries and Test Plans. Available from: http://cfpub.epa.gov/hpv-s/ on Petroleum gases as of October 12, 2006.]

3. LC50 Rat inhalation >1,464 mg/L/15 min [Peer reviewed] [European Chemicals Bureau; IUCLID Dataset, Propane (74-98-6) (2000 CD-ROM edition). Available from the database query page: http://ecb.jrc.it/esis/esis.php as of October 12, 2006.]

PHARMACOKINETICS ▲

Absorption, Distribution and Excretion:

1. A death involving asphyxiation by propane inhalation is reported. The presence of propane was determined in blood, brain, kidney, liver, and lung by gas chromatography. The brain showed the highest level of propane, whereas the kidney exhibited the lowest level. [Peer reviewed] [HAQ MZ, HAMELI AZ; J FORENSIC SCI 25 (1): 25-8 (1980)]
2. In mice exposed to a liquid gas mixture containing propane, butane, & isobutane, (at 17, 31, & 52%, respectively), death occurred within 15 seconds of exposure. Concn of the cmpd in lung tissue were max within 1 hr of death & decreased thereafter depending on the degree of putrefaction. No residues or only traces were detected by the 15th day postmortem. Max concn were observed in the adipose tissue 4 days after death & the cmpd were still detectable by the 15th day. /Propane, butane & isobutane mixture/ [Peer reviewed] [CANDELA RG ET AL; BOLL SOC ITAL BIOL SPER 55 (1): 38-41 (1979)]
3. Inhalation represents the major route by which propane is absorbed systemically. Studies ... in human volunteers showed that blood levels of propane could be detected after exposure to 250-1,000 ppm. ... Compared to respiratory absorption, dermal penetration of propane can be considered to be very low. ... the distribution /in tissues/ can be expected to follow the same pattern observed for butane. [Peer reviewed] [Snyder, R. (ed.) Ethyl Browning's Toxicity and Metabolism of Industrial Solvents. 2nd ed. Volume 1: Hydrocarbons. Amsterdam - New York - Oxford: Elsevier, 1987., p. 263]

Metabolism/Metabolites:

1. /Propane/ is metabolized by microorganism via the malonyl succinate pathway. [Peer reviewed] [European Chemicals Bureau; IUCLID Dataset, Propane (74-98-6) (2000 CD-ROM edition). Available from the database query page: http://ecb.jrc.it/esis/esis.php as of October 13, 2006.]
2. In mice ... /propane/ was converted to isopropanol and acetone following inhalation. In the presence of microsomes prepared from liver homogenate of mice, the test substance was converted in vitro to isopropanol, too. The oxidation of isopropanol to acetone occurred in the presence of alcohol dehydrogenase. The metabolites were detected in blood, liver, kidney and brain of the exposed mice. [Peer reviewed] [European Chemicals Bureau; IUCLID Dataset, Propane (74-98-6) (2000 CD-ROM edition). Available from the database query page: http://ecb.jrc.it/esis/esis.php as of October 13, 2006.]

Interactions:

1. Propane, when used as an aerosol propellant with isobutane in deodorant and antiperspirant products (65 to 70% by wt), has not been shown to cause skin irritation in 125 human volunteers who applied the aerosol products twice daily for 12 wk. [Peer reviewed] [Snyder, R. (ed.) Ethyl Browning's Toxicity and Metabolism of Industrial Solvents. 2nd ed. Volume 1: Hydrocarbons. Amsterdam - New York - Oxford: Elsevier, 1987., p. 265]
2. When dogs were exposed to 15-90% propane concn for 10 min, the heart was more sensitive to ventricular fibrillations induced by epinephrine than without propane treament. [Peer reviewed] [Snyder, R. (ed.) Ethyl Browning's Toxicity and Metabolism of Industrial Solvents. 2nd ed. Volume 1: Hydrocarbons. Amsterdam - New York - Oxford: Elsevier, 1987., p. 264]

7.0 ENVIRONMENTAL FATE/EXPOSURE POTENTIAL

SUMMARY ▲

Environmental Fate/Exposure Summary:

Propane's production and use in the petroleum industry, as a heating fuel and in outdoor gas grills may result in its release to the environment through various waste streams. Combustion of polyethylene and gasoline, waste incinerators as well as disposal of products associated with the petroleum and natural gas industries may also contribute to its release into the environment. Propane is a component of natural gas and crude petroleum. If released to air, a vapor pressure of 7,150 mm Hg at 25 deg C indicates propane will exist solely as a gas in the atmosphere. Vapor-phase propane will be degraded in the atmosphere by a reaction with photochemically-produced hydroxyl radicals; the half-life for this reaction in air is estimated to be 14 days. Propane does not contain chromophores that absorb at wavelengths >290 nm and therefore is not expected to be susceptible to direct photolysis by sunlight. If released to soil, propane is expected to have moderate mobility based upon an estimated Koc of 460. Propane is readily degraded by soil bacterium; within 24 hr propane was oxidized to acetone. Volatilization from moist soil surfaces is expected to be an important fate process based upon an estimated Henry's Law constant of 7.07X10-1 atm-cu m/mole. Propane will volatilize from dry soil surfaces based upon its vapor pressure. If released into water, propane is expected to adsorb to suspended solids and sediment based upon the estimated Koc. Biodegradation in water is not expected to be an important environmental fate process; after 192 hr, the trace concentrations of propane contained in gasoline remained unchanged for both a sterile control and a mixed culture sample collected from ground water contaminated with gasoline. Volatilization from water surfaces is expected to be an important fate process based upon this compound's estimated Henry's Law constant. Estimated volatilization half-lives for a model river and model lake are 41 min and 2.6 hours, respectively. An estimated BCF of 13 suggests the potential for bioconcentration in aquatic organisms is low. Hydrolysis is not expected to be an important environmental fate process since this compound lacks functional groups that hydrolyze under environmental conditions. Occupational exposure to propane may occur through inhalation and dermal contact with this compound at workplaces where propane is produced or used. Propane is widely detected in air. The most likely pathway by which the general public is exposed to propane is by inhalation due to the release of this substance from natural gas and crude oil emissions. Monitoring data also indicate that the general population may be exposed to propane via ingestion of food and drinking water, although these pathways are considered minor when compared to inhalation. (SRC) [Peer reviewed]

POLLUTION SOURCES ▲

Natural Occurring Sources:

Propane is a constituent in the paraffin fraction of crude oil and natural gas. [Peer reviewed] [Tania Carreon; Patty's Toxicology. (2005) NY, NY: John Wiley & Sons, Inc. Aliphatic Hydrocarbons. On-line posting date: April 16, 2001.]

Artificial Sources:

1. The principal volatile decomposition products /of phenolic resins/ are methane, acetone, carbon monoxide, propanol, & propane. [Peer reviewed] [Landrock, A.H. Handbook of Plastics Flammability and Combustion Toxicology. Park Ridge, New Jersey: Noyes Publications, 1983., p. 51]
2. In gasoline: 0.07-0.08 vol %; in flue gas of municipal incinerator: < 0.4-0.5 ppm [Peer reviewed] [Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983., p. 1017]
3. Propane's production and use in the petroleum industry may result in its release to the environment through various waste streams(1-6). Combustion of polyethylene(7) and gasoline(3-6), waste incinerators(8) as well as disposal of products associated with the petroleum and natural gas industries(1,2) may also contribute to its release into the environment. [Peer reviewed] [(1) Sauer TC Jr; Org Geochem 7: 1-16 (1981) (2) Arnts RR, Meeks SA; Atmos Environ 15: 1643-51 (1981) (3) Zweidinger RB et al; Environ Sci Tech 22: 956- 62 (1988) (4) Nelson PF, Quigley SM; Atmos Environ 18: 79-87 (1984) (5) Sigsby JE et al; Environ Sci Technol 21: 466-75 (1987) (6) Neligan RE; Arch Environ Health 5: 581-91 (1962) (7) Hodgkin JH et al; J Macromol Sci Chem 17: 35-43 (1982) (8) Carotti AA, Kaiser ER; J Air Pollut Contr Assoc 22: 224-53 (1972)]

ENVIRONMENTAL FATE ▲

1. TERRESTRIAL FATE: Based on a classification scheme(1), an estimated Koc value of 460 (SRC), determined from a log Kow of 2.36(2) and a regression-derived equation(3), indicates that propane is expected to have moderate mobility in soil(SRC). Volatilization of propane from moist soil surfaces is expected to be an important fate process(SRC) given an estimated Henry's Law constant of 7.07X10-1 atm-cu m/mole(SRC), derived from its vapor pressure, 7150 mm Hg(4), and water solubility, 62.4 mg/L(5). Propane is expected to volatilize from dry soil surfaces(SRC) based upon its vapor pressure(4). Using cell suspensions of microogranisms isolated from soil and water, propane was oxidized to acetone within 24 hours(6,7), suggesting that biodegradation may be an important fate process in soil and sediment. [Peer reviewed] [(1) Swann RL et al; Res Rev 85: 17-28 (1983) (2) Hansch C et al; Exploring QSAR. Hydrophobic, Electronic, and Steric Constants. ACS Prof Ref Book. Heller SR, consult. ed., Washington, DC: Amer Chem Soc p.4 (1995) (3) Lyman WJ et al; Handbook of Chemical Property Estimation Methods. Washington, DC: Amer Chem Soc pp. 4-9 (1990) (4) Daubert TE, Danner RP; Physical and Thermodynamic Properties of Pure Chemicals Data Compilation. Washington, DC: Taylor and Francis (1989) (5) Yalkowsky SH, He Y, eds; Handbook of aqueous solubility data. Boca Raton, FL: CRC Press p.77 (2003) (6) Patel RN et al; Appl Environ Microbiol 39: 727-33 (1980) (7) Hou CT et al; Appl Environ Microbiol 46: 178-84 (1983)]
2. AQUATIC FATE: Based on a classification scheme(1), an estimated Koc value of 460 (SRC), determined from a log Kow of 2.36(2) and a regression-derived equation(3), indicates that propane is expected to adsorb to suspended solids and sediment(SRC). Volatilization from water surfaces is expected(3) based upon an estimated Henry's Law constant of 7.07X10-1 atm-cu m/mole(SRC) derived from its vapor pressure, 7150 mm Hg(4), and water solubility, 62.4 mg/L(5). Using this Henry's Law constant and an estimation method(3), volatilization half-lives for a model river and model lake are 41 minutes and 2.6 days, respectively(SRC). According to a classification scheme(6), an estimated BCF of 13.1(SRC), from its log Kow(2) and a regression-derived equation(7), suggests the potential for bioconcentration in aquatic organisms is low(SRC). After 192 hr, the trace concn of propane contained in gasoline remained unchanged for both a sterile control and a mixed culture sample collected from ground water contaminated with gasoline(8). This indicates that biodegradation may not be an important fate process in water. [Peer reviewed] [(1) Swann RL et al; Res Rev 85: 17-28 (1983) (2) Hansch C et al; Exploring QSAR. Hydrophobic, Electronic, and Steric Constants. ACS Prof Ref Book.

Heller SR, consult. ed., Washington, DC: Amer Chem Soc p.4 (1995) (3) Lyman WJ et al; Handbook of Chemical Property Estimation Methods. Washington, DC: Amer Chem Soc pp. 4-9, 15-1 to 15-29 (1990) (4) Daubert TE, Danner RP; Physical and Thermodynamic Properties of Pure Chemicals Data Compilation. Washington, DC: Taylor and Francis (1989) (5) Yalkowsky SH, He Y, eds; Handbook of aqueous solubility data. Boca Raton, FL: CRC Press p.77 (2003) (6) Franke C et al; Chemosphere 29: 1501-14 (1994) (7) Meylan WM et al; Environ Toxicol Chem 18: 664-72 (1999) (8) Jamison VW et al; pp. 187-96 in Proc Int Biodeg Symp 3rd Sharpley JM, Kapalan AM, eds. Essex Eng (1976)]

3. ATMOSPHERIC FATE: According to a model of gas/particle partitioning of semivolatile organic compounds in the atmosphere(1), propane, which has a vapor pressure of 7150 mm Hg at 25 deg C(2), is expected to exist solely as a gas in the ambient atmosphere. Gas-phase propane is degraded in the atmosphere by reaction with photochemically-produced hydroxyl radicals(SRC); the half-life for this reaction in air is estimated to be 14 days(SRC), calculated from its rate constant of 1.15X10-12 cu cm/molecule-sec at 25 deg C(3). Propane does not contain chromophores that absorb at wavelengths >290 nm and therefore is not expected to be susceptible to direct photolysis by sunlight(4). [Peer reviewed] [(1) Bidleman TF; Environ Sci Technol 22: 361-367 (1988) (2) Lyman WJ; p. 31 in Environmental Exposure From Chemicals Vol I, Neely WB, Blau GE, eds, Boca Raton, FL: CRC Press (1985) (3) Akinson R; J Phys Chem Ref Data Monograph No 1 (1989) (4) Lyman WJ et al; Handbook of Chemical Property Estimation Methods. Washington, DC: Amer Chem Soc pp. 8-12 (1990)]

ENVIRONMENTAL TRANSFORMATIONS ▲

Biodegradation:

1. ... Propane is utilized by Microbacterium vaccae, & is readily degraded by soil bacteria. ... Mycobacterium phlei is capable of growing on propane as the only carbon source. Propane is suggested to be metabolized by the various microorganisms via the malonyl succinate pathway. [Peer reviewed] [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. 3182]
2. AEROBIC: Within 24 hr, propane was oxidized to its corresponding methyl ketone, acetone (1-3), and the corresponding alcohols, 1-propanol and 2-propanol, by cell suspensions of over 20 methyltrophic organisms isolated from lake water and soil samples. After 192 hr, the trace concn of propane contained in gasoline remained unchanged for both a sterile control and a mixed culture sample collected from ground water contaminated with gasoline(4). The average propane utilization by microflora of 5 soils was 23 and 32% for single and mixed alkanes, respectively(5). The respective gas exchange and degradation rate constants were 0.67X10-5 sq cm sec-1 and 0.033 day-1 for propane contained in a model estuarine ecosystem at 10 deg C and a salinity of 30 parts per trillion; the corresponding biodegradation half-life ranged from 33 to 99 days(6). At 20 deg C and a salinity of 30 parts/per trillion, the respective gas exchange and degradation rate constants were 0.92X10-5 sq cm sec-1 and 0.120 day-1; the corresponding biodegradation half-life for n-propane ranged from 7 to 9 days(6). [Peer reviewed] [(1) Patel RN et al; Appl Environ Microbiol 39: 727-33 (1980) (2) Patel RN et al; Appl Environ Microbiol 39: 720-6 (1980) (3) Hou CT et al; Appl Environ Microbiol 46: 178-84 (1983) (4) Jamison VW et al; pp. 187-96 in Proc Int Biodeg Symp 3rd Sharpley JM, Kapalan AM eds. Essex Eng (1976) (5) Brisbane RG, Ladd JN; J Gen Appl Microbiol 14: 447-50 (1968) (6) Bopp RF et al; Org Geochem 3: 9-14 (1981)]
3. The degradation of n-alkanes by microorganisms is similar to the degradation of fatty acids. The terminal methyl group is enzymatically oxidized by incorporation of a molecular oxygen by a monooxygenase producing a primary alcohol with further oxidation to an acid group, although involvement of a dioxygenase is also postulated. Once the fatty acid is

produced, it is degraded into 2-carbon units via the beta-oxidation pathway. ... Another pathway for n-alkane degradation that is encountered less often is the oxidation of both terminal carbons to form a dioic acid with subsequent beta-oxidation. Subterminal oxidation of the 2-carbon atom is seen mainly in C3-C6 alkanes. ... A dehydrogenation of the n-alkane may also occur yielding an alkene which is then converted to an alcohol, although there is little evidence for this theory. Some microorganisms have been shown to have both terminal and subterminal oxidation, each having different rates of activity. /In a study comparing/ ... growth on long and short chain alkanes by some bacteria ... the initial oxidase had a broad specificity and would oxidize C1-C8 alkanes. ... /n-Alkanes/ [Peer reviewed] [Parr, J.F., P.B. Marsh, and J.M. Kla (eds.). Land Treatment of Hazardous Wastes. Park Ridge, New Jersey: Noyes Data Corporation, 1983., p. 327]

Abiotic Degradation:

1. Estimated lifetime under photochemical smog conditions in SE England: 31 hr [Peer reviewed] [Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983., p. 1017]
2. The rate constants for the vapor phase reaction of propane with photochemically produced hydroxyl radicals was measured to be 1.15X10-12(1), 2.0X10-12(2), 1.49X10-12 (3), 1.22X10-12(4) and 1.20X10-12(5) cu cm/molecule-sec at 27(2,3), 25(1,4) and 22(5) deg C, respectively, which correspond to atmospheric half-lives of about 14(1) 8.0(2), 10.8 (3), 13.2(4) and 13.4(5) days respectively at an atmospheric concn of 5X10+5 hydroxyl radicals per cu cm. Alkanes are generally resistant to hydrolysis(7). Propane does not contain chromophores that absorb at wavelengths >290 nm and therefore is not expected to be susceptible to direct photolysis by sunlight(7). An air sample containing propane at a concentration of 140 ppbC was not reduced within 6 hrs of irradiation by natural sunlight in downtown Los Angeles, CA(6). [Peer reviewed] [(1) Akinson R; J Phys Chem Ref Data Monograph No 1 (1989) (2) Cox RA et al; Environ Sci Technol 14: 57-61 (1980) (3) Darnall KR et al; J Phys Chem 82: 1581-4 (1978) (4) Atkinson R et al; Internat J Chem Kin 14: 781-8 (1982) (5) Baulch DL et al; J Phys Chem Ref Data 13: 1259-1380 (1984) (6) Kopczynski SL et al; Environ Sci Technol 6: 342-7 (1972) (7) Lyman WJ et al; Handbook of Chemical Property Estimation Methods NY: McGraw-Hill p. 7-4, 8-12 (1982)]
3. The photo oxidation of propane by ozone in air is not expected to be environmentally important(1). Experimental data showed that 7.7% of the propane fraction in a dark chamber reacted with nitrogen oxides to form the corresponding alkyl nitrate(2,3), suggesting nighttime reactions with radical species and nitrogen oxides may contribute to the atmospheric transformation of propane. [Peer reviewed] [(1) Atkinson R, Carter WPL; Chem Rev 84: 437-70 (1984) (2) Atkinson R et al; J Phys Chem 86: 4563-9 (1982) (3) Atkinson R et al; Preprints Div Environ Chem 23: 173-6 (1983)]

ENVIRONMENTAL TRANSPORT ▲

Bioconcentration:

An estimated BCF of 13 was calculated in fish for propane(SRC), using a log Kow of 2.36(1) and a regression-derived equation(2). According to a classification scheme (3), this BCF suggests the potential for bioconcentration in aquatic organisms is low (SRC). According to a classification scheme(3), this BCF suggests the potential for bioconcentration in aquatic organisms is moderate(SRC). [Peer reviewed] [(1) Hansch C et al; Exploring QSAR. Hydrophobic, Electronic, and Steric Constants. ACS Prof Ref Book. Heller SR, consult. ed., Washington, DC: Amer Chem Soc p. 6 (1995) (2) Meylan WM et al; Environ Toxicol Chem 18: 664-72 (1999) (3) Franke C et al; Chemosphere 29: 1501-14 (1994)]

Soil Adsorption/Mobility:

The Koc of propane is estimated as 460(SRC), using a log Kow of 2.36(1) and a regression-derived equation(2). According to a classification scheme(3), this estimated Koc value suggests that propane is expected to have moderate mobility in soil. [Peer reviewed] [(1) Hansch C et al; Exploring QSAR. Hydrophobic, Electronic, and Steric Constants. ACS Prof Ref Book. Heller SR, consult. ed., Washington, DC: Amer Chem Soc p. nn (1995) (2) Lyman WJ et al; Handbook of Chemical Property Estimation Methods. Washington, DC: Amer Chem Soc pp. 4-9 (1990) (3) Swann RL et al; Res Rev 85: 17-28 (1983)]

Volatilization from Soil/Water:

The Henry's Law constant for propane is estimated as 7.07X10-1 atm-cu m/mole (SRC) derived from its vapor pressure, 7150 mm Hg(1), and water solubility, 62.4 mg/L(2). This Henry's Law constant indicates that propane is expected to volatilize rapidly from water surfaces(3). Based on this Henry's Law constant, the volatilization half-life from a model river (1 m deep, flowing 1 m/sec, wind velocity of 3 m/sec)(3) is estimated as 41 minutes(SRC). The volatilization half-life from a model lake (1 m deep, flowing 0.05 m/sec, wind velocity of 0.5 m/sec)(3) is estimated as 2.6 days(SRC). Propane's estimated Henry's Law constant indicates that volatilization from moist soil surfaces may occur(SRC). The potential for volatilization of propane from dry soil surfaces may exist(SRC) based upon its vapor pressure(1). [Peer reviewed] [(1) Daubert TE, Danner RP; Physical and Thermodynamic Properties of Pure Chemicals Data Compilation. Washington, DC: Taylor and Francis (1989) (2) Yalkowsky SH, He Y, eds; Handbook of aqueous solubility data. Boca Raton, FL: CRC Press p. 77 (2003) (3) Lyman WJ et al; Handbook of Chemical Property Estimation Methods. Washington, DC: Amer Chem Soc pp. 15-1 to 15-29 (1990)]

ENVIRONMENTAL CONCENTRATIONS ▲

Water Concentrations:

1. RAIN/SNOW: Propane was detected at maximum concentration of 4 ppbv in arctic snow pack(1). [Peer reviewed] [(1) Ariya PA et al; J Atmos Chem 34: 55-64 (1999)]
2. SEAWATER: All 8 near surface sea water samples from the intertropical Indian Ocean contained propane at concn ranging from 2.53 to 14.66 nL of gas/L(1). Propane was detected in mid-Atlantic seawater at concentrations ranging from 51-65 pmol/L. Mid-Atlantic seawater emits propane to the air at a rate of 0.17-1.2X10+8 molec/cm sq sec (2). [Peer reviewed] [(1) Bonsang B et al; J Atmos Chem 6: 3-20 (1988) (2) Plass C et al; J Atmos Chem 15: 235-251 (1992)]

Effluents Concentrations:

1. In gasoline: 0.07-0.08 vol %; in flue gas of municipal incinerator: < 0.4-0.5 ppm [Peer reviewed] [Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983., p. 1017]
2. Flue gases from a waste incinerator at Babylon, Long Island, NY was found to emit propane at concn generally less than 0.5 ppm(1). Propane is a product of gasoline(2-5), natural gas(5) and polyethylene(6) combustion. The average exhaust from 67 gasoline fueled vehicles was found to contain propane at a concn 0.1% by weight(3). The average concn of propane for the exhaust of 46 automobiles was 2.6, 1.6 and 2.2 weight % of total hydrocarbon according to the federal test procedure, hot soak test and the New York City cycle, respectively(4). Propane from car exhaust ranged in concn from 0.02 to 0.05

ppmV with an average for 8 samples of 0.03 ppmV(5). A Texaco refinery located in Tulsa, OK was attributed with emissions to the surrounding atmosphere where the propane concn was measured to be 95.5 and 189.8 ppbC for two min before and after 1:33 PM(6). The propane content of the air downwind of a Mobil natural gas facility in Rio Blanco, CO was 465.3 ppbC(7). Underwater hydrocarbon vent discharges from offshore oil production platforms contained propane at a concentration in the vapor phase at 2,000 umol/L of gas (8). [Peer reviewed] [(1) Carotti AA, Kaiser ER; J Air Pollut Contr Assoc 22: 224-53 (1972) (2) Zweidinger RB et al; Environ Sci Tech 22: 956-62 (1988) (3) Nelson PF, Quigley SM; Atmos Environ 18: 79-87 (1984) (4) Sigsby JE et al; Environ Sci Technol 21: 466-75 (1987) (5) Neligan RE; Arch Environ Health 5: 581-91 (1962) (6) Hodgkin JH et al; J Macromol Sci Chem 17: 35-43 (1982) (7) Arnts RR, Meeks SA; Atmos Environ 15: 1643-51 (1981) (8) Sauer TC Jr; Environ Sci Technol 15: 917-23 (1981)]

3. Gas-phase propane was detected in a Los Angeles tunnel at a concentration of 47 mg/L (1). Propane was detected in a tunnel at a concentration of 26 ug/cu m(2) which was about 4 times greater than the background propane levels of 5.8 ug/cu m(2). Propane was found in the Cassiar tunnel in Vancouver, BC, Canada in 1993 and 1995 at mass fractions of 0.81 and 0.047, respectively, as well as Tuscorora, Caldecott and Fort McHenry tunnels at mass fractions of 0.08, 0.07 and 0.03, respectively(3). Propane accounted for 0.88, 0.95 and 1.17% of the emissions on a Raleigh, NC highway, Dyanomenter, and an Atlanta, GA roadway, respectively(4). Gasoline containing propane (100 ug/g) emitted propane from the tail pipes of catalytic and non catalytic engines at rates of 650 and 9,300 ug/km(5). Propane emissions from cars driving in urban, suburban, rural and motorways were observed as 7.8, 3.69, 2.13 and 1.35 mg/km(6). Propane concentration in exhaust had mean concentration of 0.21 ppm(7). Propane was detected with annual means of 1 ug/cu m in London, England background and curbside and annual mean ranging from 4-21 ug/cu m in European cities(7). Propane was detected in gasoline vapors at concentrations ranging from 0.02-2.8 mg/ cu m(8). [Peer reviewed] [(1) Fraser MP et al; Environ Sci Technol 31: 2051-2060 (1998) (2) Defre R et al; Environ Health Prospect 4: 31-7 (1994) (3) Rogak SN et al; J Air Waste Management Assoc 48: 604-615 (1998) (4) Doskey PV et al; J Air Waste Management 42: 1437-1445 (1992) (5) Scheff PA, Wadden RA; Environ Sci Technol 27: 617-625 (1993) (6) Bailey JC et al; Sci Tot Environ 93: 199-206 (1990) (7) Bailey JC et al; Atmos Environ 24: 43-52 (1990) (8) Altshuller AP; J Air Waste Management Assoc 43: 1221-1230 (1993)]

Sediment/Soil Concentrations:

SEDIMENT: Propane was detected in 10 of 10 sediment samples from Walvis Bay of the Namibian shelf of SW Africa at concn of 15.0, 8.8, 8.5, 9.9, 12.3, 16.5, 6.4, 7.8, 7.3, and 4.0 ng/g(1). Sediments from the Bering Sea contained propane gas at concn ranging from 4 to 150 nL/L(2). [Peer reviewed] [(1) Whelan JK et al; Geochim Cosmochim Acta 44: 1767-85 (1980) (2) Kvenvolden KA, Redden GD; Geochimica et Cosmochimica Acta 44: 1145-50 (1980)]

Atmospheric Concentrations:

1. ... Measurements in a medium size USA city in 1972 have shown community air concn of approx 50 ppb. [Peer reviewed] [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. 3181]
2. Expected ground level concn in USA urban air: 0.05-0.40 ppm [Peer reviewed] [Verschueren, K. Handbook of Environmental Data of Organic Chemicals. 2nd ed. New York, NY: Van Nostrand Reinhold Co., 1983., p. 1017]
3. URBAN: The average propane concn for 2 samples per 4 sites in Tulsa, OK was 43.3 ppbC with a range of 4.6 to 189.8 ppbC(1). The propane concn for 6 sites in Rio Blanco, CO averaged 81.6 ppbC with a range from 3.2 to 465.3(2). Propane was detected in 21 of 21 air samples from Houston, TX ranging in concn from 13.0 to 592.4 ppm with an average of

108.1 ppm(2). The arithmetic and geometric means were 12.2 and 10.1 ppbC, respectively, for the atmospheric propane content at urban locations in New England(3). [Peer reviewed] [(1) Arnts RR, Meeks SA; Atmos Environ 15: 1643-51 (1981) (2) Lonneman WA et al; Hydrocarbons in Houston Air USEPA-600/3-79/018 p. 44 (1979) (3) Colbeck I, Harrison RM; Atmos Environ 19: 1899-904 (1985)]

4. URBAN: The ground level atmospheric concentration of propane at was 23 ppb 13:25 hours and 166 ppb at 08:00 hours for Huntington Park, CA(1). At 1500 feet the propane concn was 13 ppb at 07:43 hours and at 08:07 hours at a height of 2,200 ft the propane concn was 9 ppb(1). The propane concn ranged from 11 to 99 ppbV at a downtown Los Angeles location during the fall, 1981(2). The propane concn at 1100 ft just east of Antioch, CA was 7.0 ug/cu m, at 1000 ft near Pittsburg, CA was 7.5 ug/cu m, at 1100 ft over Carquinez Strait, CA was 5.0 ug/cu m and at 1000 ft over San Pablo Bay, CA was 1.5 ug/cu m(3). According to the National Ambient Volatile Organic Compounds (VOCs) Database, the median urban atmospheric concn of propane is 5.733 ppbV for 541 samples (4). [Peer reviewed] [(1) Scott Research Labs Inc; Atmospheric Reaction Studies in the Los Angeles Basin, NTIS PB-194-058 p 86 (1969) (2) Grosjean D, Fung K; J Air Pollut Control Assoc 34: 537-43 (1984) (3) Sexton K, Westberg H; Environ Sci Tech 14: 329-32 (1980) (4) Shah JJ, Heyerdahl EK; National Ambient VOC Database Update USEPA 600/3-88/010 (1988)]
5. URBAN: The ground level atmospheric concentration of propane at was 23 ppb 13:25 hours and 166 ppb at 08:00 hours for Huntington Park, CA(1). At 1500 feet the propane concn was 13 ppb at 07:43 hours and at 08:07 hours at a height of 2,200 ft the propane concn was 9 ppb(1). The propane concn ranged from 11 to 99 ppbV at a downtown Los Angeles location during the fall, 1981(2). The propane concn at 1100 ft just east of Antioch, CA was 7.0 ug/cu m, at 1000 ft near Pittsburg, CA was 7.5 ug/cu m, at 1100 ft over Carquinez Strait, CA was 5.0 ug/cu m and at 1000 ft over San Pablo Bay, CA was 1.5 ug/cu m(3). According to the National Ambient Volatile Organic Compounds (VOCs) Database, the median urban atmospheric concn of propane is 5.733 ppbV for 541 samples (4). [Peer reviewed] [(1) Louw CW et al; Atmos Environ 11: 703-17 (1977) (2) Mulcahy MFR et al; Paper IV p 17 in Occurrence Contr Photochem Pollut, Proc Symp Workshop Sess (1976) (3) Nelson PF, Quigley SM; Environ Sci Technol 16: 650-5 (1982) (4) Stump FD, Dropkin DL; Anal Chem 57: 2629-34 (1985) (5) Uno I et al; Atmos Environ 19: 1283-93 (1985) (6) Rudolph J, Khedim A; Int J Environ Anal Chem 290: 265-82 (1985) (7) Mohan Rao AM, Panditt GG; Atmos Environ 2: 395-401 (1988)]
6. SUBURBAN: According to the National Ambient Volatile Organic Compounds (VOCs) Database, the median suburban atmospheric concn of propane is 10.480 ppbV for 225 samples(1). The propane concn was 3.0, 2.0 and 2.0 ug/cu m at 10, 15 and 40 mi downwind of Janesville, WI 8-14-78(2). [Peer reviewed] [(1) Shah JJ, Heyerdahl EK; National Ambient VOC Database Update USEPA 600/3- 88/010 (1988) (2) Sexton K; Environ Sci Technol 17: 402-7 (1983)]
7. SUBURBAN: At street level at the Empire State and World Trade Buildings in Manhattan, NY the average propane concn of 4 samples was 10 ppbC in July 1978(1). In 1975 the average propane concn of 14 air samples taken between 05:30-08:30 and 12:30-15:30 EST at the World Trade Center in New York City NY were 24 and 12 ppbC, respectively (1). In 1975 the average propane concn of 11 and 8 air samples taken between 5:30-8:30 AM and 12:30-3:30 PM at the Interstate Sanitation Commission in New York City, NY were 39 and 25 ppbC, respectively(1). [Peer reviewed] [(1) Altwicker ER et al; J Geophys Res 85: 7475-87 (1980)]
8. URBAN/SUBURBAN: Propane was detected in Tapei, Taiwan, Hamburg, Germany, Chicago, IL, Athens, Greece and Osaka, Japan at concentrations of 6.4, 2.1, 3.2, 1.2 and 8.9 ppbv respectively(1). Propane was detected in 100% of the urban areas tested with a mean concentration of 2.74 ppb(2). Propane was detected in areas around Berlin, Germany including rural (Fohnau), residential (Nansen Strasse) and street (Frankfurter Alee) sites at concentrations of 1.42, 3.23 and 4.55 ug/cu m, respectively(3). Propane was detected in Edmonton, Alberta, Canada at median concentrations 14.94 and 34.76 ug/cu