ORNL INTERNAL USE ONLY
RECID 00001
DATE 12-9-10

AIR LIQUIDE

MATERIAL SAFETY DATA SHEET

Prepared to U.S. OSHA, CMA, ANSI and Canadian WHMIS Standards

1. PRODUCT AND COMPANY INFORMATION

CHEMICAL NAME; CLASS: BENZENE

Packaged in Cylinders Pressurized with Nitrogen or Helium

SYNONYMS: Benzol: Benzole; Benzolene: Carbon Oil; Coal Naphtha; Cyclohexatriene; Phene; Mineral Naphtha; Motor Benzol; Nitration Benzene; Phenyl Hydride; Pyrobenzoyl; Pyrobenzole; NCI-C55276

CHEMICAL FAMILY NAME: Aromatic Hydrocarbon/Benzene

FORMULA: C_6H_6

	Document Number: 20008
PRODUCT USE:	Manufacture of chemicals; minor component of gasoline; solvent and reactant in laboratories
MANUFACTURED/SUPPLIED FOR:	AIR LIQUIDE
ADDRESS:	2700 Post Oak Drive Houston, TX 77056-8229
EMERGENCY PHONE:	CHEMTREC: 1-800-424-9300
BUSINESS PHONE:	
General MSDS Information	1-713/896-2896
Fax on Demand:	1-800/231-1366

2. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW: Benzene is a colorless, flammable, toxic liquid, with a characteristic aromatic odor. Benzene is a known human carcinogen and a possible human mutagen. Inhalation of vapors of Benzene can cause serious, permanent damage to the blood system. Skin and eye contact can be irritating. This liquid is very flammable; vapors are heavier than air and may travel long distances to source of ignition and flashback. If involved in a fire Benzene will decompose to produce toxic gases (i.e. carbon monoxide, carbon dioxide, irritating aldehydes and ketones). Persons responding to fires or emergencies involving Benzene must have adequate fire protection and wear personal protective equipment to protect against the significant health hazards posed by Benzene.

SYMPTOMS OF OVER-EXPOSURE BY ROUTE OF EXPOSURE: Benzene is a serious poison by all routes of exposure. The symptoms of each route of exposure are described below.

INHALATION: The immediate symptoms of inhalation of vapors of Benzene are due to the initial excitation, followed by depression of the central nervous system. Central nervous system symptoms include drowsiness, headache, nausea, incoordination and unconsciousness, that can lead to death in severe cases. Other symptoms of acute over-exposure to vapors of Benzene can include transient euphoria, ataxia (incoordination of voluntary muscular movements), vertigo, tinnitus, substernal pain, cough, hoarseness and general irritation of the nose, throat and respiratory tract, confusion, stupefaction and coma. In cases of severe over-exposure (as may occur in a confined space, or other poorly ventilated areas, or if large volumes are used or released), tremors, convulsions and death, due to respiratory paralysis or circulatory collapse can occur within minutes to several hours following exposure. Reversible liver and kidney effects have been reported after exposure to Benzene. The effects associated with various levels of Benzene vapors are as follows:

CONCENTRATION	SYMPTOM OF EXPOSURE
Brief (10 minute) up to 25 ppm:	No symptoms.
50-150 ppm:	Exhilaration, headache, tiredness, nose and throat irritation.
20,000 (for 5-10 min):	Collapse and death

One of the most significant health effects associated with Benzene is the potential for blood system disorders which develop after long-term exposures to relatively low vapor concentrations. There are reports that exposure to low levels (10 ppm) over an extended time period (24 weeks) of Benzene vapors can damage the bone marrow and blood systems. This damage can result in the development of serious health disorders (including anemia and leukemia). Adverse effects on the immune system have also been reported. Refer to "Other Health Effects" in this section for further information.

CONTACT WITH SKIN or EYES: Contact with the skin can cause irritation and redness. Repeated or prolonged contact can also cause dermatitis, resulting in dry, itchy, cracked skin as Benzene is a defatting agent, removing oils from the skin. Contact with the vapors of Benzene and the eyes will be irritating. Direct contact of the liquid with the eyes can cause irritation, pain; prolonged contact may result in tissue damage.

SKIN ABSORPTION: Benzene poisoning through skin contact has been reported, although skin absorption is not considered as significant a route of exposure as via inhalation or ingestion. Symptoms of absorption may be similar as those described in "Ingestion".

INGESTION: Ingestion of Benzene will cause a burning sensation in the mouth and stomach, nausea, vomiting, excess salivation and vomiting of blood. Benzene is readily absorbed into the body following ingestion exposures, producing symptoms of central nervous system depression and other symptoms similar to those described in "Inhalation". If ingested, Benzene presents a potential aspiration hazard. Aspiration of even small amounts of Benzene into the lungs can result in immediate pulmonary edema (a potentially fatal accumulation of fluid in the lungs), chemical pneumonitis and hemorrhage of pulmonary tissue.

2. HAZARD IDENTIFICATION (Continued)

INJECTION: Injection is not anticipated to be a significant route of over-exposure for this product. If Benzene is "injected" (as may occur through punctures by contaminated, sharp objects), symptoms described in "Inhalation" can occur.

OTHER HEALTH EFFECTS: The chief target organ affected by serious Benzene exposure is the blood and bone marrow system. Chronic Benzene exposure eventually leads to pancytopenia (abnormal decrease of all three formed elements of the blood; hemoglobin, disease-fighting leukocytes and blood-clotting thrombocytes), followed by thrombocytopenia (problems with the blood-clotting properties of the blood) and anemia. These syndromes can lead to sudden, overwhelming infections. After exposure to Benzene, bleeding from the nose, gums, or mucous membranes and development of small bruises can occur. Benzene is a known human carcinogen and can produce forms of leukemia. Direct contact with the liquid with mucous membranes will result in the development of hemorrhagic lesions.

HEALTH EFFECTS OR RISKS FROM EXPOSURE: An Explanation in Lay Terms. Over-exposure to may cause the health effects described on the following page.

ACUTE: Acute inhalation over-exposure to Benzene will initially act as a narcotic, possibly leading to coma in extreme cases. Following exposure to high concentrations, victims may be unconscious, and if exposure continues, death can follow from respiratory failure and circulatory collapse. Contact with the skin can cause irritation and dermatitis. Contact with the eyes is irritating, causing burning and watering of the eyes. Ingestion of Benzene will cause gastric distress, hemorrhage and possible severe depression of the central nervous system. Aspiration of Benzene into the lungs, following ingestion, can result in severe damage to the lungs; death may result.

CHRONIC: Chronic exposure to Benzene causes serious damage to the health by all routes of exposure. Chronic oral and inhalation exposure causes severe effects on the blood system, including damage to the bone marrow, leading to a decrease in production or changes to the cells of hemoglobin, hematocrit, red and white blood cells. Effects can occur with an exposure level as low as 10 ppm for 24 weeks. Benzene also causes harmful changes to the immune system, decreasing the production of mature B- and T- white blood cells. Benzene is a confirmed human carcinogen, which can produce Hodgkin's Disease, leukemia and lymphomas by inhalation. Human mutation data are reported for Benzene. See Section 11 (Toxicological Information) for further information. Symptoms of chronic exposure by most routes can be delayed for months to years after exposure has ceased.

TARGET ORGANS: Respiratory system, central nervous system, blood and immune systems, bone marrow, heart, liver, kidneys, skin, eyes and reproductive system.

3. COMPOSITION and INFORMATION ON INGREDIENTS

CHEMICAL NAME	CAS #	mole %	EXPOSURE LIMITS IN AIR					
			ACGIH		OSHA			OTHER
			TLV ppm	STEL ppm	PEL ppm	STEL ppm	IDLH ppm	
Benzene	71-43-2	100%	10, A2	NE	1	5	500	NIOSH REL: 0.1 ppm TWA; 1 ppm STEL OSHA Action Level: 0.5 ppm EPA-A; IARC-1; MAK-A1; NIOSH-X; NTP-1; OSHA-X;

This material is classified as hazardous under OSHA regulations in the United States and the WHMIS in Canada.

NE = Not Established C = Ceiling Limit A2 = Suspected Human Carcinogen. See Section 16 for Definitions of Terms Used.

NOTE: All WHMIS required information is included. It is located in appropriate sections based on the ANSI Z400.1-2004 format.

4 FIRST-AID MEASURES

RESCUERS SHOULD NOT ATTEMPT TO RETRIEVE VICTIMS OF EXPOSURE TO BENZENE WITHOUT ADEQUATE PERSONAL PROTECTIVE EQUIPMENT. If necessary, a Self-Contained Breathing Apparatus should be worn.

INHALATION: If vapors, mists, or sprays of Benzene are inhaled, remove victim to fresh air. Remove victim(s) to fresh air as quickly as possible. Only trained personnel should administer supplemental oxygen and/or cardio-pulmonary resuscitation if necessary. Remove or cover gross contamination to avoid exposure to rescuers.

SKIN EXPOSURE: If Benzene contaminates the skin, immediately begin decontamination with running water. Minimum flushing is for 15 minutes. Remove exposed or contaminated clothing, taking care not to contaminate eyes. Victim must seek medical attention if any adverse reaction occurs.

EYE EXPOSURE: If Benzene or its vapors enter the eyes, open victim's eyes while under gentle running water. Use sufficient force to open eyelids. Have victim "roll" eyes. Minimum flushing is for 15 minutes. Victim must seek immediate medical attention.

INGESTION: If Benzene is swallowed, CALL PHYSICIAN OR POISON CONTROL CENTER FOR MOST CURRENT INFORMATION. If professional advice is not available, do not induce vomiting. Victim should drink milk, egg whites, or large quantities of water. If vomiting occurs naturally, have victim lean forward to reduce risk of aspiration. Never induce vomiting or give diluents (milk or water) to someone who is unconscious, having convulsions, or who cannot swallow.

Victims of chemical exposure must be taken for medical attention. Rescuers should be taken for medical attention, if necessary. Physicians should refer to "Recommendations to Physicians" in Section 11 (Toxicological Information). Take copy of label and MSDS to health professional with victim.

5. FIRE-FIGHTING MEASURES

FLASH POINT, (Closed Cup): -11°C (12°F)

AUTOIGNITION TEMPERATURE: 498°C (928°F)

FLAMMABLE LIMITS (in air by volume, %):

Lower (LEL): 1.3%
Upper (UEL): 7.1%

FIRE EXTINGUISHING MATERIALS:

Water Spray: YES (for cooling only)
Foam: YES
Halon: YES
Carbon Dioxide: YES
Dry Chemical: YES
Other: Any "B" Class.

UNUSUAL FIRE AND EXPLOSION HAZARDS: Benzene is a Class IB flammable liquid and presents a serious fire hazard to firefighters. Due to the low flash point, vapors can form explosive mixtures with air, at room temperature. When involved in a fire, this material may decompose and produce toxic gases (i.e., carbon monoxide, carbon dioxide, irritating aldehydes and ketones). The vapors of Benzene are heavier than air and may spread long distances; distant ignition and flash-back are possible. Benzene can float on water; therefore, water contaminated with this product can spread the flammable liquid and can spread fire. Containers of Benzene, when involved in fire, may rupture or burst in the heat of the fire.

Explosion Sensitivity to Mechanical Impact: Not sensitive.

Explosion Sensitivity to Static Discharge: Benzene can accumulate static charge by flow or agitation; vapors can be ignited by static discharge.

SPECIAL FIRE-FIGHTING PROCEDURES: In the event of fire, cool containers of this product with water to prevent failure. Use a water spray or fog to reduce or direct vapors. Water may not be effective in actually extinguishing a fire involving Benzene, due to its low flash point. Stop the leak or discharge, if possible. For small releases, if it is not possible to stop the leak, and it does not endanger personnel, let the fire burn itself out. Incipient fire responders should wear eye protection. Structural fire fighters must wear Self-Contained Breathing Apparatus and full protective equipment, including chemically resistant clothing. Large fires should be fought from a distance with an unmanned hose holder or monitor nozzles. If this product is involved in a fire, fire run-off water should be contained to prevent possible environmental damage. If necessary, decontaminate fire-response equipment with soap and water solution.

6. ACCIDENTAL RELEASE MEASURES

LEAK RESPONSE: Evacuate immediate area. Uncontrolled releases should be responded to by trained personnel using pre-planned procedures. Proper protective equipment should be used. In case of a leak, clear the affected area, protect people, and respond with trained personnel.

Minimum Personal Protective Equipment should be **Level B: triple-gloves (rubber gloves and nitrile gloves, over latex gloves), chemically resistant suit and boots, hard-hat, and Self-Contained Breathing Apparatus.** Monitor the surrounding area for combustible vapor levels. Combustible vapor levels must be below 10% of the LEL for Benzene (LEL = 1.3%) before personnel are permitted to enter the area. If necessary, ventilate area.

Monitoring should be done for the levels of Benzene and oxygen. Colorimetric tubes are available to detect the presence of Benzene. Levels of Benzene should be below levels listed in Section 2 (Composition and Information on Ingredients) and the atmosphere must have at least 19.5 percent oxygen before personnel can be allowed in the area without Self-Contained Breathing Apparatus.

Eliminate all sources of ignition before clean-up operations begin. Use non-sparking tools. Absorb spilled liquid with activated carbon, polypads or other suitable absorbent materials. Prevent material from entering sewer or confined spaces. Decontaminate the area thoroughly. Place all spill residue in an appropriate container and seal. If necessary, decontaminate spill-response equipment with soap and water solution. Dispose of in accordance with Federal, State, and local hazardous waste disposal regulations (see Section 13, Disposal Considerations).

THIS IS AN EXTREMELY FLAMMABLE, TOXIC LIQUID: Protection of all personnel and the area must be maintained. All responders must be adequately protected from exposure.

7. HANDLING AND STORAGE

WORK PRACTICES AND HYGIENE PRACTICES: Avoid all contact with this material. All employees who handle this material should be trained to handle it safely. Avoid breathing the sprays or mists generated by Benzene. Wash hands after handling chemicals. Do not eat or drink while handling chemicals. All work practices should minimize the release of Benzene. Eyewash stations and safety showers should be in areas of use of Benzene.

Note: Refer to the OSHA Benzene Standard (29 CFR 1910.1028) for specific requirements associated with the use of this product. The Action Level for Benzene is 0.5 ppm as an 8-hour, time-weighted average. In workplaces where employees are exposed above the Action Level, the OSHA requirements for monitoring, establishment of regulated areas, methods of compliance, respiratory protection, emergency response protocol, medical surveillance, training and record keeping must be followed.

STORAGE AND HANDLING PRACTICES: Entrances to regulated areas (as defined by the OSHA Benzene Standard) must be posted with signs which reads as follows:

DANGER
BENZENE
CANCER HAZARD
FLAMMABLE- NO SMOKING
AUTHORIZED PERSONNEL ONLY

Cylinders should be stored upright and be firmly secured to prevent falling or being knocked-over. Cylinders can be stored in the open, but in such cases, should be protected against extremes of weather and from the dampness of the ground to prevent rusting. Cylinders of this product must be properly labeled. When handling the liquid, care must be taken to avoid splashing during dispensing from the container. Never transfer liquids by pressurizing the original container with air or gas. Do not dispense in storage area unless the dispensing area is segregated by fire-resistant construction. Never return contaminated Benzene to original container.

Cylinders should be stored in dry, well-ventilated areas away from sources of heat, ignition and direct sunlight. Keep storage area clear of materials which can burn. Do not allow area where cylinders are stored to exceed 52°C (125°F). Store containers away from heavily trafficked areas and emergency exits. Store away from process and production areas, away from elevators, building and room exits or main aisles leading to exits. Protect cylinders against physical damage. Consideration should be taken to install leak detection and alarm equipment for storage areas.

Cylinders should be separated from oxygen cylinders, or other oxidizers, by a minimum distance of 20 ft., or by a barrier of non-combustible material at least 5 ft. high, having a fire-resistance rating of at least 0.5 hours. Isolate from other incompatible chemicals, such as strong oxidizers, metals, and metal oxides (refer to Section 10, Stability and Reactivity, for more information).

7. HANDLING AND STORAGE (Continued)

Storage areas must meet national electrical codes for Class 1 Hazardous Areas. Post "No Smoking or Open Flames" signs in storage or use areas. Consider installation of leak detection and alarm for storage and use areas. Have appropriate extinguishing equipment in the storage area (i.e. sprinkler system, portable fire extinguishers).

Use only compatible materials for cylinders, process lines, and other Benzene-handling equipment. Lines should be purged with dry nitrogen both before and after maintenance activity. Use a check valve or other protective device in the discharge line to prevent hazardous backflow.

Never tamper with pressure relief valves and cylinders. Use non-sparking ventilation systems, approved explosion-proof equipment, and appropriate electrical systems. Electrical equipment used in gas-handling operations, or located in storage areas, should be non-sparking or explosion proof.

Use a check valve in the discharge line to prevent hazardous backflow. Never tamper with pressure relief devices in valves and cylinders.

Periodic inspections of process equipment by knowledgeable persons should be made to ensure that the equipment is used appropriately and the system is kept in suitable operating condition.

Keep the smallest amount necessary on-site at any one time. Full and empty cylinders should be segregated. Use a first-in, first-out inventory systems to prevent full containers from being stored for long periods of time.

SPECIAL PRECAUTIONS FOR HANDLING CYLINDERS: Cylinders of Benzene can present significant safety hazards. The following rules are applicable to work situations in which cylinders are being used.

Before Use: Move cylinders with a suitable hand-truck. Do not drag, slide or roll cylinders. Do not drop cylinders or permit them to strike each other. Secure cylinders firmly. Leave the valve protection cap (where provided) in-place until cylinder is ready for use.

During Use: Use designated CGA fittings and other support equipment. Do not use adapters. Do not heat cylinder by any means to increase the discharge rate of the product from the cylinder. Do not use oils or grease on cylinder-handling fittings or equipment. Immediately contact the supplier if there are any difficulties associated with operating cylinder valve. Never insert an object (e.g wrench, screwdriver, pry bar, etc.) into valve cap openings. Doing so may damage valve, causing a leak to occur. Use an adjustable strap wrench to remove over-tight or rusted caps. Never strike an arc, on a compressed gas cylinder or make a cylinder part of and electric circuit.

After Use: Close main cylinder valve. Valves should be closed tightly. Replace valve protection cap. Mark empty cylinders "EMPTY".

NOTE: Use only DOT or ASME code containers designed for flammable storage. Close valve after each use and when empty.

STANDARD VALVE CONNECTIONS FOR U.S. AND CANADA: Use the proper CGA connections, DO NOT USE ADAPTERS:

THREADED: CGA - 510
PIN-INDEXED YOKE: Not applicable.
ULTRA HIGH INTEGRITY: Not applicable.

PROTECTIVE PRACTICES DURING MAINTENANCE OF CONTAMINATED EQUIPMENT: Follow practices indicated in Section 6 (Accidental Release Measures). Make certain application equipment is locked and tagged-out safely. Purge gas handling equipment with inert gas (i.e. nitrogen) before attempting repairs. Always use product in areas where adequate ventilation is provided.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION

VENTILATION AND ENGINEERING CONTROLS: Use with adequate ventilation. Use a mechanical fan or vent area to outside. Where appropriate, use a non-sparking, grounded ventilation system separate from other exhaust ventilation systems. Ensure eyewash/safety shower stations are available near areas where this product is used.

RESPIRATORY PROTECTION: Maintain exposure levels of Benzene below the levels listed in Section 2 (Composition and Information on Ingredients) and oxygen levels above 19.5% in the workplace. Use supplied air respiratory protection if Benzene levels exceed exposure limits and if oxygen level is below 19.5% or during emergency response to a release of this product. If respiratory protection is required, follow the requirements of the Federal OSHA Respiratory Protection Standard (29 CFR 1910.134), or equivalent State standards. The following NIOSH respiratory protection recommendations are for Benzene.

8. EXPOSURE CONTROLS - PERSONAL PROTECTION (Continued)

CONCENTRATION	RESPIRATORY EQUIPMENT
At Concentrations Above the NIOSH REL, or Where there is no REL, at any Detectable Concentration:	Positive-pressure, full facepiece SCBA or positive pressure, full-facepiece Supplied Air Respirator (SAR) with an auxiliary positive pressure SCBA.
Escape	Gas mask with organic vapor cartridge or escape-type SCBA should be used.

The IDLH concentration for Benzene is 500 ppm. The carcinogenic effects of Benzene were not considered by NIOSH in determination of the IDLH.

NOTE: In areas which exceed the OSHA Action Level of Benzene, the respirator selection guidelines in the Benzene Standard [29 CFR 1910.1028 (g)] apply.

EYE PROTECTION: Splash goggles or safety glasses. Face-shields should be worn if contact with the liquid is anticipated.

HAND PROTECTION: Wear leather gloves for handling of cylinders of this product. Wear chemically impervious gloves appropriate for Benzene for industrial use. Gloves should have a resistance to breakthrough greater than 8 hours, such as polyvinyl alcohol, Barricade™ or Responder™. **Butyl rubber, natural rubber, neoprene, nitrile rubber, or polyethylene, polyvinyl chloride, Saranex™, Chemrel™ are not recommended.** Use triple gloves for spill response (see Section 6, Accidental Release Measures).

BODY PROTECTION: Use body protection appropriate for task. An impervious, full-body, encapsulating suit may be necessary for some operations involving Benzene. Safety shoes are recommended when handling cylinders.

9. PHYSICAL and CHEMICAL PROPERTIES

VAPOR DENSITY (air = 1) = 2.7

BOILING POINT: 80°C (76°F)

FREEZING/MELTING POINT: 5.5°C (42°F)

SPECIFIC GRAVITY @ 20°C (68°F) (water = 1): 0.877

SOLUBILITY IN WATER @ 25°C (77°F): 180 mg/mL

EVAPORATION RATE (diethyl ether = 1): 2.8

ODOR THRESHOLD: 97 ppm(detection); 97 ppm (recognition)

VAPOR PRESSURE @ 20°C (68°F) 75 mm Hg: 10 kPa

pH: Not applicable.

MOLECULAR WEIGHT: 78.11

EXPANSION RATIO: Not applicable.

SPECIFIC VOLUME (ft^3/lb): 5.5

COEFFICIENT WATER/OIL DISTRIBUTION: Log P (oct) = 1.18-1.9; 2.13; 2.15

APPEARANCE AND COLOR: Colorless, flammable liquid, with a characteristic aromatic hydrocarbon odor.

HOW TO DETECT THIS SUBSTANCE (warning properties): The odor of Benzene is not a good warning property as a the odor threshold is above the TLV.

10. STABILITY and REACTIVITY

STABILITY: Normally stable.

DECOMPOSITION PRODUCTS: If Benzene is involved in a fire, it may ignite to yield toxic fumes of carbon monoxide, carbon dioxide, irritating aldehydes and ketones.

MATERIALS WITH WHICH SUBSTANCE IS INCOMPATIBLE: Benzene becomes spontaneously flammable in the presence of sodium peroxide and potassium peroxide. Benzene can explode on contact with chromic anhydride, permanganic acid and chlorine. Benzene can react vigorously with oxidizing materials. Benzene may react violently or explosively with risk of fire with nitric acid, ozone, diborane, interhalogens (i.e., bromine trifluoride, bromine pentafluoride, chloride trifluoride, iodine pentafluoride, iodine heptafluoride), dioxygen difluoride, dioxygenyl tetrafluoroborate, permanganic acid, peroxodifsulfuric acid, peroxomonosulfuric acid. Benzene will react with nitryl perchlorate, causing a slight explosion and flash. Benzene will react vigorously with uranium hexafluoride. Benzene will attack rubber and plastics.

HAZARDOUS POLYMERIZATION: Will not occur.

CONDITIONS TO AVOID: Avoid contact with incompatible materials, sparks, flame static discharge and other sources of ignition. Avoid exposing cylinders to extremely high temperatures, which could cause the cylinders to rupture or burst.

11. TOXICOLOGICAL INFORMATION

TOXICITY DATA: The following information is available for Benzene.

Skin-Rabbit, adult 15 mg/24 hours open Mild irritation effects
Skin-Rabbit, adult 20 mg/24 hours Moderate irritation effects
Eye effects-Rabbit, adult 88 mg Moderate irritation effects
Eye effects-Rabbit, adult 2 mg/24H Severe irritation effects
oms-Human: lymphocyte 5 µmol/L
Microsomal Mutageniticity Assay-Mouse: embryo 2500 mg/L
Oral-Mouse TDLo: 6500 mg/kg (female 8-12 days post): Reproductive effects Teratogenesis, Carcinogenesis, and Mutagenesis
Inhalation-Mouse TCLo: 5 ppm (female 6-15 days post): Teratogenic effects
Inhalation-Man TCLo: 200 mg/m^3/78 weeks -intermittent: Carcinogenic effects, Blood effects
Inhalation-Human TCLo: 10 ppm/8 hours /10 years-intermittent: Carcinogenic effects, Blood effects
Oral-Rat TDLo: 52 g/kg/52 weeks - intermittent: Carcinogenic effects
Inhalation-Rat TCLo: 1200 ppm/6 hours/10 weeks - intermittent: Equivocal tumorigenic agent
Oral-Mouse TDLo :18,250 mg/kg/2 years - continuos: Carcinogenic effects
Inhalation-Human TC :8 ppb/4 weeks- intermittent: Carcinogenic effects, Blood effects
Inhalation-Dog, adult LCLo: 146,000 mg/
Inhalation-Cat, adult LCLo: 170,000 mg/m^3
Inhalation-Mouse TC: 300 ppm/6 hours/16 weeks intermittent: Carcinogenic effects
Inhalation-Human LCLo :2 pph/5 minutes
Oral-Man LDLo: 50 mg/kg
Inhalation-Human LCLo: 20,000 ppm/5
Inhalation-Man TCLo: 150 ppm/1 year - intermittent: Blood effects
Inhalation-Human TCLo: 100 ppm
Intravenous-Rabbit, adult LDLo :88 mg/kg
Inhalation-Human TC: 10 mg/m 3/11 years- intermittent: Carcinogenic effects, Blood effects
Inhalation-Mouse TCLo: 300 ppm/6 hours/16 weeks-intermittent: Equivocal tumorigenic agent
Skin-Mouse TDLo: 1200 g/kg/49 weeks - intermittent: Neoplastic effects
Intraperitoneal-Mouse TDLo: 1200 mg/kg/8 weeks - intermittent: Neoplastic effects
Subcutaneous-Mouse TDLo 600 mg/kg/17 weeks - intermittent: Equivocal tumorigenic agent
Parenteral-Mouse TDLo: 670 mg/kg/19 weeks - intermittent: Equivocal tumorigenic agent
Inhalation-Human TC: 150 ppm/15 minutes /8 years - intermittent: Carcinogenic effects, Blood effects
Oral-Rat TD: 52 g/kg/1 years - intermittent: Carcinogenic effects
Oral-Rat TD: 10 g/kg/52 weeks - intermittent: Carcinogenic effects
Inhalation-Man TC :600 mg/m^3/4 years - intermittent: Carcinogenic effects, Blood effects
Inhalation-Man TC: 150 ppm/11 years - intermittent: Carcinogenic effects, Blood effects
Inhalation-Mouse TC :1200 ppm/6 hours/10 weeks - intermittent: Equivocal tumorigenic agent
Oral-Mouse TD: 2400 mg/kg/8 weeks - intermittent: Neoplastic effects
Inhalation-Human LCLo: 65 mg/m^3/5 years: Blood effects
Oral-Rat LD50: 3306 mg/kg
Inhalation-Rat LC50: 10,000 ppm/7 hours
Intraperitoneal-Rat LD50 :2890 µg/kg
Oral-Mouse LD50: 4700 mg/kg
Inhalation-Mouse LC50: 9980 ppm
Intraperitoneal-Mouse LD50: 340 mg/kg
Oral-Dog, adult LDLo: 2000 mg/kg

Additional Information on Benzene: Because of the chronic toxicity effects associated with Benzene, a component of this product, additional information is provided, as follows:

EFFECTS ON THE BLOOD AND BLOOD-FORMING ORGANS: Extensive studies have conclusively proven that oral and inhalation exposure to benzene causes severe effects on the blood system, including damaging the bone marrow where new blood cells are formed. Most studies report a decrease in hemoglobin, hematocrit, red and white blood cells, platelets and/or changes in the cells. Effects of varying severity have been demonstrated with both intermittent and continuous exposures to concentrations as low as 10 ppm for 24 weeks.

EFFECTS ON THE IMMUNE SYSTEM: Studies have also conclusively shown that benzene causes harmful changes to the immune system which protects the body from disease. Benzene has decreased the number of mature B- and T-lymphocytes (white blood cells which produce disease-fighting antibodies). Exposure of mice to 300 ppm for 6 to 23 weeks resulted in a decrease in the number of mature B- and T-lymphocytes. Rats and mice exposed orally to 25 to 200 mg/kg/day for 2 years had significantly reduced white blood cells and lymphocytes.

SUSPECTED CANCER AGENT: Benzene is listed as follows:

BENZENE: ACGIH-A2 (Suspected Human Carcinogen); EPA-A (Human Carcinogen); IARC-1 (Carcinogenic to Humans); MAK-A1 (Capable of Inducing Malignant Tumors/Experience with Humans); NIOSH-X (Carcinogen); NTP-1 (Known to be a Carcinogen); OSHA-X (Carcinogen); Cal-OSHA (Carcinogen).

IRRITANCY OF PRODUCT: Benzene is irritating to the skin, eyes, and other contaminated tissue.

SENSITIZATION OF PRODUCT: Benzene is not known to cause respiratory system or skin sensitization in humans. Cardiac sensitization to stimulants (i.e. epinephrine, ephedrine) is a possible result of severe or chronic over-exposure.

REPRODUCTIVE TOXICITY INFORMATION: Listed below is information concerning the effects of Benzene on the human reproductive system.

Mutagenicity: Human mutation data are available for Benzene. These data were obtained from individuals who were exposed at levels which produced changes in the blood system.
Embryotoxicity: Benzene is not reported to cause embryotoxic effects in humans.
Teratogenicity: Benzene is not reported to cause embryotoxic effects in humans. Teratogenic data are available from clinical studies involving test animals exposed to relatively high doses of Benzene. Fetotoxic effects (i.e., reduced birth weight and/or minor skeletal variations) were observed at exposures above 50 ppm.
Reproductive Toxicity: Data on reproductive effects on ovaries and testes are available from clinical studies involving test animals exposed to relatively high doses of Benzene. These data were obtained at doses which caused toxic effects on other organs.

11. TOXICOLOGICAL INFORMATION (Continued)

A mutagen is a chemical which causes permanent changes to genetic material (DNA) such that the changes will propagate through generation lines. An embryotoxin is a chemical which causes damage to a developing embryo (i.e. within the first eight weeks of pregnancy in humans), but the damage does not propagate across generational lines. A teratogen is a chemical which causes damage to a developing fetus, but the damage does not propagate across generational lines. A reproductive toxin is any substance which interferes in any way with the reproductive process.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Pre-existing blood system disorders, respiratory conditions, central nervous, liver, kidney, and cardio-vascular conditions may be aggravated by severe or chronic over-exposure to this product. Skin disorders may also be aggravated by exposures to Benzene.

RECOMMENDATIONS TO PHYSICIANS: The following guidelines are derived from "Clinical Toxicology of Commercial Chemical Products" (5th edition, 1984)

- Check for signs of impending pulmonary edema.
- Because of the aspiration hazard, avoid emetic drugs, whenever practical.
- For over-exposures in which emesis is advisable: If the patient is not drowsy, comatose, or in respiratory difficulty, induce vomiting. If necessary, as an alternative treatment, remove Benzene from the stomach via gastric lavage. One or two ounces of mineral oil may be instilled and left in the stomach at the completion of lavage.
- Avoid epinephrine because of its possible adverse effect on the sensitized myocardium. Avoid all digestible fats, oils and alcohol,, which may promote the absorption of Benzene in the intestinal system.
- If eyes or skin are affected, wash thoroughly and apply a bland analgetic ointment.
- Because of the possibility of ventricular fibrillation, monitor the EKG continuously and be prepared to administer external cardiac massage.

RECOMMENDATIONS TO PHYSICIANS (Continued): Refer to the OSHA Benzene Standard [29 CFR 1910.1028; paragraph(i) and Appendix C] for specific information on Medical Surveillance requirements (i.e. for the general physical exam, medical history, specific tests, and re-examination protocol).

BIOLOGICAL EXPOSURE INDICES (BEIs): The following Biological Exposure Indices (BEIs) are currently applicable for Benzene.

BIOLOGICAL EXPOSURE INDICES (BEIs) for Benzene are as follows:

CHEMICAL DETERMINANT	SAMPLING TIME	BEI
BENZENE • Total phenol in urine • Benzene in exhaled air: mixed-exhaled end-exhaled	• End of shift • Prior to next shift	• 50 mg/g creatinine • 0.08 ppm • 0.12 ppm

12. ECOLOGICAL INFORMATION

ENVIRONMENTAL STABILITY: Benzene will be degraded over time into other organic compounds. The following environmental data are available for Benzene.

Benzene: K_{OW} = 2.13. Water Solubility = 1791 mg/L. BCF (*Anguilla japonica*, eels) = 3.5. BCF (*Clupea harengus Pallasi*, pacific herring) = 4.4. BCF (goldfish) = 4.3. BCF, benzene = 24 (estimated). If benzene is released into the soil, it will be volatilized near the surface or it will leach to the groundwater. No degradation of benzene (BOD) was reported in coarse-filtered Lake Superior harbor water incubated at 21°C for 12 days. In the marine eco-system, biodegradation occurs from 2 days to 2 weeks in the summer and spring, respectively. The half-life of Benzene in estuarine water was 6 days, as measured by $^{14}CO_2$ produced. Biodegradation half-lives of 28 and 16 days were reported in die-away tests for degradation of up to 3.2 UL/L benzene using groundwater and Lester River water, respectively, under aerobic conditions. In a base-rich para-brownish soil, 20 ppm benzene was 24% degraded in one week, 44% in 5 weeks and 47% in 10 weeks. It is not expected to adsorb to sediment nor bioconcentrate in aquatic organisms.

EFFECT OF MATERIAL ON PLANTS or ANIMALS: Benzene may be harmful or fatal to contaminated plant and animal-life (especially if large quantities of this product are released). Refer to Section 11 (Toxicology Information).

12. ECOLOGICAL INFORMATION (Continued)

EFFECT OF CHEMICAL ON AQUATIC LIFE: Benzene can be harmful or fatal to contaminated aquatic plant and animal life. Benzene floats on water, and can potentially form slicks which are capable of creating oxygen-deprived waterways which can contaminate coastal and shore life. The following aquatic toxicity data are available for Benzene.

LC_{100} (*Tetrahymena pyriformis*, ciliate) = 12.8 mmol/L/24 hours
LC_{50} (*Palaemonetes pugio*, grass shrimp) = 27 ppm/96 hours
LC_{50} (*Cancer magister*, crab larvae, stage 1) = 108 ppm/96 hours
LC_{50} (*Crangon franciscorum*, shrimp) = 20 ppm/96 hours
LC_{50} (*Poecilia reticulata*, guppy) = 63 ppm/14 days
LC_{50} (*Morone saxatilis*, bass) = 5.8 to 10.9 ppm/96 hours
LC_{50} (*Salmo trutta*, brown trout yearling) = 12 mg/L/1-hour
LC_{50} (*Ambystoma mexicana*, mexican axototl salamander, 3-4 weeks after hatching) = 370 mg/L/48 hours
LC_{50} (clawed toad, 3-4 weeks after hatching) = 190 mg/L/48 hours
LD_{50} (*Carassium auratus*, goldfish) = 46 mg/L/24-hours
LD_{50} (*Lepomis macrochirus*, bluegill sunfish) = 60 mg/L/2-hours

TLm (*Artemia salina*, brine shrimp) = 66-21 mg/L/24 hours
TLm (*Pimephales promelas*, fathead minnow) = 35.5 to 33.5 mg/L/24 hours, 96 hours (soft water)
TLm (*Pimephales promelas*, fathead minnow) = 24.4 to 32 mg/L/24 hours, 96 hours (hard water TLm (bluegill) = 22.5 mg/L/24 hours (soft water)
TLm (*Carassium auratus*, goldfish) = 34.4 mg/L/24 hours, 96 hours (soft water)
TLm (*Lebistes reticulata*, guppy) = 36.6 mg/L/24 hours, 96 hours (soft water)
TLm (*Gambusia affinis*, mosquito fish) = 395 mg/L/24 hours

13. DISPOSAL CONSIDERATIONS

PREPARING WASTES FOR DISPOSAL: Waste disposal must be in accordance with appropriate Federal, State, and local regulations. Return cylinders with any residual product to Air Liquide. Do not dispose of locally.

14. TRANSPORTATION INFORMATION

THIS MATERIAL IS HAZARDOUS AS DEFINED BY 49 CFR 172.101 BY THE U.S. DEPARTMENT OF TRANSPORTATION.

PROPER SHIPPING NAME: Benzene
HAZARD CLASS NUMBER and DESCRIPTION: 3 (Flammable Liquid)
UN IDENTIFICATION NUMBER: UN 1114
PACKING GROUP: PG II
DOT LABEL(S) REQUIRED: Flammable Liquid
NORTH AMERICAN EMERGENCY RESPONSE GUIDEBOOK NUMBER (1996): 130

MARINE POLLUTANT: Benzene is not classified by the DOT as a Marine Pollutant (as defined by 49 CFR 172.101, Appendix B).

SPECIAL SHIPPING INFORMATION: Cylinders should be transported in a secure position, in a well-ventilated vehicle. The transportation of compressed gas cylinders in automobiles or in closed-body vehicles present serious safety hazards and should be discouraged.

NOTE: Shipment of compressed gas cylinders which have not been filled with the owners consent is a violation of Federal law (49 CFR, Part 173.301 (b).

TRANSPORT CANADA TRANSPORTATION OF DANGEROUS GOODS REGULATIONS: THIS MATERIAL IS CONSIDERED AS DANGEROUS GOODS. Use the following information for the preparation of Canadian Shipments.

PROPER SHIPPING NAME: Benzene
HAZARD CLASS NUMBER and DESCRIPTION: 3 (Flammable Liquid),
9.2 (Substance Hazardous to the Environment)
UN IDENTIFICATION NUMBER: UN 1114
PACKING GROUP: PG II
SPECIAL PROVISION: (109)
REGULATED LIMIT: 50 kg

15. REGULATORY INFORMATION

SARA REPORTING REQUIREMENTS: Benzene is subject to the reporting requirements of Sections 302, 304 and 313 of Title III of the Superfund Amendments and Reauthorization Act, as follows:

CHEMICAL	SARA 302	SARA 304	SARA 313
Benzene	NO	YES	YES

This product is subject to the reporting requirements of Sections 311 and 312 of Title III of the Superfund Amendments and Reauthorization Act (40 CFR 370.21).

SARA THRESHOLD PLANNING QUANTITY: Not applicable.

TSCA INVENTORY STATUS: Benzene is listed on the TSCA Inventory.

CERCLA REPORTABLE QUANTITIES (RQ): 10 lbs.

15. REGULATORY INFORMATION (Continued)

CALIFORNIA PROPOSITION 65: Benzene is listed on the California Proposition 65 Lists. WARNING: Benzene is known to the State of California to cause cancer.

STATE REGULATORY INFORMATION: Benzene is covered under the following specific State regulations:

Alaska - Designated Toxic and Hazardous Substances: Benzene.
California - Permissible Exposure Limits for Chemical Contaminants: Benzene
Florida - Substance List: Benzene
Illinois - Toxic Substance List: Benzene.
Kansas - Section 302/313 List: Benzene
Massachusetts - Substance List: Benzene.
Minnesota - List of Hazardous Substances: Benzene.
Missouri - Employer Information/Toxic Substance List: Benzene
New Jersey - Right to Know Hazardous Substance List: Benzene
North Dakota - List of Hazardous Chemicals, Reportable Quantities: Benzene.
Pennsylvania - Hazardous Substance List: Benzene.
Rhode Island - Hazardous Substance List: Benzene
Texas - Hazardous Substance List: Benzene
West Virginia - Hazardous Substance List: Benzene
Wisconsin - Toxic and Hazardous: Benzene

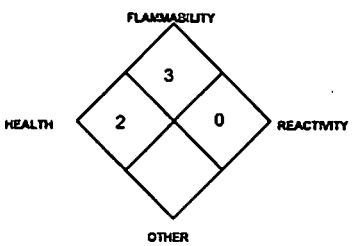
OTHER U.S. FEDERAL REGULATIONS:

- Benzene is subject to the requirements of CFR 29 1910.1000. Benzene is listed on Table Z.2.
- Benzene is subject to the requirements of CFR 29 1910.1028, the OSHA Benzene Standard. The Action Level for Benzene is 0.5 ppm as an 8-hour, time-weighted average under this regulation.
- The EPA is promulgating water regulations for certain volatile synthetic organic chemicals. Specifically, this notice promulgates a maximum contaminant level for Benzene at 0.005 mg/L.
- Benzene is not subject to the reporting requirements of Section 112(r) of the Clean Air Act.
- Benzene is not listed in Appendix A as a highly hazardous chemical, per 29 CFR 1910.119: Process Safety Management of Highly Hazardous Chemicals. Under this regulation, however, any process that involves a flammable liquid on-site, in one location, in quantities of 10,000 lbs (4,553 kg) or greater is covered under this regulation unless it is used as a fuel.
- Benzene does not contain any Class I or Class II ozone depleting chemicals (40 CFR part 82).
- Benzene is not listed a Regulated Substance, per 40 CFR, Part 68, of the Risk Management for Chemical Releases.

OTHER CANADIAN REGULATIONS: Benzene is categorized as a Controlled Product, Hazard Classes B2, D2A and D2B, as per the Controlled Product Regulations.

16. OTHER INFORMATION

NFPA RATING



HAZARDOUS MATERIAL INFORMATION SYSTEM

HEALTH	(BLUE)	2
FLAMMABILITY	(RED)	3
REACTIVITY	(YELLOW)	0
PROTECTIVE EQUIPMENT		X

EYES	RESPIRATORY	HANDS	BODY
See Section 8			

For routine industrial applications

16. OTHER INFORMATION (Continued)

MIXTURES: When two or more gases or liquefied gases are mixed, their hazardous properties may combine to 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 make your safety evaluation of the end product. Remember, gases and liquids have properties which can cause serious injury or death.

Further information can be found in the following pamphlets published by: Compressed Gas Association Inc. (CGA), 4221 Walney Road 5th floor, Chantilly, VA 20151-2923. Telephone: (703) 788-2700.

P-1 *"Safe Handling of Compressed Gases in Containers"*

AV-1 *"Safe Handling and Storage of Compressed Gases"*

PREPARED BY:

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619/565-0302

Fax on Demand: 1-800/231-1366

AIR LIQUIDE

This Material Safety Data Sheet is offered pursuant to OSHA's Hazard Communication Standard, 29 CFR, 1910.1200. Other government regulations must be reviewed for applicability to this product. To the best of Air Liquide's knowledge, the information contained herein is reliable and accurate as of this date; however, accuracy, suitability or completeness are not guaranteed and no warranties of any type, either express or implied, are provided. The information contained herein relates only to this specific product. If this product is combined with other materials, all component properties must be considered. Data may be changed from time to time. Be sure to consult the latest edition.