LA CHEMICAL
SINCE 1914

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MATERIAL SAFETY DATA SHEET

Hydrochloric Acid

SECTION 1 – CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

Product Name: Hydrochloric Acid
Synonyms: Muriatic acid, 20 Baume, 22 Baume
Product Use: pH adjustment for water treatment
Major Update: 06/25/99
CAS#: 7647-01-0
MSDS Code: HCl-e
ANSI/NSF Standard 60 Maximum Dose for Potable Water: 40 mg/L

Emergency Contacts (24 hr.)

FOR EMERGENCIES INVOLVING CHEMICAL SPILL OR RELEASE, CALL

1-888-306-7070.

SECTION 2 – COMPOSITION / INFORMATION ON INGREDIENTS

Hazardous Ingredient(s)	% (w/w)	ACGIH/OSHA TLV/PEL	CAS NO.
Hydrogen chloride	31 - 36	5 ppm ceiling	7647-01-0

SECTION 3 – HAZARD IDENTIFICATION

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Emergency Overview: Danger! Extremely corrosive! Causes severe burns and eye damage. Harmful if inhaled. Harmful or fatal if swallowed. Highly reactive with alkaline materials. Not flammable, but reacts with most metals to form explosive/flammable hydrogen gas. Read the entire MSDS for a more thorough evaluation of the hazards.

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Potential Health Effects:

General : Hydrochloric acid (HCl) is a very strong acid. Solutions can be extremely corrosive. The severity of effects depends on the concentration of the solution and the duration of contact. In general, HCl solutions and mists with a pH of 3 or less are a significant health concern.

Inhalation: Vapor or mist from concentrated solutions can cause severe nasal irritation, sore throat, choking, coughing and difficulty breathing (50-100 ppm). Prolonged exposures can cause burns and ulcers to the nose and throat. Severe exposures (e.g. 1000-2000 ppm), for even a few minutes, can cause a life-threatening accumulation of fluid in the lungs (pulmonary edema). Symptoms of pulmonary edema such as shortness of breath can be delayed for several hours after the exposure.

Skin Contact: Corrosive! Concentrated solutions may cause pain and deep and severe burns to the skin. Prolonged and repeated exposure to dilute solutions often causes irritation, redness, pain and drying and cracking of the skin.

Eye Contact: Immediate pain, severe burns and corneal damage, which may result in permanent blindness. Low concentrations of vapor or mist (10-35 ppm) can be immediately irritating, causing redness.

Ingestion: Causes severe irritation or corrosive burns to mouth, throat, esophagus and stomach. Symptoms may include difficulty in swallowing, intense thirst, nausea, vomiting, diarrhea and in severe cases, collapse and death.

Existing Medical Conditions Possibly Aggravated By Exposure: Skin irritation may be aggravated in individuals with existing skin lesions. Breathing of vapors or sprays (mists) may aggravate acute or chronic asthma and chronic pulmonary disease such as emphysema and bronchitis.

Chronic Effects: Repeated exposure to low concentrations of acid mist or vapor may cause redness, swelling and pain (dermatitis). Exposure to low concentration of acid mist or vapor by inhalation may cause bleeding of nose and gums, bronchitis, stomach pain (gastritis), and brownish discoloration and damage to tooth enamel. Dental erosion becomes more severe with increased exposure.

Carcinogenicity: Hydrochloric acid is not classified as carcinogenic by ACGIH (American Conference of Governmental Industrial Hygienists) or IARC (International Agency for Research on Cancer), not regulated as carcinogens by OSHA (Occupational Safety and Health Administration), and not listed as carcinogens by NTP (National Toxicology Program).
IARC Evaluation: There is inadequate evidence for the carcinogenicity in humans of hydrochloric acid. There is inadequate evidence for the carcinogenicity in experimental animals of hydrochloric acid. Overall evaluation: Hydrochloric acid is not classifiable as to its carcinogenicity to humans (Group 3).

SECTION 4 – FIRST AID MEASURES

General: Corrosive effects on the skin and eyes may be delayed, and damage may occur without the sensation or onset of pain. Strict adherence to first aid measures following any exposure is essential. SPEED IS ESSENTIAL. OBTAIN IMMEDIATE MEDICAL ATTENTION.

Inhalation: Move victim to fresh air. Give artificial respiration ONLY if breathing has stopped. Do not use mouth-to-mouth method if victim ingested or inhaled the substance: induce artificial respiration with the aid of a pocket mask equipped with a one-way valve or other proper respiratory medical device. Give Cardiopulmonary Resuscitation (CPR) if there is no pulse AND no breathing. Obtain medical attention IMMEDIATELY.

Skin Contact: Immediately flush skin with running water for a **minimum** of 20 minutes. Start flushing while

removing contaminated clothing. If irritation persists, repeat flushing. Obtain medical attention IMMEDIATELY. Do not transport victim unless the recommended flushing period is completed or flushing can be continued during transport.

While the patient is being transported to a medical facility, apply compresses of iced water. If medical treatment must be delayed, immerse the affected area in iced water. If immersion is not practical, compresses of iced water can be applied. Avoid freezing tissues.

Discard heavily contaminated clothing and shoes in a manner, which limits further exposure. Otherwise, wash clothing separately before reuse.

Eye Contact: Immediately flush eyes with running water for a **minimum** of 20 minutes. Hold eyelids open during flushing. If irritation persists, repeat flushing. Obtain medical attention IMMEDIATELY. Do not transport victim until the recommended flushing period is completed unless flushing can be continued during transport.

Ingestion: DO NOT INDUCE VOMITING. If victim is alert and not convulsing, rinse mouth and give 240 to 300 mL (8 to 10 oz.) of water to dilute material. If milk is available, it may be administered after the water has been given. If spontaneous vomiting occurs, have victim lean forward with head down to avoid breathing in of vomitus, rinse mouth and administer more water. IMMEDIATELY contact local poison control center. IMMEDIATELY transport victim to an emergency facility. Never give anything by mouth if victim is rapidly losing consciousness, or is unconscious or convulsing.

Note to Physicians: This product may cause severe pneumonitis if aspirated. If ingestion has occurred less than 2 hours earlier, carry out careful gastric lavage; use endotracheal cuff if available, to prevent aspiration. Observe patient for respiratory difficulty from aspiration pneumonitis. Give artificial resuscitation and appropriate chemotherapy if respiration is depressed. Following exposure the patient should be kept under medical review for at least 48 hours as delayed pneumonitis may occur. DO NOT attempt to neutralize the acid with weak bases since the reaction will produce heat that may extend the corrosive injury.

SECTION 5 – FIRE FIGHTING MEASURES

Flash Point	Not applicable. Not combustible
Flammable Limits (Lower)	Not applicable
Flammable Limits (Upper)	Not applicable
Auto Ignition Temperature	Not applicable
Decomposition Temperature	Thermally stable up to temperatures of about 1500 deg C (2730 deg F).
Combustion and Thermal Decomposition Products	hydrogen and chlorine
Rate of Burning	Not applicable
Explosive Power	Not sensitive
Sensitivity to Mechanical Impact	Not sensitive

Fire and Explosion Hazards: Reacts with many metals to liberate hydrogen gas, which can form explosive mixtures with air. Hydrogen, a highly flammable gas, can accumulate to explosive concentrations inside drums, or any types of steel containers or tanks upon storage.

Extinguishing Media : For large fires use an all purpose type AFFF foam according to foam manufacturer's recommended techniques. The foam supplier should be consulted for recommendations regarding foam types and delivery rates for specific applications. Use carbon dioxide or dry chemical media for small fires. Do NOT use carbon dioxide, if cyanides are involved in fire. If only water is available, use it in the form of a fog.

Fire Fighting Procedures: As appropriate for surrounding materials/equipment. Water spray should be used to cool containers. Water spray may be used to knock down escaping vapor.

Fire Fighting Protective Equipment: Use self-contained breathing apparatus and special protective clothing.

Evacuation: If tank, rail car or tank truck is involved in a fire, ISOLATE for 800 meters (1/2 mile) in all directions; also, consider initial evacuation for 800 meters (1/2 mile) in all directions.

NOTE: Also see "Section 10 - Stability and Reactivity"

SECTION 6 – ACCIDENTAL RELEASE MEASURES

Spills, Leaks, or Releases:

- Restrict access to area until completion of clean up. Ensure trained personnel conduct clean up.
- Wear adequate personal protective equipment. Do not touch spilled material.
- Remove all ignition sources (no smoking, flares, sparks or flames). All equipment should be grounded. Ventilate area.
- Stop leak if possible without personal risk.
- Small spills: Cover with DRY earth, sand or other non-combustible material. Use clean non-sparking tools to collect material and place it into loosely covered plastic containers for later disposal.
- Large spills: Isolate spill or leak area immediately for at least 25 to 50 meters (80 to 160 feet) in all directions. Keep unauthorized personnel away. Stay upwind. Keep out of low areas. Prevent entry into sewers and confined areas. Dike with inert material (sand, earth, foamed polyurethane, foamed concrete, etc.). Consider insitu neutralization and disposal. Absorb bulk liquid with fly ash or cement powder. Neutralize with recommended materials, taking care to avoid any foaming or splattering that may occur from the neutralization reaction of the acid with these materials. Make sure all liquid has been thoroughly contacted and absorbed by the dry materials. Transfer absorbed spill material and any contaminated underlying soil to a suitable chemical waste container. Ensure adequate decontamination of tools and equipment following clean up. Washing down of spills with water is not recommended as this tends to spread the contamination and increases the likelihood of percolating the acid down through the soil and/or of uncontrolled flow of acid into sewers, streams, or other waters. Hydrochloric acid leaks, or spills must not come in contact with any acid soluble sulfide wastes (such as sewers) because of the danger of evolving hydrogen sulfide gas.

  Comply with Federal, Provincial/State and local regulations on reporting releases.

Deactivating Chemicals: Lime, limestone, sodium carbonate (soda ash), sodium bicarbonate.

The following absorbent materials have been tested and recommended for vapor suppression and/or containment of 26% and 35% hydrochloric acid solutions: a mixture of (75%) anionic polyacrylamide (R1779) and (25%) nonionic polyacrylamide (Versicol W25). Individually use the anionic polyacrylamide or nonionic polyacrylamide, and Cellosize WP3H (hydroxyethyl cellulose).

Waste Disposal Methods: Dispose of waste material at an approved waste treatment/disposal facility, in accordance with applicable regulations. Do not dispose of waste with normal garbage or to sewer systems.
Note - Clean-up material may be a RCRA Hazardous Waste on disposal.
- Spills are subject to CERCLA reporting requirements: RQ = 5000 lb. (˜ 500 gal. ; 2270 kg) .

SECTION 7 – HANDLING AND STORAGE

Handling: Take all precautions to avoid personal contact. Prevent release of vapor or mist into workplace air. Always ensure adequate ventilation in handling areas. Locate safety shower and eyewash station close to chemical handling area. Inspect containers for leaks before handling. Use EXTREME care when diluting with water. Always add acid to water. CAUTION: Hydrogen, a highly flammable gas, can accumulate to explosive concentrations inside drums, or any types of steel containers or tanks upon storage. Storage containers should be vented on a regular basis. Trained personnel should only do venting. Label containers. Keep containers closed when not in use. Empty containers may contain residues, which are hazardous.

Storage: Store in a cool, dry, well ventilated area, out of direct sunlight and away from heat sources. Store away from incompatible materials such as oxidizing materials, reducing materials, and strong bases. Use corrosion-resistant structural materials and lighting and ventilation systems in the storage area. Use containers, which are securely labeled and protected from damage. Storage drums must be coated with an acid resistant material. Rubber-lined steel, PVC/FRP, FRP, Hastelloy C-276, Inconel 625, and tantalum, are the most commonly used corrosion - resistant materials of construction at room temperature. Rubber, glass, plastic and ceramic ware are also resistant to corrosion. Vented containers must be used and must be kept closed when not being used. Containers should have a safety relief valve. Care should be taken to release any internal pressure slowly. Use corrosion-resistant transfer equipment when dispensing. Limit quantity of material in storage. Restrict access to storage area. Post warning signs when appropriate. Keep storage area separate from populated work areas. Inspect periodically for deficiencies such as damage or leaks.

Storage tanks should be above ground and surrounded with dikes capable of holding entire contents.

Storage Temperature: Exposure to extremes of heat and cold should be avoided. Ideal storage temperature is 10-27°C (50-80.6°F). Do not expose sealed containers to temperatures above 40°C (104°F).

Other Precautions: If stored indoors, building floors should be acid resistant with drains to a recovery tank. Electrical equipment should be flameproof and protected against corrosive action. Wood and other organic materials should not be used on floors, structural materials and ventilation systems in the storage area.

SECTION 8 – EXPOSURE CONTROLS / PERSONAL PROTECTION

PREVENTIVE MEASURES

Recommendations listed in this section indicate the type of equipment, which will provide protection against over exposure to this product. Conditions of use, adequacy of engineering or other control measures, and actual exposures will dictate the need for specific protective devices at your workplace.

Engineering Controls: Local exhaust ventilation should be applied wherever there is an incidence of point source emissions or dispersion of regulated contaminants in the work area. The most effective measures are the total enclosure of processes and the mechanization of handling procedures to prevent all personal contact with hydrochloric acid. Because of the high potential hazard associated with this substance, stringent control measures such as enclosure or isolation are recommended when dealing with large quantities. Electrical installations should be protected against the corrosive action of acid vapors. Smoking should be prohibited in areas in which hydrochloric acid is stored or handled.

PERSONAL PROTECTIVE EQUIPMENT

Eye Protection: Wear splash resistant chemical goggles and full faceshield. Maintain eye wash fountain and quick-drench facilities in work area.

Skin Protection: Wear impervious protective clothing, including boots, gloves, lab coat, apron or full body suit, as appropriate, to prevent skin contact.
Recommended Materials: Guidelines for hydrochloric acid, 37%:
RECOMMENDED (resistance to breakthrough longer than 8 hours): Butyl rubber, neoprene, Viton(TM), Saranex(TM), Barricade(TM), CPF 3(TM), Responder(TM), Trellchem HPS(TM).
RECOMMENDED (resistance to breakthrough longer than 4 hours): Natural rubber, nitrile rubber, polyvinyl chloride, Teflon(TM), 4H(TM)(polyethylene/ethylene vinyl alcohol).
CAUTION, use for short periods only (resistance to breakthrough less than 1 hour): Polyethylene.
NOT RECOMMENDED for use (resistance to breakthrough less than 1 hour): Polyvinyl alcohol.

Respiratory Protection: Up to 50 ppm: Chemical cartridge respirator with cartridge(s) to protect against hydrogen chloride; or gas mask with canister to protect against hydrogen chloride or powered air-purifying respirator with cartridge(s) to protect against hydrogen chloride; or Supplied Air Respirator (SAR); or full-facepiece Self-contained breathing apparatus (SCBA).

EMERGENCY or planned entry into unknown concentration or IDLH conditions: Positive pressure, full-facepiece SCBA; or positive pressure, full-facepiece SAR with an auxiliary positive pressure SCBA.
ESCAPE: Gas mask with acid gas canister or escape-type SCBA.

EXPOSURE GUIDELINES

PRODUCT: Hydrochloric Acid:

ACGIH Ceiling Exposure Limit (TLV-C) : 5 ppm (7.5 mg/m^3)
OSHA Ceiling Exposure Limit (PEL-C) : 5 ppm (7 mg/m^3)
Immediately Dangerous to Life and Health (IDLH): 50 ppm

AIHA- Emergency Response Planning Guidelines (ERPGs)
ERPGs are for community emergency planning limits and not workplace exposure limits.

- ERPG-1 : 3 ppm
- ERPG-2 : 20 ppm
- ERPG-3 : 100 ppm

The ERPG-1 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing other than mild transient adverse health effects or perceiving a clearly defined, objectionable odor.

The ERPG-2 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing or developing irreversible or other serious health effects or symptoms, which could impair an individual's ability to take protective action.

The ERPG-3 is the maximum airborne concentration below which it is believed that nearly all individuals could be exposed for up to 1 hr without experiencing or developing life-threatening health effects.

SECTION 9 – PHYSICAL AND CHEMICAL PROPERTIES

Alternate Name(s)	Hydrogen chloride, Muriatic acid
Chemical Name	Hydrochloric acid
Chemical Family	Inorganic acid
Molecular Formula	H-Cl
Molecular Weight	36.46
Appearance	Colorless, or slightly yellow liquid
Odor	Pungent odor
pH	Less than 1
Solubility (Water)	Miscible in all proportions in water
Solubility (Other)	Soluble in alcohol, ethers , benzene.
% Volatile by Volume	100
% Volatile Organic Compounds	Zero

BAUME	**18Be**	**20Be**	**22Be**	**23Be**
Concentration	27.92	31.45	35.21	37.14
Vapor Pressure (mm Hg at 20C)	11	20	72	150
Boiling Point (Deg. C):	98	85	62	50
Melting Point (Deg. C):	-58	-40	-31	-27
Freezing Point (Deg. C):	-58	-40	-31	-27
Specific Gravity	1.14	1.16	1.18	1.19
Viscosity (cp at 20 Deg. C):	1.60	1.75	1.90	2.00

SECTION 10 – STABILITY AND REACTIVITY

Hazardous Decomposition Products: When heated to decomposition, emits toxic hydrogen chloride fumes. Thermal oxidative decomposition produces toxic chlorine fumes and explosive hydrogen gas.

Chemical Stability: Stable under conditions of normal use.

Conditions to Avoid: Avoid heat, flames, sparks and other sources of ignition.

Incompatibility with other Substances: A strong mineral acid, concentrated hydrochloric acid is incompatible with many substances and highly reactive with strong bases, metals, metaloxides, hydroxides, amines, carbonates and other alkaline materials. Incompatible with materials such as cyanides, sulfides, sulfites, sulfuric acid and formaldehyde. Contact with metals may produce flammable hydrogen gas. When diluting, add acid to water. Do NOT add water to the acid.

Hazardous Polymerization: Will not occur. Hydrochloric acid is a stable product and does not polymerize. However, it may induce hazardous polymerization with aldehydes and epoxides.

SECTION 11 – TOXICOLOGICAL INFORMATION

TOXICOLOGICAL DATA:

Toxicological Data: LD_{50} (oral, rabbit) = 900 mg/kg

LC_{50} (inhalation, rat) = 3124 ppm for 1 hr

Eye Effects (rabbit): Application of a 1% hydrochloric acid (0.25N) solution for 20 seconds caused scarring of the cornea. Other studies have reported that application of 5 mg for 30 seconds caused mild irritation, and that application of a 5% solution caused minimal irritation (duration not indicated).

Skin Effects (rabbit): Application of 0.5 mL of a 17% concentrated solution for 4 hours caused corrosive burns.

Mutagenicity: Mutagenic effects have been reported in one bacterial test (E. Coli-DNA repair), in three insect tests (Drosophila, grasshopper) and in one in vitro mammalian cell test (hamster lung cells). HCl was negative in another in vitro mammalian cell test (Syrian Hamster Embryo cells). The significance of the positive reports is questionable since pH (acidity) can influence the results of short-term tests.

Reproductive Effects: Female rats were exposed to 450 mg/m3 for 1 hour either prior to mating or on day 9 of pregnancy. Developmental effects were observed in the offspring. However, this exposure caused toxic effects, including mortality, in the mothers.

Teratogenicity and Fetotoxicity: No information is available.

Synergistic Materials: None known

SECTION 12 – ECOLOGICAL INFORMATION

Ecotoxicological Information:
Fish Toxicity: LC100 Trout 10mg/L 24hr, LC50 Shrimp 100 to 330ppm/48hr (salt water)
LC_{50} Gold fish 178 mg/L (one to two hours of survival time)
The concentration of hydrochloric acid that was found to be injurious to crops is 350 mg/L.
Toxicity is primarily associated with pH. Toxic to aquatic life.
Invertebrate and Microbial Toxicity: Acidification of soy broth containing Listeria monocytogenes to pH 4.4 inhibited microbial activity.

Persistence and Degradation: When hydrochloric acid is spilled onto soil, it will begin to infiltrate. The presence of water in the soil will influence the rate of chemical movement in the soil. During transport through the soil, hydrochloric acid will dissolve some of the soil material, in particular those of a carbonate base. The acid will be neutralized to some degree. However, significant amounts of acid are expected to remain for transport down toward the ground water table. Hydrogen chloride in water dissociates almost completely, with the hydrogen ion captured by the water molecules to form the hydronium ion.

SECTION 13 – DISPOSAL CONSIDERATIONS

Review federal, state and local government requirements prior to disposal.

Do not dispose of waste with normal garbage, or to sewer systems.

Whatever cannot be saved for recovery or recycling, including containers should be managed in an appropriate and approved waste disposal facility. Processing, use or contamination of this product may change the waste management options.

RCRA: Test waste material for corrosivity, D002, prior to disposal.

SECTION 14 – TRANSPORT INFORMATION

	TDG	**DOT**
Shipping Name	Hydrochloric acid or Hydrochloric acid solution	Hydrochloric acid, solution
Hazard Class/Division	8: Corrosive liquid 9.2- Substance hazardous to the environment	8: Corrosive Liquid
Identification No. **Packing Group:**	UN1789 II	UN1789 II
Limit	Regulated Limit: 230kg	RQ=5000 lbs.

Note: Classification 9.2 applies if Regulated Limit is exceeded

IATA/ICAO Class: 8

Transportation Emergency Telephone Number: 1-888-306-7070

SECTION 15 – REGULATORY INFORMATION

USA Classification

OSHA Classification: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200)

SARA Regulations sections 313 and 40 CFR 372: Y

SARA Hazard Categories, SARA SECTIONS 311/312 (40CFR370.21):

ACUTE: Y
CHRONIC: N
FIRE: N
REACTIVE: N
SUDDEN RELEASE: Y
OSHA PROCESS SAFETY (29CFR1910.119): Y

TSCA Inventory Status: Y

This product does not contain nor is it manufactured with ozone depleting substances.

Other Regulations/Legislation which apply to this product:
California Proposition 65: N
California Director's List of Hazardous Substances, Rhode Island Hazardous Substance List, New Jersey Environmental Hazardous Substance, Minnesota Hazardous Substance List, Massachusetts Extraordinarily Hazardous Substance, Florida Hazardous Substances List.

Right –To-Know: Illinois, Massachusetts, New Jersey, Pennsylvania

Canadian Classification

This product has been classified in accordance with the hazard criteria of the CPR (Controlled Products Regulations) and this MSDS (Material Safety Data Sheet) contains all the information required by the CPR.

Controlled Products Regulations (WHMIS) Classification:
Class D1A – Immediate and serious effects - Very Toxic
Class E - Corrosive

CEPA / Canadian Domestic Substances List (DSL): On the Canadian Domestic Substances List (CEPA DSL).

WHMIS Ingredient Disclosure List: Confirmed A; Meets criteria for disclosure at 1% or greater.

EEC CLASSIFICATION: C, R 34

EINECS: 231-595-7

SECTION 16 – OTHER INFORMATION

The information contained herein is offered only as a guide to the handling of this specific material and has been prepared in good faith by technically knowledgeable personnel. It is not intended to be all-inclusive and the manner and conditions of use and handling may involve other and additional considerations. No warranty of any kind is given or implied and PIONEER will not be liable for any damages, losses, injuries or consequential damages that may result from the use of or reliance on any information contained herein. This Material Safety Data Sheet is valid for three years.

National Fire Protection Association (NFPA) Rating
Hazardous Materials Identification System (HMIS) Rating

	NFPA	HMIS
HEALTH	3	3
FIRE	0	0
REACTIVITY	1	1
SPECIAL		

4= Extreme/Severe
3 = High/Serious
2 = Moderate
1 = Slight
0 = Minimum
W =Water Reactive

REFERENCES:

1. **RTECS-Registry of Toxic Effects of Chemical Substances,** On-line search, Canadian Centre for Occupational Health and Safety RTECS database, Doris V. Sweet, Ed., National Institute for Occupational Safety and Health, U.S. Dept. of Health and Human Services, Cincinnati, Entry Update/Dec1997.

2. Transport Of Hazardous Materials (49CFR), Canadian Centre for Occupational Health and Safety, Issue : 99-2 (May, 1999)

3. **ChemAdvisor,** Canadian Centre for Occupational Health and Safety, October 1998.

4. **"CHEMINFO"**, through **"CCINFOdisc"**, Canadian Centre for Occupational Health and Safety, Hamilton, Ontario, Canada, (May, 1999).

5. Chemlist, STN Database, Chemical Abstract Service, Feb 1999

6. DOSE, Royal Society of Chemistry, 1998.

7. **HSDB-Hazardous Substances Data Bank** , through "CCINFO disc", Canadian Centre for Occupational Health and Safety, Hamilton, Ontario, Canada, (May, 1999).

8. NFPA 49 Hazardous Chemicals Data 1994 Edition, National Fire Protection Association, Quincy,

MA, 1994

9. NIOSH POCKET GUIDE TO CHEMICAL HAZARDS, U.S. Department of Health and Human Services, National Institute for Occupational Safety and Health, June 1997

10. "1999 Threshold Limit Values and Biological Exposure Indices", American Conference of Government Industrial Hygienists, 1999.

11. TRANSPORT OF DANGEROUS GOODS (TDG), Canadian Centre for Occupational Health and Safety , * Issue : 99-2 (May, 1999)

Legend:

AFFF - Aqueous Film Forming Foam
CAS # - Chemical Abstracts Service Registry Number
CERCLA- Comprehensive Environmental Response, Compensation, and Liability Act
CFR - Code of Federal Regulations
DOT - Department of Transportation
EPA - Environmental Protection Agency
LC_{50} - The concentration of material in air expected to kill 50% of a group of test animals
LD_{50} - Lethal Dose expected to kill 50% of a group of test animals
LEL - Lower Explosive Limit
MSHA - Mine Safety and Health Administration
NIOSH - National Institute for Occupational Safety and Health
PEL - Permissible Exposure Limit
PVC - Polyvinyl chloride
RCRA - Resource Conservation and Recovery Act
SARA - Superfund Amendments and Reauthorization Act of the U.S. EPA
STEL - Short Term Exposure Limit
TC - Transport Canada
TDG - Transportation of Dangerous Goods Act/Regulations
TLV - Threshold Limit Value
TSCA - Toxic Substances Control Act
TWA - Time-Weighted Average
UEL - Upper Explosive Limit