UCON FLUIDS & LUBRICANTS

HYDROLUBES

UCON® Hydrolube HP-5046D

Introduction

UCON® Hydrolube HP-5046D is a patented, new generation, high-performance, water-glycol hydraulic fluid designed to operate at pressures up to 5000 psi (345 bars).

Features and Benefits

- **Fire Resistant**
  Recognized worldwide by Factory Mutual Corporation as a Group 1 Less Hazardous Hydraulic Fluid, UCON Hydrolube HP-5046D is also approved in Canada by CANMET for use as a Fire Resistant Hydraulic Fluid in all underground mining equipment. Reduced fire hazards improve personnel safety in storage, handling, and use, as well as lower insurance premiums.
- **High-Pressure Performance**
  UCON HP-5046D is the only proven water-glycol fluid for use at pressures up to and exceeding 5000 psi (345 bars).
- **All-Season Usage**
  With a Viscosity Index (VI) of 192 and a pour point of -63°C (-81°F), HP-5046D can be used year round where other fluids may require 2 or 3 viscosity grades to operate through different seasons.
- **Low Pump Wear**
  More reliable and longer service life means lower maintenance costs and less downtime.

UC-1204

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Features and Benefits (cont'd)

- **Clean, Long-Lasting**
  When proper fluid and equipment maintenance procedures are followed, UCON® Hydrolube HP-5046D remains clean, does not produce sludge, and lasts longer than conventional fluids.
- **Low Toxicity**
  Classified by the USDA as H-2, UCON Hydrolube HP-5046D can be used in federally inspected meat, poultry, and egg processing plants as a hydraulic fluid in locations in which there is no possibility of the lubricant or lubricated part contacting edible products. Also, under OECD Guideline 420 for Acute Oral Toxicity Testing, HP-5046D is classified as a "compound which does not present a significant acute toxic risk if swallowed."
- **WHMIS Classification**
  In Canada, under the Workplace Hazardous Materials Information System (WHMIS), UCON HP-5046D is classified as NOT CONTROLLED. More specifically, HP-5046D classifies as "non irritant" under OECD Guideline 404 for Dermal Irritation/Corrosion Testing.
- **Water Solubility Means Easy Cleanup**
  UCON HP-5046D is 100 percent soluble in water, making equipment and shop cleanups easier than with conventional hydraulic fluids.
- **Readily Biodegradable**
  Formulated with 35-40 percent water and specially selected performance-enhancing additives, UCON HP-5046D is readily biodegradable, thus minimizing disposal problems and reducing plant maintenance costs.
- **Economical**
  UCON HP-5046D is a cost-effective alternative hydraulic fluid that in many instances is less expensive overall than other synthetic lubricants.
- **Easy Conversion**
  Although UCON Hydrolube HP-5046D is not compatible with conventional lubricating oils, vegetable oils, or other synthetic fluids, Union Carbide has developed simple conversion procedures applicable to many hydraulic systems.

Typical Physical Properties

Viscosity, cSt (SUS)	
at 0°C (32°F)	340 (1600)
at 40°C (104°F)	46 (215)
at 65°C (150°F)	22 (106)
Viscosity Index (est.)	192
pH	9.0–10.0
Reserve Alkalinity (mL 0.1N HC/100 mL sample)	160-200
Water Content, %	35-40
Compressibility at 78°F, psi^{-1} (est.)	
at 500 psi	4.3×10^{-6}
at 1000 psi	3.6×10^{-6}
at 1500 psi	3.4×10^{-6}
Thermal Conductivity at 100°F, BTU/ft/hr/°F (est.)	0.26
Coefficient of Thermal Expansion per °C (est.)	
at 20°C	0.00066
at 55°C	0.00068
Specific Heat at 68°F, BTU/lb/°F (est.)	0.68
Density, g/cc	
at 25°C	1.0877
at 40°C	1.0770
at 80°C	1.0370
Density, lb/gal	
at 15.56°C	9.09
at 20°C	9.07
Vapor Pressure at 100°F, psia	1.1
Flash Point	None
Pour Point, °C (°F)	-63 (-81)
Appearance	Red liquid
Corrosion Resistance Properties	
Liquid Solution (copper, iron, steel, brass)	Excellent
Vapor Phase (steel, cast iron)	Excellent

NOTE: Not recommended for use with zinc, galvanized iron, or cadmium.

Performance Characteristics

High-Pressure Capabilities

The superior performance of UCON® Hydrolube HP-5046D has been demonstrated by independent laboratory tests at 5000 psi, and in-service field trials and commercial applications at greater than 5000 psi (345 bars). Visual and quantitative measurements show little indication of wear of pump parts or motor components.

Excellent Fire Resistance
UCON® Hydrolube HP-5046D extends the superior fire resistance characteristics of water-glycol fluids into the high-performance arena. Since a water-glycol fluid will not burn until all the water has evaporated, there is much less fire hazard from a spill or leak onto a hot metal surface. In addition, there is considerably less flame and smoke associated with UCON HP-5046D than with other fire-resistant synthetic hydraulic fluids, such as polyol or phosphate esters. UCON Hydrolube HP-5046D is Factory Mutual Approved as a Group I Less Hazardous Hydraulic Fluid.

Cost Effective
Outstanding antiwear performance has been demonstrated in both low- and high-pressure applications. The use of UCON Hydrolube HP-5046D provides cost savings, both initially and in make-up, for the best overall cost vs. performance. The fluid has been used as long as two years without changeout. Cost effectiveness also includes longer-lasting, better-performing hydraulic system components.

Environmental Safety
This "Diethylene Glycol-Water"-based fluid requires no special handling and can be managed using standard waste treatment procedures. UCON Hydrolube HP-5046D does not contain any phenol.

Seal and Hose Compatibility
Historically, water-glycol fluids have exhibited excellent compatibility and service life with standard hydraulic seals and hose elastomers. UCON Hydrolube HP-5046D affords similar elastomer compatibility with commonly used materials, such as "Viton," high-nitrile Buna N, EPDM, butyl, silicone, and halogenated elastomers (e.g., "Aflas," "Kalrez," etc.). Urethanes and Buna S (SBR) elastomers are **not** compatible with UCON HP-5046D.

Performance Test Results

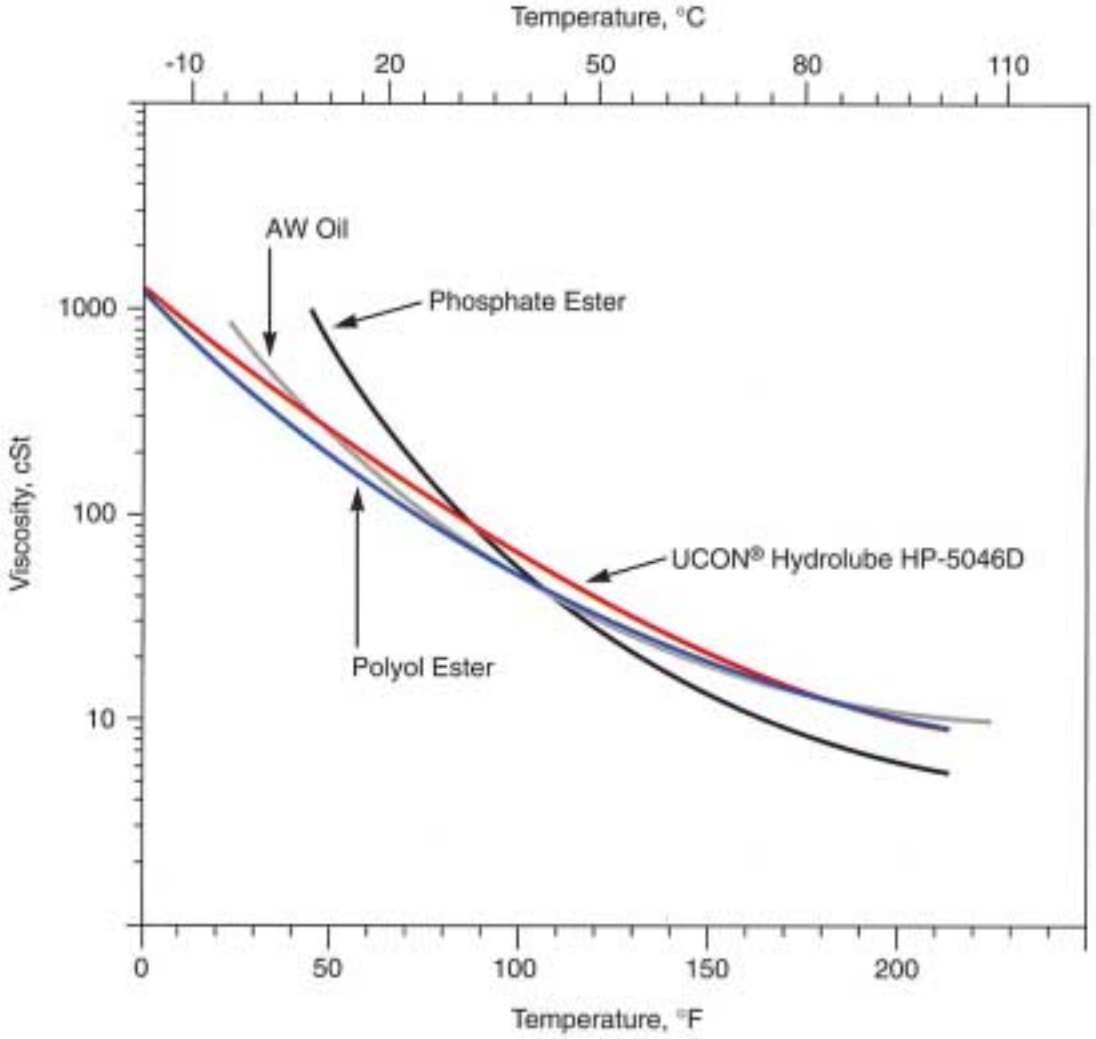
Viscosity Properties
Because of its relatively low pour point (-63°C) and high viscosity index (192), UCON HP-5046D can be used over a wide temperature range with only a minimal impact on the bulk fluid viscosity. The viscosity index and pour point of HP-5046D is compared to "typical" ISO 46 grade mineral oil, phosphate ester, and polyol ester hydraulic fluids in Table 1.

Table 1 • Comparison of Viscosity Index and Pour Points of Hydraulic Fluids

Hydraulic Fluid	Pour Point, °C	Viscosity Index
Mineral Oil	-34	90-120
Phosphate Ester	-26	185
Polyol Ester	-26	150-185
UCON® Hydrolube HP-5046D	-63	192

UCON® Hydrolube HP-5046D has a comparable viscosity-temperature profile to typical competitive fluids, as shown in Figure 1.

Figure 1 • Viscosity vs. Temperature for Hydraulic Fluids



Pump Wear Performance

ASTM D 2882 Test As the data in Table 2 indicate, UCON® Hydrolube HP-4056D is significantly superior to conventional water-glycol and exhibits wear characteristics similar to those of phosphate/polyol esters and AW oil.

Table 2 • Comparative ASTM D 2882 Pump Wear(1) Test Results

Fluid	Wear Rate, mg/hr
Phosphate Ester	0.05
UCON® Hydrolube HP-5046D	0.10
Polyol Ester	0.10
Antiwear Hydraulic Oil	0.24
Conventional Water-Glycol	0.65

(1) Test Conditions:
Tests were conducted over 100 hr at 2000 psi (13.8 MPa) and 1200 rpm using a vane pump equipped with a 30 L/min ring.
Pass Criteria: <1 mg/hr wear

In the Fuel Injection Shear Stability Test (ASTM D 3945), UCON HP-5046D shows no viscosity loss at shear rates up to 10^6 sec-1.

High-Pressure Piston Pump Test UCON Hydrolube HP-5046D was also evaluated independently in a Sunstrand series 22 axial piston pump using a modified Water Stability Test employed by Southwest Research Institute. As shown in Table 3, no significant flow degradation (0.8%) was observed over the full duration. (A flow degradation of 10% constitutes failure.) Furthermore, test parts showed negligible wear after running 225 hours with HP-5046D (Figure 2).

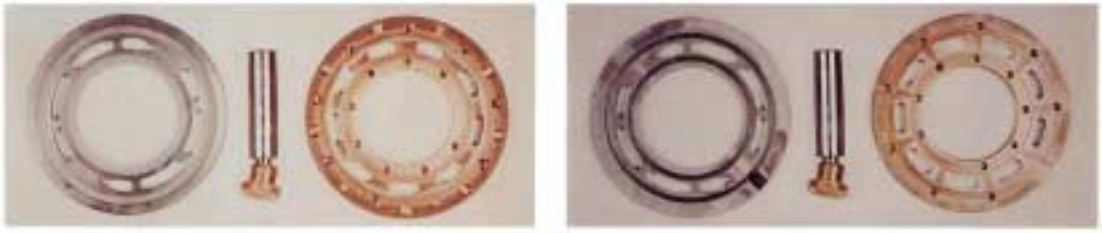
Table 3 • High-Pressure Axial Piston Pump Test(1) Results

Time, hr	Flow Rate, gal/min (L/min)
1	24.9 (94.4)
75	24.9 (94.4)
125	24.9 (94.4)
225	24.7 (93.6)

(1) Test Conditions:
- Sunstrand 22-2132 Variable Displacement Axial Piston Pump
- Input Speed – 3100 rpm
- Load Pressure – 5000 psi (345 bars)
- Temperature, Reservoir – 120°F (49°C)
  Loop – 170°F (77°C)

Pass Criteria: <10% flow rate decrease

Figure 2 • Sunstrand Series 22 Axial Piston Pump Parts After Running 225 hr with UCON® Hydrolube HP-5046D



Side 1 Side 2

High-Pressure Hydrostatic Drive Test UCON Hydrolube HP-5046D proved itself to be a very stable fluid with excellent lubrication properties under the high-pressure conditions of the following test.

Table 4 • High-Pressure Hydrostatic Drive Simulation

High-Pressure Hydro-Static Drive Simulation	Observations
• Sunstrand Series 20 Motor and Pump • Case Drain Flow: 5 GPM (19 L/min) • 600 sec Pressure Cycle: 1300 psi (90 bars) to 4500 psi (310 bars) • Duration: 500 hr (5 days/wk, 16 hr/day) • Operating Temperature Variation: +14°C (57°F) to -21°C (-6°F) • Pass Criteria: <5% flow rate decrease. Visual inspection of pump parts. Fluid integrity.	• The Sunstrand pump and motor performed well. Visual inspection before and after the test did not indicate unusual wear or stress. • No significant change in flow rate occurred during the test period. • Fluid exhibited excellent shear-stability. All chemical and physical properties of the fluid remained virtually unchanged. • Conclusions: UCON® Hydrolube HP-5046D is a very stable fluid with excellent lubrication properties under high-pressure conditions.

Flammability Testing

Although good lubricants, hydraulic oils have flammability characteristics that often make them unacceptable where rupture of the hydraulic system may occur. In such applications, prudent safety practice demands "fire safe" fluids.

Factory Mutual Research Corporation has defined the most commonly accepted criteria for "fire safe" fluids. They utilize two tests to determine the relative fire safety of a hydraulic fluid.

In the Spray Flammability Test, hydraulic fluid is pumped through a standard spray nozzle which is rotated through an open flame. The relative fire safety of a fluid is defined by the time required for the flame to extinguish itself (if indeed that happens) before it is rotated through the flame again.

In the Hot-Channel Test, hydraulic fluid is sprayed into a flame-heated trough. Relative flammability is determined by the amount of time required for the flame to become extinguished after the spraying stops.

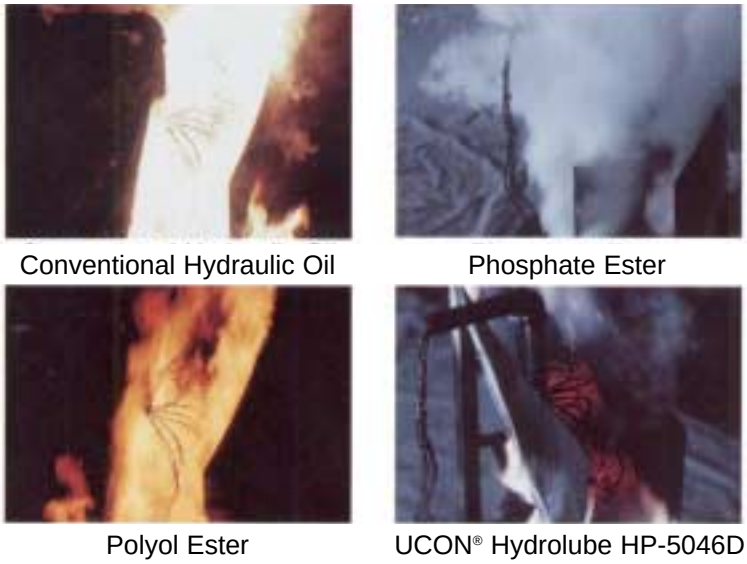
The performance of a conventional hydraulic oil, a phosphate ester, a polyol ester, and UCON® Hydrolube HP-5046D were compared utilizing both the Spray Flammability and Hot-Channel Tests. The results indicated that although the phosphate ester and polyol ester were better than oil and passed the Factory Mutual criteria, they both exhibited substantial flammability characteristics by continuing to burn as the flame was in the spray cone. Neither fluid exhibited the same degree of fire safety as UCON HP-5046D (see Figures 3 and 4), which never ignited in the spray flammability test.

Figure 3 • Spray Flammability Testing of Various Hydraulic Fluids

Conventional Hydraulic Oil | Phosphate Ester

Polyol Ester | UCON® Hydrolube HP-5046D

Figure 4 • Hot-Channel Flammability Testing of Various Hydraulic Fluids

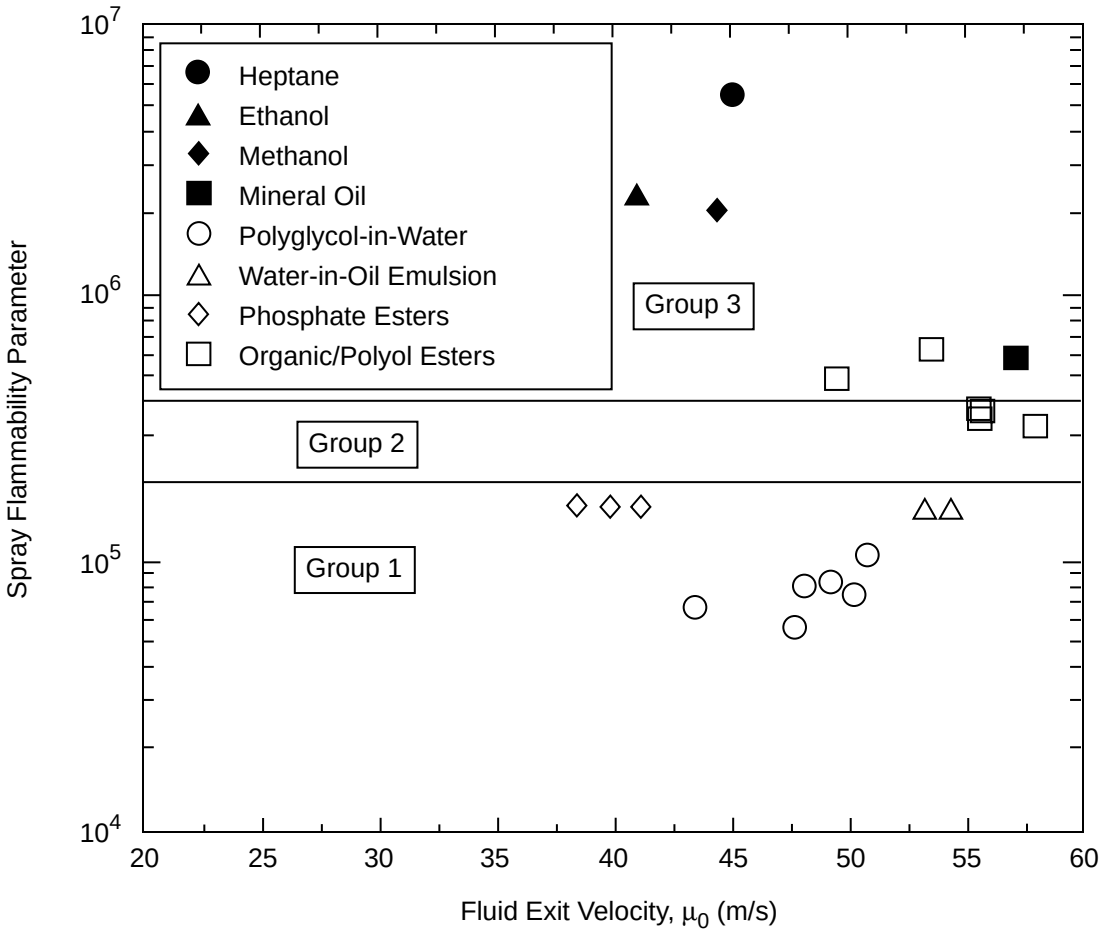


Conventional Hydraulic Oil | Phosphate Ester

Polyol Ester | UCON® Hydrolube HP-5046D

Factory Mutual Research Corporation is now revising their testing procedure to more adequately discriminate between the obvious fire-resistance differences offered by these and other hydraulic fluids. The new procedure will quantify fire resistance with the use of a "spray flammability parameter" (SFP), which is related to the critical heat flux required for fluid ignition and the chemical heat release rate of the burning process. In general, water-containing hydraulic fluids, such as water-glycols, have the lowest SFP; polyol esters are typically much higher, and phosphate esters exhibit intermediate values, as illustrated in Figure 5.

Figure 5 • Spray Flammability Parameter (SFP) as a Function of Fluid Exit Velocity at 6.9 MPa Nozzle Pressure (source: M.M. Khan and A.V. Brandao, Fluid Power Technical Paper No. I96-2.12, April 1996)



Group 1: The fluid is unable to stabilize a spray flame having an SFP* of $20x10^4$ or less.
Group 2: The fluid is less flammable than mineral oil, but may stabilize a spray flame (under certain conditions) having an SFP greater than $20x10^4$ but less than $40x10^4$.
Group 3: Flammability of the fluid is close to that of mineral oil having an SFP greater than $40x10^4$.

*Spray flammability parameter.

Field Trials

The excellent high-pressure performance of UCON® Hydrolube HP-5046D in test stands has been confirmed in various industry field trials and demonstrated in many commercial applications. Specific information relating to your potential application can be obtained from your Union Carbide Sales Representative.

Case Histories

Customers have provided the following case histories of successful use of UCON Hydrolube HP-5046D:

- A leading agricultural equipment manufacturer reported twice the pump life using UCON Hydrolube HP-5046D in an "Enerpac" piston pump operated at 5000-7000 psi (345-483 bars).
- A major integrated steel company found that pump life doubled when they converted their Kress hot slag haulers with Tyrone gear pumps and Cessna piston pumps from a conventional water-glycol to UCON Hydrolube HP-5046D.
- UCON Hydrolube HP-5046D is a specified fluid for use in a Caterpillar hot slag hauler where the fluid has reduced pump wear by a factor of two in the Tyrone gear pump operated at an estimated loop temperature of 200°F (93°C) and 2500 psi (172 bars). Note: This is a rather extreme temperature and requires an effective heat exchanger in the reservoir to quickly cool the bulk fluid upon return to the normal running temperature. Systems should not be run at this loop temperature without effective cooling on return to the reservoir.
- A major steel industry service company has switched to UCON Hydrolube HP-5046D in hot-slag haulers where the fluid has doubled the pump life.
- A major Canadian steel company has doubled their pump life in Hydura compensated axial piston pumps running at 2800 psi (193 bars) and 1200 rpm. They cut pump consumption over a four-month period from eight units to four units with UCON Hydrolube HP-5046D.
- A northeastern lumber mill converted the Sunstrand hydrostatic drive in their log carriage system, operating at a peak pressure of 5000 psi (345 bars), to UCON Hydrolube HP-5046D from a conventional water-glycol. The result: trouble-free operation for over four years.

Further Information

For more detailed information on fluid and component maintenance, please refer to "UCON Hydrolube HP-5046D — Guidelines for Hydraulic System Operation," Union Carbide publication (UC-506A).

Product Safety

When considering the use of any Union Carbide products in a particular application, you should review our latest Material Safety Data Sheets and ensure that the use you intend can be accomplished safely. For Material Safety Data Sheets and other product safety information, contact the Union Carbide Sales Office nearest you. Before handling any other products mentioned in the text, you should obtain available product safety information and take necessary steps to ensure safety of use.

No chemical should be used as or in a food, drug, medical device, or cosmetic, or in a product or process in which it may contact a food, drug, medical device, or cosmetic until the user has determined the suitability and legality of the use. Since government regulations and use conditions are subject to change, it is the user's responsibility to determine that this information is appropriate and suitable under current, applicable laws and regulations.

Union Carbide requests that the customer read, understand, and comply with the information contained in this publication and the current Material Safety Data Sheet(s). The customer should furnish the information in this publication to its employees, contractors, and customers, or any other users of the product(s), and request that they do the same.

Emergency Service

Union Carbide maintains a 24-hour emergency service for its products. The Chemical Manufacturers Association (CHEMTREC), Transport Canada (CANUTEC), and the National Chemical Emergency Center also maintain 24-hour emergency service:

Location	Union Carbide Products	All Chemical Products
Mainland United States and Puerto Rico	Phone Union Carbide HELP: **(800) UCC-HELP** (toll-free), i.e., (800) 822-4357	Phone CHEMTREC: **(800) 424-9300** (toll-free)
Alaska and Hawaii	Phone Mainland United States: **(304) 744-3487** (collect)	Phone CHEMTREC: **(800) 424-9300** (toll-free)
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At sea, radio U.S. Coast Guard, who can directly contact Union Carbide **HELP. . . (800) 822-4357** (toll-free) or **CHEMTREC. . .(800) 424-9300** (toll-free).

DO NOT WAIT. Phone if in doubt. You will be referred to a specialist for advice.

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