Industrial Solutions

UCAR™ FLIGHTGUARD™ AD-49

Propylene Glycol Based Type IV Aircraft Anti-Icing Fluid

Table of Contents

Abbreviations and Symbols

AAF	Aircraft Anti-icing Fluid
ADF	Aircraft Deicing Fluid
ADFs	Aircraft Deicing Fluids
AMS	Aerospace Material Specification
ARP	Aerospace Recommended Practice
AS	Aerospace Standard
ASTM	American Society for Testing and Materials
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
EC	Effective Concentration
FAA	Federal Aviation Administration (U.S.)
HHET	High Humidity Endurance Test
HOT	Holdover Time
IC	Inhibition Concentration
ISO	International Standards Organization
LC	Lethal Concentration
LOUT	Lowest Operational Use Temperature
SDS	Safety Data Sheet
OAT	Outside Air Temperature
RDF	Runway Deicing Fluid
SAE	Society of Automotive Engineers
ThOD	Theoretical Oxygen Demand
U.S.	United States (of America)
UV	Ultraviolet
WHMIS	Workplace Hazardous Material Information System (Canada)
WSET	Water Spray Endurance Test
>	Greater Than
<	Less Than

Introduction

Product Description

UCAR FLIGHTGUARD AD-49 Aircraft Deicing/Anti-icing Fluid (ADF/AAF) is designed to protect aircraft against the accumulation of ice, snow, and frost. UCAR FLIGHTGUARD AD-49 ADF/AAF is an SAE1 Aerospace Material Specification (AMS) 1428/1 fluid that contains propylene glycol, water, corrosion inhibitors, wetting agents, thickener, and green dye. UCAR FLIGHTGUARD AD-49 ADF/AAF nominally contains 50% propylene glycol, 49% water, and less than 1% of the other formulation ingredients. UCAR FLIGHTGUARD AD-49 ADF/AAF is formulated to be used neat (undiluted) as an anti-icing fluid for extended protection time during winter precipitation conditions.

SAE Aerospace Standard (AS) 6285 requires that flight crews be informed about the percentage of Type IV fluid/water mixture. By definition, neat (undiluted as shipped by the manufacturer) Type IV fluid is 100/0, that is 100 parts of neat fluid and 0 parts of user-added water. For the purpose of communications with flight crews, the concentration of neat UCAR FLIGHTGUARD AD-49 is 100.

DO NOT DILUTE UCAR™ FLIGHTGUARD™ AD-49 ADF/AAF
If you have any questions, please contact your Dow representative.

Conformance to Industry Standards

SAE AMS 1428. UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF conforms to the technical requirements of the most current version of the Society of Automotive Engineers Aerospace Material Specification[1] (SAE AMS) 1428/1.

Certificates of Conformance. Copies of the certificates of conformance are available upon request.

Recommended Practices

Fluid use guidelines and Holdover Time Tables are published by regulatory agencies such as Transport Canada and the U.S. Federal Aviation Administration. SAE AS 6285 describes deicing and anti-icing processes. UCAR FLIGHTGUARD AD-49 ADF/AAF should be used in accordance with these documents to design a program for safe and effective winter deicing and anti-icing operations. Also see application section (pages 13-14).

Warning

This product information bulletin contains important safety information. Read the entire product information bulletin before using UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF. Read, understand and comply with the Safety Data Sheet for this product before using.

[1]SAE Standards available from the Society of Automotive Engineers Inc., 400 Commonwealth Drive, Warrendale, PA 15096-0001, USA, (877) 606-7323 (U.S. and Canada) or (724) 776-4970 (outside U.S.), www.sae.org.

Hazards of Ice, Snow and Frost

A very small amount of roughness, in thickness as low as 0.36 mm (1/64 in.), caused by ice, snow or frost, disrupts the air flow over the lift and control surfaces of an aircraft. The consequences of this roughness are severe lift loss and impaired maneuverability. Ice can also interfere with the movement of aircraft control surfaces and/or add significantly to aircraft weight. There is no such thing as an insignificant amount of ice on an aircraft.

Ice can form even when the outside air temperature (OAT) is well above 0°C (32°F). An aircraft equipped with wing fuel tanks will have fuel that, after a certain amount of flight time, may reach a sufficiently low temperature to cool the wing temperature below the OAT. This phenomenon is known as cold-soaking.

Cold-soaking can also be caused by fueling an aircraft with cold fuel. If there is rain or high humidity, ice can form on the cold-soaked wing and accumulate over time. This ice can be invisible to the eye and is often referred to as clear ice. This ice can be detected by running one's hand over the aircraft surface or by using specially designed ice-detecting cameras.

Chunks of clear ice dislodged during takeoff or climb can be ingested by aft-mounted engines, thus damaging or possibly stopping them. Chunks of clear ice can also damage critical aircraft surfaces. Cold-soaking is a problem for any aircraft, not just those with aft-mounted engines, because the ice formed may be rough and cause lift loss and impair maneuverability.

Definition of Ice, Snow and Frost

Note that throughout this product information bulletin, the terms ice, snow, and frost may include any form of frozen accumulation, such as water, ice, snow, slush, snow pellets, snow grains, frost, hoarfrost, rime, glaze, etc., as well as mixtures of deicing/anti-icing fluids with such frozen accumulation.

Performance Properties

Water Spray Endurance Test

UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF is formulated to have a high viscosity when the fluid is at rest (i.e., subjected to very low shear forces). It produces a thicker layer on an aircraft surface than aircraft deicing fluid.

The Water Spray Endurance Test (WSET) was developed to provide quantitative laboratory data for comparing the performance of various aircraft anti-icing fluids and for simulating anti-icing fluid behavior in freezing precipitation.

The standard WSET is performed in a climatic chamber where the temperature is controlled at -5°C (23°F). At this temperature, aircraft anti-icing fluid is poured onto aluminum alloy panels that are tilted at a 10° angle. A fine mist of freezing water is sprayed on the panel at the rate of 5 grams per square decimeter per hour. Because of gravitational forces, the aircraft anti-icing fluid will decrease in thickness with time, starting from the top of the panel. Consequently, ice will start to form at the top edge of the panel and progressively move downward. When the ice front reaches 2.5 cm (1 inch) from the top edge, the elapsed test time is recorded as the WSET time.

Under these laboratory conditions, UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF typically has a WSET time of 90 to 100 minutes. This time exceeds the SAE AMS 1428 Type IV WSET requirement of 80 minutes.

High Humidity Endurance Test

The High Humidity Endurance Test (HHET) was developed to provide quantitative laboratory data for comparing aircraft deicing/anti-icing fluids and to simulate aircraft anti-icing fluid behavior under certain frosting conditions. The standard HHET is performed in a climatic chamber, in which conditions are controlled at 0°C (32°F) and 96% relative humidity. The aircraft deicing/ anti-icing fluid is poured onto an aluminum alloy panel at -5°C (23°F) and tilted at a 10° angle. On a reference plate without aircraft deicing/anti-icing fluid, frost must form at a rate of 1.2 grams per square decimeter per 4 hours. As in the WSET, frost forms at the top of the panel and progressively spreads downward. When the frost front reaches 2.5 cm (1 inch) from the top of the panel coated with the deicing/aircraft anti-icing fluid, the test is stopped and the elapsed time recorded.

Under these laboratory conditions, UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF typically results in an HHET time of greater than 12 hours. This HHET time exceeds the SAE AMS 1428 Type IV fluids requirement of 8 hours.

Aerodynamics

Deicing and/or anti-icing fluid remaining on the aircraft following the deicing and/or anti-icing operation can affect the aerodynamic performance of any aircraft. As the temperature decreases, deicing and/or anti-icing fluids generally become more viscous and have an increased effect on aerodynamics. There are two separate aerodynamic acceptance tests, one for faster aircraft and one for slower aircraft. The objective of the tests is to determine the coldest temperature at which the deicing/anti-icing fluids have acceptable characteristics as they flow off lifting and control surfaces during the takeoff ground acceleration and climb.

One test, known as the high speed aerodynamic acceptance test, establishes the aerodynamic flow-off requirement for fluids used to deice or anti-ice large transport jet aircraft with rotation speeds generally exceeding approximately 100 to 110 knots and with ground acceleration times exceeding approximately 23 seconds. The other test, known as the low speed aerodynamic acceptance test, establishes the aerodynamic flow-off requirements for slower aircraft whose takeoff rotation speeds generally exceed about 60 knots and with ground acceleration times exceeding approximately 16 seconds. Both tests are fully defined in SAE AS 5900.

The viscosity of a fluid is a measure of its resistance to flow. A low-viscosity fluid flows more readily than a high-viscosity fluid. A Newtonian fluid (water, for example) is one whose viscosity, at a given temperature, does not change regardless of the shear forces applied to it. A non-Newtonian fluid changes viscosity as different shear forces are applied to it. UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF is a non-Newtonian fluid. Being a non-Newtonian fluid, the viscosity of UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF decreases when subjected to high shear as during takeoff.

The extent of viscosity reduction depends on the shear forces which, in turn, depend on the takeoff speed and geometry of the wing and control surfaces. If there is sufficient speed (takeoff speed) and time (ground roll time), the viscosity reduction allows most of the fluid to flow off during takeoff minimizing adverse effects on aerodynamic performance.

High-speed aerodynamic acceptance for UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF and its dilutions are reported below (see Lowest Operational Use Temperature section on page 7).

Since the geometry of the wing and control surfaces, takeoff speed and ground roll time are the responsibility of the airframe manufacturer, Dow recommends the use of UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF on high-speed aircraft only if the airframe manufacturer has approved the use of Type IV fluids (or specifically UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF) for use on its aircraft.

Some airframe manufacturers have allowed the use of Type IV fluids on their low-speed aircraft. Dow recommends the use of UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF on low-speed aircraft only if the airframe manufacturer has approved the use of Type IV fluids (or specifically UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF) for use on its aircraft.

Consult your Dow representative for more information.

Lowest Operational Use Temperature

The lowest operational use temperature (LOUT) of an anti-icing fluid is generally recognized as the higher of:

1. the lowest temperature at which it meets the aerodynamics acceptance test for a given type of aircraft, or
2. the freezing point of the fluid plus the freezing point buffer of 7°C (about 13°F).

A fluid must not be used when the outside ambient temperature or skin temperature of the aircraft is below the lowest operational use temperature of the fluid.

The following table illustrates the lowest operational use temperature of UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF when applied to aircraft whose takeoff characteristics pertain to the high speed aerodynamics acceptance test:

UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF Performance Properties (High-Speed)

Concentration UCAR™ FLIGHTGUARD™ AD-49 PG Based TYPE IV AAF/Water	High Speed Aerodynamics	Freezing Point	Lowest-Operational Use Temperature (High-Speed)
100/0	above -29°C (-20°F)	-33°C (-27°F)	-26°C (-15°F)

Freezing Point

Undiluted UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF has a freezing point of -33°C (-27°F) and is formulated to help provide protection against freezing and a viscosity suitable for outside storage and handling during extreme winter temperatures. Read the Storage, Handling and Testing Section (pages 10-13) regarding the proper transfer and storage techniques recommended for this product.

Freezing Point Determination

The addition of water (through contamination or precipitation) raises the freezing point of UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF, reducing its effectiveness. Therefore, its freezing point should be checked frequently and regularly to ensure safe winter operation. The freezing point of UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF can be measured directly, using a method such as ASTM Method D 1177. However, this method is cumbersome for use in the field. The freezing point of UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF can be effectively and easily monitored in the field by measuring the refraction of the fluid. The refraction is related to the concentration of propylene glycol, the freezing point depressant contained in UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF, and, therefore, to its freezing point.

Selection and Care of Refractometers

Criteria. Temperature-compensated portable refractometers can be conveniently used for measurements in the field. Select a refractometer that can be calibrated easily, read easily, and covers the refractive index range of interest.

UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF, as delivered, should have a refractive index of 1.3905-1.3935 (refraction of 35.2-36.8°Brix). Pure water has a refraction of 0°Brix. Therefore refractometers for use with UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF should have a range of 0.0° to at least 37°Brix.

Commercially available refractometers. Examples of temperature-compensated portable refractometers are the MISCO 10431VP, PA201, and PA202[1] and Rhino Brix50[2].

Among the refractometers which should not be used are: the MISCO 7084VP or 7064VP refractometers. Also do not use battery testers to test the refraction of UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF.

Hydrometer. Do not use an (automotive) hydrometer for estimating freezing points. It does not have sufficient accuracy for the determination of the freezing point of aircraft deicing fluid formulations.

According to the refractometer manufacturers1,2, temperature compensated refractometers, such as those described above, provide accurate direct readings as long as the instrument itself is in the range of 16°C to 38°C (60°F to 100°F). The temperature of the sample has little bearing on the accuracy of the reading as the sample size is so small that it immediately assumes the temperature of the refractometer.

In winter, because outside temperatures are low, it is particularly important to keep the refractometer in the range of 16°C to 38°C (60°F to 100°F) in order to have accurate readings. Do not keep the refractometer outside. Correction factor curves for refractometer temperature variations are available from the refractometer manufacturers.

Checking the zero and calibrations. Refer to refractometer manufacturer's literature on calibration to determine method and frequency of calibration for individual refractometers.

Materials Compatibility

UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF meets the materials compatibility requirements of major airframe manufacturers and industry associations. Materials compatibility tests are performed by an independent laboratory. Detailed results from these tests are available from your Dow sales representative.

[1]Available from MISCO Products, Cleveland, OH, USA, (800) 358-1100 or (216) 831-1000.
[2]Available from Reichert Technologies, Depew, NY, USA (888) 849-8955 or (716)-686-4500.

Operational Properties

Shear Stability

As discussed in the Aerodynamics section, when an aircraft anti-icing fluid is subjected to high shear, as during the takeoff ground roll, the viscosity decreases, allowing most of the fluid to flow off the wing. Aircraft anti-icing fluids are also subjected to shear whenever they are pumped or when they pass through a nozzle or restriction device. If the shear is not excessive, UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF will maintain its high viscosity and provides anti-icing protection for the aircraft surface while the aircraft is at rest.

For more information see the Storage, Handling and Testing section (pages 10-13).

Thermal Stability — Accelerated Aging

UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF meets the requirements of SAE AMS 1428 for thermal stability. Like all other Type IV fluids, it is possible to degrade UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF by excessive heating. See the Heating UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF section (page 12).

Thin Layer Thermal Stability

Leading-edge heating devices can be activated in a few instances while an aircraft is on the ground. In such cases, the anti-icing fluid is subjected to high temperatures. UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF does not leave insoluble residues in a standard laboratory test designed to simulate conditions created by these thermal devices.

Storage Stability

Under normal ambient storage conditions, the shelf life of UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF exceeds one year. For testing, see the Storage, Handling and Testing section (pages 10-13).

Appearance

UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF is provided as a translucent green liquid. The green color is added as a visual aid to assist in the application and detection of the fluid on the aircraft surfaces.

Physical Properties

Surface Tension

UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF is formulated to provide rapid and uniform wetting and spreading on the surface of the aircraft, maximizing the efficiency and effectiveness of its application. This is reflected by its low surface tension of about 31 dyne/cm (See Table 1).

Viscosity

UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF is a shear thinning non-Newtonian fluid; its viscosity is high when the fluid is at rest, but is lower when the fluid is subjected to shearing forces. Since viscosity varies depending on the force applied to the fluid, when viscosities are measured and compared, it is important to specify precisely the methods of measurement. For instance, with a rotational viscometer, temperature, viscometer model, rotation speed, spindle number, and time after beginning of rotation must be reported.

For quality control purposes, Dow recommends the following method to measure the viscosity of UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF:

1. Centrifuge the sample to remove air bubbles. Air bubbles interfere with viscosity measurements.
2. Use a Brookfield Digital Viscometer Model DV-II, or equivalent equipped with a small sample adapter and thermostatic chamber (SC4-31/13R).
3. Control the thermostatic chamber at 20°C ± 0.5 using a constant temperature bath.
4. Place 10 mL of the bubble-free UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF into the Brookfield small sample adapter fitted with spindle 31.
5. Wait for 15 minutes for the sample temperature to equilibrate (hint: prevent condensation water from contaminating the sample).
6. Start the rotation of the Brookfield viscometer spindle at 0.3 rpm.
7. Take the reading at exactly 10 minutes ± 1 second.
8. Increase the speed to 6 rpm and take the reading at 2 minutes.
9. Increase the speed to 30 rpm and take the reading at 30 seconds.
10. Report the result in mPa•s.

Viscosities measured under a variety of conditions are given in Table 1.

pH, Specific Gravity, and Refraction

The pH, specific gravity, and refraction values are provided in Table 1. The use of refraction is discussed in the Performance Properties Section: Freezing Point Determination (page 7).

Flash Point

UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF has a flash point as measured by the ASTM Method D 93 of greater than 100°C. During normal use and under proper storage and handling conditions, UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF is considered to be non-flammable.

Table 1. Typical Performance, Operational and Physical Properties of UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF

Typical Performance Properties		
Water Spray Endurance Test Time	100/0 (neat fluid)	90-100 minutes
	75/25	70 minutes
	50/50	16 minutes
High Humidity Endurance Test Time	100/0 (neat fluid)	90-100 minutes
Aerodynamics Concentration UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF/Water	High Speed Aerodynamics	Lowest-Operational Use Temperature (High Speed)
100/0	above -29°C (-20°F)	-26°C (-15°F)
Freezing Point	100/0 (neat fluid):	-33°C (-27°F)
Materials Compatibility	Meets SAE AMS 1428	
Typical Operational Properties		
Shear Stability		**Viscosity CPs at 20°C**
Spindle #31 0.3 rpm 6 rpm 30 rpm		 16500 2000 810
Storage Stability		Minimum one year
Appearance		Green
Typical Physical Properties*		
Surface Tension		31.3 dyne/cm
pH		7.0
Flash Point		>100°C
Specific Gravity @ 20°C		1.038
Refreactive Index @ °C		1.3920
°Brix @ 20°C		36.0

*Typical properties, not to be construed as sales specifications.

Environmental Properties

Biodegradation

UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF should be readily biodegraded in both surface-water and conventional wastewater treatment plants. However, large discharges of these or any other readily biodegradable substance could result in a temporary reduction or depletion of dissolved oxygen levels in the receiving waterways, with a potential adverse effect on aquatic life. Generally, low winter temperatures and increased dilution from stormwater flow during periods of use tend to minimize any adverse effects on dissolved oxygen levels and aquatic life.

For additional information, please see the Safety Data Sheet.

Effect on Aquatic Life

Aquatic toxicity for UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF is summarized in Table 2.

Table 2. Aquatic Toxicity

Product	**Organism**	**Toxicity**	
UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF		LC_{50} 48 hours, mg/L	LC_{50} 96 hours, mg/L
	Fathead minnows		1,050
	Daphnia magna	1,125	

Glycol Recovery, Collection and Disposal

UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF contains a high-quality grade propylene glycol. This single glycol component formulation will facilitate propylene glycol reclamation from used deicing fluids. Recovered glycol must be tested for the intended end-use.

Appropriately contain, collect and dispose of runoff from deicing operations and divert to permitted outfalls or to a waste treatment system. Check with local authorities to assure compliance with federal, state, provincial and local laws. Please note that laws and regulations governing disposal may change. It is the responsibility of the user to assure disposal is appropriate and in compliance with legal requirements.

Environmental Impact

In summary, UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF generally will not persist in the environment, but can be harmful to aquatic life if discharged into a receiving waterway without further dilution. Collection and treatment, including glycol reclamation, of spent aircraft deicing and anti-icing fluids is recommended.

Mammalian Toxicity

See the Safety Data Sheet.

Storage, Handling and Testing

UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF is available from Dow in drums, tote tanks, or bulk.

Storage Tanks

Stainless steel storage tanks are recommended for this product. Opaque fiberglass- reinforced polyester or opaque polyethylene are also acceptable. Carbon steel storage tanks cannot be used for this product.

Piping

Stainless steel piping is recommended for this product. Carbon steel piping cannot be used. The piping surfaces should be smooth, and sharp bends should be avoided. A minimum pipe diameter of 3 inches is recommended. Flexible hoses can also be used.

Pumps

See page 12 for recommendations on the types of pumps to use for this product.

Preclusion of UV Degradation

Do not store in clear or semi-transparent plastic, polyethylene, fiberglass or glass storage tanks, containers or bottles. Sunlight and fluorescent lights are sources of ultraviolet light. If any ultraviolet transparent vessel is used, cover it with an opaque material or an opaque coating, preferably light in color.

Receiving

Prior to unloading UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF, check the shipping documents and product, the refraction, the color, and for suspended matter.

- Make sure that the shipping documents and product label are indeed for UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF.
- Measure the refractive index and make sure it is in the range 1.3905-1.3935 (35.2-36.8°Brix).
- Verify that the color is green.
- Verify that it is substantially free of suspended matter.
- Retain the sample for one year in an opaque bottle. Record the product name, lot number, and date of receipt on the bottle.

Do not use UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF if one of the following conditions occurs:

1. If the shipping documents or product label shows the fluid not to be UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF, or
2. the refractive index reading of the delivered product does not fall in the acceptable range of 1.3905-1.3935 (35.2-36.8 °Brix), or
3. if the color is not green, or,
4. the UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF is not substantially free from suspended matter.

Contact your Dow representative immediately. In particular, do not unload a shipment of UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF into your storage container or deicing truck if any of these requirements are not met.

Field Tests and Acceptable Range of Results

- **Label.** Think of checking the label (and shipping papers as well for shipments) to ascertain the identity of a fluid as a field test. The only acceptable result for the label test is the expected name of the fluid. If you expect to have or receive UCAR™ FLIGHTGUARD™ AD-49 Aircraft Deicing Anti-icing Fluid SAE Type IV, the label must read "UCAR™ FLIGHTGUARD™ AD-49 Aircraft Deicing/Anti-icing Fluid SAE Type IV."
- **Color.** UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF is green. If the color is different, the sample is considered unacceptable. UCAR™ Aircraft Deicing Fluids (ADF) are orange. Do not depend on color alone to determine that the correct product has been delivered or is being used. Always check the label, shipping papers and refractive index.
- **Refractive Index.** The use of the refractometer is explained in the Freezing Point Determination section. The acceptable refractive index range for UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF is 1.3905-1.3935 (35.2-36.8 °Brix).
- **Suspended Matter.** Look at the sample. It should be substantially free from suspended matter, and must not have any oily residues within or on the surface. The presence of any oily residue is a form of contamination. Such a contamination may interfere with the wetting capabilities of the fluid. A fluid that does not wet well may have significantly shorter holdover times. Do not use a fluid that has any sign of an oily residue. The acceptable suspended matter range for UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF is "substantially free." The presence of a slight haze or air bubbles in UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF is normal.
- **Viscosity.** Viscosity in the laboratory is commonly measured using a Brookfield viscometer (see the Viscosity section, page 8).
- **pH.** The pH can be measured easily using a portable pH meter. These meters are available from several laboratory equipment vendors. The acceptable pH range is 6.5 - 7.5.
- **Sampling.** Whenever collecting samples, it is important to obtain a representative sample. A Sampling Guideline is available from your Dow representative.
- **Records.** Keep records of the test results. The Sampling Guideline makes recommendations on the information to record.

- **Test Frequency.** Test fluid from all vessels at least once a year before the deicing season begins and continue to do so on a regular basis. Check the label, color, refraction, suspended matter, viscosity, and pH of UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF to make sure it has not been degraded or contaminated.

Test samples from storage tanks, and anti-icing truck tanks. Use the fluid only if the label, color, refraction, suspended matter, viscosity, and pH are within the accepted range.

Whenever fluids are transferred, check the label (on both the source and receiving vessel), color, refraction, and suspended matter of the fluid in the receiving vessel after the transfer. Use only if the test results are within the accepted range. Receiving is a form of transfer (See the Receiving Section, page 10).

If UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF is stored in deicing trucks with uninsulated tanks that permit heat to transfer to the UCAR™ FLIGHTGUARD™

AD-49 PG Based Type IV AAF tanks, tests should be performed frequently (see Heating UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF, page 13).

Tests by Dow

Send samples to Dow for a full analysis and confirmation of acceptability when (1) product samples tested as above fail to meet all requirements; (2) contamination, either accidental or willful, is suspected; or (3) you deem for any reason that such confirmation is necessary. Contact your Dow sales representative for the proper sample mailing address and the applicable labeling and transportation requirements.

Contamination

Contamination can generally be avoided by establishing good procedures and practices. All circumstances that permit contamination to occur cannot be listed below. However, please be aware of the following modes of contamination:

- **New Equipment.** When new equipment is placed into service, make sure that it has been cleaned. Pay particular attention to new deicing trucks which are often shipped with an antifreeze solution in the pump and piping system. This antifreeze solution is an unwanted contaminant. Drain, rinse with water, and then fill with UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF before putting the deicing truck into service.

- **Leaky Covers.** Some deicing trucks or storage tanks have covers that allow rainwater or melted snow into the tank, leading to unwanted dilution. Make sure that the tank covers of the trucks or of the storage tank do not allow water in the tank, but remember that the tanks must be vented at all times.
- **Leaky Tanks.** Some deicing/anti-icing trucks have the anti-icing fluid tank sharing a common wall with the deicing fluid tank. Some tank walls are spot welded (they should be seam-welded) or can develop cracks allowing the deicing fluid into the anti-icing fluid tank or vice versa. The presence of even a small amount of deicing fluid in the UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF tank can cause significant performance problems. Make sure tanks do not leak. Some trucks have a hose containing deicing fluid that goes through the anti-icing fluid tank. Make sure that the hose and its fittings have no leaks.
- **Forbidden Transfers.** Never transfer UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF from a deicing/anti-icing truck into the UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF storage tank. If there was contamination in the truck, contamination would propagate to the entire storage tank.
- **Dedicated Equipment.** Use dedicated storage and handling facilities for UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF. Make sure loading and unloading lines are clean and free of contaminants.
- **Labeling.** Conspicuously label storage tanks, loading and transfer lines, valves, deicing/anti-icing truck tanks, and pumps for instant identification to minimize risk of product contamination. Before transferring any fluid, check the label on both the source and receiving vessel to make sure that it is really the transfer that you intended to make. Labels for UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF are available from your Dow representative.
- **Forbidden Mixtures.** Do not mix UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF with any other product. This includes but is not limited to, UCAR™ PG Based ADF Dilute "55/45", or with any other aircraft anti-icing or deicing fluid products, runway deicing fluid, or with any other material, including, but not limited to, fuel or propylene glycol.
- **Contamination Checks.** Check regularly the anti-icing fluid to make sure that it is not contaminated. Viscosity is usually degraded by contamination.

Shear Degradation

UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF will permanently lose viscosity when subjected to excessive shear.

- **Pumps.** To lessen shear degradation, use low-shear positive displacement pumps (e.g. diaphragm or progressive cavity) or air pressure for transfer. **Do not use high shear pumps (e.g. gear or centrifugal) for this product.** Do not circulate for extended periods.
- **Filters.** Do not filter UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF. Pumping through filters may subject the fluid to excessive high-shear conditions resulting in viscosity degradation.

Heating UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF

- **Storage Temperature.** Ideally, UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF should be stored unheated. Avoid unnecessary heating of UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF as there may be water evaporation or thermal degradation, both of which can result in off-specification viscosity.
- **Water Evaporation.** It is a requirement of SAE AMS 1428 that the viscosity of anti-icing fluids decrease upon water evaporation (paragraph 3.2.2 of AMS 1428). As UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF is heated (indirect heating due to the proximity of uninsulated deicing fluid truck tanks, standby heating or heating for application), there may be water evaporation resulting in very significant viscosity decrease. As water evaporates, the glycol concentration and refraction increase. It is not sufficient to simply rely on refraction measurement to ensure that the fluid still meets requirements. It is possible for the fluid to lose a small amount of water (with accompanying small increase in refraction) such that the refraction is still within requirements but with the viscosity outside requirements. Avoid heating the fluid for any extended period of time to prevent water evaporation. If heated, try to minimize water evaporation by keeping the lids closed on anti-icing equipment, but keep vents open at all times to avoid a pressure buildup.
- **Thermal Degradation.** Even in the absence of evaporation, if UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF is heated, the fluid may thermally degrade with accompanying reduction in viscosity. Avoid unnecessary heating. Recirculation or keeping the fluid at high temperatures for long periods of time could lead to degradation. We recommend that the heating elements be turned off when equipment designed for deicing is being used to apply the aircraft anti-icing fluid. Indirect heating due to the proximity of uninsulated deicing fluid truck tanks can be a very significant source of heat.

Tarmac

Pavement covered with UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF may be messy for ground vehicles or ground crews walking on tarmac. Use caution in walking or in operating equipment in those areas where UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF may be on the pavement. Wipe your feet before entering buildings, vehicles, or aircraft. Read the Application Section for more information.

Runway

SAE Type IV aircraft anti-icing fluids are viscous and are designed to shear off the aircraft as it accelerates during the takeoff run thus depositing some anti-icing fluid onto the runway. The SAE Type IV fluid deposited on the runway may cause snow to melt and change the reported surface condition. Loose blowing snow may adhere to the anti-icing fluid, increasing the accumulation of snow on the runway. This effect may eventually create slush and ice conditions, resulting in lower friction values in the first third of the runway. This effect is dependent upon weather conditions and the amount of aircraft traffic. If the runway is used for mixed operations (both takeoffs and landings) this may create an increased risk for landing aircraft.

Airport operators should be aware of this potential issue. Additional airfield maintenance by timely runway sweeping and application of formate- or acetate-based runway deicing fluid to the area where the anti-icing fluid is deposited will eliminate or significantly reduce the accumulation of the anti-icing fluid.

Shelf Life

UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF is formulated with components that should be stable for at least one year under unheated storage conditions. However, periodic testing of the fluid is prudent to ensure that the fluid is still acceptable for use. UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF stored unheated for one year should be sampled and tested for conformance to specification for color, suspended matter, refractive index, viscosity, and pH. Material not meeting the specification requirements should be sampled and sent to Dow for further testing. These measurements should be repeated every year. A sampling guideline is available from your Dow representative. Under heated storage conditions, UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF should be checked more often and regularly.

Equipment Inspections

- Tank Inspection. Inspect storage tanks and deicing trucks at least once per year or more often if reasons arise. It is best to test just prior to the winter season. If contamination occurs, tanks should be cleaned or replaced.
- Application Equipment Inspection. Before using UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF, test application equipment on at least an annual basis. Routine calibration and recertification of each instrument's performance in aircraft deicing/anti-icing fluid service should be conducted according to the instrument manufacturer's instruction.

Application

Industry Practices and Government Regulations

Individual aircraft manufacturers provide specific anti-icing and deicing recommendations for various aircraft. Obtain and follow these specific recommendations. Understand industry aircraft deicing and anti-icing application standard practices, such as those of SAE Aerospace Standard (AS) 6285. Also follow applicable government regulations, including those of Transport Canada, the U.S. Federal Aviation Administration, the U.S. Department of Transportation, and other Federal, state, provincial, and local agencies.

The application information given below is provided as general information only. The responsibility for correct application rests with the user.

Two-Step Deicing/Anti-icing

Two-step deicing/anti-icing is generally used when the aircraft is contaminated and when precipitation is active.

- **First Step.** Apply hot UCAR™ PG Based Aircraft Deicing Fluid (ADF) until all the snow, ice and frost are removed from the aircraft.

  Spraying UCAR™ ADF

  Dispense the hot aircraft deicing fluid, such as UCAR™ aircraft deicing fluid close to the surface to be deiced; applying from a distance results in heat loss as fluid temperature drops quickly when moving through air. Colder deicing fluids are much less effective, or even ineffective, in removing/melting frozen precipitation.

  Dispense the hot fluid directly onto the total aircraft surface to be deiced. If applied only to the front part of the wing, allowing it to flow back to the aft part, the fluid will cool down significantly as it moves on to the surface of the wing, making it less effective, or even ineffective, in melting frozen contamination on the aft part of the wing.

  Make sure there is no frozen precipitation remaining underneath the deicing fluid.

  Apply the hot UCAR™ ADF in sufficient quantity so that the remaining fluid on the surface to be protected has a freezing point at least 10°C below outside ambient temperature (OAT). As the deicing fluid is applied, it is being diluted by the ice, snow or whatever frozen accumulations it is removing. Its freezing point is thus increased. Sufficient deicing fluid must be applied to make sure that the diluted fluids are flushed away. If you are uncertain about the concentration of the deicing fluid on the wing(s), you can determine its freezing point by checking its refraction.

  The deicing operation should be performed as close to takeoff as possible. "End-of- the-runway" deicing, performed on a designated pad adjacent to the runway, can minimize the time between deicing and takeoff.

- **Second Step.** Apply the UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF to aircraft surfaces before any refreezing occurs.

One-Step Anti-icing

The one-step anti-icing procedure is generally used on aircraft when overnight frosting conditions are forecasted. The aircraft anti-icing fluid is applied late at night on the clean aircraft surface. Typically, UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF protects an aircraft for several hours during frost conditions. Always check the aircraft surface for ice before putting aircraft into operation.

Using UCAR™ FLIGHTGUARD™ AD-49 in One-Step Anti-Icing

Caution: The application of UCAR™ FLIGHTGUARD™ AD-49, especially when used in a one step process, may cause residues to collect in aerodynamically quiet areas, cavities and gaps. These residues can affect flight safety. Users should inspect aircraft as recommended in SAE Aerospace Standard (AS) 6285. If residues are present, users should evaluate their application practices and establish an appropriate inspection and cleaning program.

Apply unheated UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF to an aircraft that is free of ice, snow, or frost. Unheated UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF is viscous and, thus, will not penetrate or melt frozen accumulation. While UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF will flow off during takeoff, the ice could remain on the aircraft causing lift loss or impaired maneuverability. Do not use unheated UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF on an aircraft contaminated with any snow, ice, or frost.

The one step application is also used as a preventative measure when freezing rain is forecasted. The UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF will most likely be overcome by the freezing rain and deicing will be required. However, the presence of the UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF will make it easier (less time spent in removing the ice and less deicing fluid used) to remove the ice as the bond between the ice and the aircraft will have been made weaker.

Spraying

- **Pressures.** The high fluid pressures and flow rates normally associated with aircraft deicing are not required for anti-icing operation and, where possible, pump speeds should be reduced accordingly. Although the operation should be optimized for each aircraft type and configuration, as well as for existing weather conditions (e.g., the wind), field experience has shown that pump outlet pressures of 45 to 70 psig generally provide a very even application.
- **Proper Coverage.** Apply a sufficient amount to completely coat the surfaces to be covered and to form a coating of typically 1 to 3 mm (0.04 to 0.11 inches). Insufficient coverage results in a thin layer and reduced protection. Mathematically, it takes 1 liter to cover 1 square meter with 1 mm; since application is never perfect, it will take at least 1 liter/square meter to achieve 1 mm. (In non-metric units, it will take at least 1 U.S. gallon/40 sq. ft to achieve 0.04 inches. Conversion factors: 1 liter = 0.2642 U.S. gallon; 1 mm = about 0.04 inch; 1 square meter = 10.76 square feet.)

  The spray nozzle should be adjusted to give a semi-fan pattern. Let the fluid fall gently onto the surfaces to be covered. Avoid high fluid velocities (such as used with Type I deicing fluids). It is easier to have a good coverage when the nozzle is close to the surface to be covered. Close coordination of the truck driver and the sprayer in the bucket is important for trucks needing two operators.
- **Areas To Be Covered.** Check with the aircraft manufacturer. Generally the surfaces to be covered include the leading edges, wing upper surface, horizontal stabilizer, rudder and fuselage upper surface on center engine aircraft. Pay particular attention to the leading edges, making sure they have proper coverage.
- **Excessive Application.** Conversely, excess application would result in UCAR™ FLIGHTGUARD™ AD-49 PG } Based Type IV AAF flowing onto the tarmac. This is wasteful and may lead to accumulations that may become messy for ground vehicles and ground crews. If there is accumulation on the tarmac, use mechanical means (vacuum trucks) to remove the fluid. Avoid the use of solid absorbents on UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF unless the absorbent is to be immediately removed from the pavement.
- **Forced Air Trucks.** Some trucks, which are used to spray aircraft anti-icing fluids conventionally, also have the ability to spray the fluid either injected into an air UCARstream
  or sprayed on top of the airstream.

  Forced air can be used as long as it is verified that the product has not been degraded and sufficient thickness has been applied. Forced air applications of UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF may result in a thinner coat of fluid on the wing or an uneven application of the fluid.
- **Trained Personnel.** Use only trained personnel to apply UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF safely. Personnel should be advised to read, understand, and follow the precautions listed in this bulletin, the Safety Data Sheet (SDS), and on the product label before using this UCAR™ FLIGHTGUARD™ AD-49 PG Based

Type IV AAF.

Holdover Time and Protection Time

Extrapolation of laboratory endurance time WSET results to real weather conditions is extremely difficult. Real-weather freezing and frozen precipitation take several forms, such as snow, wet snow, freezing rain, ice pellets, etc., which are significantly different from laboratory water spray in form, size, and rate. Precipitation rates can vary significantly from moment to moment and, in North America, are known to reach rates higher than 40 grams per square decimeter per hour.

A close check to ensure that the aircraft is free from frost, ice, snow, etc. should be performed before the aircraft leaves the gate and starts to taxi. Do not operate the aircraft if the holdover time guideline has been exceeded unless you can verify the aircraft is free of snow, ice, frost, etc.

Duration of the protection period afforded by aircraft deicing/anti-icing fluids during winter conditions cannot be accurately predicted because it is affected by a multitude of factors, such as temperature of the aircraft surface and outside air, relative humidity, solar radiation, wind speed and direction, and the type and rate of precipitation. Continuous precipitation dilutes the fluid, which will eventually freeze. For that reason, a close check to ensure that the aircraft is free of ice, snow, or frost immediately prior to takeoff, is always necessary.

Do Not Rely Solely On Holdover Time Charts.

Holdover time is the expected protection time of the anti-icing fluid under various weather conditions. The estimated protection time is the time interval between the beginning of the anti-icing operation and the failure of the fluid to protect any water on the wing from freezing.

As discussed in the Water Spray Endurance Test section (page 5), it is extremely difficult to accurately predict the protection time of an aircraft anti-icing fluid in real weather conditions.

There are many variables affecting the protection time: thickness of fluid layer, wind velocity, precipitation rate, outside air temperature (OAT), aircraft skin temperature, solar radiation, types of precipitation or other hydro-meteorological deposits (drizzle, rain, freezing drizzle, freezing rain, snow, snow pellets, snow grains, ice pellets, hail, hailstones, ice crystals, dew, hoarfrost, rime, glaze, and blowing snow). Jet blast from other aircraft, sudden changes in temperature or precipitation type or rate, etc. can affect the holdover time.

Nevertheless, such organizations as the FAA and Transport Canada publish holdover guideline tables. Such tables are guidelines only; holdover times are not absolutes. The tables are published with cautionary notes reminding potential users that holdover tables are for general information only and are to be used in conjunction with a pre-takeoff check.

Times of protection are shortened:

- in heavy weather conditions,
- by high winds,
- by jet blast, and
- by fuel temperatures lower than OAT

During precipitation, verify that the aircraft is free of ice, snow, and other frozen deposits and remains free of these deposits until “rotation” and takeoff.

Communications with Flight Crews

See Product Description, (page 4).

Loss of Fluid Effectiveness

A fluid has lost its effectiveness when it is no longer able to absorb and melt precipitation. Some visual clues that a fluid has lost its effectiveness include loss of gloss, snow or ice accumulation, surface freezing, build-up of ice crystals in or on the fluid, or the presence of slush. A pre-takeoff check of the aircraft is the only way to determine if an aircraft is free of ice and snow and is safe to take off.

Product Safety

When considering the use of any Dow product in a particular application, you should review our latest Safety Data Sheet for that product and ensure that the use you intend can be accomplished safely. For Safety Data Sheets and other product safety information, contact Dow at the numbers listed on the back of this brochure. Before handling any products mentioned in the text, you should obtain available product safety information and take necessary steps to ensure that the product is used safely and that environmentally acceptable practices are followed.

Because 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.

The customer should furnish the information in these publications to its employees, contractors, and customers, or any other users of the product(s), and request that they do the same.

Precautions

UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF is recommended for application on aircraft exterior surfaces only.

Do not use UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF to deice or anti-ice:

- Cockpit windows
- Helicopters (unless authorized by helicopter manufacturer)
- Aircraft brake pads
- Runways
- Pavement
- Roadways
- Sidewalks
- Vehicles
- Ground support equipment.

Do not spray UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF directly into engines or auxiliary power units (APU).

Do not use UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF as antifreeze for:

- Vehicles
- Ground support equipment
- Sanitary water facilities
- Aircraft or portable lavatories.

Do not spray UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF onto aircraft with:

- Vents open
- Pack valves open
- Baggage doors open
- Bystanders near or under plane.

Do not remove labels from a vessel or drum containing UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF, unless they have been drained and cleaned.

Do not use recycled UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF.

When using any SAE Type IV aircraft anti-icing fluid care should be taken to note any accumulation on the runway which may lower friction values where snow accumulation occurs. This effect is dependent upon weather conditions and the amount of aircraft traffic (see Runway, page 13).

Airport operators should be aware of this potential issue. Additional airfield maintenance by timely runway sweeping and application of formate- or acetate-based runway deicing fluid to the area where the anti-icing fluid is deposited will eliminate or significantly reduce the accumulation of the anti-icing fluid.

Read the Safety Data Sheet before using this product.

For more information regarding UCAR™ FLIGHTGUARD™ AD-49 PG Based Type IV AAF, contact your Dow sales representative.

Emergency Service

The Chemical Manufacturers Association (CHEMTREC), Transport Canada (CANUTEC), and the National Chemical Emergency Center maintain 24-hour emergency service. Learn More:

Location	All Chemical Products
United States and Puerto Rico	Phone CHEMTREC: **+ 800 424 9300** (toll-free)
Canada	Phone CANUTEC: **+ 613 996 6666** (collect)
Any other location worldwide	Phone CHEMTREC (United States): **+ 703 527 3887 (collect)**
At sea, radio U.S. Coast Guard, who can directly contact **CHEMTREC...+ 800 424 9300** (toll-free).	
DO NOT WAIT. Phone if in doubt. You will be referred to a specialist for advice.	

Learn More

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*Toll free service not available in all countries

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