SAE AMS 1424/1 Propylene Glycol-Based Type I Fluids

UCAR

PG Aircraft Deicing Fluids

- Concentrate
- “55/45”

Aircraft Deicing Fluids for Safe Winter Operations

Important

This product information bulletin (Form No. 183-00024-0917, issued September 2017) replaces all previously issued product information bulletins for UCAR PG ADF Concentrate and UCAR PG ADF Dilute “55/45”. Please destroy all previously issued product information bulletins on this product.

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Abbreviations and Symbols

AAF	Aircraft Anti-icing Fluid
ADF	Aircraft Deicing Fluid
ADFs	Aircraft Deicing Fluids
AMS	Aerospace Material Specification
ARP	Aerospace Recommended Practice
ASTM	American Society for Testing and Materials
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
EC	Effective Concentration
HHET	High-Humidity Endurance Test
IC	Inhibition Concentration
LC	Lethal Concentration
LOUT	Lowest Operational Use Temperature
MSDS	Material 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)
WSET	Water Spray Endurance Test
WHMIS	Workplace Hazardous Material Information System (Canada)
>	Greater than
<	Less than

Introduction

Product Description

UCAR™ PG Aircraft Deicing Fluids (ADFs) are propylene glycol-based fluids containing water, corrosion inhibitors, wetting agents, and an orange dye. These products are formulated to assist in removing ice, snow, and frost from the exterior surfaces of aircraft. UCAR PG ADFs are supplied in two forms: UCAR PG Aircraft Deicing Fluid (ADF) Concentrate and UCAR PG Aircraft Deicing Fluid Dilute "55/45". Both forms share the same formulation except for the concentration of propylene glycol.

UCAR PG ADF Concentrate nominally contains approximately 88.0% by weight propylene glycol. UCAR PG ADF Concentrate must be mixed with the appropriate amount of water before use to make a UCAR PG ADF aqueous solution with the desired freezing point (see the Performance Properties section).

UCAR PG Aircraft Deicing Fluid Dilute "55/45" nominally contains approximately 51% by weight propylene glycol. UCAR PG ADF Dilute "55/45" is a UCAR ADF aqueous solution which can be made by mixing 55 parts by volume UCAR PG ADF Concentrate with 45 parts of water. UCAR PG ADF Dilute "55/45" is a ready-to-use fluid.

Visit Us Online

In addition to this product information bulletin, visit our web site at www.ucaradf.com for more information.

Conformance to Industry Standards

UCAR PG Aircraft Deicing Fluids conform to all technical requirements of the latest version of the Society of Automotive Engineers Aerospace Material Specification (SAE AMS) 1424/1 for Aircraft Deicing/Anti-icing Fluid SAE Type I glycol-based fluid, the Douglas CSD #1 Type VI specification, revised May 1988, and the Boeing D6-17487 specification, revision L. Copies of certificates of conformance issued by independent laboratories are available upon request.

Recommended Practices

This product information bulletin provides the technical details which, in conjunction with the most recent version of the Society of Automotive Engineers Aerospace Standard (AS6285), permit the users to design a program for safe and effective aircraft deicing and anti-icing operations.

[1] SAE standards available from the Society of Automotive Engineers, Inc., 400 Commonwealth Drive, Warrendale, PA 15096-0001, (724) 776-4841, www.sae.org. This website lists the current version(s) of the pertinent documents.

Warning

This product information bulletin contains important safety information. Read this entire product information bulletin before using UCAR PG Aircraft Deicing Fluids. Read, understand, and comply with the Material Safety Data Sheet for this product before using.

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 consequence of this roughness is severe lift loss and impaired maneuverability. Ice can also interfere with the movement of control surfaces or add significantly to aircraft weight. There is no such thing as an insignificant amount of ice.

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 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, ice, snow, or frost include any form of frozen accumulation, such as water/ice/snow/slush or mixtures of deicing/anti-icing fluid with ice, snow, snow pellets, snow grains, frost, hoarfrost, rime, glaze, slush, etc.

Performance Properties

Freezing Point of UCAR PG ADF Concentrate and UCAR PG ADF Dilute "55/45"

UCAR PG ADF Concentrate, as delivered, has a pour point of -81°C (-114°F). The fluid never actually freezes, but becomes glass-like in consistency. UCAR PG ADF Concentrate must be diluted with water before use. Refer to Sections entitled "Adjusting the Concentration of UCAR PG ADFs" and "Lowest Operational Use Temperature." UCAR PG ADF Dilute "55/45", as delivered, has a freezing point of about -36°C (-32.8°F).

Freezing Point of UCAR PG ADF Aqueous Solutions

A UCAR PG ADF aqueous solution is defined as any mixture of water with UCAR PG ADF Concentrate. By definition, UCAR PG ADF Dilute "55/45" is an aqueous solution. Figure 1 shows the freezing point curve of UCAR PG ADF aqueous solutions as a function of the percent volume of UCAR PG ADF Concentrate in water. The freezing points are determined by the American Society for Testing Materials (ASTM) D1177 method, which measures the temperature of the first ice crystal formation.

Freezing Point Determination

Frequent determinations of the freezing point of UCAR PG ADFs are mandatory to ensure the desired freezing point is maintained. Adjustment of the freezing point, if required (see the Adjusting the Concentration of UCAR PG ADFs section), also requires a mandatory check of the freezing point. The freezing point can be measured directly, using a method such as ASTM method D1177. However, this method is cumbersome for use in the field. The freezing point of UCAR PG ADF aqueous solutions can be effectively and easily monitored in the field by measuring their refraction. The magnitude of the refraction is related to the concentration of propylene glycol contained in the solution and therefore to the deicing fluid freezing point. Appropriately calibrated refractometers that read in degrees Brix may be used in conjunction with figure 2 to determine the concentration of UCAR PG ADF Concentrate in a deicing fluid solution. The freezing point for this concentration can then be read from figure 1, or read directly from figure 3 or table 1.

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 and is calibrated, reads easily, and covers the refraction range in degrees Brix to be measured.

UCAR PG ADF Concentrate, as delivered, should have a refraction of 50.5°–53.5°Brix. Upon dilution, the resulting UCAR PG ADF aqueous solution for use on aircraft must have a maximum refraction of 39.0°Brix (an explanation of the significance of the 39.0°Brix is in the Aerodynamic Performance Section). Therefore, refractometers for use with UCAR PG ADF Concentrate and its dilutions must cover the range of at least 0.0°–54.0°Brix.

UCAR PG ADF Dilute "55/45", as delivered, should have a refraction of 32.5° to 36.5°Brix. In the field, the amplitude of the refraction of UCAR PG ADF Dilute "55/45" may vary due to dilution or evaporation. It is recommended that a refractometer covering the range of 0.0° to 50.0°Brix be used.

Commercially available refractometers. Two refractometers (50.0°–90.0° and 0.0°-50.0°) are needed to cover the required range for UCAR PG ADF Concentrate and its dilutions.

Other refractometers used for field measurement of UCAR PG ADF aqueous solutions are the orange colored MISCO 7084VP and MISCO 7064VP Glycol and Battery Testers. These refractometers are less precise and less accurate than the above described refractometers. They display three scales simultaneously (freezing point of ethylene glycol solutions, freezing point of propylene glycol solutions and battery charge) which may cause confusion. Particular care must be exercised to read the correct scale—only the propylene glycol scale must be used to determine the freezing point of UCAR PG ADF aqueous solutions. There is also a systematic nonlinear error when reading the freezing point. There is no Brix scale on these refractometers.

Do not use the older, red colored MISCO 7084 or MISCO 7064 Glycol and Battery Testers. They are not sufficiently accurate. The true freezing point temperature of UCAR PG ADF aqueous solutions can be significantly lower than the instrument reading.

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

Temperature compensation. According to the refractometer manufacturers, 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 quickly 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. Correction factor curves for refractometer temperature variation are available from the refractometer manufacturers.

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

[1] MISCO refractometers are available from MISCO Products, Cleveland, Ohio, 1-800-358-1100 or (216)831-1000

[2] Leica refractometers are available from VWR Scientific, several locations in the USA and Canada, 1-800-932-5000 or (514)344-3525

Freezing Point Buffer

According to SAE AS 6285, residual SAE Type I fluid on the aircraft surfaces following the deicing operation must have a freezing point at least 10°C (18°F) below the OAT or aircraft skin temperature. This difference between the OAT and freezing point of the fluid is called the freezing point buffer. SAE AS 6285 further warns that aircraft skin tempera-ture may be lower than OAT. A deicing fluid with an even lower freezing point should be considered under these conditions. When selecting the freezing point of the deicing fluid to be used, consideration must be given to the freezing point buffer and to the aerodynamic performance of the fluid. Read the Aerodynamic and Lowest Operational Use Temperature sections.

Example. If the OAT is -10°C (+14°F), the freezing point of the deicing fluid must be lower than -20°C (-4°F). (The fluid must also meet the aerodynamic acceptance test.)

Adjusting the Concentration of UCAR PG ADFs

Use the following equations to estimate the amount of UCAR PG ADF Concentrate or water to add to a UCAR PG ADF aqueous solution to adjust its concentration (and freezing point). Concentration is defined as the volume percent UCAR PG ADF Concentrate in the aqueous solution. Always mix thoroughly and measure the refraction following adjustment to assure the proper freezing point has been obtained.

Equation 1: To increase the concentration* (increase the refraction):

$$\text{Volume of UCAR PG ADF Concentrate to add} = \frac{\left(\text{Desired Concentration} - \text{Current Concentration}\right) \times \text{Volume of Fluid}}{(100 - \text{Desired Concentration})}$$

* Concentration is defined as the volume percent UCAR PG ADF Concentrate in the aqueous mixture.

Equation 2: To decrease the concentration* (decrease the refraction):

$$\text{Volume of Water to add} = \frac{\left(\text{Current Concentration} - \text{Desired Concentration}\right) \times \text{Volume of Fluid}}{(\text{Desired Concentration})}$$

* Concentration is defined as the volume percent UCAR PG ADF Concentrate in the aqueous mixture.

Three examples of the use of these equations follow:

Example 1: A 3,500-gallon quantity of UCAR PG ADF aqueous solution has a refraction of 25.2°Brix. Table 1 says its freezing point is -17°C (1°F) and it contains 39 percent by volume UCAR PG ADF Concentrate. Its current concentration is, thus, 39. To lower the freezing point to -30°C (-22°F), table 1 says the desired concentration is 51. Using equation 1, it is determined that 857 gallons of UCAR PG ADF Concentrate needs to be added and thoroughly mixed. The final Brix reading should be 32.0°Brix.

Example 2: A 2,000-gallon quantity of UCAR PG ADF aqueous solution has a refraction of 33.0°Brix. By inspection of figures 3 and 1 (or table 1), the solution contains about 53 percent by volume UCAR PG ADF Concentrate (current concentration) and has a freezing point of -33°C (-27°F). To have a freezing point of -28°C (-18°F), the desired concentration needs to be 49 as obtained from figure 1 or table 1. The freezing point is raised by mixing thoroughly 163 gallons of water (calculated by equation 2 above). The final Brix reading should be 31.0°Brix.

Example 3: Determine the amount of water needed to make deicing fluid with a freezing point of -33°C (-27°F) starting from 19,000 liters of UCAR PG ADF Concentrate. The current concentration, by definition, of UCAR PG ADF Concentrate is 100. The desired concentration, from figure 1 or table 1, is 53. Equation 2 requires mixing 16,849 liters of water with the UCAR PG ADF Concentrate. The final reading should be 33.0°Brix.

Table 1

UCAR PG ADF Freezing Point, Percent by Volume of UCAR PG ADF Concentrate in Water, and Refraction

Freezing Point °C	Freezing Point °F	Percent by Volume of UCAR PG ADF Concentrate in Water	Refraction at 20°C °Brix
0	32.0	0	0.0
-1	30.2	5	3.5
-3	26.6	10	7.0
-4	24.8	15	10.3
-6	21.2	20	13.6
-8	17.6	25	16.8
-9	15.8	27	18.1
-10	14.0	28	18.7
-11	12.2	30	19.9
-12	10.4	32	21.2
-13	8.6	33	21.8
-14	6.8	35	23.0
-15	5.0	36	23.6
-16	3.2	37	24.2
-17	1.4	39	25.3
-18	-0.4	40	25.9
-19	-2.2	41	26.5
-20	-4.0	42	27.0
-21	-5.8	43	27.6
-22	-7.6	44	28.2
-23	-9.4	45	28.7

Freezing Point °C	Freezing Point °F	Percent by Volume of UCAR PG ADF Concentrate in Water	Refraction at 20°C °Brix
-24	-11.2	46	29.3
-25	-13.0	47	29.8
-26	-14.8	48	30.4
-28	-18.4	49	30.9
-29	-20.2	50	31.5
-30	-22.0	51	32.0
-31	-23.8	52	32.5
-33	-27.4	53	33.0
-34	-29.2	54	33.6
-36	-32.8	55	34.1
-37	-34.6	56	34.6
-39	-38.2	57	35.1
-40	-40.0	58	35.6
-42	-43.6	59	36.1
-44	-47.2	60	36.6
-45	-49.0	61	37.1
-47	-52.6	62	37.6
-49	-56.2	63	38.0
-51	-59.8	64	38.5
-53	-63.4	65	39.0
does not freeze		100	50.5-53.5

Figure 1

Freezing Point of UCAR PG ADF Aqueous Solutions vs. Percentage by Volume of UCAR PG ADF Concentrate in Water

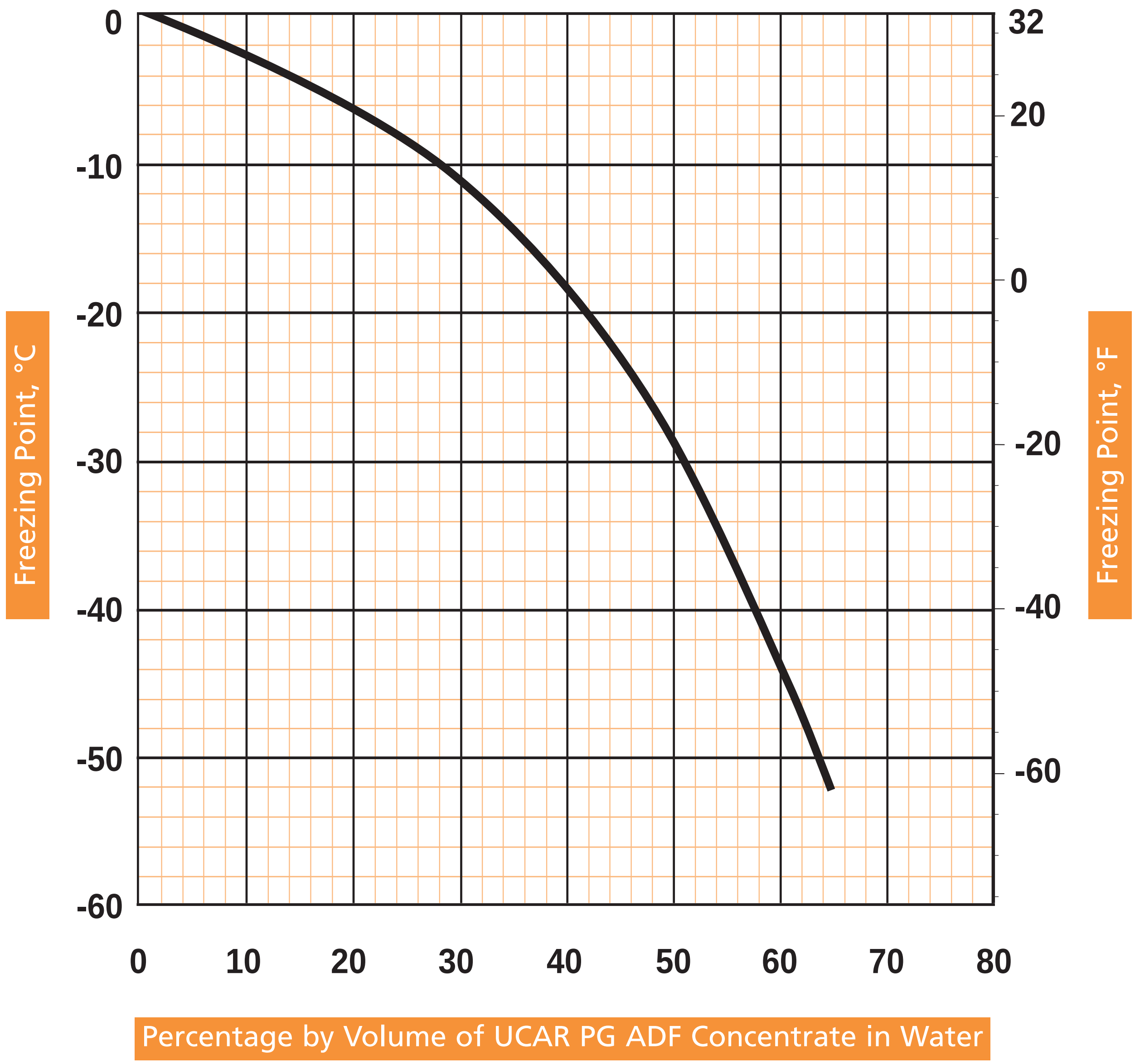


Figure 2

Refraction (°Brix) at 20°C of UCAR PG ADF Aqueous Solutions
vs. Percentage by Volume of UCAR PG ADF Concentrate in Water

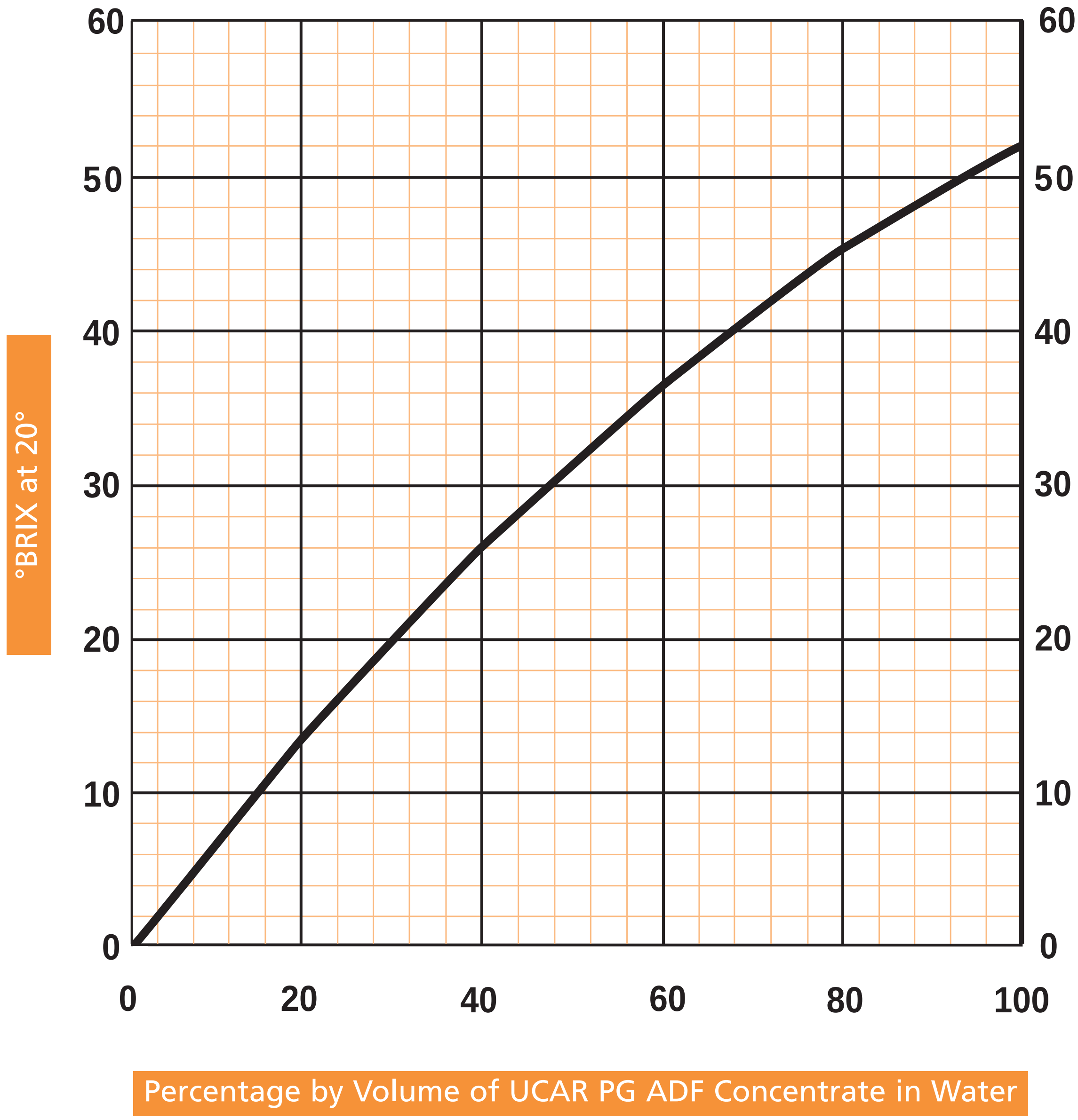
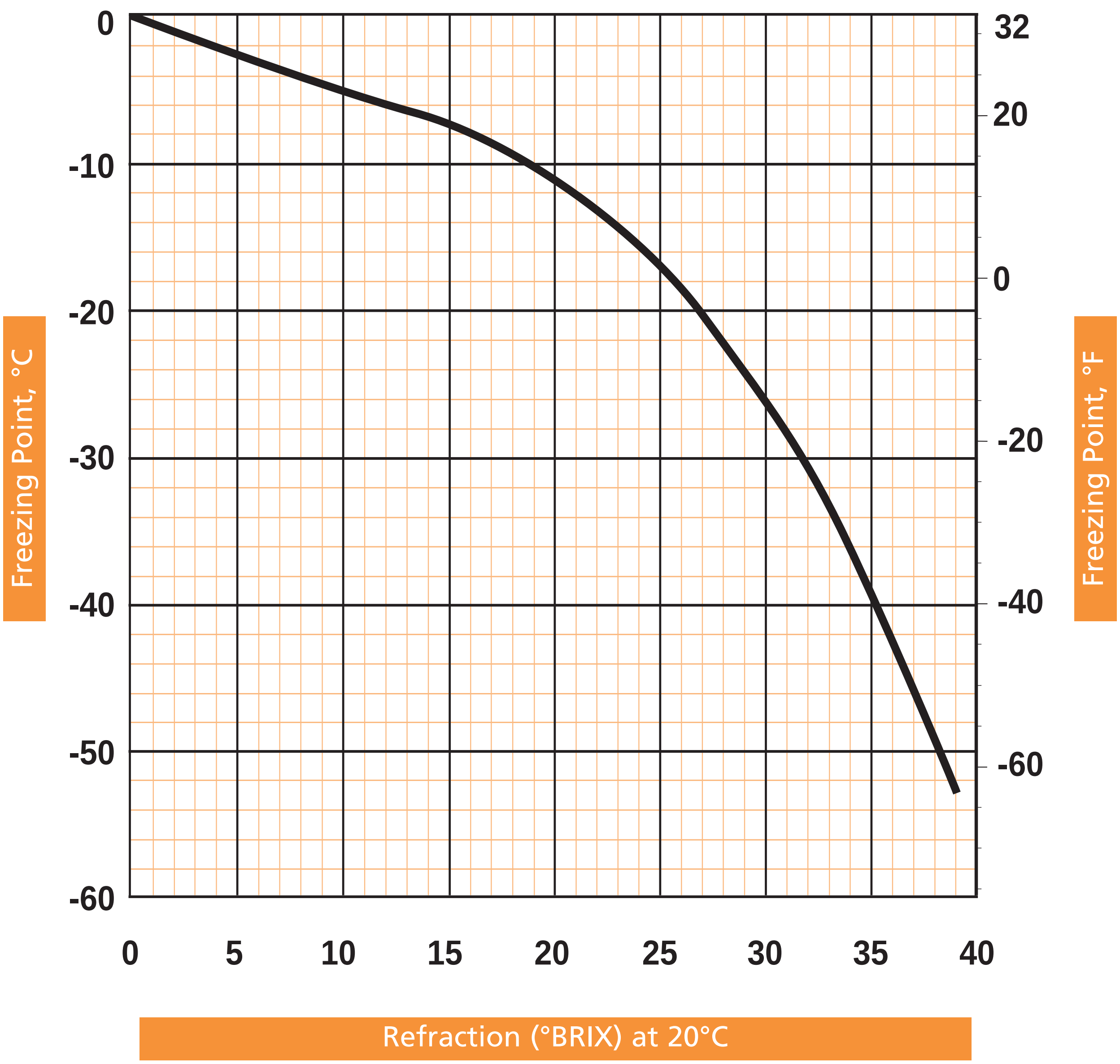


Figure 3

Freezing Point vs. Refraction (°Brix) at 20°C of UCAR PG ADF Aqueous Solutions



Aerodynamic Performance

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 become more likely to have a deleterious 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 aerodynamic characteristics as they flow off lifting and control surfaces during the takeoff ground acceleration.

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 whose takeoff rotation speeds generally exceed approximately 100 to 110 knots and with ground acceleration time exceeding about 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 approximately 60 knots and with ground acceleration time exceeding about 16 seconds.

When used in accordance with instructions and appropriate application procedures, aqueous dilutions of UCAR PG ADF Concentrate are designed to flow easily from aircraft surfaces during takeoff. As long as the freezing point buffer is met, UCAR PG ADFs having a refraction of 39°Brix or less conform to the high-speed aerodynamic acceptance test at or above -32°C (-25.6°F) and to the low-speed aerodynamic acceptance test above -25°C (-13°F). UCAR PG ADFs with a refraction at or above 39°Brix must not be used. Consult the aircraft manufacturer to find out if the aircraft to be deiced falls within the high-speed or the low-speed aerodynamic acceptance criterion. (See Freezing Point Buffer and Lowest Operational Use Temperature sections.) For aircraft deicing at temperatures below the lowest operational use temperature of UCAR PG ADFs, an ethylene glycol-based Dow aircraft deicing fluid should be considered. Contact your Dow representative for more information or visit us online at www.ucaradf.com.

Example: Water was mixed with UCAR PG ADF Concentrate. Refraction is measured at 41.5°Brix.
Question: Can the fluid be used on an aircraft?
Answer: No. The refraction is higher than 39°Brix.

Lowest Operational Use Temperature

The lowest operational use temperature (LOUT) of a deicing 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 10°C or 18°F.

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

Lowest Operational Use Temperature for High-Speed Aircraft

The following table illustrates the lowest operational use temperature of UCAR PG ADF Concentrate and some of its aqueous dilutions when applied to aircraft whose takeoff characteristics pertain to the high-speed aerodynamics acceptance test:

UCAR PG ADF Aqueous Solutions Lowest Operational Use Temperature (High-Speed Aerodynamics)

Volume Ratio UCAR PG ADF Concentrate/ Water	High-Speed Aerodynamics	Freezing Point	Lowest Operational Use Temperature for High-Speed Aircraft
100/0	-	Does not freeze	Do not use. Brix is above 39°
65/35	-32°C (-25.6°F)	-53°C (-63°F)	-32°C (-25.6°F)
60/40	-32°C (-25.6°F)	-44°C (-41°F)	-32°C (-25.6°F)
55/45†	-25°C (-13°F)	-36°C (-33°F)	-25°C (-13°F)
50/50	-24°C (-11.2°F)	-29°C (-20.2°F)	-24°C (-11.2°F)

† UCAR PG ADF Dilute "55/45"

Checklist for High-Speed Aircraft

What follows is a quick checklist to make sure that a UCAR PG ADF aqueous solution can be used on an aircraft whose takeoff characteristics pertain to the high-speed aerodynamic acceptance criterion. Before spraying the aircraft, determine the following:

1. Is refraction 39°Brix or less?
2. Is the OAT -32°C (-25.6°F) or above?
3. Is the freezing point of the fluid at least 10°C or 18°F below the OAT?

If all of the answers are yes, then the fluid meets the criteria and can be used.

Example: The UCAR PG ADF has a refraction of 39°Brix, the OAT is -40°C, and the aircraft is a large jet transport coming under the high-speed aerodynamic criterion. Does the fluid meet the freezing point buffer and the aerodynamic criteria?

1. Is refraction 39°Brix or less? – yes.
2. Is the OAT -32°C (-25.6°F) or above? – no.
3. Is the freezing point of the fluid at least 10°C or 18°F below the OAT? – yes.

Answer: One of the answers is no, thus the fluid cannot be used. Snow, frost, or ice must be removed by some other means, or wait until the OAT rises to -32°C. For aircraft deicing at temperatures below -32°C (-25.6°F), an ethylene glycol-based Dow aircraft deicing fluid should be considered. Contact your Dow representative for more information or visit us online at www.ucaradf.com.

Lowest Operational Use Temperature for Low-Speed Aircraft

The table at right illustrates the lowest operational use temperature of UCAR PG ADF Concentrate and some of its aqueous dilutions when applied to aircraft whose takeoff characteristic pertain to the low-speed aerodynamics acceptance test.

Checklist for Low-Speed Aircraft

What follows is a quick checklist to make sure that a UCAR PG ADF aqueous solution can be used on an aircraft whose takeoff characteristics pertain to the low-speed aerodynamic acceptance criterion. Before spraying the aircraft, determine the following:

1. Is refraction 39°Brix or less?
2. Is the OAT -25°C (-13°F) or above?
3. Is the freezing point of the fluid at least 10°C or 18°F below the OAT?

If all of the answers are yes, then the fluid meets the criteria and can be used.

Example: The UCAR PG ADF has a refraction of 39°Brix, the OAT is -20°C, and the aircraft is a small propeller driven aircraft coming under the low-speed aerodynamic criterion. Does the fluid meet the freezing point buffer and the aerodynamic criteria?

1. Is refraction 39°Brix or less? – yes.
2. Is the OAT -25°C (-13°F) or above? – yes.
3. Is the freezing point of the fluid at least 10° C or 18°F below the OAT? – yes.

Answer: All of the answers are yes, thus the fluid meets the criteria and can be used.

UCAR PG ADF Aqueous Solutions Lowest Operational Use Temperature (Low-Speed Aerodynamics)

Volume Ratio UCAR PG ADF Concentrate/ Water	Low-Speed Aerodynamics	Freezing Point	Lowest Operational Use Temperature for Low-Speed Aircraft
100/0	–	Does not freeze	Do not use. Brix is above 39°
65/35	-25°C (-13°F)	-53°C (-63°F)	-25°C (-13°F)
60/40	-25°C (-13°F)	-44°C (-47°F)	-25°C (-13°F)
55/45†	-24°C (-11°F)	-36°C (-33°F)	-24°C (-11°F)
50/50	-23°C (-9°F)	-29°C (-20.2°F)	-19°C (-2.2°F)

† UCAR PG ADF Dilute "55/45"

Water Spray Endurance Test

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

The standard WSET test, defined in SAE AS5901, is performed in a climatic chamber where the temperature is controlled at -5°C (23°F). At this temperature, aircraft deicing/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 deicing/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 in.) from the top edge, the elapsed test time is recorded as the WSET time.

Under these laboratory conditions, aqueous solutions of UCAR PG ADF Concentrate conform to the SAE AMS 1424 Type I fluid requirement of 3 minutes minimum. Typical values are listed in table 2.

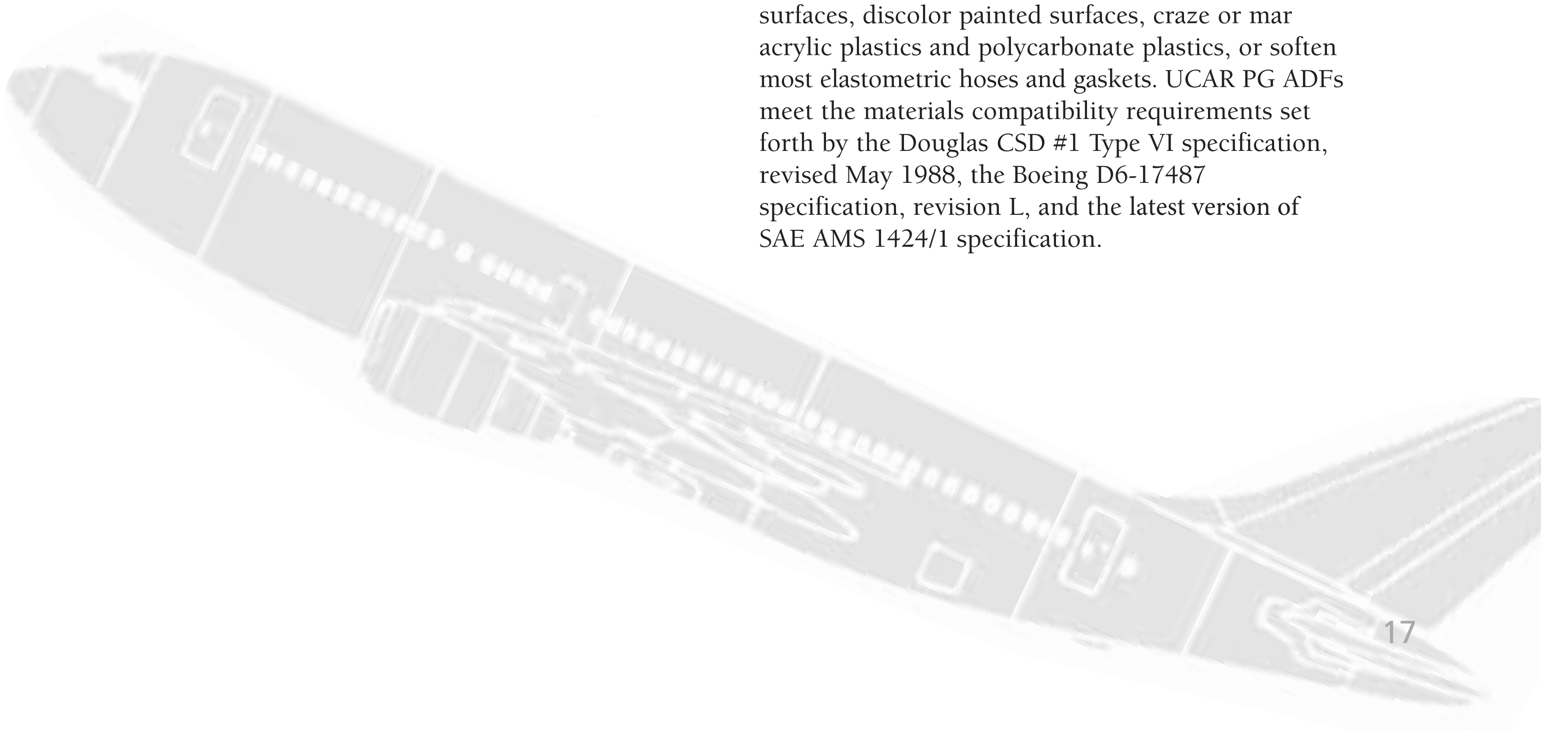
High-Humidity Endurance Test

The High-Humidity Endurance Test (HHET) was developed to provide quantitative laboratory data for comparing aircraft deicing/anti-icing fluids and to simulate deicing/aircraft anti-icing fluid behavior under certain frosting conditions. The standard HHET test, defined in SAE AS5901, 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 test, frost forms at the top of the panel and progressively spreads downward. When the frost reaches 2.5 cm (1 in.) from the top of the panel coated with the aircraft deicing/anti-icing fluid, the test is stopped and the elapsed time recorded.

Under these laboratory conditions, aqueous solutions of UCAR PG ADF Concentrate conform to SAE AMS 1424 Type I fluid requirement of 20 minutes minimum. Typical values are listed in table 2.

Materials Compatibility

UCAR PG ADFs contain a specially designed inhibitor package to minimize corrosion of aircraft materials of construction. Under normal and appropriate application procedures and conditions, UCAR PG ADFs are designed to not corrode metal surfaces, discolor painted surfaces, craze or mar acrylic plastics and polycarbonate plastics, or soften most elastometric hoses and gaskets. UCAR PG ADFs meet the materials compatibility requirements set forth by the Douglas CSD #1 Type VI specification, revised May 1988, the Boeing D6-17487 specification, revision L, and the latest version of SAE AMS 1424/1 specification.



Operational Properties

Color

UCAR PG ADFs are orange liquids. The color is added as a visual aid to assist in the application and detection of the fluid on aircraft surfaces. The dye is formulated to be degraded by ultraviolet light.

Suspended Matter

UCAR PG ADFs, as delivered, should be substantially free from suspended matter and homogeneous.

Hard Water Compatibility

UCAR PG ADFs are compatible with hard water as shown by the results of the SAE AMS 1424 testing. Should the fluid be diluted by the user with water containing up to 350 ppm hardness, the corrosion inhibitors will not precipitate out of solution. Therefore, the deicing fluid formulation continues to provide corrosion inhibition for storage systems and aircraft surfaces. Do not dilute with water above 350 ppm hardness as precipitates may form and may clog lines in application equipment and spray nozzles. UCAR PG ADF Dilute “55/45” is a ready-to-use formulation and further dilution with water is not required.

Physical Properties

Surface Tension

Thorough coverage of aircraft surfaces by the deicing fluid is essential to remove all frozen accumulations and prevent freezing of the residual fluid on aircraft surfaces. UCAR PG ADFs contain wetting agents that facilitate uniform wetting and spreading of the fluid on the surface of the aircraft. This is reflected by their low surface tension, see table 2.

Viscosity

Viscosities of UCAR PG ADFs are listed in Table 2.

Specific Gravity, pH, and Refraction

These properties are listed in table 2. There is additional information on refraction in figure 3 and table 1. The measurement of refraction is discussed in the Freezing Point Determination section.

Flash Point

During normal use, the fluid is nonflammable under proper storage and handling. The fluid has no flash point.

Table 2

Typical Performance, Operational and Physical Properties

Performance Properties	UCAR PG ADF Concentrate[†]	UCAR PG ADF Dilute "55/45"
Pour Point[(a) (c)]:		
°C	<-81	-36
°F	<-114	-33
Lowest Operational Use Temperature[†]:		
for high-speed aircraft	must be diluted	-25°C (-13°F)
for low-speed aircraft	must be diluted	-24°C (-11°F)
Material Compatibility:		
SAE AMS 1424D	conforms	conforms
Boeing D6-17487 revision L	conforms	conforms
Douglas CSD #1 Type VI	conforms	conforms
Operational Properties		
Color	orange	orange
Suspended Matter	substantially free	substantially free
Physical Properties		
Refraction:		
n_D^{20}	1.4211 - 1.4275	1.3856 - 1.3929
degrees Brix at 20°C	50.5 - 53.5	32.5 - 36.5
Specific Gravity[(b)]:		
20/20°C	1.040 - 1.060	1.035 - 1.055
pH at 25°C	8.0 - 9.0	7.5 - 8.5
Viscosity, centipoises:		
at 20°C (68°F)	38	34
at 0°C (32°F)	95	87
at -20°C (-4°F)	425	392
Flash Point, °F:		
Cleveland open cup (ASTM Method D92)	No Flash	No Flash
Pensky-Martens closed cup (ASTM Method D93)	No Flash	No Flash
Surface Tension, mN/m	40	38

(a) For freezing points of aqueous solutions, see figure 1, figure 3 and table 1.
(b) For density see the Shipping Data section.
(c) Freezing Point is for UCAR PG ADF Dilute "55/45".
† UCAR PG ADF Concentrate must be diluted before use (see the Performance Properties section).

Environmental Properties

Biodegradation

Organic chemicals can serve as food (substrate) for microorganisms. When aerobic bacteria oxidize organic matter, oxygen is consumed during the process and the amount required is proportional to the amount of organic material present. As long as oxygen is available, aerobic microbial decomposition of the organic matter will continue until the oxygen demand is satisfied. That is, it will continue until the aerobic microorganisms have oxidized all of the organic material they are capable of oxidizing. The amount of oxygen used during this process is defined as the biochemical oxygen demand (BOD).

The theoretical oxygen demand (ThOD) is the amount of oxygen required to completely oxidize an organic material to carbon dioxide and water. This value may be calculated on a theoretical basis from the composition of the organic material. If the chemical structure is not known or if it is a mixture, the chemical oxygen demand (COD) is determined by a standard dichromate chemical oxidation procedure. COD is usually a good estimate of theoretical oxygen demand. Note that the theoretical oxygen demand may not be reached as some substrates are converted to bacterial cellular material which degrades very slowly.

The biodegradability of a product may be evaluated by biochemical oxygen demand (BOD) tests. This procedure permits comparison of the amount of oxygen consumed by microorganisms in the standard oxidation (BOD) of the test material to the theoretical oxygen demand (ThOD) or chemical oxygen demand (COD). A quantitative way of expressing biodegradability is to take the ratio of BOD over ThOD (or COD) times 100; this ratio is known as the percentage biooxidation.

Laboratory BOD tests using unacclimated biomass indicate that UCAR PG ADF is rapidly biodegraded in a system which attempts to simulate the dilute biological conditions of a river or a lake. The mean of several BOD determinations on UCAR PG ADF Concentrate show that at 5, 10, and 20 days at 20°C there is 53, 64, and 79 percent biooxidation (see first comment), respectively. ThOD, COD, and BOD for UCAR PG ADF Concentrate are summarized in table 3.

Table 3

UCAR PG ADF Chemical Oxygen Demand, Biochemical Oxygen Demand, and Biodegradability

Chemical Oxygen Demand of UCAR PG ADF Concentrate (Kg O_2/Kg Fluid)			1.38
Biochemical Oxygen Demand (BOD) (Kg O_2/Kg Fluid)		5 day @ 20°C	0.7314
		28 day @ 20°C	1.0626
		5 day @ 5°C	0.0138
		28 day @ 5°C	0.4692
Biodegradability of UCAR PG ADF Concentrate:		% degraded at 20°C	% degraded at 5°C
	5 day	53%	1%
	10 day	64%	3%
	20 day	79%	3%
	28 day	77%	34%

UCAR PG ADFs should be readily biodegraded in both surface waters and in conventional wastewater treatment plants. However, large discharges of this or any other biodegradable substances could result in the temporary reduction or temporary depletion of dissolved oxygen levels in the receiving waterway, with a resultant adverse effect on aquatic life. Generally, low winter temperatures and increased dilution from storm water flow during periods of deicer use tend to minimize adverse effects on dissolved oxygen levels and aquatic life.

Effect on Aquatic Life

Aquatic tests on the reformulated UCAR PG ADF Concentrate with fathead minnows show that a concentration of 6.9 grams per liter (6,900 ppm) is required to kill approximately 50 percent of the exposed minnows (96-hour LC_{50}). Tests show that a concentration of 20.9 grams per liter (20,900 ppm) is required to kill approximately 50 percent of the exposed rainbow trout (96-hour LC_{50}). Additional tests on *Daphnia magna* show that a concentration of 19.2 grams per liter (19,200 ppm) is required to immobilize approximately 50 percent of exposed *Daphnia* (48-hour EC_{50}). Also, a concentration of 4.2 grams per liter (4,280 ppm) is required to immobilize approximately 50% of exposed *Ceriodaphnia dubia* (48-hour EC_{50}). Aquatic toxicity for UCAR PG ADF Concentrate is summarized in table 4.

Aircraft deicing or anti-icing fluids that are allowed to enter surface waters can have an adverse effect on aquatic life. For that reason, The Dow Chemical Company recommends that the runoff from deicing operations be contained and diverted to either a waste treatment system or a glycol reclamation system.

When it is not practical to contain runoff from deicing operations, and it is allowed to enter surface waters, there are two ways the diluted fluid can have an adverse effect on aquatic life. The first, described in the preceding paragraphs, involves oxygen depletion. The second, in which one or more of the components of the fluid are toxic to aquatic life, is expressed in the amount of fluid an organism can be exposed to before it is toxic to that organism. The aquatic testing requirements are spelled out in detail in the latest version of SAE AMS 1424.

Glycol Recovery

UCAR PG ADF Concentrate contains a high-quality grade of 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 and recertified where applicable.

Collection and Disposal

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

Environmental Impact

In summary, UCAR PG ADF Concentrate and its aqueous dilutions are readily biodegradable and relatively harmless to aquatic life as reported in tables 3 and 4. Collection and treatment, including glycol reclamation, of spent aircraft deicing and anti-icing fluids are recommended.

Table 4

UCAR PG ADF Aquatic Toxicity

	UCAR PG ADF Concentrate (mg/L)	UCAR PG ADF (at 85 wt% PG) (mg/L)	UCAR PG ADF (at -26°C Freezing Point) (mg/L)
Ceriodaphnia dubia 48 hour EC_{50}	4,280	4,431	8,376
Rainbow Trout 96 hour LC_{50}	20,900	21,636	40,900
Fathead Minnow 96 hour LC_{50}	6,900	7,143	13,503
Daphnia magna 48 hour EC_{50}	19,200	19,876	37,573

Storage, Handling, and Testing

Material Compatibility

UCAR PG ADFs, when stored as directed, are not corrosive and will not damage materials such as carbon steel, iron, aluminum, stainless steel, copper, and most fiberglass-reinforced plastics commonly used to construct storage tanks, transfer lines, and fittings. UCAR PG ADFs are also compatible with many elastomers used in hoses, gaskets, and seals, as shown.

UV Degradation

The orange dye in UCAR PG ADFs is designed to degrade upon exposure to ultraviolet (UV) light. When exposed to UV light, UCAR PG ADFs will progressively fade in color. UCAR PG ADFs will maintain their deicing properties, but the lack of orange color will make it more difficult to judge which section of the aircraft has been sprayed and which has not. 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 (dark colors tend to generate higher temperatures inside the container when exposed to sunlight).

Storage Tanks

Well-maintained carbon steel, coated carbon steel, opaque fiberglass-reinforced polyester, opaque polyethylene, aluminum, and stainless steel are satisfactory materials for storage tanks.

Compatibility of UCAR PG ADFs with Various Materials of Construction

Material	Propylene Glycol Temp°F	Propylene Glycol Rating
Alloy 20CbS	–	–
Aluminum	60-170	2
Brass	60-90	2
Bronze	60-210	2
Carbon Steel	60-210	2
Copper	60-90	2
Hastelloy B	60-90	2
Inconel	60-90	2
Monel	60-90	2
Nickel	60-90	2
S04 SS	60-90	2
316 SS	60-210	2
Titanium	60-90	1
ABS	80	
CPVC	50	
Epoxy	200	
Fluorocarbons FEP	400	
Fluorocarbons TFE	470	
Furfuryl Alcohol	250	
Chlorinated Polyesters	100	
Polyethylene	140	
Polypropylene	140	
PVC	50	
Vinyl Ester	210	
Viton A	90	
Neoprene GR-M (CR)	80	
Nitrile Buna N (NBR)	80	

Rating Code
Metals: 1 = <2 mlls/year, 2 = <20 mlls/year
Plastics & Elastomers: Temperature indicates upper limit

Receiving UCAR PG ADF Concentrate

Prior to unloading UCAR PG ADF Concentrate, check the shipping documents and product label, the refraction, the color, and for suspended matter (for a description of the tests, see the Field Tests section).

- Make sure that the shipping documents and product label are indeed for UCAR PG ADF Concentrate.
- Measure the refraction and make sure it is in the range 50.5° to 53.5°Brix.
- Verify that the color is orange.
- Check for suspended matter.
- Keep the sample for one year in an opaque bottle.

If the shipping documents or product label show the fluid not to be UCAR PG ADF Concentrate, or the Brix reading of the delivered product does not fall in the acceptable range, or if the color is not orange, or if the fluid is not substantially free from suspended matter or has oily residues, do not use the product. Contact your Dow representative immediately. In particular, do not unload a shipment of UCAR PG ADF Concentrate into your storage container or deicing truck if any of these requirements are not met.

Receiving UCAR PG ADF Dilute “55/45”

Prior to unloading UCAR PG ADF Dilute “55/45”, check the shipping documents and product label, the refraction, the color, and for suspended matter (for description of the tests, see Field Tests section).

- Make sure that the shipping documents and product label are indeed for UCAR PG ADF Dilute “55/45”.
- Measure the refraction and make sure it is in the range 32.5° to 36.5°Brix.
- Verify that the color is orange.
- Check for suspended matter.
- Keep the sample for one year in an opaque bottle.

If the shipping documents or product label show the fluid not to be UCAR PG ADF Dilute “55/45”, or the Brix reading of the delivered product does not fall in the acceptable range, or if the color is not orange, or if the fluid is not substantially free from suspended matter or has oily residues, do not use the product. Contact your Dow representative immediately. In particular, do not unload a shipment of UCAR PG ADF Dilute “55/45” into your storage container or deicing truck if any of these requirements are not met.

Field Tests and Acceptable Range of Results

This section gives a brief description of the field tests and the acceptable range associated with those tests for UCAR PG ADFs.

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. For instance, if you expect to have or receive UCAR PG ADF Concentrate, the label must read "UCAR PG ADF Concentrate."

Color. UCAR PG ADFs are orange. If the color is different, the sample is considered unacceptable. The acceptable color range for UCAR PG ADF aqueous solutions is "orange." Sight tubes on trucks or storage tanks must not be used to judge the color of UCAR PG ADFs contained within the vessel because the fluid fades when exposed to UV light (see the UV Degradation section).

UCAR Aircraft Deicing Fluid/Aircraft Anti-icing Fluid (ADF/AAF) ULTRA+ is green. UCAR ADF Concentrate, UCAR ADF XL 54, and UCAR ADF "50/50" 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 and shipping papers and refraction.

Refraction. The use of the refractometer with the Brix scale is explained in the Freezing Point Determination section. The acceptable refraction range for UCAR PG ADF Concentrate is 51.0–53.0°Brix. The acceptable refraction range for UCAR PG ADF Dilute "55/45" is 32.5° to 36.5°Brix. Since the user dilutes UCAR PG ADF Concentrate depending on his own needs, the user has to set the acceptable range depending on the OAT. Users are also reminded that before using UCAR PG ADF aqueous solutions, the lowest operational use criteria (freezing point buffer and aerodynamics) must be met (see the Lowest Operational Use Temperature section).

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 is "substantially free."

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 for UCAR PG ADF Concentrate is 8.0 to 9.0. The acceptable pH range for aqueous dilutions of

UCAR PG ADF is 7.5 to 8.5.

Sampling. Whenever collecting samples, it is important to obtain a representative sample. A sampling guideline is available from your Dow representative or can be downloaded from www.dow.com/en-us/aircraft/resource-center.

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, and pH of UCAR PG ADFs to make sure it has not been degraded or contaminated. Test samples from delivery vessels, storage tanks, and aircraft deicing truck tanks. Use the fluid only if the label, color, refraction, suspended matter, and pH are within the accepted range.

Whenever water is mixed with UCAR PG ADFs check the color, refraction, and suspended matter of the resulting fluid mixture. Use only if the test results 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 UCAR PG ADF Concentrate and Receiving UCAR PG ADF Dilute “55/45”sections.

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. Be aware of the following:

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 rinse with UCAR PG ADF aqueous solutions with the appropriate refraction before putting the deicing truck into service.

Leaky covers. Some deicing trucks or storage tanks have covers which can allow rainwater or melted snow into the tank, leading to unwanted dilution and contamination. Make sure that the tank covers of the trucks or of the storage tank do not allow water into 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 (and 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 small amounts of deicing fluid in the anti-icing fluid can cause significant performance problems. Make sure the tanks do not leak. Some of these trucks also 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 PG ADF from a deicing/anti-icing truck into the UCAR PG ADF storage tank. If there were contamination in the truck, contamination would propagate to the entire storage tank.

Dedicated equipment. Use dedicated storage and handling facilities for UCAR PG ADF. 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 vessels—make sure that it is really the transfer that you intended to make. Labels/decals for UCAR PG ADF Concentrate and UCAR PG ADF Dilute "55/45" are available from your Dow representative.

Forbidden mixtures. Do not mix UCAR PG ADFs with any other product. This includes, but is not limited to, UCAR ADF/AAF ULTRA+, UCAR ADF "50/50", UCAR ADF XL 54, and UCAR ADF Concentrate, 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, ethylene glycol, or propylene glycol.

Pumps

UCAR PG ADFs are shear stable and can be transferred with commercially available pumps (e.g., centrifugal, gear, progressive cavity, diaphragm) without affecting their performance. The viscosity of the fluid increases as its temperature is lowered. Additional pumping power may be required to pump the fluid at temperatures close to its freezing point. The user should always check that the design and construction of the deicing storage system are appropriate for use with UCAR PG ADFs. UCAR PG ADFs may be filtered.

Heating UCAR PG ADFs

Standby heated storage. Ideally UCAR PG ADF should be stored unheated. It may be maintained in heated standby storage before or during the active deicing events to save time when heating to the final application temperature. If heated, the fluid should be kept in standby mode at a temperature less than 60°C (140°F). Avoid unnecessary heating during idle times as there may be thermally induced degradation (see the Thermal Degradation section).

Heating for application. For application to the aircraft, UCAR PG ADFs should be heated, but to no more than 82°C (180°F); see the Spraying section for application temperatures. The surface temperature of any heating element should not exceed 121°C (250°F) to prevent thermal degradation of the ethylene glycol. If the UCAR PG ADF begins to boil, immediately lower the amount of energy being supplied to the heating element.

Evaporation. As UCAR PG ADFs are heated (standby heating or heating for application), there may be water evaporation resulting in an increase in the glycol concentration and of the refraction. Verify the refraction regularly to make sure that the deicing fluid refraction and freezing point are within the acceptable range. Try to minimize evaporation by keeping the lids closed on deicing equipment but keep vents open at all times to avoid a pressure build-up. Water loss due to evaporation can be replenished by direct addition to the tank. The addition of the appropriate quantity of water or deicing fluid to the tank must be accompanied by a sufficient mixing process, such as recirculation. Measure the refraction of the UCAR PG ADF solution in the storage tank following any addition of water (or deicing fluid) in order to confirm that the fluid retains the proper freezing point.

Thermal degradation. A lowering of pH or an increase in glycol concentration (increase in refraction) or discoloration are indicative of thermal degradation.

Shelf Life

Properly used and stored UCAR PG ADFs are formulated with components that should be stable under unheated storage conditions. However, periodic testing of the fluid is prudent to ensure that the fluid is still acceptable for use. UCAR PG ADFs stored for one year should be sampled and tested for conformance to specification for color, suspended matter, pH, and refraction. 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 PG ADFs should be checked more often and regularly.

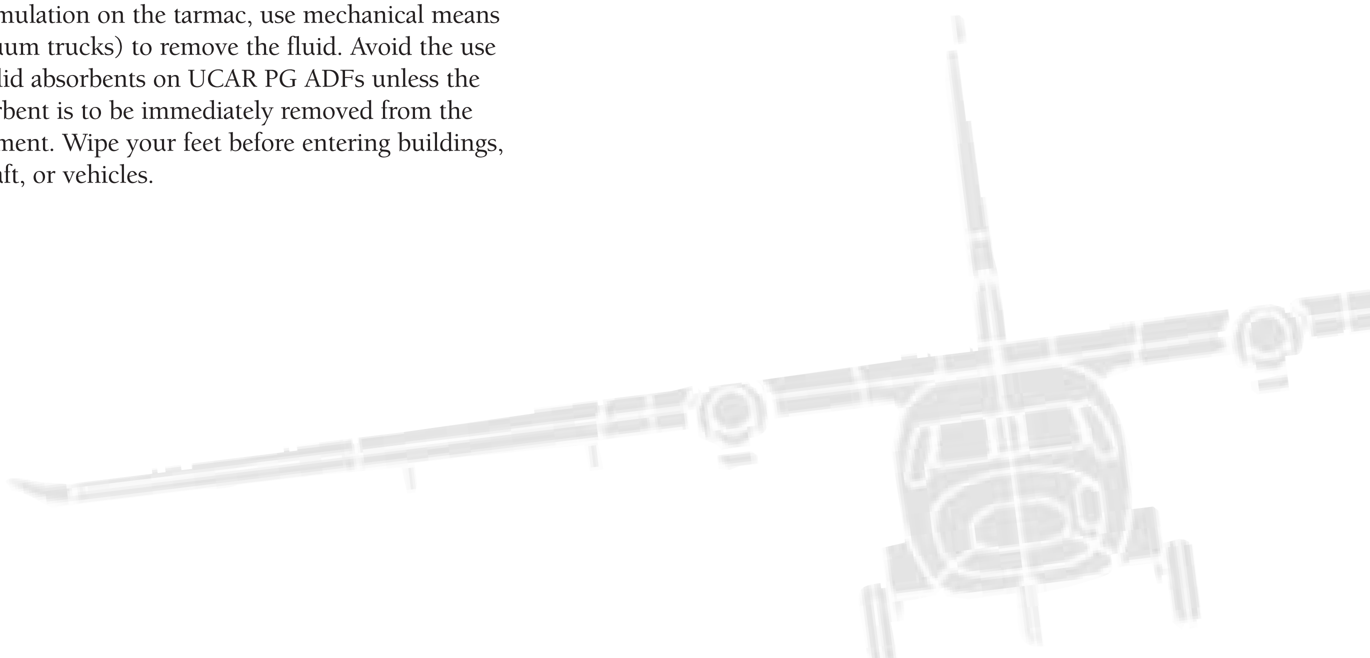
Tarmac

Areas sprayed with UCAR PG ADFs may become slippery. Exercise caution in walking or in operating equipment on tarmac areas where the fluid has dripped. Do not cover slippery areas with excessive sand as this may further degrade friction. If there is accumulation on the tarmac, use mechanical means (vacuum trucks) to remove the fluid. Avoid the use of solid absorbents on UCAR PG ADFs unless the absorbent is to be immediately removed from the pavement. Wipe your feet before entering buildings, aircraft, or vehicles.

Equipment Inspections

Tank inspection. Inspect storage tanks and deicing trucks at least once a 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. Corrosion in carbon steel tanks most often occurs in the vapor space of partially empty tanks by evaporation and subsequent condensation of water from the deicing fluid. To prevent corrosion, keep tanks containing aircraft deicing fluid full during the summer and other periods of low use.

Application equipment inspection. Before using UCAR PG ADFs, test application equipment on at least an annual basis. Routine calibration and recertification of each instrument 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 deicing and anti-icing recommendations for various aircraft. Obtain and follow these specific recommendations. Understand industry aircraft deicing and anti-icing application standard practices, such as the most recent version of the Society of Automotive Engineers Aerospace Standard (SAE AS6285. Also follow applicable government reg-ulations, 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.

One-Step Deicing with Forced Air/Fluid

Some deicing fluid truck manufacturers sell “forced air” trucks. Some of these trucks are equipped to spray small amounts of fluid into or on top of an air stream. This type of application is suitable only when there is no active precipitation or, if there is active precipitation, when followed by the application of deicing fluid, without forced air, in accordance with SAE AS6285.

One-Step Deicing/Anti-icing

One-step deicing/anti-icing is generally used with deicing fluids when the aircraft is contaminated and when there is no precipitation or when the precipitation is low in intensity, that is when the expected holdover time for Type I fluid will not be exceeded.

One step. Apply hot UCAR™ PG ADF until all the snow, ice, and frost are removed from the aircraft.

UCAR PG ADFs are SAE Type I deicing/anti-icing fluids. SAE Type I fluids offer very limited protection against refreezing and ice or snow buildup during precipitation or frost-forming conditions. Precipitation dilutes the fluid, raises its freezing point, and permits freezing to occur on the surface of the aircraft. When precipitation is higher in intensity, protection time may be extended by applying UCAR FLIGHTGUARD AD-49 in a two-step deicing/anti-icing procedure according to the instructions provided in its product information bulletin.

Two-Step Deicing/Anti-icing

First step. Apply hot UCAR PG ADF until all the snow, ice, and frost are removed from the aircraft.

Second step. Apply the UCAR FLIGHTGUARD AD-49 to aircraft surfaces before the residual UCAR PG ADF aqueous solution on the aircraft freezes.

Performance of some other anti-icing fluids may be adversely affected when they come into contact with UCAR PG ADFs and thus they should be applied according to their respective manufacturer’s instructions and those of the latest revision of the SAE AS6285.

Spraying

Application temperature and velocity. UCAR PG ADFs are most effective when heated from 65°C (150°F) to 82°C (180°F) and applied at higher velocity (when compared to the application of anti-icing fluids) to dislodge and melt frozen accumulations. The thermal and mechanical energies of the hot fluid melt, dislodge, and flush away frozen accumulations. See the Heating UCAR PG ADFs section.

Pressure. Do not exceed pressures specified by airframe manufacturers to avoid mechanical damage to the aircraft. UCAR PG ADFs will not shear degrade when handled by a variety of commercially available pumps. See the Pumps section.

Heat loss. Dispense the hot UCAR PG ADFs 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.

Application to the entire surface. 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 onto the surface of the wing, making it less effective, or even ineffective, in melting frozen contamination on the aft part of the wing.

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

Sufficient quantity. Apply the hot UCAR PG 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 aircraft surface, you can determine its freezing point by checking its refraction.

Areas to be deiced. Check with the aircraft manufacturer. All critical surfaces must be free of ice, snow, and frost.

Trained personnel. Use only trained personnel to apply UCAR PG ADFs safely. Personnel should be advised to read, understand, and follow the precautions listed in this bulletin, the Material Safety Data Sheet (MSDS), and on the product label before using UCAR PG ADFs.

Holdover Time and Protection Time

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. It is extremely difficult to accurately predict the protection time of an aircraft anti-icing fluid in real weather conditions.

Extrapolation of laboratory 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. Unlike laboratory tests, outside precipitation rates can vary significantly from moment to moment and are known to reach rates higher than 40 grams per square decimeter per hour which is much higher than the 5 grams per square decimeter per hour of the laboratory WSET test.

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.

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.

There are many variables affecting the protection time: 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. These variables can affect the holdover times.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.

These holdover timetables are to be used with a conventional method of fluid application. Manufacturers of aircraft deicing fluid trucks are now producing "forced air" trucks. These trucks are designed to use "air only," "air with fluid injection," or "air with fluid applied on top of the air stream." It is important to note that published holdover time guidelines shall not be used when using forced air/fluid unless followed by the application of deicing fluid without forced air, in accordance with SAE AS6285.

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 ice, snow, or frost.

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

Times of protection are shortened:

- in heavy weather conditions
- by high winds
- by jet blast
- by aircraft skin 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.

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, buildup of ice crystals in or on the fluid, or the presence of slush. When the fluid has lost its effectiveness, another complete deicing of the aircraft must be done before it should be permitted to take off. A pre-takeoff check of the aircraft is the only way of determining if an aircraft is free of ice and snow.

Precautions

UCAR PG Aircraft Deicing Fluids are only recommended for application on aircraft exterior surfaces.

DO NOT use UCAR PG Aircraft Deicing Fluids to deice or anti-ice:

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

DO NOT spray UCAR PG Aircraft Deicing Fluids directly into engines or auxiliary power units (APU).

DO NOT use UCAR PG Aircraft Deicing Fluids as antifreeze for:

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

DO NOT spray UCAR PG Aircraft Deicing Fluids 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 PG Aircraft Deicing Fluids unless it has been drained and cleaned.

DO NOT use recycled UCAR PG Aircraft Deicing Fluids to deice or anti-ice any aircraft.

Read the Safety Data Sheet before using this product.

For more information regarding UCAR Aircraft Deicing Fluid products, contact your Dow sales representative.

Shipping Data

	UCAR PG ADF Concentrate	UCAR PG ADF Dilute “55/45”
Average Weight per Gallon, lb.		
at 20°C (68°F)	8.7183	8.6618
at 15.6°C (60°F)	8.7431	8.6861
Average Weight per Liter, kg		
at 20°C (68°F)	1.0448	1.03803
at 15.6°C (60°F)	1.0478	1.0409
Coefficient of Expansion, per °C		
at 20°C (68°F)	0.00068	0.00057
at 55°C (130°F)	0.00075	0.00072
Flash Point		
Cleveland open cup (ASTM Method D92)	No Flash	No Flash
Pensky-Martens closed cup (ASTM Method D93)	No Flash	No Flash

(Determined on typical commercial material. Subject to change without notice).

Product Stewardship

The Dow Chemical Company has a fundamental concern for all who make, distribute, and use our family of aircraft deicing and anti-icing fluids, and the environment we share. This concern is the basis for our Product Stewardship philosophy, by which we assess all available information on our products and then take appropriate steps to protect employee and public health and the environment. In addition, Dow is committed to implementing the guiding principles and management practices of the chemical industry's Responsible Care† initiative, which includes Product Stewardship as one of the Management Practices. As part of our Product Stewardship effort, information such as Safety Data Sheets and literature on Dow aircraft deicing and anti-icing fluids are provided to assist customers in handling our products in a safe and responsible manner.

† Service mark of the American Chemistry Council (ACC)

Emergency Service

The American Chemistry Council (CHEMTREC), Transport Canada (CANUTEC), and the National Chemical Emergency Center maintain 24-hour emergency service.

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, which 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.

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