U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: Approval and Use of Fuel System Icing Inhibitors (FSII)

Date: 03/27/2024

Initiated By: AIR-625

AC No: 20-29C

1 PURPOSE.

This advisory circular (AC) describes an acceptable method to demonstrate compliance with Title 14, Code of Federal Regulations (14 CFR) §§ 23.2620(a)(1), 25.1583(b)(1), 27.1583(b)(1), 29.1583(b)(1), 33.7(b)(2), and 33.7(c)(2) regarding the requirements for the approval and use of Fuel System Icing Inhibitors (FSII) in engines and aircraft. Additional guidance on specifications and standards applicable to FSII is also provided.

2 APPLICABILITY.

2.1 The guidance in this AC applies to engine, auxiliary power unit, airplane, and rotorcraft manufacturers and modifiers; operators of airplanes and rotorcraft; airport into-plane fuel providers; and other handlers and distributors of FSII intended for aviation use.

The contents of the document do not have the force and effect of law and are not meant to bind the public in any way. The document is intended only to provide information to the public regarding existing requirements under the law or agency policies. This AC describes an acceptable means, but not the only means, to demonstrate compliance with the requirements for the approval and use of FSII in engines and aircraft in §§ 23.2620(a)(1), 25.1583(b)(1), 27.1583(b)(1), 29.1583(b)(1), 33.7(b)(2), and 33.7(c)(2).

3 CANCELLATION.

This AC cancels AC 20-29B, *Use of Aircraft Fuel Anti-Icing Additives*, dated January 18, 1972.

4 RELATED READING MATERIAL.

The following materials are referenced in this document. Unless otherwise indicated, you should use the current edition from the FAA.

4.1 **Title 14, Code of Federal Regulations (CFRs), §§:**

- 23.1529, *Instructions for continued airworthiness*.
- 23.2430, *Fuel Systems*.
- 23.2610, *Instrument markings, control markings, and placards*.
- 23.2620, *Airplane flight manual*.
- 25.951, *General*.
- 25.1529, *Instructions for Continued Airworthiness*.
- 25.1541, *General.*
- 25.1557, *Miscellaneous markings and placards*.
- 25.1583, *Operating limitations.*
- 27.951, *General*.
- 27.1529, *Instructions for Continued Airworthiness*.
- 27.1541, *General.*
- 27.1557, *Miscellaneous markings and placards*.
- 27.1583, *Operating limitations*.
- 29.951, *General*.
- 29.1529, *Instructions for Continued Airworthiness*.
- 29.1541, *General.*
- 29.1557, *Miscellaneous markings and placards*.
- 29.1583, *Operating limitations.*
- 33.4, *Instructions for Continued Airworthiness*.
- 33.7, *Engine ratings and operating limitations.*
- 33.15, *Materials.*
- 33.67, *Fuel system*.

4.2 **FAA Publications.**

- AC 20-24, *Approval of Propulsion Fuels, Additives, and Lubricating Oils*.
- AC 20-113, *Pilot Precautions and Procedures to be taken in Preventing Aircraft Reciprocating Engine Induction System and Fuel System Icing Problems*.
- AC 20-125, *Water in Aviation Fuels*.

4.3 **Non-FAA Documents**

- EASA Certification Memorandum, *Fuel Specification Changes*, CM No.: EASA CM – PIFS – 009

4.4 **Industry Standards.**

The following industry publications from the American Society for Testing and Materials (ASTM), Airlines for America (formerly the Air Transport Association (ATA)), the Defense Standard ("Def Stan"), the Energy Institute (EI), the Joint Inspection Group (JIG), the Military – Detail Specification ("MIL-DTL"), and the North Atlantic Treaty Organization (NATO) provide additional information, guidance, and standards on FSII.

- ASTM D910, *Standard Specification for Leaded Aviation Gasolines*.
- ASTM D1655, *Standard Specification for Aviation Turbine Fuels.*
- ASTM D3240, *Standard Test Method for Undissolved Water In Aviation Turbine Fuels*.
- ASTM D4054, *Standard Practice for Evaluation of New Aviation Turbine Fuels and Fuel Additives*.
- ASTM D4171, *Standard Specification for Fuel System Icing Inhibitors*.
- ASTM D4815, *Standard Test Method for Determination of MTBE, ETBE, TAME, DIPE, tertiary-Amyl Alcohol and C1 to C4 Alcohols in Gasoline by Gas Chromatography*.
- ASTM D5006, *Standard Test Method for Measurement of Fuel System Icing Inhibitors (Ether Type) in Aviation Fuels*.
- ASTM D6227, *Standard Specification for Unleaded Aviation Gasoline Containing a Non-hydrocarbon Component.*
- ASTM D6615, *Standard Specification for Jet B Wide-Cut Aviation Turbine Fuels*.
- ASTM D7547, *Standard Specification for Hydrocarbon Unleaded Aviation Gasoline*.
- ASTM D7566, *Standard Specification for Aviation Turbine Fuel Containing Synthesized Hydrocarbons*.
- ASTM D7826, *Standard Guide for Evaluation of New Aviation Gasolines and New Aviation Gasoline Additives*.
- ASTM MNL5, *Aviation Fuel Quality Control Procedures.*
- ATA 103, *Standard for Jet Fuel Quality Control at Airports*.
- Def Stan 68-150, *Mixture of Fuel System Icing Inhibitor and Lubricity Improving Additive Joint Service Designation: AL-48*.
- Def Stan 68-252, *Fuel System Icing Inhibitor NATO Code: S-1745, Joint Service Designation: AL-41*.

- Def Stan 91-086, *Turbine Fuel, Aviation Kerosene Type: High Flash Type Containing Fuel System Icing Inhibitor* NATO Code: F-44, Joint Service Designation: AVCAT/FSII.
- Def Stan 91-087, *Turbine Fuel, Aviation Kerosene Type, Containing Fuel System Icing Inhibitor NATO Code: F-34 JSD: AVTUR/FSII.*
- Def Stan 91-090, *Gasoline, Aviation: Grades 80/87, 100/130 and 100/130 Low Lead. Joint service Designation: AVGAS 80, AVGAS 100 and AVGAS 100LL.*
- Def Stan 91-091, *Turbine Fuel, Kerosene Type, Jet A-1; NATO Code: F-35, Joint Service Designation: AVTUR*.
- EI IP 424, *Determination of fuel system icing inhibitor content of aviation turbine kerosenes by high performance liquid chromatography*.
- EI IP 566, *Liquid Petroleum Products - Determination of hydrocarbon types and oxygenates in automotive-motor gasoline - Multidimensional gas chromatography method*.
- EI 1540, *Design, construction, commissioning, maintenance and testing of aviation fueling facilities*.
- EI 1581, *Specifications and laboratory qualification procedures for aviation fuel filter/water separators*.
- EI 1583, *Laboratory tests and minimum performance levels for aviation fuel filter monitors.*
- JIG 2, *Aviation Fuel Quality Control & Operating Standards for Airport Depots & Hydrants.*
- JIG 1, *Aviation Fuel Quality Control & Operating Standards for Into-Plane Fueling Services.*
- MIL-DTL-5624, *Turbine Fuel, Aviation, Grades JP-4 and JP-5*.
- MIL-DTL-83133, *Turbine Fuel, Aviation, Kerosene Type, JP-8 (NATO F-34), NATO F-35, and JP-8+100 (NATO F-37)*.
- MIL-DTL-85470, *Detail Specification: Inhibitor, Icing, Fuel System, High Flash NATO Code Number S-1745*.
- NATO AFLP – 3747, *Guide Specifications (Minimum Quality Standards) for Aviation Turbine Fuels (F-24, F-27, F-34, F-35, F-37, F-40 AND F-44).*

4.5 DEFINITIONS.

The following terms and definitions apply to this AC.

- **Biocide.** A chemical substance or microorganism intended to destroy, deter, render harmless, or exert a controlling effect on any harmful organism by chemical or biological means.

- **Conventional Materials.** Those fuel system materials utilized in the current fleet of gas turbine-powered aircraft. See ASTM D4054 for a listing of turbine engine conventional materials and ASTM D7826 for piston engine conventional materials.
- **Dissolved Water.** Water that exists in the same phase as fuel and is inseparable from the fuel. Dissolved water cannot be removed by conventional means, such as settling, filtration system, or measured by field equipment.
- **Entrained Water.** Free water droplets that are suspended in the fuel and exist in a separate phase from the fuel.
- **Free Water (or undissolved water).** Water that is above the fuel saturation limit that exists in a separate phase from the fuel, as a separate layer with identifiable boundaries or entrained water.
- **Saturation Level.** The saturation level is the maximum ability of fuel to hold dissolved water in a solution.

5 BACKGROUND.

5.1 Ice Formation in Aircraft Fuel Systems.

5.1.1 Ice formation in aircraft fuel systems is a known threat to the continued safe operation of the aircraft due to the potential impact of icing on fuel flow and the proper functioning of the aircraft fuel system. Ice can form in aviation fuel due to trace levels of water present in fuel and aircraft fuel tanks. Due to changing ambient conditions, fuel in the aircraft fuel tank will absorb water from the atmosphere. See Appendix A for information about water absorption by aviation fuels. See AC 20-113 for additional guidance and information on ice formation in aircraft fuel systems.

5.1.2 FAA airworthiness standards include a requirement that airplanes, engines, and rotorcraft demonstrate the ability to continue operating in conditions that are conducive to ice formation in the fuel system.[1] Compliance with this requirement typically involves either equipping the engine fuel system with a fuel-oil heat exchanger or requiring the use of FSII in the fuel. Larger airplanes, rotorcraft, and engines are typically equipped with a fuel-oil heat exchanger that heats the fuel and water to above-freezing temperatures to prevent ice formation.

5.1.3 Aircraft fuel system components (e.g., valves, pumps, intertank transfer lines/flapper valves, etc.) are part of the fuel system for turbine-powered engines. Design features of the fuel system are qualified through tests to perform their intended function during fuel icing conditions during certification (see Section 6.0).

1 14 CFR §§ 25.951(c), 27.951(c), 29.951(c), and 33.67(b)(4)(ii) require turbine engine fuel systems to be capable of sustained operation throughout its flow and pressure range with fuel initially saturated with water at 80°F and having 0.75 cc (or 0.025 ounces or 0.75ml or 198 parts per million by volume (ppmv)) of free water per gallon added and cooled to the most critical condition for icing likely to be encountered in operation.

5.1.4 FSII use is a compliance method with the fuel system icing requirements. When this method is selected to comply with fuel system icing requirements, the use of the additive becomes mandatory. The FSII additive must then be listed as a limitation in the aircraft flight manual (see Section 6.0). Markings at the refueling locations are also required (see Section 7.1).

5.2 **FSII Background.**

5.2.1 In the early 1960s, the U.S. military approved ethylene glycol monomethyl ether (EGME) as an aviation FSII additive used in military jet fuels. This action was in response to aircraft accidents caused by ice formation in jet fuel and associated fuel line blockages; however, the U.S. Navy experienced challenges meeting the military fuel flashpoint specification (≥60°C) in JP-5 fuel that contained EGME. In addition, there were human safety concerns because EGME is highly toxic. In the late 1980s, diethylene glycol monomethyl ether (DiEGME) replaced EGME as the FSII additive specified in civil and military jet fuel specifications worldwide. DiEGME is an acceptable alternative FSII for those aircraft approved for use with EGME. The following industry publications specify the acceptable concentrations of DiEGME in jet fuel:

- ASTM D1655, ASTM D6615, and ASTM D7566 specify that DiEGME, which meets the ASTM D4171 (Type III) requirements, be permitted in jet fuel in concentrations of 0.07 to 0.15 percent by volume. Additionally, the test method specified in ASTM D5006 can determine the concentration of DiEGME in jet fuel.
- DiEGME, which meets the MIL-DTL 85470 requirements, is specified as a mandatory additive at a concentration of 0.07 to 0.10 percent by volume in MIL-DTL-83133 for JP-8 and NATO AFLP-3747 for F-24. The required concentration range in MIL-DTL-5624 is 0.10 to 0.15 percent by volume for JP-4, and 0.08 to 0.11 percent by volume for JP-5.
- Def Stan 91-086, 91-087, and 91-091 specify that DiEGME, which meets the Def Stan 68-252 requirements, be permitted for use in concentrations of 0.10 to 0.15 percent by volume. Additionally, the test methods specified in EI IP 424 and ASTM D5006 can be used to determine the concentration of DiEGME present in jet fuel. Def Stan 91-091 also permits additive blend AL48 to be used when both DiEGME and lubricity improver additive are required. See DEF Stan 68-150 for the requirements for the AL48 additive blend.
- Both DiEGME and Isopropyl Alcohol ("IPA") are specified for use in the primary aviation gasoline specifications. ASTM D910, D6227, and D7547 specify that IPA meeting the ASTM D4171 (Type II) requirements be permitted for use in concentrations recommended by the aircraft manufacturer. ASTM D910, D6227, and D7547 specify that DiEGME meeting the ASTM D4171 (Type III) requirements be permitted in concentrations of 0.10 to 0.15 percent by volume, and that ASTM D5006 can be used to determine the concentration of DiEGME in aviation gasoline. Def Stan 91-090 also specifies similar requirements for DiEGME and IPA. Additionally, suitable methods for determining IPA concentration are specified in EI IP 526 and ASTM D4815.

Note: This AC provides guidance for DiEGME approval and use. The guidance that applies to IPA will be noted.

5.2.2 Extensive tests conducted by the U.S. Navy and U.S. Air Force, coupled with many years of service experience, has confirmed that DiEGME does not adversely affect jet fuel properties or performance at the specified concentration levels. However, certain military aircraft have experienced fuel tank coating peeling attributed to the use of DiEGME at the higher end of the previously specified 0.10 to 0.15 percent by volume concentration range. The proposed fuel tank topcoat peeling mechanism is related to the condensation of FSII rich fuel vapors in the ullage. In studies that investigated a reduction in the DiEGME concentration range, the U.S. Air Force confirmed that anti-icing efficacy should be maintained at typical water contamination levels in aviation fuel provided the DiEGME concentration is greater than 0.04 percent by volume. Consequently, to accommodate expected losses during fuel handling and transportation and ensure the DiEGME concentration in the aircraft fuel tank consistently exceeds 0.04 percent by volume, the 0.07 to 0.10 percent by volume concentration ranges specified in MIL-DTL-83133 for JP-8 and NATO AFLP-3747 for F-24 were selected.

5.2.3 FSII Functional Mechanism.

The DiEGME's molecular structure enables the additive to navigate through the fuel/water mixture and inhibit the freezing of free water residing in the fuel system. The DiEGME's molecular structure is composed of both polar and non-polar chemical groups. The non-polar groups enable DiEGME to be soluble in jet fuel, while the polar groups promote DiEGME migration (partitioning) into the free water phase in the fuel. The polar groups then interact with the polar water molecules to depress the freezing point temperature of the final mixture. A ratio of greater than one part DiEGME to one part water in the water phase is typically necessary to depress the freezing point of the free water to that of the jet fuel freezing point.

5.2.4 Microbial Contamination.

The presence of free water in fuel can promote the growth of microorganisms, such as bacteria, yeast, and mold. This microbial contamination in fuel tanks can lead to fuel system operational problems due to filter plugging, corrosion of metallic structures (e.g., wing tanks), degradation of protective coatings, alloys and electrical insulation, and impaired fuel sensor readings. These microorganisms feed on fuel at the fuel/water interface; they require only a small amount of water to live and grow. Service experience and military testing indicate that DiEGME may inhibit the growth of microorganisms at concentration levels as low as 0.02 percent by volume in the fuel phase. Consequently, the use of DiEGME at the concentrations necessary for the inhibition of ice formation may also inhibit microbial contamination.

Note: DiEGME is not classified as a biocide, and the operator should refer to the aircraft service instructions for recommended products and practices relating to biocides.

6 AIRWORTHINESS COMPLIANCE.

Fuel containing anti-icing additives in engines and aircraft may be approved as an acceptable means of complying with the requirements for the approval and use of FSII in engines and aircraft in §§ 23.2620(a)(1), 25.1583(b)(1), 27.1583(b)(1), 29.1583(b)(1), 33.7(b)(2), 33.7(b)(3), and 33.7(c)(2).

6.1 Approval of Propulsion Fuel Additives.

See AC 20-24 for additional guidance and information pertaining to the approval of propulsion fuel additives.

6.2 DiEGME FSII Additive Performance.

As stated in paragraph 5.2.1, DiEGME is listed in the primary jet fuel specifications as an acceptable additive at concentration levels of 0.07 to 0.15 percent by volume because DiEGME has been found to be an effective aircraft FSII at those concentration levels.

6.2.1 For engine, airplane, and rotorcraft fuel systems that specify a concentration range within the range stated in the applicable fuel specification, if DiEGME is specified as a mandatory additive, an analysis that refers to the applicable fuel specification may be used for compliance with §§ 23.2430(a)(3), 25.951(c), 27.951(c), 29.951(c), and 33.67(b)(4)(ii).

6.2.2 For engine, airplane, and rotorcraft fuel systems that specify a DiEGME concentration range that is not within the range stated in the applicable fuel specification, compliance with §§ 23.2430(a)(3), 25.951(c), 27.951(c), 29.951(c), and 33.67(b)(4)(ii), (where applicable) must be demonstrated by test or analysis.

6.3 DiEGME FSII Fuel System Compatibility.

As stated in paragraph 5.2.1, DiEGME is listed in the primary jet fuel specifications as an acceptable additive at concentration levels of 0.07 to 0.15 percent by volume. This additive acceptability indicates that DiEGME has been determined to have no effect on jet fuel properties and performance and to be suitable for use in civilian engines, airplanes, and rotorcraft fuel systems that use conventional materials.

6.4 For engine, airplane, and rotorcraft fuel systems that utilize conventional fuel system materials, a similarity analysis that refers to the applicable fuel specification may be used for showing compliance with §§ 23.2430(a)(3), 25.603, 25.951(c), 27.603, 27.951(c), 29.603, 29.951(c), and 33.15.

6.5 For engine, airplane, and rotorcraft fuel systems that utilize unconventional fuel system materials, the compatibility of those materials with DiEGME should be demonstrated by test or analysis for compliance with §§ 23.2430(a)(3), 25.603, 25.951(c), 27.603, 27.951(c), 29.603, 29.951(c), and 33.15.

7 OTHER REQUIREMENTS FOR COMPLIANCE WITH THIS METHOD.

7.1 Instructions for Continued Airworthiness (ICAs).

The following should be included in the ICAs for compliance with §§ 23.1529, 25.1529, 27.1529, 29.1529, and 33.4 for engines, airplanes, and rotorcraft that require the use of DiEGME as an FSII:

- Required DiEGME concentration range when injecting DiEGME into the fuel supplied to the aircraft, or directly into the fuel tank, should be within 0.07 and 0.15 percent by volume unless a different range is substantiated (see paragraph 6.2.2). Warnings should be placed in the ICA stating that the exceedance of the maximum allowable concentration of FSII may damage the aircraft fuel system.
- Procedures for testing to verify that the DiEGME concentration in the aircraft fuel tank exceeds 0.04 percent by volume should be included.
- Procedures and acceptable types of equipment for either injecting DiEGME into the refueling equipment or for blending DiEGME into the fuel tank.
- Procedures for de-fueling airplanes or rotorcraft containing fuel with DiEGME. These procedures should include warnings regarding the handling of fuel containing DiEGME after removal from the airplane or rotorcraft.

7.2 Other FSII Additives.

7.2.1 The following compliance guidance is applicable to engine, airplane, and rotorcraft fuel systems that specify FSII additives other than DiEGME:

- It should be demonstrated that the additive does not have any adverse effects on the operation, performance, durability, or materials of the products intended for use.
- It should be demonstrated that the additive does not have any adverse effects on the performance of the intended base fuel.
- It should be demonstrated that the additive is compatible with all other additives, or a combination of all other additives, permitted for use in the intended base fuel.
- It must be demonstrated that the additive provides satisfactory protection against the accumulation of ice in fuel systems per §§ 23.2430(a)(3), 25.951(c), 27.951(c), 29.951(c), and 33.67(b)(4)(ii), where applicable.

7.2.2 The following should be included in the ICAs for compliance with §§ 23.1529, 25.1529, 27.1529, 29.1529, and 33.4 for engines, airplanes, and rotorcraft that require the use of FSII additives other than DiEGME:

- Required specified FSII additive concentration range when refueling the aircraft.
- Minimum concentration range of the specified FSII additive in the aircraft fuel tank to prevent fuel system icing and a means to test for this concentration.
- Procedures and acceptable types of equipment for either injecting the specified FSII additive into the refueling equipment or blending it into the fuel tank.

- Procedures for de-fueling airplanes or rotorcraft containing fuel with FSII additive. These procedures should include warnings regarding the handling of fuel containing FSII additive after removal from the airplane or rotorcraft.

8 DIEGME BLENDING, HANDLING, AND STORAGE.

Operators of aircraft that require the use of FSII should ensure the facility supplying their fuel and FSII adheres to the following guidance:

8.1 DiEGME Blending and Usage in Fuel.

FSII injection equipment should meet the below guidance and meet the requirements specified in the aircraft's ICA.

- DiEGME should be mixed into fuel as a fine stream or well-distributed droplets to ensure that it dissolves into the fuel before the additive settles to the bottom of the fuel tank. This DiEGME distribution can be done by injecting DiEGME into the refueling stream with an atomizing nozzle or injecting it upstream of a high shear device, such as a fuel pump. FSII should not be applied by pouring the additive or slug dosing. Undissolved DiEGME can damage elastomers, tank coatings, and other materials in aircraft.
- DiEGME should be mixed in fuel containing as little free water as possible. If the fuel contains substantial amounts of free water, the DiEGME will preferentially move into the free water phase and be removed with the water during pre-flight sumping of the fuel tanks. This can result in a lower effective FSII concentration level in the fuel within the aircraft tank. Therefore, injection should occur downstream of ground handling water filtration systems, and not immediately upstream of the filtration systems.
- The DiEGME injection level of 0.07 to 0.15 percent concentration is set to accommodate anticipated losses during fuel handling, transport, or dilution. However, regardless of the concentration of DiEGME injected or mixed in the fuels tank, the concentration level of DiEGME in an aircraft fuel tank should be a minimum of 0.04 percent by volume to ensure the inhibition of ice formation in the fuel system. The ASTM D5006 test method provides a procedure for determining the concentration level of DiEGME using a hand-held optical or digital refractometer. This method is also suitable for use as a field test for checking that injection equipment is operating satisfactorily.
- Fuel off-loaded from airplanes or rotorcraft that contains DiEGME should not be re-used on other aircraft nor returned to any part of the aviation fuel supply chain. Many aircraft are not approved to operate with fuel containing DiEGME, and some types of fuel handling equipment, such as filter monitors are not compatible with fuel containing DiEGME.

Note: Additional information on the use and handling of FSII may be found in ASTM MNL5, EI 1540, JIG 2, JIG 1, and ATA 103.

8.2 **Ground Filtration Systems and Equipment.**

It is recommended that DiEGME FSII be injected into the fuel at the point of delivery to the aircraft and downstream of the fuel ground handling equipment. This is to ensure proper blending and to prevent compromising the effectiveness of the ground filtration systems. The guidance in this section applies to injection systems located upstream of ground filtration systems.

8.2.1 Filter monitors qualified to EI 1583 should not be exposed to fuel containing DiEGME. The water absorbing material in the filter monitor, called super absorbent polymer, degrades in the presence of DiEGME and may mix with the fuel and pass downstream into the aircraft fuel system. The super absorbent polymer particles may accumulate on fuel system components and lead to operational problems.

8.2.2 Only EI 1581 category M or M100 filter water separators (also called filter water separators/coalescers) may be exposed to fuel containing DiEGME. These filters are specifically qualified for use with DiEGME.

8.3 **Additive Storage/Injection Tanks.**

8.3.1 Take precautions to prevent water and moist air from entering the DiEGME additive tank. The water will molecularly bind with the DiEGME resulting in water saturated DiEGME that has significantly reduced effectiveness when mixed with the fuel. Incorporate a silica gel drier or other desiccants in the DiEGME tank air vent. You may also use dry nitrogen to prevent moist air from entering the storage tank.

8.3.2 It is recommended that DiEGME be stored in stainless steel or Teflon coated tanks. If DiEGME is stored in aluminum or fiberglass tanks, or tanks with epoxy-type tank linings, take precautions to minimize the exposure of storage tank walls to DiEGME or DiEGME/water solutions. DiEGME can be corrosive to aluminum tanks and can degrade fiberglass tanks and epoxy-type tank linings.

8.3.3 Fuel facilities should minimize the time condensed water from fuel containing DiEGME sits in tank bottoms, sumps, or other low points in the fuel handling system. This can be done by draining the sumps, tank bottoms, and other low points of water at scheduled or regular intervals.

8.3.4 DiEGME supplies should be managed to minimize storage time due to long-term stability concerns. It is recommended that DiEGME supplies be regularly tested for conformance to the specification of ASTM D4171, MIL-DTL-85470 or Def Stan 68- 252.

8.3.5 Care should be taken to ensure that other de-icing chemicals typically found at airports, such as diesel exhaust fluid, aircraft de-icing fluid or aircraft anti-icing fluid are not inadvertently loaded into the DiEGME injection system. Use of chemicals not listed in the engine, airplane, or rotorcraft operating limitations could lead to harmful deposits, aggressive attack of fuel system materials, or other hazardous consequences leading to engine power losses or shutdowns.

9 SUGGESTIONS FOR IMPROVING THIS AC.

If you have suggestions for improving this AC, you may use the Advisory Circular Feedback Form at the end of this AC.

DANIEL J. ELGAS Digitally signed by DANIEL J. ELGAS Date: 2024.03.27 13:29:21 -04'00'

Daniel J. Elgas
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Appendix A. Water in Aviation Fuel.

A.1 The tendency of water and fuel to mix, and a fuel's particular saturation level, varies with its composition and temperature. The saturation level for jet fuel, in parts per million by volume (ppmv), is approximately equivalent to the temperature of the fuel in degrees Fahrenheit. For example, a jet fuel at 50°F may contain approximately 50 ppmv of dissolved water. However, this guidance pertains primarily to conventional petroleum-derived fuels and may vary for fuels that contain synthetically or alternatively derived compounds. Water that remains in solution as dissolved water will not have any adverse impacts on aircraft or engine operation. See AC 20-125 for additional guidance and information pertaining to water in aviation fuels.

A.2 Free water exists in fuel, either as a separate and distinct free water phase (or slug) or as entrained water. The free water phase is a separate layer or body characterized by a well-defined boundary with the fuel, such as the "water bottoms" in fuel tanks. Entrained water exists as small droplets dispersed in the fuel. See ASTM D3240 for the test method used to measure free water.

A.3 Ground handling filter separators contain water coalescers and separators used to remove the free water phase from the fuel; however, they do not remove all of the entrained water particles because the droplet size is so small. These entrained water particles that remain after filtration will eventually settle out of the fuel. Experience has shown that jet fuels uploaded onto aircraft before flight contain 10 to 30 ppmv of entrained water but may increase to up to 70 ppmv in the aircraft fuel tank with aircraft flight operations.

A.4 As an aircraft climbs in altitude, the air temperature typically decreases. The reduced ambient temperature causes the fuel to cool and reduces the fuel's water saturation level. This reduced fuel saturation level causes the dissolved water to fall out of the solution in the form of entrained water in minute droplets. Until this water can coalesce and migrate to the bottom of the tank, it will be carried in the fuel. At temperatures below the freezing point of water (0°C or 32°F), these minute droplets may undergo a phase change to produce ice particles, which can adhere to aircraft and engine fuel system surfaces, filters, and screens. This ice may accumulate and obstruct fuel flow leading to engine power loss or shutdown.

A.5 The concentration of free water in the fuel tanks may also increase during flight due to the condensation of moisture-laden air in the tank ullage space. A long-duration high altitude flight will result in tank surfaces and fuel colder than the air drawn into the tank during descent. When moisture-laden air enters the tank space, condensation may occur on the cold surfaces and mix with the fuel as entrained water. This water may exist in the fuel tank as entrained water for multiple flights before settling as free water if the fuel tank remains at a low temperature due to the higher viscosity of cold fuel. Under these conditions, the entrained water in the fuel may reach up to 130 ppmv throughout a flight. Some aircraft incorporate automatic water sumping systems, and others rely on manual activation of the sump drains to remove free water from the fuel tanks. Water sumping is recommended whenever practicable.

OMB Control Number: 2120-0746
Expiration Date: 11/30/2024

Advisory Circular Feedback Form

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Please mark all appropriate line items:

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☐ In a future change to this AC, please cover the following subject:
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