U.S. Department
of Transportation
Federal Aviation
Administration

Advisory Circular

Subject: USE OF AIRCRAFT FUEL ANTI-ICING ADDITIVES

Date: 18 Jan 72 AC No. 20-29B

Initiated by: FS-140 Change:

1. PURPOSE. This circular provides information on the use of anti-icing additives PFA-55MB and MIL-I-27686 as an acceptable means of compliance with the Federal Aviation Regulations that require assurance of continuous fuel flow under conditions where ice may occur in turbine aircraft fuel system.

2. CANCELLATION. AC 20-29A, effective June 19, 1967, is cancelled.

3. REFERENCE REGULATIONS. Part 25, Section 25.997(b), of the Federal Aviation Regulations.

4. BACKGROUND.

   a. FAA - The Southern Region approved the use of a 0.10 percent concentration (by volume) of PFA-55MB in all turbine aircraft fuels in December 1962. This approval was based upon compatibility tests of the additive in certificated aircraft and engines at a concentration of 0.15 percent of the fuel by volume and did not include approval for the use of the additive in lieu of fuel heaters. FAA may approve the 0.15 percent concentration where compatibility with the aircraft and engine fuel systems has been demonstrated (see Advisory Circular AC 20-24A).

   b. Air Force - The United States Air Force, after extensive tests with PFA-55B in JP-4 fuel, concluded that the additive satisfactorily prevents the formation of ice in the fuel. Starting in April 1, 1962, this additive, under its Military Specification No. MIL-I-27686A to D was used in all JP-4 fuel produced in the United States.

Since January 1971, anti-icing additive to Military Specification MIL-I-27686E has been used. The main change involved in this revision to the specification is deletion of the glycerin. Because of the possible effect on fuel tank coatings and seals, the use of the new MIL-I-27686E additive should be cleared for each aircraft as being compatible with the fuel system of the aircraft. This is discussed in paragraph 8 below. At the present time, with the exception of a few areas, the use of the additive in JP-4 fuel is worldwide.

5. USE OF ADDITIVE IN KEROSENE. The characteristics of these additives, PFA-55MB and MIL-I-27686, in kerosene type fuel are similar to those in JP-4 fuel. Commercial aircraft kerosene, however, does not contain the additive and provisions for blending it into this type of fuel present a complication to its use. The additive is readily soluble in water but its solubility in the fuel is relatively low. It is, therefore, essential that the additive be uniformly blended into the fuel with proper equipment and procedures. Blending facilities and the additive are available at some airports, but cases will arise where it will be necessary to blend at the aircraft to assure icing protection. To provide for these cases, it may be necessary for the aircraft to carry both the additive and blending equipment.

6. WATER IN FUEL.

a. Presence of Water in Fuel - Although rigorous precautions are taken to ensure that fuel being pumped into an aircraft contains as little water as possible, an aircraft fuel containing no water is an impossibility. This is due primarily to the affinity that hydrocarbon fuels have for water. Even if fuels are prepared, handled, and used without even contacting liquid water, the fuels will contain water picked up from the air. The extent of such pickup is largely a function of the humidity of the air drawn into the fuel tank to equalize the pressure resulting from changes in tank temperature and pressure.

b. Affinity of Fuel for Water - The affinity that fuel has for water varies with its composition and temperature. The saturation level for a jet fuel in parts per million by volume is approximately equivalent to the temperature in degrees F.; that is, a jet fuel at 50 degrees F. may contain approximately 50 parts per million of dissolved water. When the fuel is cooled, that water which is

above the saturation level is rejected as discrete water in minute particles. 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, these minute particles may be supercooled and will be deposited out only when they strike a solid obstruction and freeze.

c. Effect of Gravity - The small differences in the specific gravity of water and jet fuel (1.0, 0.77, and 0.83, respectively, for water, JP-4 and kerosene) complicate the task of removing the discrete water dispersed in the fuel. While this water will in time settle out of the fuel, the particle size is so small that filters and water separators cannot be depended upon for its complete removal. Experience has shown that jet fuels may contain up to 70 parts per million of dispersed water.

d. Condensation of Water in Flight - An aircraft after a long flight at high altitudes will have tank surfaces and fuel that are colder that the air that is drawn into the tank during descent. When moisture-laden air enters the tank space, condensation may occur in the tank. Due to the higher viscosity of cold fuel, this water will not settle out as readily and will be carried as dispersed water for a longer period of time. Under these conditions, the dispersed water in the fuel may reach 100 parts per million.

e. Microbia Control - Fuel tank corrosion has been a problem in jet aircraft due to the presence and growth of microbia at the water and fuel interface. Elimination of water and contaminants from the fuel and water reduces this corrosion, but complete elimination of water is not possible. Experience with fuel containing PFA-55MB and MIL-I-27686 has shown that when the concentration in the fuel is maintained above .05 percent by volume it is effective in eliminating many type of microbia growth and thus reduces tank corrosion.

7. ADDITIVE CONCENTRATION. Data indicate that a .015 percent by volume concentration of the additive would prevent ice formation in fuel containing 100 parts of water per million down to fuel temperature of -40 degrees F. Additive concentrations exceeding .015 percent by volume are necessary, however, for the following reasons:

a. The additive tends to separate out of the fuel during its

transportation (often via long pipe lines) from refinery to aircraft, and during long-time storage in refueling tanks. A drop in additive concentration to one-third the original refinery value has been reported.

b. Free water may have accumulated in the aircraft tank in sufficient quantity to leach further additive from the fuel.

c. Techniques for measuring the additive concentration of fuels necessarily involve some accuracy tolerance.

d. The FAA therefore considers that, to ensure continuous fuel flow under conditions where ice may occur in the fuel system, the minimum additive concentration for a loaded aircraft tank should be .035 percent by volume. Moreover, to ensure that this concentration is maintained in the loaded aircraft tank, it should be refueled with fuel containing an additive concentration of at least .06 percent by volume.

8. ACCEPTABLE MEANS OF COMPLIANCE. Fuel containing anti-icing additives PFA-55MB and MIL-I-27686 may be approved as an acceptable means of complying with Section 25.997(b), if such fuel has been demonstrated to be compatible with the engine and aircraft fuel system at an additive concentration of 0.15 percent by volume using the procedures set forth in Advisory Circular AC 20-24A. Requests for such approval are considered by the Chief, Engineering and Manufacturing Branch, for the region in which the applicant is located. The approval, in each case, is subject to the following conditions:

a. Placarding - The aircraft should be placarded near the fuel filler cover to show that fuel to be used must contain anti-icing additive PFA-55MB or MIL-I-27686 within the minimum and maximum allowed concentration.

b. Manuals - Federal Aviation Administration approved flight manuals should contain the following:

(1) The minimum concentration of the additive in a loaded fuel tank should be at least .035 percent by volume.

(2) The minimum concentration of the additive in the fuel with which the aircraft is to be refueled should be at least .06 percent by volume.

(3) The maximum concentration of the additive that may be used in fuel is 0.15 percent by volume

(4) The procedures that are to be used in blending the additive into the fuel.

(5) A list of approved types of equipment that may be used for blending the additive into the fuel.

(6) The procedures and approved equipment that may be used to determine the concentration of the additive in the fuel.

(7) A list of trade names under which the additive may be obtained.

(8) The minimum equipment that is required and approved for operations.

c. Tests - The applicant should show by tests that his additive sampling and blending procedures are feasible.

9. OTHER ADDITIVES. Fuel containing other anti-icing additives may be given similar approval after it has been conclusively demonstrated by test and service experience that:

a. The additives have no adverse effect on the engine and aircraft.

b. The additives provide satisfactory protection against the accumulation of ice that may clog fuel filters as required by Section 25.997(b).

/s/ WILLIAM G. SHREVE, JR.