Cancelled See 43B

AC NO: 20-43A

DATE: 6/12/70

ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBJECT: AIRCRAFT FUEL CONTROL

1. PURPOSE. This advisory circular alerts the aviation community to the potential hazards of inadvertent mixing or contamination of turbine and piston fuels, and provides recommended fuel control and servicing procedures.

2. CANCELLATION. Advisory Circular 20-43, dated 9/3/65, is cancelled.

3. REFERENCES. For more detail than is contained herein, see American Petroleum Institute Bulletin 1542, National Fire Protection Association Pamphlet, "Aircraft Fueling 1965."

Initiated by: FS-340

4. BACKGROUND. Since the introduction of jet aircraft fuel, there have been several instances of inadvertent fueling of piston-powered aircraft with jet fuel. Aviation fuel can only serve its ultimate purpose when the PROPER fuel is delivered into the aircraft as free from contamination as it was the day it left the refinery. Unless care and ATTENTION are given to its handling, servicing, and storage, the many precautions taken in its manufacture and transportation are wasted. Close attention to compatibility of fuel and aircraft as well as faithful adherence to good housekeeping practices is necessary to prevent possible disaster as well as costly contamination. A review of accidents attributed to fuel problems reveals that many power failures were due to use of improper fuel or careless servicing - fueling aircraft from poorly filtered tanks, particularly small tanks or drums, improper mixing of fuel additives, improper pre-flight action by the pilot, and storing aircraft with partially filled tanks, etc., which invites condensation and contamination of the fuel. It is well to remember that the consequences of using leaded gasoline in jet engines can be as damaging as the use of jet fuel in reciprocating engines.

5. TURBINE (JET) FUEL VERSUS GASOLINE. A recent investigation of powerplant malfunctioning disclosed two reciprocating engine-powered aircraft had inadvertently been serviced with jet fuel and then operated. Subsequent examination of the engines revealed extensive cylinder assembly damage that required costly parts, replacements, and overhaul. Proper attention to refueling would have prevented this. Had this fuel substitution been discovered prior to operating the engines, the expense would have been limited to the fuel tank drain job, purging, and refilling with the correct grade of aviation gasoline. Turbine engines both propeller and jet require turbine fuel. Piston engines require the proper grade of gasoline.

It may be expected that the frequency of this type of occurrence will increase in the future; especially if owners, operators, and personnel servicing aircraft do not maintain an active vigilance. Each day the list of fueling facilities having multiple types of aviation fuel grows, and the chance for error increases proportionately. Should the occasion arise where the tanks in an aircraft are accidentally filled with jet fuel, it is suggested the following procedures be followed.

a. If the engines were not operated subsequent to the refueling with jet fuel, drain the fuel tanks, lines, and system completely. Refill the tanks with the proper grade of aviation gasoline, and run the engines for approximately five minutes.

b. If the engines were operated subsequent to the refueling with jet fuel, investigate the abnormal engine operating conditions such as those related to the fuel mixture and cylinder operating temperatures. In addition, accomplish the following:

(1) Perform a compression test of all cylinders.

(2) Completely borescope inspect the interior of cylinders, giving special attention to the combustion chamber and the piston dome.

(3) Drain the engine oil and check the oil screens.

NOTE: When accomplishing (1), (2), and (3), further investigate and correct any condition found.

(4) Completely drain the fuel tanks and the entire fuel system including the engine carburetor.

(5) Flush the fuel system and carburetor with gasoline and check for leaks.

(6) Fill the fuel tanks with the proper grade of aviation gasoline.

(7) If the engine inspection was satisfactory, complete an engine run-up check.

6. MARKING.

a. Federal Aviation Regulations Part 23, section 23.1557(c)(1) requires that aircraft fuel filler openings be marked to show the word "FUEL" and the minimum fuel grade or designation for the engines. In order that these markings retain their effectiveness, regulations also require that they be kept fresh and clean. It follows, therefore, that frequent washing and occasional painting will be necessary to retain clear legibility.

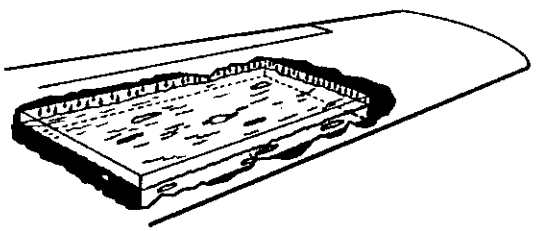
b. It is equally important that tank vehicles be most conspicuously marked to show the type of fuel carried. It is suggested that the marking be of a color in sharp contrast to that of the vehicle and in lettering at least 12 inches tall. This marking should be on each side and on the rear of the tank vehicle. It is further suggested that the tank vehicle hose lines be marked by labels next to the nozzle and every six feet. The label lettering should be at least 3/4 inches in height, be of sharp color contrast, be permanently attached, and indicate the type of fuel dispersed by that hose. The tank truck markings should be kept clean, fresh, and clearly legible at all times.

7. TRAINING. Careful instructions in operating procedures should be given to all personnel involved in fueling. This applies to flight as well as ground personnel. The ground personnel should be thoroughly indoctrinated in the facilities, procedures, equipment, and the types of fuel being dispensed -- the flight personnel in procedures and marking with particular emphasis on use of the proper type of fuel. It is further suggested that ALL personnel be re-trained periodically with

suitable records maintained to reflect the training. Fuel servicing should be performed only by trained competent personnel.

8. WHAT IS FUEL CONTAMINATION. Fuel is contaminated when it contains any material that was not provided under the fuel specification. This material generally consists of water, rust, sand, dust, microbial growth, and certain additives that are not compatible with the fuel or the fuel system materials.

9. WHAT CAUSES FUEL CONTAMINATION.



a. Water. All aviation fuels absorb moisture from the air and contain water in both dissolved and liquid form. The amount of disolved water contained varies with the temperature of the fuel. Whenever the temperature of the fuel is decreased, some of the dissolved water comes out of solution and slowly falls to the bottom of the tank. Whenever the temperature of the fuel increases, water is drawn from the atmosphere to maintain a saturation solution. Changes in fuel temperature, therefore, result in a continuous accumulation of water. During freezing temperatures, this water may turn to ice,restricting or stopping fuel flow.

b. Rust. Pipelines, storage tanks, fuel trucks, and drum containers tend to produce rust that can be carried in the fuel in small particle sizes. A high degree of filtration is required to remove the liquid water and rust particles from the fuel.

c. Dust and Sand. The fuel may be contaminated with dust and sand through openings in tanks and from the use of fuel handling equipment that is not clean.

d. Microbia. Many types of microbia have been found in unleaded fuels, particularly in the turbine engine fuels. The microbia, which may come from the atmosphere or storage tanks, live at the interface

between the fuel and liquid water in the tank. These micro-organisms of bacteria and fungi rapidly multiply and cause serious corrosion in tanks and may clog filters, screens, and fuel metering equipment. The growth and corrosion are particularly serious in the presence of other forms of contamination.

e. Additives. Certain oil companies, in developing products to cope with aircraft fuel icing problems, found that their products also checked "bug" growth. These products, known as "biocides," are usually referred to as additives. Some additives may not be compatible with the fuel or the materials in the fuel system and may be harmful to other parts of the engine with which they come in contact. Additives that have not been approved by the manufacturer and FAA should not be used.

10. FIELD TESTS. Three gallons of water were added to the half-full fuel tank of a popular make, high-wing, monoplane. After several minutes, the fuel strainer (gascolator) was checked for water. It was necessary to drain ten liquid ounces of fuel before any water appeared. This is considerably more than most pilots drain when checking for water.

In another test, simulating a tricycle geared model, one gallon of water was added to the half-full fuel tank. It was necessary to drain more than a quart of fuel before any water appeared.

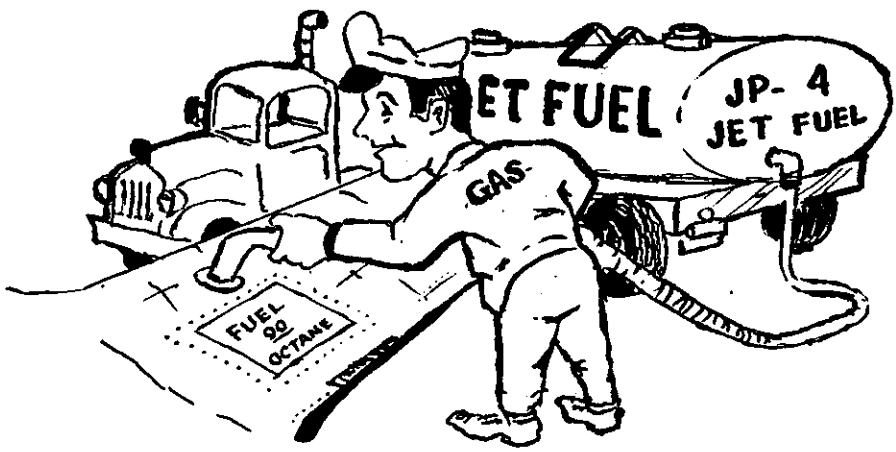
In both of these tests, about nine ounces of water remained in the fuel tank after the belly drain and the fuel strainer (gascolator) had ceased to show any trace of water. This residual water could only be removed by draining the tank sumps.

11. CONTAMINATION CONTROL. The presence of any contamination in fuel systems is dangerous. Laboratory and field tests have demonstrated that when water was introduced into the gasoline tank, it immediately settled to the bottom. Fuel tanks are constructed with sumps to trap this water. It is practically impossible to drain all water from the tanks through the fuel lines, so it becomes necessary to regularly drain the fuel sumps in order to remove all water from the system. It may be necessary to gently rock the wings of some aircraft while draining the sumps to completely drain all the water. On certain tailwheel type of aircraft, raising the tail to level flight attitude may result in additional flow of water to the gascolator or main fuel strainer. If left undrained, the water accumulates and will pass through the fuel line to the engine and may cause the engine to stop operating. The elimination of contaminants from aviation fuel may not be entirely possible, but we can control it by the application of good housekeeping habits.

a. Servicing. Storage and dispensing equipment should be kept clean at all times - free from dirt and other foreign matter. Fuel having a "cloudy" appearance or definitely "offcolor" should be suspected of contamination or deterioration and should not be used. When

additives are used, it is important that they are dispensed in accordance with the aircraft manufacturer's instructions.

Refueling from drums or cans should be considered as an unsatisfactory operation and one to be avoided whenever possible. All containers of this type are to be regarded with suspicion and the contents carefully inspected, identified, and checked for water and other contamination. Extraordinary precautions are necessary to eliminate the hazards of water and sediment. It is advisable when fueling from drums to use a 5-micron filtered portable pumping unit, or the best filtering equipment available locally, or, as a last resort, a chamois skin filter and filter funnel.



WHAT'S WRONG WITH THIS PICTURE?

Infrequently used fuel tanks should have their sumps drained before filling. Agitation action of fuel entering the tank may suspend or entrain liquid water or other contaminants - which can remain suspended for many minutes and may not settle out until after the aircraft is airborne.

b. Preflight Action. Drain a generous sample of fuel - considerably more than just a trickle - into a transparent container from each of the fuel sumps and from the main fuel strainer - or gascolator. (Remember that it was necessary to drain ten ounces in the field tests.) On certain aircraft having fuel tanks located in each wing, positioning of the fuel tank selector valve to the "BOTH ON" position may

14. SUMMARY. So that your fuel system won't let you down when you want to stay up - remember:

- o Turbine fuels for turbine engines - gasoline of the proper grade for reciprocating engines.
- o Use only the fuel recommended by the engine manufacturer.
- o Don't use additives that have not been approved by the FAA.
- o If feasible, keep fuel tanks full. Water condenses on the walls of partially filled tanks and enters the fuel system.
- o Filter all fuel entering the tank.
- o Drain fuel sumps regularly.
- o Periodically inspect and clean all fuel strainers (screens) and occasionally flush the carburetor bowl as recommended by the aircraft manufacturer.

The best insurance against fuel problems - whether aviation gasoline or jet fuel - is to practice good housekeeping in your routine maintenance and be constantly alert.

William S. Ashwood

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