Alaska Division of Forestry
Aviation Fueling Handbook

Table of Contents

Section Number	Section Title	Page Number
2680	Objective	2
2681	Identification of Aviation Fuels	2
2682	Fuel Quality and Control	4
2683	Filtration	6
2684	Bonding	8
2685	Sources of Ignition	10

2680Objective:

The objective of this chapter is to establish the procedures, guidelines, and standards for the DOF Aviation Fueling and Aviation Fuel Quality Control Program. Following these procedures will help assure the delivery of the correct type and grade of uncontaminated fuel into aircraft utilized for DOF aviation operations.

2681 Identification of Aviation Fuels:

A. Fuel Coloring:

There are two categories of aviation fuel in use today: aviation gasoline (commonly called AVGAS) and turbine or jet-fuel.

(1) Avgas:

Aviation gasoline is used in reciprocating engine aircraft. There is currently one grade of aviation gasoline in use: 100 low lead. Off-colored fuel may not meet specifications and should not be used for aviation purposes. 100 low lead (100LL) is dyed a blue color to aid in recognition.

(2) Jet Fuel:

Aviation Jet fuel is used for powering turbo-fan, turbojet and turboprop engines. There are two types of turbine fuel in used by DOF: A kerosene base (Jet A) and a blend of gasoline and kerosene (Jet B). Most commercial operators utilize Jet A. All grades of turbine fuels are colorless or straw colored.

B. Required Marking & Placards on Fuel Trucks:

Each aircraft fuel truck shall be conspicuously and legibly marked with an identification decal to indicate the product contained therein. The markings shall be on each side and the rear of the fueler tank in letters at least 3" in height.

(1) Aviation gasoline's are identified by using white letters on a blue background for 100LL

(2) Using white letters on a black background, i.e., Jet A or Jet B, identifies turbine fuels.

(3) Vehicles must be marked on both sides and on the rear of the tank:

JET A - Combustible JET B – Flammable AVGAS - Flammable

C. Required Marking & Placards on Hose Lines:

Hose lines shall be marked by decals or labeled adjacent to the nozzle to indicate the type of fuel dispensed. The decals shall read either JET A, JET B, or AVGAS dependent on the type of fuel pumped from that nozzle.

D. Required Marking & Placards on Portable Fuel Containers:

(1) Bulk Collapsible Tanks (bladders):

Large fixed collapsible tanking facilities, their accessory fueling lines and equipment shall be conspicuously and legibly marked with an identification decal to indicate the product contained therein. The markings shall be on each side and the rear of the tank in letters at least 3" in height.

(2) 55-Gallon Barrels

The top head or sides of 55-gallon barrels shall be marked in letters no smaller than 3/4" with the type and/or grade of fuel, filling date, vendor and any other pertinent information required.

(3) 5-Gallon and Smaller Containers:

All containers shall be marked with the type and/or grade of fuel contained in the containers. In many cases the 5-gallon containers will be marked by the fuel manufacturer.

CAUTION: Plastic containers are not to be used for into-aircraft refueling or defueling as the static electricity charge potential is sufficient to cause a spark with potential explosive results.

E. Required Marking & Placards on Aircraft:

Various Federal Aviation Regulations (FARs) require that aircraft fuel filler openings be marked to show the word "FUEL," the minimum fuel grade or designation for the engines, and the tank capacity. In order that these markings retain their effectiveness, regulations require that they be kept fresh and clean. Therefore, frequent washing and occasional painting / placard replacement will be necessary to retain clear legibility.

2682 Fuel Quality and Control

A. Objective:

The quality and cleanliness of aviation fuels are vital to the safety of DOF aircraft and, subsequently, all flight personnel. Fine sediment in fuel may block the engine fuel supply system and erode critical parts in the engine and fuel control systems. Free water (water not dissolved in the fuel) may freeze at high altitudes or cold outside air temperatures and plug the fuel screens, causing the engine to cease operation/flame out and possible loss of the aircraft. Salt water is extremely dangerous because of its potential effect on certain aircraft instruments. Contaminants must be separated out of fuel before the fuel is pumped into the aircraft.

B. Pilot Responsibility for Alertness during Refueling Operations:

Pilots must constantly be on the alert for non-approved aviation refueling equipment such as filters and nozzles. Refuelers may contain commingled fuels, and untrained personnel may be operating refuelers or fixed site facilities. There is always a potential for receiving incorrect type and grade or commingled fuel. The Pilot is ultimately responsible for assuring proper grade and type of fuel is delivered into his aircraft.

C. DOF Inspection of Commercial Facilities:

Areas ordering directly from commercial vendors should establish an agreement with the vendor for a DOF representative to inspect the facility prior to DOF purchasing/utilizing fuels dispensed into their aircraft. This agreement is the only authority DOF will have to conduct on-site inspections of commercial operations. It is recognized that at times of extreme workloads it may not be possible to inspect all fueling sites. The Regional Aviation Manager should be contacted to arrange an inspector.

D. Fuel Site Discrepancies:

The DOF is not obligated to conduct business or receive fuel from a vendor that does not provide fuel which meets the standards of ASTMD 1655 (Jet Fuel) and/or ASTM910 (Avgas). Bulk fuel providers will meets standard industry practices and conduct business in a professional manner.

E. Fuel Sampling and Testing:

Sampling and testing of aviation products must be accomplished during each phase of fuel transfer. This includes verification of fuel type and quality at the bulk dispensing facility pumping into DOF fuel transport vehicles or trailers, at the fuel storage facility being operated by the Area, any fuel source in the refueler or trailer which shall be conducting into-aircraft refueling, and finally, fuel quality assurance prior to any into-aircraft fueling operations.

F. Fuel Sampling after Aircraft Accidents or Selected Incidents:

Fuel samples are taken after aircraft accidents and selected serious incidents. These samples are normally drawn by or under the direction of the DOF Investigator-In-Charge (IIC). Occasionally, the IIC may request assistance from DOF qualified maintenance personnel or fuel handling personnel to draw samples from the mishap aircraft and last known refueling facilities/sites. DOF Area personnel may also be called upon to assist in the sampling of fuels. In most cases, coordination with the DOF IIC or the State Aviation Manager will be effected prior to any fuel sampling following an aircraft accident or serious incident. In some circumstances, it may be immediately necessary to take a fuel sample prior to this coordination effort.

(1) Sampling From Aircraft

(a) Fuel and lubricant samples should be taken from the aircraft as soon as possible after the mishap. Samples are to be taken as follows:

(b) A 1-gallon DOT-approved aviation fuel sampling can should be used these resources are not available, CLEAN - NEW containers can be used for drawing the fuel.

(c) One (1) gallon sample of fuel is to be drawn from the aircraft fuel sump. If the aircraft has tanks that do not flow into each other, samples must be taken from each tank's sump and containers marked to note the tank from which the fuel was drawn. Samples must be checked for color, visible water, sediment, and contaminants. All samples must be closed tightly and containers tagged **SUSPECT FUEL - AIRCRAFT ACCIDENT**, indicating the source(s) from which they were drawn (which tank), location, date, name of the individual drawing the sample (legible), with the aircraft registration number on the tag. All ambient conditions must be recorded at the time of the mishap. These samples are to be forwarded as indicated by coordination with the DOF IIC or State Aviation Manager.

(2) Sampling From Refueling Source

The fuel records history of the aircraft needs to be retraced. Procedures to obtain information and collect samples are as follows:

(a) The date of the last refueling before the mishap must be recorded, as well as the system or number of the refueler involved, location, and name of the organization or supplier of the service. A copy of the manufacturer's Fuel Analysis Report covering the Lot Number from which the suspect fuel was acquired must be obtained.

(b) The organization that provided the last refueling must be contacted, and information recorded to indicate the date that the applicable refueler, tank, trailer, rollagon, barrel, etc., was filled and the bulk storage system/facility from which it was filled.

(c) The organization responsible for the bulk storage system/facility must also be contacted. The date the fuel was received into the storage system and the supplier of the fuel need to be recorded. If the fuel in storage has not been tested for 90 days or more, it should be retested. Storage tank records should indicate daily water bottom checks and test results when products were received.

Note: The fuel source under control of DOF should be under a "DO NOT USE" procedure at this time. Only the DOF IIC or State Aviation Manager can authorize entry for

sampling or release of the fuel source for use. If so authorized, proceed with step (4) and (5).

(d) One (1) gallon samples must be drawn from each of the following refueler locations: tank sump, filter sump, and hose nozzle; or if the aircraft was last refueled directly from other than a refueler (tank, rollagon, fixed fueling facility, barrel, etc.), a one (1) gallon sample must be drawn from the hose nozzle. Also, if possible, a one (1) gallon sample should be drawn from the supplying bulk storage outlet. All samples must be tightly closed and tagged as noted in A (2) above.

(e) Samples are to be forwarded as indicated by coordination with the DOF IIC or State Aviation Manager.

G. Fuel Sampling Kit:

A general use fuel sampling kit should contain the following items:

(i) DOT-approved clean 1-gallon sample can.

(ii) Sample tags, shipping tag, and labels.

(iii) Four clear (glass), 4-ounce sample bottles to use for visual checks.

2683 Filtration:

A. Policy:

All DOF owned, operated and maintained aircraft refueling facilities will have a filtration unit qualified to a current aviation industry standard. All aircraft refueling will be done according to the filter manufacturers' operating specifications, the aircraft manufacturers' requirements, and this supplement.

B. General:

DOF operates and contracts for a wide variety of make and model aircraft in every type of terrain, weather and cultural environment. Many of these aircraft engines and their fuel systems have been designed with some limited tolerance for particulates and water. For this reason the most important component in any aircraft refueling facility is the filtration system.

C. Pilots:

Each pilot is required to consult the aircraft operators manual and engine capabilities and limitations section for each aircraft to be flown in order to determine if the resources present in the refueling system permit compliance with the aircraft requirements for the following:

(1) Type and grade of fuels approved.

(2) Type and amount of additives approved for use.

(3) Particulates in milligram per gallon (mg/G) or milligram per liter (mg/L) allowed, if stated.

(4) Water in parts per million (ppm), allowed, if stated.

(5) Any fuel related limitations to the fuel system components and engine.

D. Filter Considerations:

There are three major filter considerations that shall be met. These are:

(1) All filters must be "aviation approved" and identified in writing or placarding to meet the most current aviation petroleum industry standard. In North America, the two industry standards sought by filtration manufacturers are:

(2) Institute of Petroleum (IP). For "Aviation Fuel Filter Monitors with Absorbent Type Elements," such as Velcon's Aquacon Aviation Elements.

(3) American Petroleum Institute (API 1581). For aviation Filter/ Separator (F/S) at large volume, bulk storage and refuelers.

(4) All filters must match the pumping pressures and flow rate in gallons per minute (gpm) of the facility.

(5) Any individual responsible for an aviation refueling facility must assure adherence to the manufacturer's specified conditions for filter installation, maintenance, inspection, and element change-out.

E. Differential Pressure:

Pressure is measured in pounds per square inch (psi). Pressure differential across a filter element is measured as psiD. By manufacturers' recommendations, absorbent monitor filters downstream of pumps capable of discharge of pressures in excess of 25 psi shall have a gauge(s) to measure differential pressure, e.g. inlet pressure (IP) minus (-) outlet pressure (OP) equals (=) psiD (IP - OP = psiD). Additionally, manufacturers recommend filter change-out when specific levels of psiD are reached.

NOTE: A low or near zero psiD reading may indicate the filter element is missing or has been ruptured.

F. Filter Change-Out Criteria:

All DOF Aviation Fueling Facilities will replace system fuel filters prior to the beginning of fueling operations each spring or when required to by the filter manufacturer if more often than once a year is required.

NOTE: Aviation contracts require changing of elements every year prior to contract start.

G. Filter Vessel Tagging/Placarding:

All filter vessels shall be tagged or placarded with the following information:

(1) F/S elements manufacturer's change-out recommendations and instructions

(2) Manufacturer's information regarding change-out if the F/S has been modified.

(3) Date of element change-out.

(4) Legibly printed name of the individual completing the change-out.

NOTE: No system should ever be operated at a flow rate greater than for which the filter system is qualified or rated.

2684 Bonding:

A. General:

It is important to remove all sources of ignition in the vicinity of any fuel handling operation, such As any open flame, spark, smoking, unapproved engine operation and the less obvious is the ignition source hazard offered by static electricity.

B. Static Electricity:

Static electricity, sufficient to cause combustion of fuel vapors, can occur by the free falling of fuel liquids into tanks, flowing through a pipe, filter or hose, by pouring from one container into another, or the splashing of fuel into a fueler or aircraft during loading and fueling / defueling operations. One serious source of static electricity is the pouring of AVGAS from or into plastic containers. The issue of static electricity and its associated hazard relating to fuel handling operations as an ignition source is covered in more detail in Sources of Ignition section in this Chapter.

C. Bonding:

To minimize the hazard of static electricity, it is necessary to equalize the electrical charges before they build-up to a high enough potential to create a static spark. Prior to making any

fueling connection to the aircraft, the fueling equipment shall be bonded to the aircraft by use of a cable, thus providing a conductive path to equalize potential between the fueling equipment and aircraft. The nozzle shall be bonded with a nozzle bond cable having a clip or plug to a metallic component of the aircraft that is metallically connected to the tank filler port. If there is no plug receptacle or means for attaching a clip, the operator shall touch the filler cap with the nozzle spout before removing the cap so as to equalize the potential between the nozzle and the filler port. The spout shall be kept in contact with the filler neck until the fueling is completed. When a funnel is used in aircraft fueling, it shall be kept in contact with the filler neck as well as the fueling nozzle spout or the supply container.

D. Plastic:

Plastic funnels and containers **shall never be used** in aircraft fueling. Additionally, greater potential for sparks and subsequent ignition of aviation fuels exists whenever plastic containers, or funnels, are used. These items should be avoided unless an emergency situation exists.

E. Bonding to Aircraft:

Prior to making any fueling connection to the aircraft, the fueling equipment shall be bonded to the aircraft by the use of a cable, thus providing a conductive path to equalize potential between the fueling equipment and aircraft. The bond shall be maintained until fueling connections have been removed.

F. Over-wing fueling:

When fueling over-wing, the nozzle shall be bonded with a nozzle bond cable having a clip or plug to a metallic component of the aircraft that is metallically connected to the tank filler port. The bond connection shall be made before the filler cap is removed. If there is no plug receptacle or means of attaching a clip, the operator shall touch the filler cap with the nozzle spout before removing the cap so as to equalize the potential between the nozzle and the filer port. The spout shall be kept in contact with the filler neck until fueling is completed.

G. Special Considerations when Handling Fuels:

(1) Splashing

Splashing can be minimized during the loading of a fueler by placing the end of the loading spout at, or as near as possible to, the compartment bottom. Fuel flow would be reduced until the spout end is covered with fuel. When filling large storage tanks, splashing can be minimized by slowing down the initial flow rate until the end of the tank inlet line is covered with at least two feet of fuel. Bottom filling should be employed whenever available.

(2) Metal or Conductive Objects

Objects such as inventory gauge tapes, sample containers and thermometers should not be suspended or lowered into a tank or fueler compartment while it is being filled. Any static charge which may be present should be given at least 20 minutes after cessation of flow to bleed off before using these devices.

H. Equipment for Bonding:

(1) Bonding Cables

Bonding cables will be of a flexible, durable design and material.

(2) Plug and Jack Assembly

The plug and jack assembly and the spring clamp will be of unpainted, non-rusting metal.

(3) Testing the Bonding System

Annually, the bonding system (cables and connections) will be inspected for continuity and integrity as required by frequency of use and type of cable.

2685 Sources of Ignition:

A. Properties of Fuels:

How a fuel ignites depends on its physical properties. The properties of aviation and turbine fuels that relate to ease of ignition are flash point, flammability limits, vapor pressure, autoignition temperature, distillation range, and electrostatic susceptibility. These properties are charted in Table B-1 (Next Page).

Properties of Aviation Fuels Table B-1

Property	Gasoline	Kerosene grades		Blends of gasoline and kerosene
	AVGAS	JET A, JP-5, JP-6	JET A-1, JP-8	JET B, JP-4
Flash Point (By Closed-Cup Method at Sea Level)	-50°F	+95° to +145°F		-10°to +30°F
Flash Point (By Air Saturation Method)	-75° to -85°F	None		-60°F
Flammability Limits Lower Limit Upper Limit Temp Range for Flam Mixtures	 1.4% 7.6% -50° to +30°F	 0.6% 4.9% +95° to +165°F		 0.8% 5.6% -10° to +100°F
Vapor Pressure ASTM D 323	5.5 to 7.0 lb/ sq in	0.1 lb/sq in		2.0 to 3.0 lb/ sq in
Autoignition Temperature	+825° to +960°F	+440° to +475°F		+470° to 480°F
Freeze Point	-76°F	-40°F	-58°F	-60°F
Boiling Points Initial End	 110°F 325°F	 325°F 450°F		 135°F 485°F
Pool Rate of Flame Spread*	700 to 800 ft per min	100 ft per min or less		700 to 800 ft per min
*In mist form, rate of flame spread in all fuels is very rapid.				

B. Static Electricity:

(1) Nature of Static Electricity

Static electricity is formed when two unlike materials touch or rub; electrons are exchanged or redistributed between the two materials at the point or surface where they touch. This exchange of electrons causes unlike, but equal, charges on the two materials, and these charges attract each other as they seek electrical balance. It takes energy to separate the two surfaces because the force of electrical attraction is opposed. Since energy is never lost, the energy used to separate the attracting surfaces reappears as an increase in the electrical tension or voltage between the two surfaces. If a surface that has such a charge is a conductor and if there is a conductive pathway through which the charge can move, the charge will follow the path and leak away as it tries to find an unlike charge to balance it. If the surface that has such a charge is a nonconductor (insulator), the charge is trapped. The same sort of trapping of a charge happens when the charge is on a conductor that touches only nonconductors, because in this situation there is no path through which the charge can leak away. Equal but unlike static charges will stay as close as possible to each other. If the attraction between them is strong enough, the charge from one surface may jump the gap to the other surface in its search for equilibrium. This impulsive discharge of electricity results in a spark, and static sparking is a serious fire danger to refueling operations.

(2) Safety Measures

The charges on different materials can be equalized by connecting them with a conductor (bonding) thus significantly reducing sparking potential from static electricity. AVGAS must not be placed in plastic containers, nor plastic funnels used. The level of static electricity build-up has sufficient potential to be an ignition source when AVGAS is poured from the plastic container. Bonding is also very difficult without the proper equipment.

(3) Bonding

Bonding is the process through which two conductive objects are connected to lessen their potential differences. Bonding does not dissipate the static electricity. It equalizes the charges on two unlike objects (an aircraft and a refueling nozzle) in order to preclude arcing, in the presence of flammable vapors, as the two objects are joined. A nozzle-to-aircraft bond is required. This bond is made before the nozzle dust cap or gas tank cap is removed so that if there is a spark, it will occur before fuel vapor is present. For the same reason, the nozzle bond must not be disconnected until refueling is completed and the gas tank cap and nozzle dust cap have been replaced. Then if a spark occurs, only small amounts of fuel vapor should be present, probably not enough to support combustion.

C. Other Sources of Ignition:

(1) Engines

Operating aircraft, vehicle, and equipment engines generate heat by burning fuel. They also generate static electricity because of friction between their moving parts.

Dangers. The engine heat of an idling aircraft turbine engine is in the autoignition range of JP-4. Poorly maintained vehicle engines and/or exhaust/flame arrestor systems may backfire or discharge sparks.

Safety Measures. An aircraft must not be refueled until its engines are shut down, except as allowed under closed-circuit refueling described in chapter 4. Restrict vehicle access to the refueling area. Only those vehicles actually involved in servicing aircraft are allowed to come within 50 feet of the refueling operation. Vehicles used in and around refueling areas must be maintained to a high standard.

(2) Electrical Circuits

When electricity is flowing through a circuit, it can jump a small break or defect in the circuit by arcing. An electrical arc is simply a continuous flow of sparks between two points.

Dangers. The danger from arcing is the same or greater than from a spark. An arc usually generates more heat than a single spark.

Safety Measures. Work is not allowed to be done on an aircraft's batteries while the aircraft is being refueled. Batteries should not be changed/ replaced; and battery chargers should not be connected, used, or disconnected during refueling. Aircraft radios may operate to receive messages during refueling, but radio transmission from the aircraft being refueled is not allowed because of the danger of arcing. Flashlights are not to be used within 50 feet of the refueling operation unless they are the approved explosion-proof type. Electrically powered tools are not to be used in the refueling area. The electrical circuits of vehicles used in refueling operations must be maintained in top condition to prevent short circuits around defects.

(3) Open Flames

The danger of any open flame is that it will ignite fuel or a flammable vapor-air mixture. No open flame, open-flame device, or lighted smoking materials are allowed within 50 feet of an aircraft refueling operation. Personnel who refuel aircraft may not carry lighters or matches on their persons and must not allow anyone else to carry a lighter or matches within 50 feet of an aircraft that is being refueled. Use of exposed-flame heaters, welding or cutting torches, and flare pots within 50 feet of refueling operations is forbidden.

(4) Tools and Equipment

Drills, buffers, grinding machines, and similar tools are likely to throw off sparks when used on metal. Photographic flashbulbs and electronic flash devices may also cause sparks. No metalworking tools are allowed to be used within 50 feet of an aircraft being refueled. Flashbulbs or electronic flash devices are not to be used within 10 feet of refueling equipment or the fill port or fuel tank vents of aircraft.

(5) Sparks from Vehicles

A vehicle may pick up a static charge from two sources. One source is movement (unlike materials rubbing). The other source is the charge that spreads to the vehicle as its fuel or cargo tanks are filled.

(6) Sparks from Personnel and Clothing

The human body conducts electricity. In a very dry atmosphere, a person can build and hold a charge of several thousand volts when walking over rugs or working in certain manufacturing operations.

(a) Formation of Charge. Although a charge of this strength is unusual, the body does build up a charge during normal movement and work. Often the clothes and shoes of workers are moist enough to drain off the static electricity as fast as it is generated. The moisture provides a path for the charge to follow. Outer clothing, especially if they are made of wool or synthetic fiber, build a charge not only by absorbing part of the body charge but also by rubbing against the body and underwear. When the charged clothes are moved away from the body or taken off, the electrical tension or voltage increases to the dangerous point. If the clothes are wet with fuel, the danger is even more serious. Fuel-soaked clothes have been known to burst into flames as they were removed. Sparks can also be generated by worn footwear. Soles so worn that nails are exposed present a serious danger since fuel spills in refueling areas are common and fuel vapors near the ground ignite easily.

(b) Safety Measures. Before opening an aircraft fuel port or doing anything else that would let fuel vapors escape into the air, individuals must bond them-selves to the container by taking hold of it. If it is an aircraft or piece of metal equipment, a bare metal part can be held with both hands for a few seconds. Although this bonding will not completely discharge static electricity, it will equalize the charge on the body with the charge on the piece of equipment. No clothing is to be removed within 50 feet of a refueling operation or in an area where a flammable vapor-air mixture may exist. Individuals must not enter a flammable atmosphere after removing a garment, and least 10 minutes must pass before carrying the garment into such an atmosphere. If fuel gets on clothing, the person(s) must leave the refueling area as soon as refueling is completed and wet the clothes with water before taking them off. If there is not enough water at the site to wet the clothes thoroughly, individuals can ground themselves to a piece of grounded equipment by taking hold of it before taking off the clothes. A skin irritation from fuel is not fatal; the fire that may follow a static discharge from clothing may be fatal.

(7) Lightning

Lightning is a massive discharge of static electricity. Static charges build up in storm clouds until discharged as lightning.

(a) Dangers. The lightning stroke itself may present an ignition danger. In addition, lightning may suddenly release a charge trapped on an aircraft that is insulated from the ground. Such a freed charge may produce an arc of sufficient strength to ignite a flammable vapor-air mixture.

(b) Safety Measures. Stop refueling operations when there is lightning in the immediate area. Operations are not to be continued until the lightning has stopped.