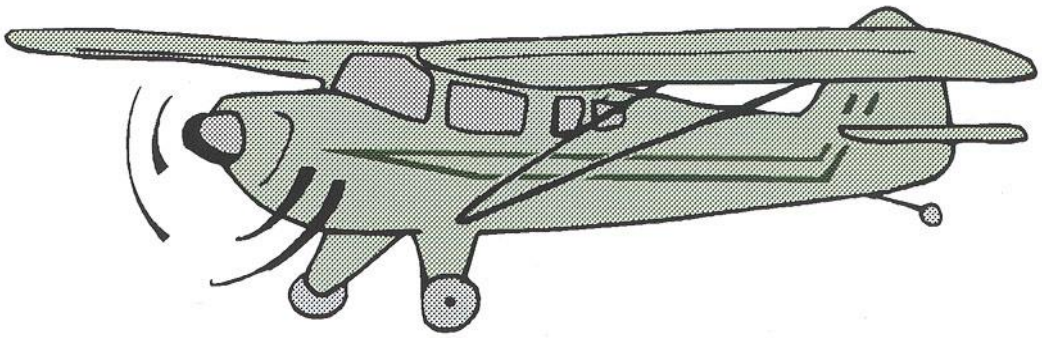
State of Vermont

AGENCY OF TRANSPORTATION

AIRPORT FUELING MANUAL



October, 2001

INDEX

Part 1 – Federal Requirements **Page**

A. Fuel Storage Preventative Maintenance

B. Receiving Aviation Fuel into Airport Storage

C. Airport Storage Quality Control Check

D. Aviation Fueling Operations

E. General Fuel Handling

Part 2 – State Requirements

Appendices

Test Procedures

Forms

Part 1 – Federal Requirements

FUEL STORAGE PREVENTATIVE MAINTENANCE

To avoid breakdown of equipment with subsequent interruption of service, and to maintain safe operation, the Aviation Fuel Storage Facility shall be inspected in accordance with the fuel vendor's recommendations and requirements. If not outlined required by the fuel vendor, the inspection shall cover the following items:

1. Fire Extinguishers – check seals and weight.

2. Grounding Cables – check operation of reel (if installed), cables for fraying and corrosion at attachment points, clips for security and operation, check grounding clamps for tightness.

3. Receiving and Loading Rack Equipment – check for protective dust cover condition, valves for proper operation and sealing (loading arms and hoses should not drip when valves are closed).

4. Pumps and Motors – check for seal leaks, condition of electrical junction boxes, mounting bolt security. Observe any unusual noises, etc, during operation. Check lubrication of pump motors and gearboxes.

5. Filter Vessel – check for mounting security, pressure gauge, and gasket leaks.

6. Piping Valves and Gauges – check for leaks and condition.

7. Storage Tanks – check vents for security and proper operation, manhole covers for tightness, thief pump for operation.

8. Electrical Relay, Fuse Planes and alarms – check conditions.

9. Storage Area – remove any debris, cut grass and/or remove weeks, if required.

Remember, good housekeeping is preventive maintenance.

RECEIVING AVIATION FUEL INTO AIRPORT STORAGE

In order to insure that on-specification fuel of the ordered type or grade and in the ordered quantity is received into storage, it is the **operator's responsibility to carry out the following procedures without exception.**

CAUTION: IF THE DAILY QUALITY CHECKS HAVE NOT BEEN PERFORMED PRIOR TO DELIVERY, THESE CHECKS MUST BE PERFORMED AND RESULTS RECORDED.

1. With gauging stick and tank calibration chart, measure and record amount of fuel in tank to insure that sufficient tank space is available for the amount of product to be received.
2.
3. Check shipping and manifest papers to insure that correct fuel and amount have been delivered. Record amount and retain delivery slip for file.
4. Check seals on compartment drain valves and dome covers. If seals are broken or not installed, reject the delivery immediately. Open dome covers and verity each compartment is filled to gauging markers.
5. Take a sample from each compartment manifold and make a "Clear and Bright" or "White Bucket" test for color, water and sediment. If check for color and contaminants is satisfactory, the fuel is acceptable and can be received into storage. If the "Clear and Bright" or "White Bucket" test is not satisfactory, allow 15 minutes additional settling time and draw one gallon from each compartment, then repeat the "Clear and Bright" or "White Bucket" check. Repeat test until fuel passes. If a clear sample is not obtained after checking each compartment three times, **reject the delivery**.
6. When the fuel quality checks indicate acceptable fuel, position transport truck at correct unloading position and connect grounding cables. Make sure fire extinguishers are acceptable.
7. Inspect hose for cleanliness. Connect hose to correctly identified receiving line and commence unloading.

NOTE

A. AVGAS is discharged directly into storage tank.

B. AVJET A is drawn from transport truck and pumped through filter/separator prior to delivery into storage tank. BE SURE PIPING VALVES ARE CORRECTLY POSITIONED FOR RECEIVING AVJET A. Note filter/separator differential pressure during receiving and record. After receipt of fuel, realign valves to refueler servicing position.

5. To insure complete delivery, check that each compartment is empty. Disconnect loading hose and grounding cables. Gage tank(s) to be sure fuel has been delivered into the proper tank(s) and secure valves for normal operation.

6. Following delivery or product into storage, the following settling times must be observed prior to product withdrawal.

A. AVGAS – minimum settling time of one (1) hour must be observed prior to product withdrawal.

B. AVJET A – if storage tank is not installed with a floating suction, settling time is one (1) hour per foot of product in tank. Example: If gauge stick indicates six feet (72 in.) of product in the tank, a six (6) hour settling time must be observed prior to product withdrawal. If storage tank incorporates floating suction discharge pipe, a two (2) hour settling time must be observed prior to product withdrawal. When settling time has elapsed, the Daily Quality Control Check prescribed for Airport Storage shall be performed and results recorded prior to product withdrawal.

AIRPORT STORAGE QUALITY CONTROL CHECK

The following Quality Control Checks must be performed to insure clean, dry, on-specification fuel in storage facility. Records shall be maintained on the appropriate forms provided/suggested (See Appendix).

1. Daily Checks and Airport Storage

    a. Check tank bottoms for water by using a gauging stick or plumb bob with water sensitive paste applied. If water is detected, it must be removed by using a "thief" pump in underground tanks and opening bottom drain valve on aboveground tanks. Following water removal, draw a sample for a "Clear and Bright" or "White Bucket" check and record results. Measure fuel level and record gallonage.

    b. Check AVGAS filter(s) and AVJET A filter/separators for water in sump. Drain sample and perform "Clear and Bright" or "White Bucket" check. Record results.

(Note – if small amounts of water or minor accumulations of contaminants are found, take a second sample. If on the second sample, you continue to observe large quantities of water or contaminant, you should immediately notify the Agency of Transportation, Maintenance and Aviation Division, 828- 2587.)

    c. Check differential pressure or filter and filter/separators and record reading (see graph, (page/appendix ____)

        1. AVGAS – take reading during filling of refueler.

        2. AVJET A – take reading during filling of refueler, when receiving product into storage from transport truck, or when recirculating fuel.

(Note – The differential pressure must be computed at actual flow in gallons per minute rather than rated flow of the filter/separator to determine when to change cartridges.)

The following graph illustrates the proper method for determining differential pressure reading at 100% rated flow versus what you actually observe.

The above example shows a filter separator system operating at 60% of maximum (rated) flow capacity and an observed differential pressure of 5 psi. Under these conditions, if the system could be boosted to 100% of flow capacity, the differential pressure would read the same value as that obtained through the correction exercise, i.e. psi.

AVIATION FUELING OPERATIONS

1. Aviation Fixed Dispenser Operations

A. AVGAS Dispensers - Product Quality Control Checks

1. Daily Checks Filter or Filter/Separator

A. Insure that filter or filter/separator are free of water and sediment by taking sump sample for "Clear and Bright" or "White Bucket" tests.

B. Take a sample from AVGAS nozzle and perform a "Clear and Bright" or White Bucket" test.

C. At the start of each day, check the differential pressure of the filter or filter/separator under actual flow conditions.

2. Weekly checks

Remove, inspect and clean all fuel nozzles screens.

(Note – If rubber particles are found on nozzle screens, deterioration or hose lining should be suspected. If particles are found on successive weekly checks, call the Agency of Transportation, Maintenance and Aviation Division, 828-2587.)

3. Monthly checks

B. Avjet Dispensers – Product Quality Control Check

1. Daily checks – Filter separator

A. Insure that filter-separator is free of water and sediment by taking sump sample for "Clear and Bright" or "White Bucket" tests.

B. Take a sample from the AVJET nozzle and perform a "Clear and Bright" or "White Bucket" test.

C. At the start of each day, check the differential pressure of the filter/separator under actual flow conditions.

2. Weekly Checks

Remove, inspect and clean all fuel nozzle screens.

(Note – If rubber particles are found on nozzle screens, deterioration of hose lining should be suspected. If particles are found on successive weekly checks, call the Agency of Transportation Maintenance and Aviation Division.)

3. Monthly checks

    a) Perform Millipore Test. Use same procedure covered in Airport Storage, Section 5. The following ASTM color rating criteria shall be met.
        1. Color rating of A-O, B-O or G-O is acceptable.
        2. Color rating A-1, B-1 or G-1 is acceptable, but the AOT Maintenance and Aviation Division must be advised of findings.
        3. If color ratings of A-2, B-2 or G-2 or greater are observed, the product is not acceptable, and the product must be withdrawn from aircraft servicing. The AOT Maintenance and Aviation Division should be advised immediately and corrective action taken.
    b) Check filter element change date.

C. Dispenser Identification

1. Dispenser Cabinets
   All cabinets shall be painted and identified with the applicable product grade.

2. Weekly Check – Airport Storage

Check operation of AVJET A Floating System Arm using test chain and record condition.

3. Monthly Checks – Airport Storage

    a) Check the date stenciled on the AVGAS filters and AVJET filter/separators to determine when the filter elements were last changed. If the one-year limit has been reached, notify the AOT Maintenance and Aviation Division.

(NOTE: Some airlines specify one-year limit. If into plane service is provided, check airline requirement change period. Notify the AOT Maintenance and Aviation Division.)

    b) Check the operation of the filter/separator automatic water drain valve by manually tripping the float mechanism using the float adjustment screw located on the valve assembly.

    c) Check AVJET A filter separator conditions once a month by conducting a Millipore Test using a Type AA 0.8 micron downstream of each AVJET filter separator.

GENERAL FUEL HANDLING

1.a CLEAR AND BRIGHT TEST

1.a.1 Introduction and Purpose

The purpose of this test is to detect possible water or solid contaminants in aviation fuel by visual inspection.

1.a.2 REFERENCES

Test Method: API Bulletin 1500 – Section 3.5.

1.a.3 DESCRIPTION

Using a transparent container, the fuel is visually observed for a clear and bright condition. Some of the locations from which samples for clear and bright tests may be obtained are: 1) point of receipt; 2) storage tank; 3) filter vessel sump and discharge (fixed and mobile); 4) refueling tank; 5) hydrant system; and 6) aircraft tank.

1.a.4 EQUIPMENT

A clean, transparent, dry, capped bottle or container capable of holding 0.25 to 1 gal (0.95 to 3.78 L) of liquid (e.g. a Mason jar) should be used. The bottle or container should preferably have a clear, undistorted bottom and an opening large enough to accommodate the sampling tap.

1.a.5 PROCEDURE

1. Take the sample at operating pressure whenever possible.
2. Let the sample settle for one minute to remove air bubbles.
3. Observe the sample against a light background for a clear and bright condition Swirl the bottle or container to create a vortex. Free water and solids tend to collect beneath the vortex.

1.a.6 CAUTIONS

1. The presence of contamination is much more evident when the sample is taken from a pressurized system. Samples removed from a static system may indicate little contamination when actually significant contamination can be found under a flow or pressurized condition.
2. The container must be thoroughly flushed before testing.
3. Be sure that the fuel sampling tap is free of loose contaminant by flushing sample tap at maximum flow prior to drawing the sample.

1.a.7 INTERPRETATION OF TEST RESULTS

The term “clear and bright” has no relation to the natural fuel color. Turbine fuel color varies from water white to straw color to amber, depending on processing and/or crude source (refer to Section A.8 for AVGAS colors). Clear and bright fuel has no floating or suspended matter. Brightness is a quality independent of the sample color and refers to the lack of suspended or free water in the sample.

Bright fuel tends to sparkle.

2.a WHITE BUCKET TEST

2.a.1 INTRODUCTION AND PURPOSE

The purpose of this test is to visually determine the possible presence of surfactants, water and/or solids in turbine fuel.

2.a.2 REFERENCES

There is no known published test standard on this subject.

2.a.3 DESCRIPTION

A fuel sample is obtained in a white bucket at operating pressure from sumps of fixed and mobile equipment, and observed for indications of surfactants or presence of water and/or solids.

2.a.4 EQUIPMENT

Preferred equipment consists of a 9-quart (8.5 L) white porcelain bucket and a bright cover coin.

2.a.5 PROCEDURE

1. Take the sample at operating pressure whenever possible.

2. Fill the white bucket to an approximate depth of 8 inches (200 mm).

3. Let the sample set for 1 minute to remove air bubbles.

4. Place the white bucket on a level surface and inspect the bottom for water droplets, solid contaminants, hazy/cloudy condition and/or brown slime.

5. Drop a shiny copper coin into the bucket. If you can easily distinguish the coin characteristics, the product is considered neither hazy nor cloudy.

2.a.6 CAUTIONS

1. The presence of contamination is more evident when the sample is taken from a pressurized system. Samples removed from a static system may indicate little contamination when actually, significant contamination can be found under flow or pressurized conditions.

2. Be sure that the fuel sampling tap is free of loose contaminant by flushing the sampling tap at maximum flow prior to drawing the sample.

3. To determine the difference between a haze caused by entrained water or air bubbles, perform a water detection test (See Section C).

INTERPRETATION OF TEST RESULTS

Rating of White Bucket Sample

Solids Contaminant Indicators	Moisture Contaminants Indicators
1. Clean	A. Bright
2. Slight Particulate Matter	B. Hazy
3. Particulate Matter	C. Cloudy
4. Dirty	D. Wet (free water)
	E. Surfactants

DEFINITIONS OF SOLIDS CONTAMINANT INDICATORS

1. Clean – Refers to lack of particles, silt or sediment, flakes or dye, rust or solids.
2. Slight Particulate Matter – Contains several fine to moderate sized particles.
3. Particulate Matter – A sample which many small particles may be seen floating or settled on the bottom.
4. Dirty – Discoloration or many particles dispersed in the fuel or settled on the bottom.

DEFINITIONS OF MOISTURE CONTENT INDICATORS

A. Bright – Brightness is a quality independent of the color of the sample and refers to the lack of suspended or free water in the sample. Bright fuel tends to sparkle.

B. Hazy – A condition resulting from fine droplets of moisture dispersed throughout the sample producing a dull, hazy appearance. This can be a temporary condition resulting from drop in temperature. During the first minute, the fuel can appear hazy due to air bubbles.

C. Cloudy – The result of extremely fine droplets of water dispersed throughout the sample giving it a milky appearance.

D. Wet – Any form of free water in the form of droplets o bulk water on the bottom of the bucket or clinging to the sides.

E. Surfactants – (Surface Active Agents) – Slime in the bottom of the bucket or at the fuel/water interface appearing as a dark brown/black layer; or scum or lacy material floating in or on the sample.

An example of the rating system would be 2C – slight particulate matter with cloudy conditions.

Part 2

Fuel Testing and Storage

INDEX

PAGES	SUBJECT
1	Forward
2	Aviation Fuels Marked for General Aviation Use
3 - 5	Aviation Fuel Contaminants
6 – 9	Testing for Aviation Fuel Contaminants
10 – 18	Airport Storage Systems

FORWARD

There are literally hundreds of thousands of general aviation aircraft in operation around the world today. These aircraft range from homebuilts to large business jets. These aircraft are thought of in terms of their performance in the air, i.e., their speed, range, rate of climb, maneuverability, etc.

Yet, it all starts on the ground, and ends on the ground. It is the ground crew who ensures that the aircraft has been properly maintained in accordance with all applicable manufacturing specifications and government regulations; that they have been properly fueled and in general, kept airworthy. It is at this ground level that most problems can be prevented and here is where you, the FBO and leader of ground support, play a vital role.

This manual has been designed to assist you in performing your role in ground support of the aircraft you service. To do your job right, you must provide responsive service with the highest quality products. This manual will greatly simplify your job but it will only help you if you study the contents and constantly refer to its section.

This is a working manual, so

PUT IT TO WORK!!!!

AVIATION FUELS MARKED FOR GENERAL AVIATION USE

I. Aviation Gasoline's for Reciprocating Aircraft Engine

A. Grant AVGAS 100LL (Low Lead)

1. Specifications
    a. Meets ASTM D-910
    b. Fuel grade designation: 100 octane lead rating, (Aviation Method), 130 performance number (super-charged or rich rating).
    c. Tetraethyl lead (TEL): 2.0 ml/Gal maximum.

2. IDENTIFICATION

CAUTION

Reciprocating engine-powered aircraft must be serviced with aviation gasolines of the certified grade. EXTREME CARE MUST BE TAKEN TO PREVENT THE INADVERTENT MIZING AND/OR SERVICING OF THESE AIRCRAFT WITH AVJET.

NOTE

Even though the term "Octane" is used in identifying the respective anti-knock qualities of various grades of gasoline, the Aviation Method noted above is unique to the testing of Aviation Gasoline's and does not relate to values reached for automotive gasoline's.

II. Aviation Fuel for Turbine Engines

AVJET A

A. Specifications
    1. Meets ASTM D-1655 Jet A
    2. Freezing Point: Below –40° F
    3. Flash Point: 105 - 150° F

B. Identification: Water White (Colorless)
    Odor (Kerosene)

AVIATION FUEL CONTAMINANTS

Aircraft engines reciprocating or turbine and their related accessories are particularly sensitive to and intolerant of, fuel contamination. Contaminants such as water, rust or scale, dirt and certain other petroleum products can cause engine failure and result in aircraft damage and serious personal injury or death to the occupants.

The primary source of contamination is listed below:

I. Water

Water occurs in three forms:

A. Dissolved in fuel – similar to humidity in air.

B. Entrained or suspended in fuel. Entrained water can be detected visually. The finely divided droplets reflect light and high concentrations impart a dull, hazy or cloudy appearance. Entrained water droplets can coalesce to form large drops of free water.

C. Bulk quantities of water occur as a layer at the bottom of tanks, filter vessels, refuelers, Etc. up which the aviation fuel floats. Bulk quantities of water may be caused by one or more of the following:

1. Leakage into storage tanks through fill lines, manholes, dome covers and vents.

2. Delivery of water-laden fuel from transport.

3. Condensation of atmospheric moisture in partially filled storage tanks.

4. The coalescence and subsequent settling of entrained water.

II. Rust or Scale

This type contaminant is generally formed and released from the insides of storage tanks, piping and transportation.

Rust appears as a red, brown or black particulate matter at the bottom of tanks, piping and transportation tanks.

III. Dirt

This type contaminant comes from airborne dust entering storage or refueler tanks through vents, dome covers, manholes, etc. Dirt can also enter fuel systems by improper handling of hoses and nozzles. Dirt will appear as particulate matter or a muddy substance in tank bottoms, filter, vessels, etc.

IV. Other Petroleum Products

Aviation fuels are manufactured to very stringent specifications and therefore, mixing with any other product will produce an OFF-SPECIFICATION fuel.

V. Micro-organisms

A. Source

Microorganisms are present in just about every facet of the fuel handling system and they can also be introduced into the system via water, soil or air contamination. The main concern in aviation fuel is extremely high rate of fuel/stagnant water interfaces. It is this high rate of reproduction that can result in a system becoming so infected that only a thorough cleaning can correct the problem.

B. Symptoms

The symptoms listed below may indicate a possible micro-organism problem which shall be further investigated.

1. Black water drained from tank bottoms and filter sumps.

2. Water drain samples that have a foul smell.

3. Tank bottom drain/sump samples that have a stringy, lacy type emulsion or heavy emulsion or heavy emulsion at the fuel/water interface.

NOTE

If microorganism contamination is suspected, notify your Aviation's Operations Representative for assistance in conducting further tests and investigations. DISCONTINUE USE OF THE AFFECTED FUEL SYSTEM UNTIL THE PROBLEM HAS BEEN CORRECTED.

VI. Surfactants

A. Unfinished AVJET stocks contain natural surfactants which are removed by refinery processing. Finished AVJET fuels can be contaminated in distribution systems with other types of surfactants such as corrosion inhibitors and chemical additives used in other products, which are transported in the same distribution system. Another source of surfactants is from the biological action of micro-organisms present in any water/ AVJET fuel interface.

B. Symptoms

The symptoms listed below may indicate a possible surfactant problem, which shall be further investigated.

1. Dark Millipore on product discharge from filter/separator, which do not show visual particulate matter.
2. Opaque water, including black water, drained from tank bottoms and filter sumps.
3. Lacy or heavy scum at fuel/water interfaces drawn from storage tanks or filter sumps.
4. Free water content above 15 ppm in product discharge from filter/separator.

NOTE

If surfactant contamination is suspected, notify your Aviation Operations Representative for assistance in conducting further tests and investigations. DISCONTINUE THE USE OF THE AFFECTED FUEL SYSTEM UNTIL THE PROBLEM HAS BEEN CORRECTED.

TESTING FOR AVIATION FUEL CONTAMINANTS

Visual and Chemical Detection – Methods and Criteria

I. Contaminant Detection - General

There are many tests that have been developed over the years that are designed to aid in the detection of fuel contaminants. However, experience has shown time and again that there is no substitution for four basic human senses of sight, sound, feel and smell.

Many problems have been averted because a line crew member noted that the fuel "didn't evaporate fast enough" or "didn't smell right" or "didn't feel right", etc.

II. Visual Detection

A. Large quantities of water in aviation fuel samples can be visually seen because the water will quickly separate from the fuel and settle to the bottom of the sample container.

B. Smaller amounts of water present in fuel samples can be concentrated by "swirling" the sample in the container. Water, being heavier than fuel, will tend to collect in the center either as bulk water or as droplets in a vertical line within the fuel sample.

C. Finely divided water droplets will appear as a haze in fuel samples. Air can also cause a haze, but the air will separate from the sample in one or two minutes, whereas, water haze may require several hours. An experienced observer can detect a very slight haze under a strong light beam equivalent to 50 parts per million or greater of free water.

III. Visual Detection – Test Methods and Criteria

A. Test Methods – Visual Detection

1. "Clear and Bright" Test

This method employs a clean glass container of approximately one quart or one liter capacity. A sample of product is drawn into the container and observed in a strong light to detect free water haze or sediment.

NOTE

This method is preferred when testing AVJET A.

2. "White Bucket" Test

This method employs a clean white enameled bucket. A sample is drawn into the bucket and swirled to concentrate any water, rust, sediment, etc. into the center.

NOTE

Experience has shown that a white enameled bucket is preferred to that of plastic because plastic tends to hold a slight static charge and hold particulate material to the sides.

B. Criteria – Visual Detection

1. Color and Odor

Avgas fuels should be the colors specified for grade:

AVGAS 100LL – Blue
AVGAS 100/130 – Green
AVGAS 80/87 – Red

Odor should be a distinct "gasoline" smell.

CAUTION

AN OFF-COLOR FINDING INDICATES AN OFF-SPECIFICATION FUEL AND INVESTIGATION IS REQUIRED.

2. Clarity – Visual Detection

When examined under good light, the fuel should be bright without cloud or haze and free of any sediment, lint, fibers or emulsion. At night, a vapor proof flash light held at a right angle to the line of vision will aid in disclosing any suspended particles in the fuel sample. The print of this page should readable through the glass container filled with fuel. Lack of clarity may be due to any one of the following:

a. Free water – appears as bulk water on the bottom of the container, droplets on the side of the container, cloudy milky haze (air in the form of line bubbles in suspension can give a cloudy appearance but will disperse in a minute or two).

b.Sediment - appears as rust or paint flakes, specks, fibers, lint, etc., suspended in fuel or settled out on the bottom of the sample container as fine silt. Sediment can be settled out by gentle swirling of the container or bucket. Depending on the source of the sample, i.e. airport storage, airport refueler, etc., various amounts of sediment can be expected. Amounts point in the fuel deliver system from which the sample was drawn and to the results of previous samples from the same sampling point. No visible sediment is permitted at the point of delivery into the aircraft, that is, the refueling nozzle. Sediment at this point indicates a problem with the filtration and/or delivery system of the refueler or dispenser.

c. Emulsion - consists of finely divided water intimately mixed with fuel containing rust, dirt, various emulsifying agents or microbial growth; appearing as a lacy, foamy band of dirty or rusty suds at the fuel-water interface. If found, such emulsions must be completely removed from the fuel supply system. (Refer to the Micro-Organisms in prior section.)

CAUTION

When performing either the "Clear or Bright" or the "White Bucket" test on AVJET A fuel, it is possible to mistake an all water sample as AVJET. The simple act of adding a known quantity of water to the sample will tell if it is all water or AVJET i.e. the water will quickly and visibly settle to the bottom in an AVJET sample. If sample is all water, the added water will not separate.

Chemical Detection – Test Methods and Criteria

A. Water Sensitive Paste or Paper

Water detecting paste and paper have been developed to indicate the presence of free water, however, they do not readily react to low concentration such as haze in a fuel sample. Water detecting paste or paper shall be used whenever gauging or checking any airport storage or refueling tank to determine the presence of bulk water at the bottom of the tank.

CAUTION

As stated above, do not rely on the water detection paste or paper to clear a fuel sample for aircraft service. Remember, low concentration of water can be just as hazardous as bulk water. USE YOUR “CLEAR AND BRIGHT” AND “WHITE BUCKET” TESTS.

B. Water Detecting Kits

1. The Hydro Kit, manufactured and available from Exxon International, is one means of checking for water in AVJET A, and its use is recommended where a chemical test for water is requested by the customer or required bye local governing authority.

The tests consist of the addition of a pre-measured amount of white powder to the AVJET A sample. If water is present, the powder turns pink. The chemical powder is sensitive to water concentration down to 30 ppm.

2. Aqua-Glo II Kit, manufactured and available from Gammon Technical Products, Inc. is another means of checking for water in AVJET A, and its use is also recommended where a chemical test for water is required by the customer or required by local governing authority.

   Test consists of passing a 500-ml (approximately ½ quart) sample through a water sensitive membrane attached to the Millipore sampling tap. The membrane is then compared to a known standard under ultraviolet light using a photocell indicator. By comparing the test and standard membranes, it is possible to detect levels of water as low as 1 ppm.

V. Disposition of Tested Fuel

Suitable containers, properly marked, should be provided for storage/disposal of tested fuel samples.

AIRPORT STORAGE SYSTEMS

Aviation fuels are stored as airports in segregates and clearly identified tanks for each type and grade of fuel, with separate product receiving connections.

Because of the difference in characteristics of Avgas and AVJET A, the design and operational procedures of Avgas and AVJET A systems are different. Water and dirt, if present in Avgas, will settle out very quickly. Water and dirt, if present in AVJET A, will settle out very slowly.

Aviation Fuel Storage and Servicing Systems are designed and constructed to facilitate detection and removal of contaminates in order to insure delivery of clean, dry on-specification fuel into aircraft. These design and construction features are illustrated and explained as follows:

1. Typical Avgas Storage Installation (see Drawing 4-1)

   The storage (1), whether underground or aboveground, is installed with a slope to provide a low point for the collection of any water or (2) is provided for gauging tank gallons and to detect bulk water by water detection paste applied to the gauging stick. A "thief" pump (3) is provided to remove water sediment from the tank "low point". (A drain valve and pipe are provided on aboveground tanks for this purpose.) A pressure-vacuum vent (4) is provided to release air pressure during receipt and delivery. A manhole (5) is provided for direct delivery of Avgas into the tank. A suction discharge pipe (7) is installed with the foot end spaced off the tank bottom (8-12 inches depending on tank size) to prevent pickup of any water and sediment which might be on the tank bottom. The pump (8) draws Avgas from the tank and pumps it through the filter (9), which removes any suspended dirt in the fuel. The filter is provided with a sump drain (10) to check and remove any water, which might have collected in the filter vessel. A differential pressure gage (11) is provided to measure the difference in pressure across the filter elements during rated flow.

   Where bottom loading of Avgas is required, a bottom loading hose (12A) and valve (13A) are fitted to the discharge pipe after filtration.

II. Typical AVJET A Storage Installation

   AVJET A, a kerosene type fuel, holds water and sediment in suspension for long periods of time. Because of this characteristic, AVJET A storage installation are designed and constructed differently than Avgas. The prime differences are the use of:

   A. Floating suction mounted on the pipe in the tank.

   B. A filter/separator with elements that remove both free water and sediment from the fuel.

   C. An automatic drain on the filter/separator.

   D. An automatic water slug valve in the discharge line downstream of the filter/separator.

E. Filtration of AVJET A as it is received into storage.

Schematically, a typical AVJET A installation is arranged as follows: See Drawings 4-2 2 pages.

The storage tank (1), whether underground or aboveground, is installed with a slope to provide a low point for collection of any water and sediment settling out on the tank. A tank fitting (2) is provided for gauging tank gallons and to detect bulk water by water detection paste applied to the gauging stick. A "thief" pump (3) is provided to remove bulk water and sediment from the "low point". (A drain valve and pipe are provided for this purpose on aboveground tanks.) A pressure-vacuum vent (4) is provided to release air pressure during receipt and delivery. A manhole (5) is provided for inspection and cleaning of tank interior. A "fill" or delivery pipe and valve (6) is installed so that AVJET A product must be pumped through the filter/separator (11) prior to delivery into the tank. A "floating suction" box and arm (7) are installed on the suction or outlet pipe (9). This design permits drawing of fuel from the top surface and minimized length of "settling" time of one hour per foot of product in the tank where floating suction is not utilized. Where "floating suction" is provided, only a two-hour "settling" time is required. A stainless steel chain (8) is provided for checking the buoyancy and flexible joint operation. The pump (10) draws AVJET A from the tank through the floating suction line (9) and valve (VI) and pumps is through the filter/separator (11) which removes any dirt in the fuel. The filter/separator is equipped with a differential pressure gage (12) to measure the difference in pressure across the filter, which is an indication of performance of the filter elements during rated flow. The filter/separator is also equipped with an automatic water drain (13) whose function is to automatically drain any water coalesced or "stripped" from the fuel when the water has accumulated to a pre-determined level. A manual drain (14) is provided to completely drain any water and sediment from the filter/separator sump. Millipore "quick, connect" taps (15) are installed "upstream" and "downstream" of the filter/separator so that Millipore checks can be made. (This test on the "dirt removing efficiency of the filter separator. The "upstream" color check indicates the cleanliness rating of the fuel in storage, whereas the "downstream" check indicates cleanliness rating of fuel after passing through the filter/separator elements. For example, if "upstream" color rating is 2 per ASTM color standards and the "downstream" color is 2, the elements are not effective and should be changed.) The fuel after being filtered by the filter/separator passes through a water slug valve (16) prior to discharging at the re-fueling loading position (17). The function of the water slug valve is to shut down the delivery system in the event of large quantity of water is encountered.

Receiving or delivery into storage is accomplished by connecting the transport truck hose (19) to the delivery connection. The fuel system valves must be positioned so that the pump (10) can draw the fuel from the transport truck and pump it though the filter/separator prior to delivery into storage tank. Positioning of valves for AVJET A delivery into storage is, referring to the schematic: V1 and V3closed, and V2 and V4

open. Note that a strainer (18) is provided in the receiving pipe. This is installed to catch any hose liner pieces, gaskets or objects that may damage the pump.

III. Typical Filter/Separator Vessel – Design and Operation (see Drawing 4-3)

Filtration equipment is installed in aviation fuel handling systems to maintain specified fuel quality by removing particulate and contaminating matter and suspended free water that may have entered the fuel during transportation and/or storage.

A filter/separator consists of a vessel containing two distinct sets of elements that continuously remove both dirt and water. The first state of elements, or coalesces, trap dirt down to the very finest particle size and at the same time force the smallest droplets of suspended water to combine into large drops. These larger drops will more readily "fallout" of the fuel and are assisted to do so at the second stage, or separator, which holds back the drops of water.

A. Operation

A better understanding of the operation of the unit is achieved by following the product flow through a typical filter/separator unit (see Cutaway-Typical Filter/Separator Drawing 4-3). Product enters the vessel through the inlet port and flows from the inside of the coalesced elements, through the elements, and out into the chamber of the vessel. The larger water droplets, having been coalesced, will tend to "drop-out" of the fuel due to gravity. The product flow continues through the second state separator elements (from the outside of the element to the inside) and out of the vessel though the outlet port.

The filtering action of each stage of elements is based upon the design and composition of the element media. First, the process of coalescing is accomplished by flowing product though a media who has a large number of small, irregular, continuous passages of very small diameter. This media is such that it is "wetted" by the water in the fuel. As the product/water emulsion passes through the media, the minute water droplets will tend to cling to the media. As the droplets are pushed along in the irregular passages, they collide with other droplets and become larger droplets. As this process is repeated again and again, more and more large droplets are formed. Through the depth of the cartridge, the droplets grow and grow. This process is known as coalescing.

Because of the extremely small diameter of the irregular, continuous passages of the coalescing media, a second function of the first stage elements becomes one of the filtering solid particles.

Because of the relatively high flow rate of the fuel through the vessel, the discrete droplets of water leaving the coalescing media must be removed by means other than gravity. Of course, gravity will begin to pull the particles towards the sump of the vessel away from the4 product flow and even remove some of the larger droplets. To

remove the smaller sized droplets, however, the second stage of filters is used. The separator elements are designed to repel the coalesced water droplets and permit the passage of the product. As the water droplets are repelled from the outer surface of the separator elements, the droplets fall to the sump of the vessel.

To summarize, then, filter/separators are tanks containing two (2) types of elements. The coalescer, flowing inside out, removes solid contaminates, breaks the fuel-water emulsion, and coalesces the water into large droplets. By gravity, the larger are removed from the product prior to entering the second stage elements. The separator element, flowing outside in, separates out the smaller water droplets from the fuel stream.

B. Operation of Automatic Drain and Water Slug Valve

As discussed above, water is removed from the product flow and accumulates in the sump of the filter vessel. For purposes of removal of this water, a manual valve is provided which must be drained daily. In addition, automatic drain and water slug valves are provided on all filter/separator units to provide the following:

1. Automatically drain the accumulated water from the filter/separator when the level of water reaches a predetermined height.

2. Automatically stop the flow of product from the filter/separator in the event of a sudden excessive slug of water entering the unit and/or when the level of the separated accumulated water reaches a predetermined height in the main body of the vessel.

In order to accomplish the above functions, the automatic control valve system normally consists of float control, float actuated pilot valve, automatic water drain valve and a water slug valve.

The operation of the water slug and automatic water drain valves is a direct resultant action in response to the float actuated pilot valve. The float is designed to float in water and sink in hydrocarbon liquid products; therefore, when the filter/separator is first put in operation, or with no water present in the sump, the float will be in its bottom condition. When in this position, the slug valve will be open and the automatic water drain valve closed.

As the water starts to accumulate in the sump as a result of the coalescing action of the elements, the float will gradually rise until it is in its “intermediate or middle position”. In this position, the automatic water drain valve will open permitting water to drain from the sump. The water slug valve will remain open. If the water caused the float to rise to its “top position” because the separated water is accumulating after than the automatic drain will permit disposal of, the water slug valve will be closed, stopping flow of product though the filter/separator.

The automatic drain valve will remain open until the water has been lowered, at which time the automatic drain will close and water slug reopen, as a result of the float returning to its lowest position.

If a sudden excessive slug of water should enter the vessel, the float will rise to its "top position" almost instantly, thereby closing the water slug valve which will remain closed until the water has been disposed of.

Based upon the operation of the automatic water control system, as described above, it is imperative that this system be kept operative i.e. maintained properly. Under no circumstances should the automatic water drain line to be "plugged or capped:, as this action would render the assembly inoperative.

Float testers are available which permit a manual raising of the float assembly to check its proper operation (Request information from Aviation Operation Representative.)

C. Indicators of Possible Filter/Separator Malfunctions and Criteria for Replacement

The best indicators of the condition of the filter/separator elements are:

1. The difference in color of the Millipore membranes, taken both before and after the filter.

2. The Differential pressure drop across the unity.

3. The amount of free water remaining in the product downstream of the Filter/separator (as measured by Aqua-Glo 11).

For these reasons, the following criteria shall be used for element replacement.

1. Elements shall be changed when the pressure differential reaches 15 PSI (measured at normal flow of the unit) or after 24 months of service, whichever condition is satisfied first.

NOTE

Upon the installation of a new filter unit or upon replacement of elements, an initial differential pressure reading of one (1) or two (2) PSI is considered normal. The differential pressure should show a progressive increase during use.

2. Elements of filtration units shall additionally be changed, whenever the Millipore test filter fails to meet acceptable criteria, as established in this manual.

3. If, during use, a drop in pressure differential reading of two (2) PSI or more at approximately the same rate of flow is observed, a condition of filter

element rupture or malfunction of the pressure gauge is indicated. Immediate corrective action must be taken.

4. If, when measured with Aqua-Glo 11, product downstream of the filter/separator contains greater than 5 PPM water.

A further indicator of the condition of the elements is the daily sample taken from the sump of the filter/separator. Normally, the sample should contain little or no water, particles, or rust, and should be comprised of product, which is clean and bright. If the sample is found to contain any abnormal deposits, such as black water, biological growth, surfactants, excessive accumulations of water or large amounts of particle contamination, this condition is an indication that either the filter/separator unit itself or both, are not working properly. Indicator, as enumerated above, should be considered as "danger signals", with immediate notification of the Operation Representative. The cause of the problem should be determined by examining all of the individual parts of the distribution system, including tanks, filter/separators, and refueling equipment. In general, if the source of the problem can be isolated quickly, corrective action taken promptly, there will be minimum of down time for the system.

IV. Airport Storage Identification Requirements

Major oil companies incorporate the current API identification specification throughout its aviation fuel supply and distribution system. In order to maintain uniformity throughout this system, up to and including delivery into the aircraft, each dealer shall comply with the following identification system.

A. Product Naming

Product naming consists of designation for the different grades of aviation gasoline's and turbine fuels in use.

1. Aviation Gasoline Grades

   Named by using the general term AVGAS followed by one number or one number and two letters. These grades are as follows:

   a. AVGAS 80
   b. AVGAS 100LL
   c. AVGAS 100

   AVGAS 80 AND 100 AFRE MARKETED IN LIMITED AREAS

2. Aviation Turbine Fuels

Named by using the general term AVJET followed by a letter

AVJET A

NOTE

The product naming system shall be used on all equipment-tanks, valves receiving and discharge lines, connection points, etc. except in areas where there is not sufficient space. In the latter case, the equipment will be identified by either the Banding or Color Coding System discussed below.

B. Color Coding of Aviation Gasoline's and Turbine Fuels

Color Coding consists of designating a color to be used with each product.

1. Aviation Gasoline Grades

This color has been arbitrarily selected to define the product and not be confused with any other aviation product.

2. Aviation Turbine Fuels

The Banding System consists of a single band around the pipe or hose of the proper color for AVGAS lines, and band for AVJET lines as required. The bands should be approximately 4-inches (10-cm) wide and are to be painted completely around the pipe in order to be visible from all sides. Bands are to be used adjacent to the product name as well as well as by themselves where required to properly identify the piping and equipment in aviation services.

Part III

Millipore Test Procedure

PAGES	SUBJECT
1 – 7	Procedure

PROCEDURE

(Note – Daily Airport Storage Checks must be performed before conducting Millipore Test.)

A. The field monitor kit will be assembled as show in figure 5-1 and 5-2.

(Note – Approved Kits are: Gammon Mini-Monitor Kits GT172 or Millipore Fluid Sampling Kit XX64-037-30.)

B. Check to see that the three-way valve is in the OFF position noted in figure 5-3. Remove the protective cap and plug from the quick release valve and insert the nipple into appropriate (depending on the product and/or filtering device to be evaluated i. e. prior to or after filter/separator, clay, product receipt, etc.) product sampling tap.

C. Connect a flushing line to the monitor holder.

D. Configure Fuel Delivery System as required to obtain sample desired (i. e. recalculate, product receipt, product loading etc.) and start product flow.

E. Turn the three-way valve to FLUSH and collect one gallon (4 liters) of fuel into a PREMARKED white bucket.

F. Turn the three-way valve to TEST and collect one gallon (4 liters) of fuel into a PREMARKED white bucket.

(Note – During the obtaining of the one gallon test sample, no valves in the fuel system should be disturbed.)

G. Turn the three-way valve to OFF, remove test apparatus, stop product flow and reconfigure fuel system as desired.

CAUTION

After flow has stopped, let at least 2 minutes pass before starting disassembly to allow decay of any electrostatic charge, which might have built up during the test.

H. Remove filter capsule from monitor cylinder.

I. Remove residual fuel from capsule by using vacuum syringe provided. ATTACH SURINGE TO DISCHARGE SIDE OF CAPSULE.

J. Separate the capsule halves and remove the filter membrane and back-up pad from the capsule using stainless steel forceps.

K. Place the filter membrane, intake side up, on a clean absorbent material and let dry.

(Note – Take care not to let the surrounding atmosphere contaminate the drying membrane, thus resulting in an unacceptable rating.)

L. Compare the "upstream" and downstream" color ratings and interpret the comparison results as follows:

1. If "upstream" and "downstream" color ratings are the same and exceed A-1, B-1 or G1, the filter elements are not functioning properly and must be changed (Probable cause: rupture or surfactant disarmament.)

2. If "upstream" color rating exceeds "downstream" color rating by more than one rating – example: "upstream" rating equals A-3 and "downstream" equals A-3, the elements are porbalby functioning properly and the problem is one of "dirty" fuel in the storage tank.

Action

A. In all cases if a Millipore color rating of 2 is obtained "downstream" of the filter/separator, the AOT Maintenance Division shall be immediately notified.

B. If the Millipore color rating of AVJET A "downstream" of the filter/separator is 3 or greater, fuel servicing from storage shall be stopped until corrective action is taken.

C. Cut test membrane is half and attach to "Millipore" cards. Retain one for your files and send other card with ½ membrane to the Agency of Transportation, Maintenance & Aviation Division, National Life Drive – Drawer 33, Montpelier VT 05633, (802) 828-2587. (See Figure 5-4.)