Avfuel Rampside Training System

Video Reference Guide

1. Fuel Handling and Fire Safety
2. Aviation Fuels and Additives
3. Fuel System Ice Inhibitor (FSII)
4. Contaminants and Fuel Testing Methods
5. Procedures for Receiving a Load of Aviation Fuel
6. Aviation Fueling Components
7. Fuel Storage Systems
8. Mobile Refueling Equipment
9. Aircraft Fueling and General Operations

Table of Contents

FUEL HANDLING AND FIRE SAFETY

Aviation fuels and their additives are hazardous materials. It's critical that your staff undergo professional safety training. In this section on fuel safety, we'll review Safety Data Sheets (SDS), personal protective equipment (PPE), fire properties, fire safety procedures, and basic procedures for spill prevention and control.

Fuel Handling and Fire Safety

Safety data sheets, or SDSs, outline procedures for handling substances in a safe manner. The Occupational Safety and Health Administration (or OSHA) requires that all staff and emergency personnel review these documents prior to handling aviation fuel products. OSHA also requires that MSDSs for products handled by your FBO be made available to all employees at your location as well as to local fire departments and local and state emergency planning officials. "Avfuel provides SDSs along with all of our fuel products."

INFORMATION FOUND IN AN SDS DOCUMENT INCLUDES:

- Chemical Product and Company Information
- Composition and information regarding ingredients
- Hazards Identification,
- First Aid Measures,
- Fire Fighting Measures,
- Accidental Release Measures,
- Handling, Storage, Exposure Controls and Personal Protection,
- Physical and Chemical Properties,
- Stability and Reactivity,
- Ecological Information,
- Disposal Considerations
- Transport Information and Regulatory Information

All safety and personal protection recommendations included on each product's SDS must be implemented at your location.

Aviation fuels are highly flammable and may contain toxic additives that should not come into contact with skin. These fuels must be handled with extreme care and caution.

Be on alert for additives including fuel system ice inhibitor (FSII) additive in turbine fuel or lead or TEL in Avgas 100LL.

Personal protective equipment, commonly referred to by the abbreviation PPE, should always be used when handling aviation fuel. PPE includes: *Gloves , Safety glasses or goggles, Non static-generating clothing, and leather shoes without exposed metal toes or taps*

It is your responsibility to use the correct PPE for the products you are handling. Consult each product's SDS for guidance.

Understanding the behavior of fire and how to extinguish it, as well as recognizing possible ignition sources helps prevent property damage and injuries. In the event of a fire, immediately call the fire department responsible for the air field regardless of whether or not you have used a fire extinguisher -- or succeeded in extinguishing the fire. The fire department can assess the situation and extinguish fires that may be out of your control. They have been trained to prevent fires from flaring up again. **Always check with the Authority Having Jurisdiction or AHJ for any additional or special requirements for your location.**

The National Fire Protection Agency or NFPA is the world's leading advocate of fire prevention and an authority on public safety. The NFPA develops and publishes, more than 300 codes and standards designed to minimize the possibility and harmful effects of fire.

Fuel Handling and Fire Safety

Two relevant fire safety publications often referred to are NFPA 30 and NFPA 407. These are commonly used in the management of aviation fuel storage facilities and fueling equipment.

NFPA 30 defines safeguards for the storage, handling, and application of flammable and combustible liquids. It also defines safety measures for fuel farm and storage construction.

NFPA 407 pertains to aircraft fuel service. It establishes reasonable minimum fire safety standards for the protection of people, aircraft, and property during the aircraft-fueling process at airports.

The FAA requires that airports with a Part 139 Certificate adhere to the standards put forth in both NFPA 30 and NFPA 407. It actually recommends that all airports, whatever their type, adopt these standards. These key publications are also endorsed by the NATA, ATA, API, and all major fuel suppliers.

Avfuel Corporation recommends that you have copies of both publications available for reference at your location at all times.

The ability to identify potential fire hazards in fuel handling is critical. Let's review the properties and risks associated with Jet-A and Avgas.

The Flash Point of a liquid refers to the lowest temperature at which an ignitable mixture of the liquid and air near its surface can form. The lower the flash point, the easier it is to ignite the material.

The flash point for Jet-A is 100 degrees Fahrenheit and its flammability is Class II. Class II means that the material must be moderately heated or exposed to relatively high temperatures before it will ignite.

The flash point for Avgas is -50 degrees Fahrenheit and its flammability is a Class III. The term Class III applies to liquids and solids that can ignite under almost all temperature conditions.

"Flammability" Conditions refers to the ratio of fuel vapor to oxygen for combustion to take place. There is a lower and upper limit to a safe, non-flammable condition: When the fuel/air mixture falls below the lower limit, the mixture is "too lean" – and there is no danger of ignition. When the fuel/air mixture exceeds the upper limit, the fuel/air mixture is too rich and will not ignite.

- Jet-A 0.74%-5.32%
- Avgas 1.4%-7.6%

AUTOIGNITION IS THE TEMPERATURE AT OR ABOVE WHICH A SUBSTANCE WILL IGNITE WITHOUT ANY OUTSIDE IGNITION SOURCE AT ALL.

- The autoignition temperature for Jet-A is 475 degrees Fahrenheit
- The autoignition temperature for Avgas is 840 degrees Fahrenheit

BUT TAKE CAUTION: Heat sources like engine exhaust,hot brakes, or bare light bulbs may be below the auto-ignition temperature and still ignite a fire! It is important that fuel not be spilled on any of these or similar heat sources. Regular inspection of all equipment, particularly protective and insulating devices such as light bulb lenses and muffler shields should be conducted frequently.

Fuel Handling and Fire Safety

The Rate of Flame Spread is the speed at which flames travel across the surface of a body of fuel. As the fire burns, the layer of fuel closest to the top begins to separate. Oxygen is present in varying concentrations and allows the fuel to vaporize in the necessary concentrations to allow flame production. As this occurs, flame spreads. The leading edge is called the flame front.

The "Net heat of Combustion" is the amount of heat energy released by combustion per volume of fuel.

THE NET HEAT OF COMBUSTION OF

- Avgas is 19,000 Btu/lb
- Jet-A 18,600 Btu/lb

The fire tetrahedron refers to the four conditions that must be present for fire to take place: Heat is needed to raise the material to its ignition temperature, causing the fuel or combustible material to ignite and a subsequentChemical chain reaction to occur. Oxygen then sustains combustion. This was originally called a "triangle" until a fourth element was added.

TO SUCCESSFULLY EXTINGUISH A FIRE, ONE COMPONENT OR SIDE OF THIS "TETRAHEDRON" MUST BE ELIMINATED.

- Removing the fuel source will starve a fire.
- Removing heat can prevent a fire from taking place or stop a fire in progress.
- Stopping the chemical reaction that feeds the fire will also starve a fire.
- Removing oxygen will smother the fire.

Fire extinguishers put out fires by taking away one or more of these elements.

We divide types of fire into five classes – A,B,C,D and K. This classification identifies different characteristics of fires to help you determine what methods and agents should be used to extinguish a fire.

Class A fires involve common combustible materials such as wood, cloth, paper, rubber and some plastics.
EXAMPLE: A wildfire

Class B fires involve flammable and combustible liquids, greases, and gases.
EXAMPLE: A Jet-A fire"Class C fires" involve energized electrical circuits.

Class C fires are started by a short circuits or high voltage sources.
EXAMPLE: Downed power line or an electrical fire on an aircraft refueler chassis.

Class D fires involve combustible metals such as magnesium, titanium, zirconium, and sodium.
EXAMPLE:In aviation, Class D fires occur due to Titanium and Magnesium alloys, often used in aircraft construction by virtue of their considerable strength-to-weight-ratios.

Class K fires involve cooking oils or fats found in kitchen fires.

WHY DO YOU NEED TO KNOW ALL THIS?

It is critical to how you extinguish or prevent a fire. Even your fire extinguishers must be of the appropriate type to the class of fire. Therefore all extinguishers on your ramp and around a given aircraft should be designed for Class B and C fires. There are certain extinguishing materials you must not use on aircraft because they can damage the aircraft or the environment. Halon, for example, should be avoided due to environmental concerns. The best bet is to stay informed:

Check with your local fire marshal frequently for the proper type of extinguishing equipment required at your facility.

Perform daily checks to ensure that extinguishers are visible and offer unobstructed access. Check any gauges frequently. If the extinguisher's seal is broken, or if there is any indication of a low charge, you should service that extinguisher or discard it using your facility's accepted disposal protocol. Perform monthly checks of fire-extinguishers to ensure that inspection tag dates are current, charges are full, and that seals and pins are in place. Be aware that extinguishers must be stored away from ice and snow. Any covers in place to prevent ice and snow from accumulating must be removed by your personnel during aircraft fueling for quick emergency access.

Your local Authority Having Jurisdiction (AHJ) is authorized to dictate changes to your storage and inspection process at any time. Always follow your local AHJ directives -- it could save a life.
As we have mentioned, there are many types of fire extinguishers. These contain different extinguishing agents. Some extinguishers are only effective on certain classes of fires. Read extinguisher labels carefully to determine what class of fire they are designed to extinguish.

LET'S DISCUSS SOME COMMON EXTINGUISHING AGENTS:

"Water" - Water is most effective at extinguishing Class A fires. It quenches and cools the fire, removing the heat component of the fire tetrahedron. However it is not effective for class B, C, or D fires. Indeed, it can be a hazard: Extra caution should be used to prevent water from being sprayed on energized electrical fires. The water can become a conductor, shocking personnel. Furthermore when used on a flammable liquid like Avgas, water can spread the fire.

CO2 - When it comes to fires, we call carbon dioxide or CO2 a smothering agent. It extinguishes fires by displacing the oxygen necessary to support combustion and is most useful against Class B and C fires. Because CO2 is a pressurized gas, it will readily disperse in windy conditions. This means it must be used at close range. Unfortunately CO2 is an asphyxiant and can be toxic in an enclosed area, so care must be taken by its user. It is neither corrosive nor conductive, and it discharges rapidly and leaves no residue.

Dry Chem - Dry chem refers to a dry chemical agent stored in a pressurized container and consisting of sodium bicarbonate (also known as baking soda), potassium Bicarbonate, or monoammonium phosphate. These solids are inert, or nonreactive and work by removing the oxygen side of the fire tetrahedron. They also interfere with the chemical chain reaction. Dry chem is typically used on Class B or C fires.

Another kind of dry chem extinguisher containing mono-ammonium phosphate may be used for fighting Class A fires. But Monoammonium Phosphate is corrosive to aircraft materials and is restricted on the airport ramp per NFPA 407.

Foam - Foams contain a blend of bicarbonate of soda and aluminum sulfate. True to their name, this combination foams when mixed with water. Foams are effective blankets that cool and smother a fire. Foam is very effective against class B fires and is effective -- to a degree -- against Class A fires. Foam does not work well on vertical surfaces as it will not cling sufficiently. It is also not effective against fires that are fed under pressure, as the pressure inhibits the foam's abilities.

Fuel Handling and Fire Safety

Halon - Halon interrupts the chemical chain reaction needed to produce fire by preventing fuel and O2 from combining. Halon leaves no residue but it is an asphyxiant and must be used with care. While Halon is useful in fighting both Class B and C fires, it has a negative environmental impact and should be avoided.

The NFPA requires fuel service personnel to be thoroughly trained in the use of available fire extinguishing equipment. Check with your AHJ or local fire station for hands-on training opportunities. Most professional fire fighters will be happy to work with you in creating a safe, fire-free environment.

You know how to identify the correct fire extinguisher. Now how do you work it? An effective way to remember is with the acronym **PASS**.

P-ULL- the safety pin
A-IM- the nozzle
S-QUEEZE- the trigger
S-WEEP -the base of the fire

CONSIDER THE FOLLOWING WHEN DECIDING WHETHER OR NOT TO USE A FIRE EXTINGUISHER:

- Is the extinguisher located in an appropriate and non-hazardous location?
- Is it in working order?
- Is the fire extinguisher of the proper type for the fire under consideration?
- Is the fire small enough to put out with a fire extinguisher?
- Has the fire been discovered by a person ready, willing, and properly trained and capable of using the extinguisher?

HERE ARE SOME MORE SAFETY CONSIDERATIONS:

- Is there any possibility of explosion?
- Could your escape route be cut off?
- Can you completely extinguish the fire?
- Could it rage beyond your ability to contain it before it can be put out completely?
- How fast can the fire department respond?

Never turn your back on a fire, even if you think it has been extinguished. There may be enough heat left to cause a deadly flashback. Post a vigilant, informed guard in a safe place near the extinguished fire's location until authorities arrive to assess the situation.

Eliminating possible ignition sources and preempting fire-friendly conditions -- such as fumes -- is your first line of defense against fires and explosions.

Avoid open containers, and be wary of fuel spills or any situation where fuel is exposed to air. These can all enable the formation of a flammable fuel/air mixture.

Fuel Handling and Fire Safety

Do not ever use leaking equipment. Repair faulty equipment immediately, and clean up even the tiniest fuel spills the instant they occur. Take care to dispose of test fuel and spill-cleanup material correctly to reduce potentially hazardous conditions at your fueling facility. Correct handling will be dictated by your local fire authority and your facility.

Always be alert for potential ignition sources and remove them immediately from your fueling and fuel storage areas. It's not worth the risk. This list is not comprehensive.

- Static electricity and sparks near a fuel source.This includes clothing that has the potential to produce static. For example, polyester is especially prone to static and should be avoided entirely.
- Plastic or galvanized fuel buckets also generate static and should not be used unless modified with bonding equipment.
- Electronic devices: These devices include but are not limited to iPods, radios, MP3 players, cellular phones, and gaming systems. Only use electronic devices that have been officially approved for use near fuel vapors.
- Matches or lighters: these are strictly prohibited and may not be carried by refueling personnel.
- Unshielded electrical equipment such as open junction boxes, switches, conduit, bare wires, or bare light bulbs.
- Failure to bond – A high differential charges can develop when bonding isn't performed correctly or at all. We will discuss the process and dangers of Bonding in more detail later in your training.
- Fuel itself can be charged -- with most of the charge carried at its surface. This can happen when splash-loading creates static as fuel drops into a tank. Aircraft brakes reach their peak temperatures up to 30 minutes after hard braking. Do not assume that a parked aircraft's brakes aren't hot enough to start a fire.
- Exhaust and Hot engines - are common igniters as we have mentioned. Take care with vehicles of all types.

Static Charge is an unmoving electrical charge. It can be caused by friction between dissimilar materials. When two materials rub against one another the electrons of one material are deposited onto the other material, leaving the first with a positive charge and the second with a negative charge caused by the new surplus of electrons.

The more aggressive the rubbing, the more electrons are transferred to the other material. The more electrons that transfer, the more powerful the static charge.

Static transfer takes place in many areas of a fueling facility. The prime culprit is the filter vessel in the aviation fuel system itself. As fuel passes through the filter media the resulting friction produces an enormous amount of static. This is regardless of whether the system uses a standard coalescer/separator, a water-monitor element or a simple micronic unit. Fuel tends to store the majority of charge at its surface. To avoid ignition, filter vessels must be filled slowly, so that air can be purged through the air-eliminator especially after changing filters.

Positive and negative static charges "want" to be balanced or neutral. Unless safe pathways are provided, they may jump or arc to another material to regain a neutral state. These jumps are an ignition source. An example of "arcing" is the mild shock you get after shuffling your socked feet across a carpet and then reaching for a doorknob or light switch. The charge created by your feet simply jumps through the space between your finger and the surface.

In aviation, for example: A landing aircraft's fuselage could acquire a charge created by its movement through air; Meanwhile, a refueler truck might generate an opposite charge as it moves along its ramp. Now we have the potential for a spark -- when the aircraft and truck are positioned for fueling, a spark might arc between the fuel nozzle and the fuselage. To prevent this spark, bonding is necessary. Bonding must occur between the refueler and the aircraft before the fuel cap is removed and before you approach with a nozzle. Bonding opens an escape pathway for the

charges to equalize so that they don't produce a spark and create a fire.

Bonding is the creation of an electrical path between two objects as a means of safely exchanging any charges. It makes two separate objects unify as one – electrically speaking.

The bonding process works by purging or returning excess electrons that have transferred from one item to another (say the ramp to the fuel truck) back to their point of origin, or to a safe alternative. Bonding reduces the electrical potential between the two pieces of equipment, thereby reducing the likelihood of a static discharge or spark.

NFPA 407 requires that you have a method for bonding equipment during fuel transfer. From transport to farm, from farm to refueler, and from refueler to aircraft there must be the ability to form electrical bonds. NFPA also requires that bonding equipment be less than 25 ohms resistance.

This bond must be made before any fueling operation is conducted. Additionally bonding of over wing nozzles is mandatory per the NFPA.

NFPA also requires a strict non-smoking rule in all fueling areas. No Smoking signs should be posted at all fueling area entrances, and all staff must be educated in the clear and present dangers of smoking. Finally a No Smoking sign must be prominently displayed in the cab of every aircraft fuel servicing vehicle.

Every employee is prohibited from carrying matches, lighters, or any other ignition sources near aircraft or at fueling locations. Lighters and ashtrays must be removed or disabled on refueling equipment.

Spills:

A spill is one of the most dangerous situations that can occur on the airport ramp because of its potential to lead to fire or explosion.

THE FIRST THING TO REMEMBER REGARDING SPILLS IS THIS:

The safety of employees, pilots, and anyone within proximity of the ramp or spill area is of paramount importance.

Be proactive when it comes to spills. Create detailed, thorough plans for managing spills of any size. Of course, having the appropriate spill equipment in place at each fueling location is a critical part of any plan, as is ongoing training of your staff.

All airport fueling operations are required to create and enforce a written spill plan -- and also to practice it regularly with staff. Every plan should take into account all personnel shifts to ensure that it can and will be executed any time of day.

Failure occurs most frequently in spill plans when there is a lack of training. Avoid this pitfall by creating (and enforcing) an education and practice drill schedule for your employees.

Let's discuss these plans in more detail. Written spill prevention plans are typically required by state and/or federal authorities. We refer to these written spill plans as Spill Prevention, Control and Countermeasures (SPCC).

Fuel Handling and Fire Safety

Your plan must be engineered for your unique location, and must encompass all storage and distribution equipment used for bulk petroleum products. These plans are typically written by a certified engineer in your state or region to prevent and control the release of oil products (including aviation fuels) into navigable waters. "Navigable Waters" actually refer to any source water that can run-off into a body of water like a lake, river, stream or reservoir This can include storm water run-off ditches and drains.

NFPA 407 has several recommendations for handling spills and leaks. Each spill must be evaluated based on its size, the type of flammable substance involved, the current weather conditions, the arrangement or proximity of equipment, and the personnel available.

A GOOD SPILL PLAN INCLUDES BASIC RESPONSE PROTOCOLS LIKE THESE:

- Evaluate whether the situation is safe. Is it safe to try to mitigate the spill?
- If possible stop the spill at its source.
- Evacuate passengers from aircraft if necessary
- Notify the airport fire response authority and/or your supervisor
- Never start or move equipment unless instructed to do so by the AHJ
- Position an extinguisher upwind of the spill
- Post a guard and direct traffic away from the area
- Use spill-handling equipment and materials to restrict the spill as much as possible
- Prevent any of the spill from reaching storm water drains and natural ground areas like grass and soil if possible

Site-specific spill clean-up equipment should be available at each and every fueling location. All mobile equipment and any storage or dispensing locations should be equipped with its own emergency spill kit. The size of each spill kit and materials found within it depends upon the location and type of fueling performed at each site. For example, a large storage location that loads mobile refuelers at 300 gallons per minute may require a larger volume of cleanup material than that of an avgas refueler loading at only 20 gallons per minute.

Maintaining fully stocked spill kits at all times is critical to safety. Integrate checks with your daily inspections. When you or your staff use a spill-pad to mop up a leak from a dripping nozzle, make sure you replace it immediately! Be proactive and add a schedule of checking and restocking spill-kits to your official spill plan.

A STANDARD MOBILE REFUELER SPILL KIT CONTAINS:

- Several absorbent containment socks to direct flow or contain a spill
- multiple absorbent pads for smaller leaks and spills,
- A loose absorbent substance that can be scattered onto a spill,
- A pillow to absorb large spills
- A set of protective gloves for personnel.

KITS FOR FUEL STORAGE SYSTEMS:

These require larger supplies of clean-up material. These larger kits are more comprehensive and may contain spill-safe brooms, spark-proof shovels, safety cones, waste-collection drums , or specialty spill vacuums to suck away large amounts of fuel from the ramp. No matter what your spill kit or kits consist of, always keep them stocked and available for emergency use.

Fuel Handling and Fire Safety

Learning and following basic procedures are important to the safety of you and your staff. Here are additional guidelines for handling aviation fuels and related products.

- Never mix jet fuel and avgas
- Do not use common piping or tanks for aviation fuels and related products. Furthermore, label all pipes and storage tanks with the product and grade.
- Eliminate any possible source of ignition
- Correctly and safely dispose of fuel-soaked rags and absorbent material
- Make sure all fire extinguishers are of the proper type, are charged, and readily positioned for use
- When handling chemicals, avoid prolonged contact with skin. Rinse exposed areas generously with soap and water
- Know where your eye wash station is located and how to use it
- Remove any and all exposed clothing and wash thoroughly or dispose of correctly.

AVIATION FUELS AND ADDITIVES

This course reviews the following: How aviation fuels are refined and distributed, the types of aviation fuels currently being used, specifications those fuels are refined to, and the use of Aviation Approved Additives.

Aviation Fuels and Additives

Aircraft are powered by liquid petroleum fuels. Liquid fuels have higher energy contents per unit volume than gases, and are easier to handle and distribute than solid fuels. Among liquids, liquid hydrocarbons offer the best combination of energy content, availability and price. Aviation fuels are primarily made from refined crude oil. Crude oil is taken from a collection point and moved by truck, pipeline or barge to a refinery, where it is stored until moved to a distillation column where it is heated until it boils. During the distillation process the crude oil's molecular structure changes. The crude is heated, and as the molecular structure changes, evaporating vapors rise and are cooled inside the column and then collected through different side draws or trays. Each distilled petroleum product has an initial boiling point or IBP and an ending boiling point or EBP. These temperatures represent the "cut points" or the point at which each product is drawn from the distillation column.

Products obtained directly from the crude oil distillation column are called "Straight Run" products. Aviation Turbine fuel as well as kerosene and diesel in their raw states are all considered straight run products. Additional refining treatments may be needed to ensure that these products meet certain requirements.

Aviation Gasoline, also called avgas, is a blended product. If it was produced directly from distilled crude, it would not meet the high specification and antiknock requirements of modern reciprocating engines.

Avgas is blended with alkylates and components like toluene and isooctane to meet its final specifications. Additional required additives of tetraethyl lead or TEL and Dyes complete the blending process before final testing and distribution.

Whether it is by hundreds of miles of pipeline, large ocean barges and ships, thirty thousand gallon railcars or over the road transport trucks, refined products are moved to their final destinations worldwide. Product integrity is vital and Quality assurance testing is conducted at each custody transfer throughout the distribution cycle from refinery to intermediate storage locations and finally to you at the airport.

You complete this custody transfer when you complete all your fuel handling requirements and deliver clean dry fuel into your customer's aircraft.

Avgas is used in reciprocating or piston-engine type aircraft. These aircraft have engines that require high performance fuels similar to the needs of a high performance race-car. It is blended very similarly to "auto" gasoline, except aviation gasoline is manufactured with improved antiknock properties for performance and does not contain detergents or lubricants associated with auto gasoline. The most prevalent aviation gasoline being produced is Avgas-100 low lead or LL . Another type of avgas produced includes avgas 100 very low lead or VLL which is blended with a lower amount of TEL (or lead).

Aviation gasoline is the only petroleum product produced with lead and a required distinguishing blue dye. Other types of avgas such as 80, 91, and 100 octane, are rarely used or manufactured. Each type is dyed with a different color as a safety precaution. The visual aid of the dye helps distinguish the different fuel types, reducing cross-fueling or cross contamination. The corresponding numbers for each product represents the octane rating of the fuel. 80-octane avgas is dyed red, 91- octane is Brown, 100-octane is green and 100LL and 100VLL octane are both blue.

Turbine fuel, known as Jet or Jet-A in the United States, is a special type of kerosene formulated for use in airplanes that have jet or turboprop type engines. Different types of turbine fuels are used in aviation, but two common types used in the USA includes Jet "A"; and Jet "A" with a fuel-system ice inhibitor or FSII additive. JET-A with FSII is more common for general aviation use. Other turbine fuel types include JET-A1 and Jet-B. JET-A1 and Jet-A are similar except for Jet-A1 has a lower freezing point and is often used for higher altitude and long distance flying. JET A1 is used for international flights and JET-B is primarily used in cold weather climates like Alaska. All Turbine fuels are clear to straw-colored and have an odor similar to kerosene and diesel.

Aviation Fuels and Additives

Turbine fuels used by the military must meet other specifications and are commonly referred to as JP products. JP-5, used by the Navy, and JP-8, used by the Air force, are the most common turbine military fuels in use today. The major difference between these products is their flash point temperatures and their additives.

Product Identification and Marking- is very important as the products should never be mixed during distribution. Even small amounts of cross contamination could result in an engine flameout.

API (American Petroleum Institute) Standard 1542 –Airport Equipment Marking for Fuel Identification- is the industry standard that should be referenced when identifying aviation fueling equipment.

Piping, tanks, or pumps containing Jet fuel should be labeled with white letters on a black background and should also contain additional black bands for the specific product.

Avgas should also be labeled clearly on any tank, piping or pump used for that product. All avgas labels, regardless of the octane number, should be marked with white letters and numbers on a red background. The addition of a stripe or band with the correct dye color should be next to the letters and numbers. For example 100Low lead would have the addition of a blue band.

Both turbine fuel and aviation gasoline are refined to standard specifications. This allows producers and users of a product to more easily identify and control properties necessary for satisfactory and reliable performance.

Two organizations have taken the lead role in setting and maintaining specifications for civilian aviation turbine fuel. These organizations include the American Society for Testing and Materials or ASTM and the United Kingdom Ministry of Defense or MOD. Specifications issued by these two organizations are very similar but not identical. Many other countries issue their own national specifications for jet fuel; these tend to be very similar or completely identical to either the ASTM or MOD specifications

ASTM is comprised of many committees. It is a consensus standards organization. This ensures that viewpoints of the large number of groups affected by and/or interested in aviation fuel specifications are considered.

GROUPS INCLUDE:

- Individual refiners.
- Petroleum refining organizations.
- Petroleum marketing organizations.
- Additive and equipment suppliers.
- Aircraft and airframe manufacturers.
- Aircraft engine manufacturers.
- Governmental regulatory agencies, like the Federal Aviation Administration (FAA).
- Special-interest groups and consultants.

Aviation Fuels fall under two primary specifications ASTM D 1655 The Standard Specification for Aviation Turbine Fuels and ASTM D 910 – Standard Specification for Aviation Gasolines. Both specifications are continually under review and can be subject to revisions as needed.

Aviation Fuels and Additives

ASTM D 1655 The Standard Specification for Aviation Turbine Fuels includes requirements for Jet A and Jet A-1.

ASTM D 910 – Standard Specification for Aviation Gasolines – contains the requirements for Grades 80, 100, 91, 100LL,and 100VLL.

Both ASTM D 1655 and ASTM D 910 include detailed property requirements for each product including evaluating test methods and corresponding limits.

When products are refined and tested to these standards, each result must be documented. (G28) The results will be included on a C of A or Certificate of Analysis. The signed C of A accompanies that specific tested batch of fuel throughout the distribution process.

The C of A provides the "baseline" for any future testing required to verify the product has maintained integrity throughout its journey from the refinery to the end user.

Additives are fuel-soluble chemicals added in very small amounts to enhance or maintain properties important to fuel performance or handling.

They can produce desired effects when added in the parts per million (ppm) concentration ranges.

Additives are used in varying degrees in aviation fuels. All aviation fuel specifications such as ASTM d1655 and ASTM d910 list approved additives along with their allowed concentrations. Some additives are required to be added, some are optional, and others are approved for use only by agreement between the buyer and seller.

Aviation fuel additives must undergo extensive testing to show their effectiveness and that they will not harm any other fuel properties or equipment. An additive must be tested at four times its maximum dosage in the presence of other additives before it is approved. This prevents harmful additive interactions.

A CURRENT LIST OF ASTM D1655 APPROVED TURBINE FUEL ADDITIVES INCLUDES:

- Conductivity Improver or Stadis 450®
- Metal Deactivator
- Corrosion Inhibitors/Lubricity Improvers
- Fuel System Ice Inhibitor or FSII – Chemical name is Diethylene glycol mono methyl either or di-EGME
- Microbial Biocides (Bio Bore®)
- Leak Detection (Tracer A®)
- Antioxidants

The usage of additives is the principal difference between commercial and military jet fuels. U.S. military jet fuels will contain three or more additives.

Jet A in the USA usually contains no additives at all, although some refineries add conductivity improver for additional fire safety.

Fuel System Ice Inhibitor or FSII and Biocides are typically added further downstream in the distribution process. Injecting FSII at the last

distribution point before it moves into airport storage is common in general aviation. The final product is commonly called blended fuel or JET-A with FSII. Many locations inject it when directly fueling aircraft.
The most common approved additives used in general aviation Jet fuels are: Conductivity inhibitor and Fuel System Ice inhibitor (FSII)

Turbine fuel is not a good conductor. Conductivity improver is added to allow the fuel to reduce static charges due to agitation or rapid movement. This helps to eliminate static generated fires during distribution. A specific amount is allowable and requires a special conductivity meter to check it. Approximately 30 percent of domestic turbine fuel has the additive mixed in. The only approved conductivity improver brand is Stadis 450®.

Fuel System Icing Inhibitor or FSII is called by brand names like Prist®, FIZZY® and Dice®. It is often misunderstood and incorrectly handled in general aviation. Because of this, Avfuel has dedicated a complete training module for this subject. FSII is required in aircraft that do not have heaters in their main fuel filter systems and are susceptible to reduced fuel flow if ice crystals form. This reduced fuel flow could possibly starve the engine of fuel, resulting in an engine failure or flameout. Most commercial aircraft have heaters on their main fuel filters to prevent ice from forming and therefore do not require the additive.

The only FSII approved for turbine fuels is di-ethylene glycol monomethyl ether or di-EGME. Di-EGME is only slightly soluble in fuel but is very soluble in water, which leads to various handling problems. Since the additive is only slightly soluble in fuel, it must be injected in small amounts with good mixing to ensure it completely dissolves.

Additives for leaded grades of avgas include tetraethyl lead and an identifying dye.

ADDITIONAL ADDITIVES APPROVED BY ASTM BUT RARELY USED ARE AS FOLLOWS:

- Antioxidant additive also called oxidation inhibitors
- Icing Inhibitors – There are two approved types: Isopropanol & di-EGME
- Electrical Conductivity additive Stadis 450®
- Corrosion Inhibitors

FUEL SYSTEM ICING INHIBITOR (FSII)

Fuel System Icing Inhibitor or FSII is commonly referred to by various brand names such as Prist®, FIZZY® and/or Dice®. FSII is a fuel additive that is often misunderstood and incorrectly handled.

- Familiarize you with FSII, how it works and clear up misconceptions regarding the product *pg 21*
- How to use a test kit for inspecting correct quantities of FSII *pg 21*
- Storage and handling essentials, such as "Injection Dos and Don'ts" *pg 23*

Fuel System Icing Inhibitor (FSII)

FSII is an acronym for "**Fuel System Icing Inhibitor**" - a chemical additive used to prevent ice formation in the fuel of aircraft lacking heaters on their main-fuel filter systems.

At high altitudes, fuel systems cool, enabling the formation of water droplets in the fuel. These droplets can freeze, restricting fuel flow through a system's filters, starving the engine and resulting in a dangerous flameout. FSII additive is a hygroscopic product: it seeks out moisture, finding and encapsulating water droplets and preventing them from freezing.

FSII does NOT lower the freezing point of the fuel; nor does it remove water or prevent condensation into free water.

FSII is commonly referred to by various brand names, including Prist®, FIZZY® and/or Dice®.

FSII IS DISPENSED INTO AN AIRCRAFT IN THE FOLLOWING WAYS:

During fueling | FSII is dispensed during fueling either A) when fuel equipment contains a specialized injector system or B) by using specially-designed aerosol cans that can be clipped to overwing nozzles.

At the loading rack | FSII is added to the fuel during the fuel transport process - usually at the loading rack when the fuel transport truck takes on the fuel.

At airfield storage | FSII is added with t a specialized injector at the airfield's bulk-storage facility.

Only one type of FSII is currently approved by the ASTM for Jet A, Jet A-1, and U.S. military fuels: DiEethylene Glycol Monomethyl Ether, often referred to as DiEGME.

The current FSII product - DiEGME - has limited solubility in fuel and therefore must be added to fuel in small increments and be thoroughly mixed to ensure that it completely dissolves. Simply "dumping" FSII into fuel does not work: precise, careful injection is the only correct method.

DiEGME has a fuel-to-additive ratio of .10-.15% (lower than EGME's range of .08-.20%). If the ratio is not correct, the FSII may not work. FSII ratios in fuel can be measured using a "B-2 kit" or a refractometer designed specifically for the DiEGME.

Avfuel recommends always having a B-2 kit on hand, regardless of whether the facility injects FSII or receives it premixed. It is recommended that locations receiving pre-mixed fuel perform the B-2 Test upon receipt (along with other quality-assurance checks).

B-2 TEST KITS INCLUDE:

- Refractometer with adjustment tool and scale (specifically designed for the current FSII, DiEGME)
- Separatory funnel and holding stand
- Graduated cylinder in milliliters(mL) or cubic centimeters (cc)
- Two small reusable syringes
- Aluminum sample dish
- Sample of clean water

Fuel System Icing Inhibitor (FSII)

B2 TESTS ALSO REQUIRE:

- Clean paper towel
- Watch or timing device
- Personal protective equipment (PPE) for handling fuel

TO PERFORM THE B-2 TEST:

- Choose an area away from poor weather conditions (it is critical to keep water out of the sample for accurate results)
- Place the separatory funnel in its stand
- Use the graduated cylinder to measure exactly 160 mL of fuel
- Pour the fuel from the graduated cylinder into the separatory funnel; loosely replace the top
- Use one of the small syringes to measure approximately 3ml (or cc) of clean water
- Calibrate the refractometer:
- Using the same syringe as above, inject the refractometer with just enough water to flood the screen
- Observe the water by holding the refractometer up to a light source
    - If the refractometer is calibrated, the shadow of the water will bisect the zero line on the scale
    - If the unit is not calibrated, adjust the water level to the zero line using the adjusting tool
- After calibrating, clean the refractometer lens with a fresh paper towel and set aside
- Using same syringe used for calibration, extract 2 mL or cc of water from the clean water sample
- Open the separatory funnel and inject the 2mL of water, replacing the top when finished
- Shake the separatory funnel with the cap on for no less than five minutes (fewer than five minutes may cause inaccurate test results)
- Place the separatory funnel back in its stand and allow contents to settle:
    - After one to two minutes, the separation of water and fuel will become apparent
    - The lower layer will contain a mixture of FSII and water because FSII is readily soluble in water
- Carefully open the valve at the bottom of the separatory funnel and use the aluminum testing dish to collect approximately 2mL of the contents
- Using the remaining unused syringe, extract 1 mL of the mixture from the aluminum test dish and dispense on to the refractometer lens
- Examine the sample by placing it toward a light source.
- **The correct FSII to fuel ratio is .10 and .15 %**

FSII's solubility in water can cause serious problems in a fuel system or aircraft containing blended fuel. If FSII comes into contact with water, the additive will separate from the fuel and combine with the water to form a thick, gelatinous mass. This mass is highly corrosive. Prevent FSII from coming into contact with any water by sumping tanks and filters daily. Bulk FSII stored in injector tanks and drums or totes must be kept completely free of water. Even tiny amounts of water contamination can result in inadequately-mixed fuel and FSII.

Fuel System Icing Inhibitor (FSII)

FOLLOW THESE STEPS TO AVOID CONTAMINATION AND ENSURE THAT FSII MIXES CORRECTLY WITH FUEL:

- Do not store drums outdoors if possible. If drums absolutely ust be stored outdoors, keep them under waterproof shelters and open only as needed.
- Only use the appropriate equipment to store and dispense FSII. Pumps, seals and hoses must be specifically designed for use with this product.
- Use a desiccant dryer (G20-OST) on storage containers and mobile refueler FSII tanks to keep moisture from entering the tank.
- Replace saturated desiccant dryers. Most dryers are blue in color when usable and become pink as they degrade. Change the dryer before it turns completely pink.
- The FSII injection point should always be downstream or post-filtration regardless of whether FSII is being injected directly into an aircraft or into/out of storage. Injecting FSII upstream or pre-filtration can disarm filter elements and destroy water-separating capabilities.

Injectors can - and do - fail: perform monthly B-2 testing and recalibration to avoid any mishaps.

Always follow the injector manufacturer's procedures for installation/calibration. Avfuel recommends adjusting your injector to approximately .125% (slightly above the minimum ratio of .10%) tol help keep FSII ratios within the required limits for all fuelings. If the injector is calibrated at the minimum ratio and unblended fuel is left in a hose from prior fueling, the wrong ratio could be delivered to the next aircraft requiring blended fuel.

FSII FACTS TO REMEMBER:

- Per the ASTM, DiEGME is the only type of FSII acceptable to use
- FSII must be mixed at the correct ratio of 1000-1500 parts per million or .10-.15% per volume
- Other ratios to remember: 1-1.5 gallons of additive to 1000 gallons of Jet-A ; 13-19oz of additive to 100 gallons of fuel with a target of 16 oz per 100 gallons.
- FSII has very limited solubility in jet fuel and must be injected – not "dumped" - to mix properly
- Daily sumping of premixed fuel prevents interaction with water (interaction with water can cause FSII to separate from the fuel and form a gelatinous layer corrosive to fuel systems and aircraft)
- FSII must be injected downstream of filter systems
- The only way to check FSII ratios in the field is with a B-2 Test

For additional assistance with FSII procedures or calibration, call the Avfuel Quality Assurance department.

** The former FSII product (EGME) was certified and labeled as a pesticide by the EPA and marketed as capable of retarding microbe growth in fuel. However, as EPA restrictions regarding pesticides increased, EGME became less desirable to consumers. As a result, DiEGME became more prevalent and is now the only type of FSII used in the United States. It is a common misconception that DiEGME also retards microbes in fuel; however, no company is marketing this feature as of this time.*

CONTAMINANTS AND FUEL TESTING METHODS

Quality Assurance procedures are designed to ensure fuel integrity and the safety of you and your customer. This segment of our training focuses on some of these critical Quality Assurance procedures.

Contaminants and Fuel Testing Methods

Containments are harder to control in turbine fuel than they are to control in avgas: avgas is less dense than turbine fuel and will not hold particulates in suspension for any period of time, is less dense than turbine fuel and will not hold water or particulates in suspension for any period of time. Turbine fuel on the other hand can easily hold water in suspension. (Keep in mind that water in turn can allow the introduction of other types of contaminants.) This is why turbine fuel requires additional safety equipment and specialized handling procedures.

If you were to deliberately mix water and dirt into a sample of avgas and a sample of jet fuel, you would find that the contaminants settle rapidly to the bottom of the avgas. However, in the jet fuel they do not settle quickly -- it will take up to an hour or more to settle out. The makeup of these two fuel types require that they each be handled and tested in very different ways. This will be discussed later.

At high altitudes even a tiny amount of dissolved water can freeze and starve an aircraft engine of fuel. Even when fuel is correctly dispensed into an aircraft's fuel tank, condensation from temperature changes can condense in the fuel tank, causing problems to the engine. This is why pilots must routinely sump the aircraft's low-point drains.

To minimize water in fuel, practice rigorous Quality Control measures, like daily inspections, routine sumping, careful maintenance of fueling equipment and correct procedures for the receipt of fuel into airport storage.

In its dissolved form water is "in solution. In this state water does not directly affect an engine in a negative way. However, if the temperature drops enough this water will separate from the fuel -- becoming entrained water -- or "free" water. In this entrained or free state water can cause engine failure. In its dissolved state, warmer fuel can hold more water in solution than colder fuel.

Aviation-Industry standards mandate that a ratio of fewer than 15 parts per million (PPM) of entrained water may remain in turbine fuel AFTER FILTRATION. Visual examinations such as the Clear & Bright or White Bucket tests will allow you to identify high concentrations of entrained water. Additional field testing methods post filtration is required monthly to ensure that lower concentrations of water meet the acceptable limits.

Free water occurs in both aviation gasoline and turbine fuel. Free water may be clear or brownish in color. The Clear & Bright or White bucket tests are the preferred detection process. In addition you can use a "Water-detection paste" to detect water in tanks. We will discuss the removal of Free water via sumping later in this training session.

Solid contaminants, or particulates must also be removed from aviation fuel. Particulates do not dissolve in fuel and can enter the fuel at any stage of distribution from the refinery to the aircraft.

PARTICULATES COMMONLY FOUND IN FUEL:

- Iron
- Rust
- Scale
- Sand
- Dirt
- Metal
- Lint
- Filter media
- Rubber
- Sludge (produced by bacteria)

Sump your tanks and filter vessels daily, and be sure that your filtration systems are functioning properly. The last point at which particulates can enter fuel is just after its filtration and just before the fuel enters an aircraft. The last line of defense at this point is the fuel nozzle's 100-micron mesh screen.

Now that you have learned how to minimize solid contamination, let's talk about how to test for it. You can detect particulates in your fuel by using visual tests like the Clear & Bright or White Bucket tests. In addition, on a monthly basis you should perform a Colorimetric (or Millipore) test on all turbine-fuel filter vessels.

The term "**surfactants**" is a contraction of the words **SURF**ace **ACT**ive age**NTS**.

Surfactants are soap or detergent-like substances that can occur naturally in fuel or can be introduced during refining. Surfactants also can accumulate from fuel's contact with pipeline surfaces during its passage. Clay treatment filters are commonly installed in pipelines to capture surfactants before they arrive at your airport, yet frequent testing is necessary.

HOW CAN YOU TELL IF YOUR FACILITY IS CONTAMINATED WITH SURFACTANTS?

One indicator is when fuel is clouded after filtration. Another is the appearance of a brown or tan frothy liquid in the bottom of or at the fuel-water interface in tanks and filter sumps of aircraft equipment. If you sump fuel from a storage tank or vessel and perform a Clear & Bright or White Bucket test, clear fuel indicates good news - you probably don't have surfactant contamination. When and if you do suspect surfactants are present, you can send a sample to a petroleum-testing lab for professional testing and a definitive answer.

MICROORGANISMS CAN ALSO INFILTRATE AVIATION FUEL.

The most common of these microorganisms, or microbes are "**hydrocarbon-utilizing microorganisms**" (or HUM bugs). They form at the fuel/water interface, where they live and thrive in the water while feeding on fuel-hydrocarbons. Turbine fuel is more prone to microorganisms because of its ability to hold water.

HUM bugs will appear as a brown or black-tinted sludge or slime on filter-separator vessel walls, fuel-storage tanks, and refueler truck tanks. They can also appear as dark brown spots on filter elements. This type of contamination can cause corrosion on steel and aluminum surfaces and attack rubber fuel system components. Additionally it can contaminate filters and system instruments on aircraft. Commercial products are available to test for HUM bugs but only confirm their presence; they do not disclose the type. Certain visual tests such as the White Bucket Test can help determine the presence of microorganisms in tank and filter sumps. The most reliable test for microbial content is via an approved laboratory. Because HUM bugs thrive in water, an effective method to prevent their growth is, of course, to eliminate water. Daily removal of free water during routine tank and filter sumping is your best defense.

Fuel can also become cross contaminated with a different fuel type or grade due to human error. If the wrong fuel is dispensed into an airplane's tank -- it can have serious consequences. The occurrence of such an error can be guarded against with a (V38) carefully designed facility, proper operating procedures, frequent and comprehensive inspections and thorough training of personnel.

If a mistake in fueling an aircraft occurs, inform your supervisor and the pilot immediately.

Fuel that is suspected to be the wrong grade or type, or contaminated in any way, should never be put into an aircraft. When in doubt, immediately contact both your supervisor and an Avfuel Quality Assurance representative. Avfuel can assist you in arranging laboratory tests to determine whether the fuel is safe for use.

While visual tests help detect fuel contamination, they are highly subjective because they rely on human interpretation.This is why thorough on-site training is so important -- to help testers develop a consistent and accurate testing standard.Detailed information regarding all field tests and procedures introduced in this section can also be found in the ASTM Manual 5 (regarding Aviation Fuel Quality Control Procedures). Remember that you and your coworkers must use appropriate protective gear and equipment (PPE) during each field test you perform.

Clear and Bright Test

The clear and bright test can reveal the presence of solids and water that are visible to the human eye.

YOU WILL NEED

- A clean, transparent and dry collection container of up to one quart. We recommend a clear quart-sized Mason jar.
    1. Draw a fuel sample at operating pressure.
    2. Allow the sample to settle. There will probably be bubbles in the fuel.
    3. Wait until they dissipate. Inspect each sample for color and determine if it is clear and bright.

The term "clear and bright" has no relation to the natural tint of the fuel. Jet fuel for example may be clear or have a straw-like tint. Avgas is tinted differently according to its grade. "Clear" simply means the fuel sample is free of any visible particulates, When you gently swirl a sample, any particulates will often accumulate at the lowest part of the liquid's vortex near the bottom of the jar.

"Bright" means the fuel is neither hazy or clouded -- Bright fuel even has a tendency to sparkle when held up to a light source. Any water suspended in your sample will appear cloudy or hazy.

When you have concluded your test, document your findings on your quality-assurance inspection sheets. A complete, step-by-step explanation of these procedures can be found in ASTM D4176 –Clear and Bright Test.

White Bucket Test

The White Bucket Test was originally designed to test for turbine fuel contamination. It can also be used for aviation gasoline color-checks. The white background of the bucket makes surfactant contamination and proper color more visible.

YOU WILL NEED

- A 9-quart white porcelain bucket and a shiny penny with well defined features. ***Never use a plastic bucket***. Plastic has a tendency to distort the appearance of fuel and can also create static electricity.

1. Place your fuel sample into the white bucket -- making sure you have a fuel depth of at least 6 inches. Bonding the bucket before you add the sample will help prevent a static spark.
2. When testing fuel drawn from a filter vessel, obtain the sample at operating pressure.
3. Let the sample settle to allow any air bubbles to dissipate.
4. Visually inspect the bottom for water, solids, or brown algae-like slime.(V68) Drop your penny into the bucket. If you are able to distinguish all of the coin's attributes clearly, the sample is neither cloudy nor hazy.
5. Rate the sample according to the presence or absence (V67b) of solid contaminants and moisture content.

Contaminants and Fuel Testing Methods

CRITERIA FOR RATING SAMPLE:

Clean or Clear
Refers to lack of particles or solids, sediment, flakes and rust. This rating would be recorded as 1.

Slight Particulate Matter
Describes fuel that contains several fine to small sized particles. This is recorded as 2.

Particulate matter
Refers to a sample with many visible small particles floating or settled at the bottom and is recorded as 3.

Dirty
Refers to Discoloration in the fuel or many small to large particles dispersed or settled on the bottom. This is recorded as 4.

Bright
Brightness is a quality independent of the color of the sample. It refers to a lack of suspended or free water in the sample. Bright fuel tends to sparkle. This rating is recorded as A.

Hazy
A condition resulting from fine droplets of water dispersed throughout the sample giving it a dull appearance. This can be a temporary condition resulting from a drop in temperature. During the first minute, the fuel can appear hazy merely due to air bubbles. This rating is recorded as B.

Cloudy
The result of extremely fine droplets of water dispersed throughout the sample giving it a milky appearance. This appearance does not usually change -- even after allowing the sample to sit for a few minutes. Record this as C.

Wet
This refers to free water on the bottom of the bucket or clinging to the sides. This water can still be detected after the sample is poured out. Water droplets will appear as tiny raised blisters on the bottom of the container. This rating is a D.

Surfactant or Microbial
Foam or slime in the bottom of the bucket or at the fuel/water interface appearing as a dark brown/black layer; scum or lacy materials floating in or on the sample. Further testing to determine whether this is microbial growth would be required. Record either type of these contaminants as E.

Record your test conclusions using the above guidelines. A rating of 1-A means “clear” and “bright.” A rating of 2-D has “slight particulate matter” and is “wet.” Close attention should be given to former entries to monitor any trends -- especially from samples obtained at the same testing point.. Any significant trend or sudden change calls for further testing. Many sources of contamination can be found by evaluating accurate historical trends.

When small amounts of water and particulates are observed, proper sumping, and a properly operating filtration system should resolve the problem. Water-indicating paste helps determine whether Free water is present at the bottom of fuel-storage tanks. This test requires the use of water-indicating paste and a fuel-gauging stick. It is important to use the proper type of indicating paste because modified paste must be used for avgas and Jet A with FSII. Spread water-indicating paste 4 to 5 inches along the sides and bottom of your gauging stick.Lower the gauging stick straight into the fuel-storage tank. Do not allow it to touch the tank’s sides. Let the stick remain in the fuel for at least 30 seconds.

Water will change the color of the indicating paste. When you retract the gauging stick, inspect it closely. The highest point on the gauging stick that has changed color indicates the depth of any water present. Water paste typically changes, or activates at 30 parts per million (PPM)

of water. Record your findings and remove the indicator paste after each test. Remove the indicator paste after the test is conducted. New paste should be applied prior to each test.

There are many commercially made tests available for testing smaller concentrations of water in turbine fuels. Shell® Water Detector, Gammon Aqua-Glo®, and the Velcon Hydrokit® test are all designed to identify entrained water of varying amounts in turbine fuel. They are not used for avgas. These tests can be used to evaluate the performance of your water-removing devices, such as filter/separators or monitor filter vessels. These tests also have the flexibility to measure water content at multiple points in the delivery system.

Hydrokit

The Hydrokit is a pass/fail test available in two sensitivity levels.The test serves to identify entrained or undissolved water in turbine fuel, by volume in concentrations of more than 15 or 30 parts per million or PPM. The aqua-glo test is the preferred method for testing blended turbine fuel containing FSII. The aqua-glo test can identify entrained or undissolved water, by volume in concentrations as low as 1 part per million.

A HYDROKIT CONTAINS THE FOLLOWING:

- A small evacuated test tube containing water sensitive colored powder. This will be used with 10ml of fuel.
- A color standard chart
- A sample container
- And a sampling device

The sample bottle and sampling device are reusable items.

Hydrokit tests should be performed downstream of the filter vessel. Samples are often drawn from the equipment fueling nozzle or from a stream of fuel from a Millipore tap located downstream (or after) your system's filter.

1. Set the fuel system to "flow" and collect a fuel sample in the clean sample container.
2. Lower the sampling device into the sample container and puncture the red stopper in the test tube with the needle.
   The sampling device must be completely submerged in the fuel at the time the stopper is punctured. (V95) This is necessary to create a vacuum inside the test tube in order to pull the required 10ml of fuel. There is a minimum fill line marked on the test tube to indicate how much fuel to place into the test tube.
3. Leave your sampling device in the sample until all fuel ceases flowing into your test tube. It is acceptable to overshoot slightly -- but you must reach the minimum fill line or your results may be inaccurate.
4. Remove the test tube and shake it to blend the water-sensitive powder with the sample.
5. Because the test is time-sensitive, wait exactly 2 minutes before reading results. Taking readings after 2 minutes may provide inaccurate results.
6. Compare the color of the test tube to your color standard chart and determine whether the sample passes or fails.
   Make certain to refer to the correct color scale for the specific hydrokit test you are using. Tests are specific for 15PPM or 30 PPM. A 15ppm test kit will not provide accurate results over its intended value -- so if you compare it with 30 ppm scales, your results will not be accurate.
7. Finally, dispose of test tube and waste fuel appropriately.

This test should be performed monthly on all turbine filter vessels downstream.

API Gravity Test

The American Petroleum Institute (API) gravity test measures how heavy or light a petroleum liquid is compared to water. This test is performed with a thermo-hydrometer. If there is a change in API gravity compared to the numbers recorded on the bill of lading from the fuel's last storage location, this may indicate that a cross contamination exists with another product. This test will not tell you what type of contaminants are present, but it will allow you to see if the fuel has changed since it left the last storage area.

TO CONDUCT AN API GRAVITY TEST YOU WILL NEED:

- An ASTM approved thermohydrometer graduated in degrees of API gravity and Fahrenheit or Celsius for the type of fuel you are testing
- A glass or plastic hydrometer cylinder
- An API gravity calculator, or a book of petroleum measurement tables

YOU SHOULD USE ASTM APPROVED THERMO-HYDROMETERS:

- For turbine fuel (Jet-A & Jet-A1), use 54HL and 55HL
- For Jet-B, use 55 HL and 56HL thermohydrometers
- For Aviation gasoline, use 57HL and 58HL

FOLLOW THESE PROCEDURES TO CONDUCT AN API GRAVITY TEST

1. Collect a fuel sample in the hydrometer cylinder, allow a few minutes for the sample to settle and any air bubbles to dissipate.
2. Remove any bubbles from the surface by touching them with the corner of a paper towel.
3. Once the sample has settled and the air bubbles have dissipated, gently lower the thermo-hydrometer into the fuel sample.
4. Depress the thermohydrometer approximately 2 inches into the sample and gently spin it as you release it. This will help remove any air bubbles that may adhere to the sides of the hydrometer and keep it away from the cylinder walls when it comes to rest. The thermohydrometer should float and not rest on the bottom of the cylinder.
5. When the thermohydrometer has come to rest and shows a steady reading, record it to the nearest scale division at the point at which the surface liquid intersects the hydrometer.
6. Record the temperature to the nearest one degree Fahrenheit or half-degree Celsius. Keep the thermohydrometer in the fuel as you inspect the temperature for maximum accuracy.
7. Now, correct the observed thermohydrometer reading to the standard temperature of 60 degrees Fahrenheit using the API gravity calculator or the book of petroleum measurement tables.
8. Record the corrected gravity measurement.
9. Compare this measurement when receiving fuel to the corrected API gravity values from the last storage facility or bill of lading. Corrected API gravity remains constant for a fuel batch. While slight differences in test results occur, a change greater than 1.0 degree API warrants further investigation. Slight differences in test results occur due to differences in test operators or sample locations, but these are usually minimal -- less than 0.3-0.5 degrees.

The Colorimetric Test

The colorimetric test, often referred to as a Millipore test, detects solid particulate contamination invisible to the human eye. It uses a fine membrane to filter particles larger than 8/10 of one micron. (V118) By comparison, a single human hair is approximately 100 microns in diameter. After moving a specific amount of fuel through the test's membrane, the membrane is dried and its color is evaluated by comparison to an ASTM-approved chart ranging from 0 for the lightest and 10 for the darkest color. The color can be evaluated for change with respect to previous tests.

This test is conducted exclusively with turbine fuels. It should be performed on the downstream side of a filter vessel on a monthly basis. Monthly testing will establish a trend for the quality of fuel passing through a given filter vessel. Commercial fueling operations may be required to perform this test simultaneously on sampling points upstream and downstream of the filter vessel.

TO PERFORM A MILLIPORE TEST, YOU WILL NEED THE FOLLOWING EQUIPMENT:

- A field sampling kit, which contains:
    10. a field monitor containing -- a colorimetric 0.8-micron membrane backed by a 34-millimeter protective paper pad,
    11. an ASTM-approved color standards chart, and
    12. a sampling probe installed in your piping system downstream of the filter vessel. It will have a quick-disconnect-type fitting and a dust cap.
- You will also need an electrically bondable collection container capable of holding 5 gallons of fuel(V127)

TO PERFORM THE MILLIPORE TEST:

Prepare the field monitor.

13. Install a new support pad with the rounded edges facing upward in the lower half of the field monitor that contains the molded spokes. Handle the pad with tweezers to avoid contamination.
14. Using tweezers, place a membrane on the support pad. Press the top half of the field monitor into position. This will clamp the outer edges of the membrane and hold it in place.
15. Install the colored dust plugs at the inlet and outlet ports of the monitor -- leave these until you are ready to perform the test.

Now that the field-monitor preparation is complete, you are ready to perform the test.

1. Separate the halves of the sampling-kit housing.
2. Remove the dust plugs from the field monitor and retain for further use.
3. Place the field monitor in the sampling housing kit with the inlet side up and the spoke side down.
4. Reassemble the halves of the sampling-kit housing. *Do not use great force to tighten it.*
5. Adjust the three-way selector valve to the "stop" position and connect the bypass hose to the bypass connection.
6. Place the outlet hose in the collection container. Next, connect the bonding wire from the sampling housing to the collection container and to the system piping.
7. Bond the sampling container to your pumping system.
8. Remove the dust cover from the sampling quick disconnect on your fuel system and connect the sampling housing.
9. Establish a steady flow rate in your system.
10. Fuel should be flowing at a steady rate not less than 50% of the highest normal flow rate of the fuel system.

11. Now place the three-way selector valve in the "test" position and collect three additional gallons. A smaller test amount is acceptable as long as you are consistent with your volume of collection from month to month. If you DO choose to use less than three gallons, collect a minimum of one full gallon.
12. If you are contractually required to follow the ATA document 103 specification, which allows a one gallon test, your flush would still be one gallon and your test would consist of only one gallon. This would result in a 1-1 sample -- or two total gallons in your sample container
13. Do not interrupt the flow of fuel by starting or stopping the system. Stop the flow when you reach the desired total amount by slowly adjusting (V146) the three-way selector valve to stop.
14. Now shut off your pumping system.
15. Detach the sample housing from the quick-disconnect and replace the dust cover.
16. Disconnect the bonding wire from the system piping; then disconnect the bypass hose.
17. Place the three-way selector valve in the "flush" position (V151) and drain residual fuel from the sampling housing.
18. Remove the outlet hose from the collection container
19. Separate the halves of the sampling housing and remove the field monitor.
20. Remove any remaining fuel from the field monitor using a suction device. Make sure to attach the device to the spoke side of the field monitor to avoid damaging the membrane.
21. Wipe the outside of the field monitor dry and reinstall the dust plugs.

Records

1. Record your dry rating by scale letter and color rating number such as B-2 or A-1. Also record the sampling size, sample location, and date of test on a record sheet.
2. Place the dry membrane in a plastic or cellophane envelope and attach it to the record sheet. Include your recorded results and sampling information on the envelope in case it becomes detached from the sheet.
3. Keep records for a minimum of three years for reference purposes.

INTERPRETATION OF TEST RESULTS:

1. Compare your current test with the previous monthly test you have taken from the same sampling location. If your result differs by two or more numerical units than the previous test or has a rating of 3 or more, further testing should be performed.
2. Non-typical membrane color can be caused by filterable contaminants or by naturally occurring color bodies in the fuel. To confirm if a non-typical result is from filterable contaminants or color bodies, one can piggyback two membranes in the sampling housing and compare them. When fuel passes through both membranes, resulting in both being stained the same color, this indicates that there are color bodies in the fuel. If the top membrane stains darker than the bottom, this indicates a filterable contaminate is trapped by the top membrane and requires further investigation.

Detailed instructions can be found in ASTM D2276 and ASTM Manual 5. Remember that you can always contact the Avfuel Quality Assurance department for further information and instructions.

Sumping

The purpose of sump sampling is to visually check for water and other contaminants that may have settled to any fuel system's low-point. This low point is called a "sump." It is normal to have small amounts of water and particulates in your fueling systems -- these can be attributed to natural condensation and airborne dirt. Removal of these contaminants is accomplished by completely drawing off the contaminants through the sump-drain valve. Sumping on a daily basis will help maintain clean, dry fuel in the system.

WHAT YOU WILL NEED:

A clean collection container is required, preferably coated with white porcelain enamel. In some cases stainless steel buckets can be used. White is preferred for color determination and is always considered the industry standard.

1. Place your collection container under the tank drain valve.
2. Open the drain valve quickly and wide enough to allow any contaminants settled at the low point of the tank to flow through the drain line. Drain just enough fuel to ensure that the drain valve and piping extending into the tank have been emptied. This process will flush the drain pipe so that your fuel sample being evaluated will consist of fuel that is in the actual tank and not just the drain valve or piping. Refuelers typically require that you open a second safety valve beneath the tank by pulling an attached drain cable.
3. Properly dispose of this fuel in a collection container or sump saver. Clean your collection container and draw a sample to be evaluated. Sample size may vary depending on the collection container used. For example, if you are using a white porcelain bucket, your sample size should be at least 6 inches deep.
4. Now, evaluate your sample, rate and record the results. If any contaminants are visible, continue sumping your tank until a clean sample is drawn -- meaning you have removed all contamination. Dispose of all samples in a collection container or sump saver.

Sumping an underground storage tank -- and even some above-ground tanks-- requires the use of what we call a "thief" or scavenge pump. This pump will extend to the very bottom of the tank. (V170) It is important to note that it may take a considerable amount of fuel to evacuate this much longer length of piping before you can observe a clean sample for recording.
Use the same general sumping techniques we have already discussed.

A filter vessel must be sumped while it is under normal operating pressure. It does not need to be flowing -- but it must be under pressure or turned on. This forces any water or contaminants to the filter-vessel sump area. Samples removed from a static- or no-pressure system may show little or no signs of contamination -- even if there is significant contamination present.

Turn on your pumping system to pressurize the filter vessel. Place your collection container under the vessel-drain valve. Since the filter vessel is pressurized, carefully and slowly open the drain valve when collecting a sample. Remember to first flush the valve and pipe if needed before obtaining the sample you will be evaluating.

Visually inspect the sample and record your results. As before, if you see contaminants ,continue sumping until you get a clean sample. Properly dispose of this fuel in a collection container or sump saver.

PROCEDURES FOR RECEIVING A LOAD OF AVIATION FUEL

Line personnel are frequently responsible for receiving fuel deliveries, and the FBO is responsible for ensuring that the product is the highest possible quality during and after unloading. Contamination during delivery not only compromises the fuel you are receiving, but fuel already in storage.

Proper Procedures for Receiving a Load of Aviation Fuel

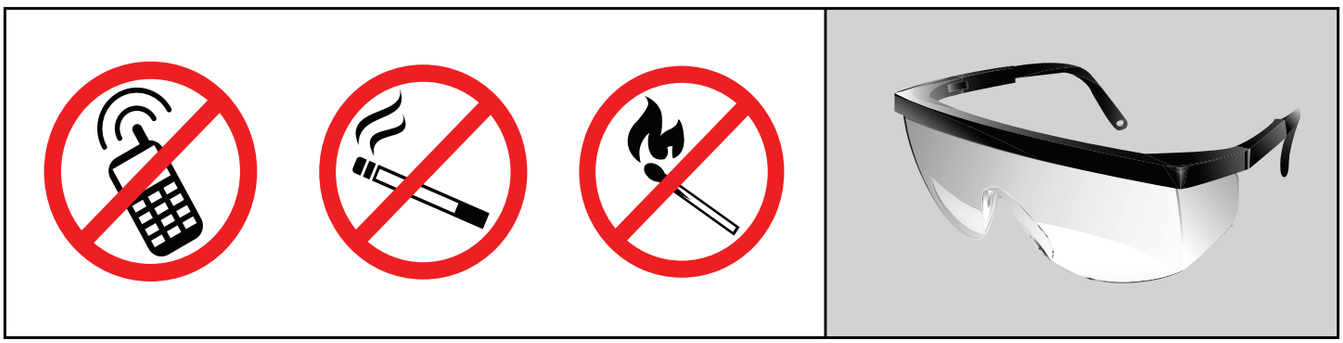
Line personnel are frequently responsible for receiving fuel deliveries, and the FBO is responsible for ensuring that the product is the highest possible quality during and after unloading. Contamination during delivery not only compromises the fuel you are receiving, but fuel already in storage.

REMEMBER THAT SAFETY COMES FIRST IN ANY OPERATION.

Here are a few mandatory measures:

- Make sure there are no sources of ignition like smoking, static electricity, bad electrical connections or exposed extension cords.
- At all times during an unloading, a representative from the FBO must be present.
- Always report fuel spills or leaks to your supervisor immediately; it is one of your responsibilities to know what your airport's compulsory response to any such incident is and how to follow that procedure.
- Before handling fuel, be sure to know precisely where your facility's first-aid kit is stored and be familiar with its contents. Know where the facility's eye wash is and how to use it.
- Wear protective eye wear and gloves when you handle aviation-fuel products.

Now let's examine a fuel-storage area. We will start with the loading point for the particular type of fuel you will be receiving. Fuel-loading locations will vary from facility to facility, so be sure to double check with your supervisor before accepting any fuel.



Storage tanks and loading points should be clearly labeled to indicate what kind of product they contain. This labeling will be color-coded and also include product type and grade.

> ***For example:*** *Avgas 100LL or Jet-A will have separate unloading lines, piping, and pumps for each fuel type. To ensure that the correct products are entered into the appropriate lines and tanks, lines are API color- coded to correspond with the product each tank or line is used for. Remember the basic rule that jet fuel and Avgas lines should never, ever be cross-connected. Proper labeling and attention to detail will help you avoid such serious mistakes.*

Product Receipt Documentation and Paperwork

Completing all quality assurance checks, following proper receiving procedures and recording all the information correctly can help ensure the aviation fuel entering your storage system is of the proper type, quantity, and quality.

Procedures for Receiving a Load of Fuel

When you receive aviation fuel, you will document this using a Product Receipt Record Sheet. The Avfuel Product Receipt Record was created to guide you through the process of receiving a load: fill it out completely for every load of fuel you receive.

This record and guide has two sides. The front is your log and checklist. It offers space to record up to six loads of fuel. The back provides detailed directions for each item on the front. Avfuel recommends that you use a new and different Product-Receipt-Record sheet for each type of product you receive. For example, you can retain all Avgas delivery records in one file, and all Jet-A delivery records in another. This will aid in your record-keeping and organization.
Avfuel recommends that you retain each record sheet for at least three years.

It is your responsibility to make sure you receive the correct paperwork with every load of fuel you receive. These third-party delivery documents should also be retained for three years. The following documents should be received with each load:

Bill of Lading (BOL)
The BOL is sometimes referred to as a Delivery Ticket or Shipping Manifest. It is the document the Department of Transportation (DOT) requires for shipping Hazmat products and is specific to the fuel in the transport trailer you are receiving. This contains critical information that you MUST verify is correct for the product you ordered. This document will contain a BOL number, the location of origin, the carrier's information and your location or shipping destination. The amount of product will be shown in both gross and net gallons, or, depending on your location's measuring standards, liters. Finally, the BOL will show the fuel's temperature at the time of loading as well as its corrected API gravity. You will use this API number for comparison to your API gravity test results. Verify all information is correct and in agreement with your order, and record your findings from the BOL on your Product Receipt Record sheet. Note; All hazmat BOLs are required to have an emergency-response telephone contact for you to use in case of emergency

Avfuel Product Release Certificate (PRC)
The PRC should come with every load of aviation fuel delivered by Avfuel and documents the "chain of custody" from the time the carrier loads fuel onto a transport at a supply terminal until it reaches its final destination at your storage facility. The PRC helps to assure the product's integrity.

The PRC has four parts:

Section 1
Provides data about the particular fuel being requested and loaded. Because it lists the BOL number, a batch number and, in some cases, a supplier tank number, PRC Section 1 helps link together BOL paperwork and the Certificate of Analysis (which we will discuss later) for good record-keeping. In most cases section 1 is completed by the carrier, but in some cases may be completed by terminal operators.

Section 2
Must be completed by the transport driver before he or she leaves the fuel terminal. It shows that the driver followed Avfuel Loading Guidelines for both pre and post –loading.

For preloading, the driver will:
A) State the type of trailer he is using,
B) Note whether it has been steam-cleaned and, if yes,
C) Record the cleaning certificate document number, and
D) That each loading-compartment is dry and clean of any residue or visual contaminants.

For post loading, the driver will:

E) Verify that the product ordered was correctly loaded by comparing it with the terminal-generated BOL.

F) He will also note if the product is Jet fuel, whether it was injected with FSII additive, and, if so, whether injection was performed by a Terminal-Rack injector or transport injector. The driver will also note the amount of additive injected.

G) The driver will allow the product to settle for a at least five minutes with the transport's loaded compartments' internal belly-valves open. He then samples each compartment to verify that the product is both clear and bright, at which point he finally prints and signs the PRC Section 2.

Section 3

Completed at the fuel's final destination prior to offloading. Together, the driver and customer:

A) Verifies that immediately prior to sampling, the delivery vehicle was not moved for a 10 minute settling period with bottom internal valves open.

B) Verifies that a visual inspection was performed of all delivery vehicle compartments and a minimum of a white bucket or a clear and bright visual inspection was conducted on a sample of product taken from each compartment of the delivery vehicle and all results were satisfactory.

C) Verifies that the invoiced BOL product is the same as ordered and loaded and is being unloaded into proper storage tank, while being on site at all times.

When completed, Section 3 shows that the customer has ascertained and approved the product for quality. It also shows which destination storage tank (by number) the customer has designated for offload.

The form also provides space for the customer to record additional information if an extra API-gravity test is conducted. The driver also has extra space to record arrival time and any possible demurrage time, as well as an explanation. An example of a demurrage time includes broken customer-equipment or abnormal delays caused by the customer prior to unloading. Section 3 also requires the customer and driver's signatures prior to the start of offloading.

Section 4

Completed by the customer after offloading. It requires the recording of gross and/or net gallons received, and a signature stating that the customer received product in good order.

Certificate of Analysis (C of A)

The C of A contains laboratory results for the entire batch of fuel from which the delivered quantity was taken. It is a signed document that proves the product was tested to ATSM D910 specifications (for Avgas) or ASTM D1655 specification (for Jet fuel). It is usually not mandatory for the transport carrier to include this form with each load. However, if it is requested by a third party and mutually agreed on by the supplier and customer, a C of A can be prearranged at the time of fuel-order. Commercial Air carriers and the military require a copy of this document with each load of fuel they receive. When it is supplied, the C of A should be filed with the BOL and other shipping documents.

Before Unloading

Procedures to follow prior to receiving a transport load

Now that we have thoroughly reviewed the paperwork associated with the fuel delivery, let's take a look at the physical process of receiving a load of fuel at your facility.

First, greet the driver and ask for the BOL, PRC and CoA (if required). Confirm the product you are receiving is the correct grade and type of fuel that you ordered. Make sure the paperwork shows the correct destination. Also, check that the transport shows the correct placards for the product he is hauling. For example the placard number for Avgas is 1203; the number for JetA is 1863.

Make sure the driver has access to the fuel-storage area with plenty of room to maneuver the transport truck. The driver should park so that, in the event of an emergency, the truck can be moved forward and away from the fuel-storage area. Once the truck is parked, chock its wheels to prevent rolling. Try to level the delivery trailer as much as possible for accurate sampling and a successful offload of all fuel inside.

Bond the transport truck to the receiving fuel-storage system. This must occur before any other operation. To do so, directly attach a bonding wire between the fuel storage system and to the transport truck. Allow the truck to sit motionless for 10 minutes with its internal belly valves opened. This allows air bubbles to dissipate and any contaminants to settle out before you take testing-samples. Note: Always ask the driver if he has opened the belly valves -- do not assume that he has. If these valves are not opened during settling, any contaminants will not enter the tubes and therefore will not be detected during sampling checks.

Pre-delivery inspection checks should be performed at your fuel storage area just prior to receipt of the load or while the transport driver prepares the truck for unloading.

First sump your storage tank and filter vessel and make sure the sample is clear and bright. Correctly position all necessary valves for receiving fuel and close the tank-outlet valve. If you are unsure of the correct position of each valve, ask your supervisor before proceeding.

You will also need to make sure your storage tanks can hold the entire amount of fuel intended for delivery. To help you compare capacity, every storage tank has a conversion rate chart for number of inches of fuel to actual quantity. With the driver present, "stick" the tank and record your reading with him. Ascertain that your tank's high-level alarm is operational prior to unloading by following the tank manufacturer's directions and precautions.

Verify that fire extinguishers and spill kits are full and available for immediate use. Next, verify that the delivery hose is clean. Some FBO locations own a delivery hose but most use the hose brought by the carrier. Remember that any delivery hose must be capped and stored correctly to exclude contaminants. Now that you've completed your pre-delivery inspections, you're ready to inspect the fuel while it's on the transport truck.

Inspecting the Transport

If at any time you find a problem when inspecting the fuel in the transport, request that the driver and the load of fuel remain onsite and immediately contact Avfuel's dispatch department for direction.

When inspecting a transport load, Avfuel recommends transport-trailer "top checks" for additional fuel-quality assurance. This allows you to check for any contaminants that could be floating on top of the fuel that could not be seen in visual bottom sampling. To do so, first familiarize yourself with and follow applicable safety requirements made by your company and any authority having jurisdiction (or AHJ). Though Avfuel recommends this quality assurance check, the customer is solely responsible for any injury or damages suffered while visually inspecting the top of the delivery vehicle and waives all claims against Avfuel, the carrier or the driver for such injury or damages.

Always have the transport driver open the transport's dome lid or manway hatch: it may be under pressure. Before inspection, empty your pockets of anything that could fall into the tank. Unlike avgas, when checking Jet fuel you should be able to see through the fuel to the tank's

bottom: watch carefully for particulates and puddled water, and make sure it appears to be the proper color and neither hazy nor cloudy. Fuel should appear clear and bright.

Once fuel has settled, you are required to perform minimally a White Bucket or Clear & Bright visual test with samples from each compartment. This test ensures that the aviation fuel is visually free of any contaminants.

When obtaining the sample it is important to understand that all trailers are not designed the same way. They may have a single compartment with one receiving or drop tube, or multiple compartments with each having an individual drop tube, or multiple compartments feeding into a single common manifold. Ask the driver if you are not sure about the transport type, and inform him you need to take a sample from each compartment for your visual test. If the trailer's drop port shows road grime, have the driver wipe it off before sampling. Then, make sure the driver extracts the samples while you are observing the process.

Finally, perform the visual test as outlined in the QA testing module. You may need to take more than one sample to achieve proper results, and up to five gallons per compartment is allowed. Note that small amounts of particulate can be present in a sample from normal road conditions, so some practical judgment should be used. If in doubt, bring in another professional from your FBO, contact your supervisor, or call Avfuel's Quality Assurance department for further assistance.

ADDITIONAL TESTING

Depending on your company's operational procedures or individual contracts for air carriers or military, you may be required to perform additional tests for receiving fuel. API, FSII and colorimetric tests are just some examples of those that may be required.

Avfuel recommends performing the API gravity test for both JET and Avgas100LL. For Pre-blended fuel (Jet-A with FSII), Avfuel recommends the FSII field test be completed before receipt. Both of these tests are discussed in the QA testing and FSII modules.

API GRAVITY TESTING

This test will verify that the fuel received has not been contaminated with another product since it left the supply terminal. Follow testing procedures as discussed in the QA testing module. API results should be compared to the BOL and within one (1) degree API of accuracy. Any change greater then one degree is reason for further testing. If the API is off by more than a degree, do not off-load product, hold the driver and fuel load and call the Avfuel Dispatch. The dispatch representative will ask you for additional information, contact the terminal for possible BOL changes and relay information to Avfuel's Quality Assurance team if necessary. The discrepancy in API gravity might not be the result of contamination but from a paperwork error at the terminal.

API COMPOSITE SAMPLING

When collecting API-gravity samples from multiple-compartment trailers, a composite sample should be used. This is can be accomplished by adding one step while taking your visual White Bucket test. You will need an extra five (5) gallon bonded bucket . After performing the visual test on each separate compartment, empty approximately one quart from each into the extra 5 gallon bucket. Try to draw the same size sample from each compartment. Next, empty a comingled sample into your API sampling container and perform the API gravity test.

FSII TESTING OF A TRANSPORT LOAD

When receiving a pre-blended load of JET-A with FSII additive, perform a field test for proper additive ratio before offloading. The sample can be derived from your visual test or from a composite sample (if the transport has more than one compartment). Test results should be between .10-.15% per volume -- as outlined in the QA testing module procedures.

If your first sample results do not fall within the proper testing range of .1-.15%, request the driver to re-open the transport's internal belly valves and allow the product to settle for 10 more minutes. Obtain a new sample and repeat the test.

Unloading

After the necessary quality assurance and safety checks have been completed to your satisfaction, it is time to unload the fuel. Connect the unloading hose from the transport truck to the loading point on the fuel storage system.

THE THREE MOST COMMON WAYS TO TRANSFER FUEL INTO A STORAGE SYSTEM ARE:

1. By "gravity drop" into an Underground Storage Tank. This method is common on older Avgas and Jet systems.
2. By a transport truck with a mounted pump that pushes the fuel into an above-ground storage tank. This is a common technique on many avgas tanks.
3. By a storage-tank system with a pump that draws the fuel out of the transport, through a filter, and into the storage tank.

Always unload fuel through the filter vessel if possible to rid the fuel of any unseen contaminants. Open the unloading valve and begin unloading. Some storage systems are equipped with a dead-man feature. In order for the offloading pump to run, this switch must be pressed. If at any time the switch is released, this will stop the pump, halting the offloading process. Once the unloading has begun, continue to check for leaks in the hose or connecting points. If any are found, cease the unloading process until you can stop the leak or collect the leaking fuel. Check and record the differential pressure of the filter vessel at maximum flow.

YOU MUST REMAIN PRESENT AT ALL TIMES DURING UNLOADING.

After Unloading

Once you have received all the transport's compartments, visually verify that they are all empty. Now, close all unloading valves on both the transport and the fuel storage tank. Remove and store the unloading hose. Replace and secure any tank fill dust covers or caps. Reposition all valves so that you can now pump fuel from the storage area. Sump the receiving filters and tank and record your results on the product-receipt record sheet.

With the driver present, stick the storage tank once more and record the inch reading. The stick reading will not exactly match the BOL because aviation fuels tend to expand and contract with temperature fluctuations. However, if you notice any large discrepancies in the volume, keep the driver onsite, contact your supervisor and the Avfuel dispatch department.

If discrepancy is small, simply proceed by completing all your paper work and signing the appropriate parts of the PRC. If possible allow the new fuel to settle for one hour per vertical-foot in the tank – or for a minimum of two hours -- before any fuel is removed from the storage area. Any contaminants that may have been present in the storage tank prior to the addition of the new fuel will have been stirred up and need a chance to settle back to the bottom of the tank, where they can be collected and removed.

Finally, re-secure the fuel storage facility.

Procedures for Receiving a Load of Fuel

Following the enclosed procedures will assist you to always unload aviation fuel properly, keep your fuel-storage area free from any outside contaminants, and provide you and your coworkers with a safe fueling environment. If you have any other questions about receiving a load of aviation fuel, ask your supervisor or contact Avfuel Corporation's Quality Assurance team.

AVIATION FUELING COMPONENTS

This section covers standard aviation fueling equipment components, their purposes, relevant safety features, proper operation, maintenance, and recommended inspection schedules.

*Additional components specific to storage or mobile refueling equipment will be covered in those specific sections.

Bonding

All fueling locations should be equipped with a bonding reel or a fixed bonding cable with a clamp to reduce static charge that could occur during fueling.

THE COMMON TYPES OF BONDING CLAMPS ARE:

- Copper alligator clamp
- Heavy-duty clamp (sturdier clamps most commonly seen at military fueling locations)
- The NFPA, the military and certain air carriers may require a smaller bonding clamp or bayonet attached to the fueling nozzle.

Conduct daily inspections of aviation clamps. Look for visible damage or corrosion. Repair/replace damaged clamps/broken cables immediately.

BONDING PRIOR TO MAKING ANY FUELING CONNECTIONS IS REQUIRED WHEN:

- Receiving a load of fuel from Transport to Fuel Storage
- Transferring fuel from Fuel Storage to a Mobile Refueler
- Transferring fuel from a Stationary Fuel Cabinet to an Aircraft
- Transferring fuel from a Mobile Refueler or Hydrant Cart to an Aircraft

ADHERE TO THE FOLLOWING STEPS WHEN BONDING:

- Connect the bonding cable to the equipment you are transferring fuel to/from before approaching an aircraft with a fuel hose.
- NFPA requires an additional bonding connection during over-wing refueling using a smaller bonding clamp or bayonet attached to the over-wing fueling nozzle. Alternatively, the aircraft may be bonded by touching the nozzle to the aircraft's refueling cap prior to its removal and continuing to touch the spout to the filler neck until fueling is complete.
- A bonding cable should be connected to a grounding rod on your fixed storage system. This connection and all other bonding connections should be no greater than 25 ohms. Check the conductivity monthly using with a volt-ohm meter.

TO CHECK CONDUCTIVITY:

Verify that the volt-ohm meter will "zero out" by touching the two leads together. When directly connected to each other, the resistance should be zero. Connect one lead to the clamp and the other lead to the pumping system. Conductivity should be no greater than 25 ohms.

Check with the local Authority Having Jurisdiction (AHJ) for airport-specific bonding/grounding requirements.

Filter Vessels and Elements

Most modern fueling facilities provide filtration both into storage and into aircraft. Larger facilities may provide additional filtration when moving fuel from a fixed storage system to a mobile refueler to an aircraft.

Fueling operations are typically equipped with filter vessels to remove dirt, water, and other potential fuel contaminants. Aviation turbine fuels should be filtered a minimum of two times before entering an aircraft. Avgas should be filtered at least once.

Components

Worldwide standards for filter quality are set by the American Petroleum Institute (API) in partnership with the Energy Institute (EI). Avfuel strongly recommends using aviation filtration components meeting the most current API/EI editions/standards.

"Filter vessel" refers to the outer casing of a filter. The filters inside the filter vessel are referred to as "filter elements."
The inner walls of a filter vessel are typically coated with an epoxy to guard against rusting and corrosion. The epoxy is designed for longevity, but will degrade over time and will eventually need to be repaired or reapplied.

Filter vessels should have a manufacturer's tag or data-plate providing detailed information, such as model numbers, serial numbers, maximum flow rates, pressure ratings, date of manufacture, lid-gasket numbers, part numbers and more. Inspect filter vessel interiors for rust or epoxy flaking during annual filter changes and mark the vessel with a date placard to ensure timely replacements going forward. Always follow manufacturer's recommendations for filter change procedures and schedules. The physical size of filter vessels and the type of elements inside vary between jet and avgas filter vessels.

- **Filter/separators or "2-stage" filter vessels** remove both solid contaminants and water. 2-stage filter vessels are standard for primary filtration of turbine fuels and are also frequently used in avgas facilities. These vessels contain two elements (or "stages"): the coalescer, which removes solids and water; and the separator, which only removes water. Note: while the separator will remove entrained water, it may not stop a slug of free water from reaching an aircraft– therefore, a water defense system must be in place when using a filter/separator vessel.

- **Filter monitors** are another commonly-used filter vessel for both avgas and jet fuel systems. The filter monitor uses multiple membranes to trap particulates and absorb water. These membranes restrict fuel flow when saturated, continually removing these items from the fuel.

    - Filter monitors are used as the second point of filtration in jet-fuel systems - prolonged exposure to wet fuel shortens the service life, and turbine fuel holds more water than avgas.
    - While very effective in removing solids and water, filter monitors must not be viewed as failsafe. The ability to absorb water degrades over time, requiring that DAILY quality assurance checks and procedures (such as - but not limited to -recording differential pressure and sumping) be conducted.
    - Filter monitors should not be used with blended Jet fuels containing Fuel System Ice Inhibitors (FSII). FSII can degrade the monitor's ability to absorb water and potentially cause the formation of a viscous substance that may flow downstream, eventually reaching the fuel system or aircraft.

ALL FILTER VESSELS SHOULD BE EQUIPPED WITH A DIFFERENTIAL PRESSURE GAUGE AND MAY CONTAIN ONE OR MORE OF THE FOLLOWING COMPONENTS:

- Air eliminators
- Pressure relief valves
- Drain and sample valves
- Sump heaters
- Water defense floats
- Probes

All filter vessels are equipped with a low-point sump for the monitoring and removal of potential contaminants - sump daily and record findings. *(Note: sumping of filter vessels should be conducted with the system powered ON in order to pressurize the vessel.)* Avfuel recommends

conducting additional monthly tests of all turbine fuel filter vessels include, including entrained water tests and colorimetric/millipore tests.

Additionally, all filter vessels are equipped with direct-read differential pressure gauges or "DP" gauges to monitor the condition of the interior elements. Filters restrict the flow of fuel, resulting in lower flow pressure downstream.

The difference between pressure at a vessel's inlet and outlet is called the "differential pressure" or "Delta-P." Delta-P is measured in pounds per square inch (PSI). Document the differential pressure daily to identify trends that may indicate abnormal conditions or elements needing replacement - for example, a PSI reading that is lower than usual may indicate a ruptured element; while a sudden increase in PSI may indicate solid contaminant accumulation in a filter/separator, or may indicate that a monitor vessel's elements are saturated with water or particulate.

Recording a DP every day at the equipment's maximum flow rate will serve as your ongoing indicator of your vessel's performance. Record the DP as a numerical value for accurate comparison with previous days. Adjust DP readings for maximum flow when necessary.

Manufacturers generally require elements be replaced when the DP reaches 15 PSI at the filter vessel's maximum rated flow. However, if your filtration system moves slower than its maximum rated flow, it may be necessary to replace the element before 15 PSI is observed.
Check DP gauges annually for accuracy. Replace or repair as necessary. DP gauges may be equipped with their own filters that require periodic replacement – simplify replacement schedules by changing gauge filters when replacing elements. Follow the manufacturer's recommendations for testing and replacement of the gauge and its components.

Water Defense Systems

Water defense systems are required on filter/separators to prevent slugs or bulk amounts of water from passing through filter elements. Should bulk water enter the vessel, the water defense system will shut down the pumping system.

Water defense systems are located in the sump area of filter vessels and possess either an electric probe or a mechanical float. On stationary storage systems, activated probes/floats will either turn off control valves (often called slug valves) or shut down power to motors/pumps. On mobile systems, probes/floats turn off downstream control valves, stopping fuel flow while also activating an indicator light to notify the system operator.
Maintenance checks on mechanical checking systems are typically performed on a quarterly basis - follow manufacturer recommendations for frequency and procedures. Some vessels are equipped with mechanical check devices that can be pushed up to raise the float, mimicking activation and shutting down fuel flow. Additionally, water injection tests (outlined below), conducted by injecting a known quantity of water into the low point or sump of a vessel, should be performed annually. Tester must adhere strictly to manufacturer guidelines when performing a water injection test.

WATER INJECTION TEST:

Always follow manufacturer guidelines when performing a water injection test

1. Ensure that system is turned on and flowing and that sump valves and test-pump valves are in proper position according to manufacturer recommendations prior to conducting test.
2. Approximately 3 quarts (¾gallon) of water is needed to activate the system - never inject more water than necessary.
3. If the water defense system is functioning correctly, the float or probe will trigger the control valve to turn off and will activate the "caution" light.

4. Upon completion, evacuate water via the test pump and sump the vessel until the fuel will pass a clear and bright test.
5. Dispose of test water/fuel mixture in an approved waste container
6. Continue with annual filter replacement.

NOTE: Water defense checks should NOT to be performed on filter monitor elements. Injecting water into a monitor vessel will activate the super- absorbent membranes and require that elements be replaced.

Pump Pressure Gauges/Nozzle Pressure Gauges

Pump pressure gauges and nozzle pressure gauges help monitor fuel systems and protect aircraft receiving fuel. Pump pressure gauges are found on both avgas and turbine systems, while nozzle pressure gauges are primarily reserved for turbine systems capable of fueling an aircraft via a single point (a nozzle that connects directly to an aircraft) or closed-port fueling.

Nozzle pressure gauges monitor the pressure of fuel flowing through the nozzle during single point fueling. Single point nozzle pressure must be less than or equal to 40 PSI -- airfield fueling systems must be designed to maintain this limit. Nozzle-pressure gauges must be accurate to +/- 2%.

Pump gauges are used to monitor the pump's performance. Pump and nozzle gauges should be tested annually. These tests are conducted with certified gauges designed for specifically for testing - iInstall the certified gauge and compare the reading to the reading with gauges currently in operation. Gauges can also be removed and sent to a calibration company for testing. **Always repair or replace defective gauges immediately - neglecting to do so could damage aircraft.**

Pumps

Two types of pumps are commonly present on fuel storage systems and mobile refuelers: centrifugal pumps and positive displacement pumps. These pumps are driven by an attached electric motor or gearbox and mounted on a ground skid or platform. Underground storage tanks (USTs) and self-serve or small above-ground storage tanks use submersible pumps located inside the tank. Submersible pumps function by lifting the fuel out of the tank. Pumps on mobile refuelers are driven by the vehicle's chassis-drive-train or by a PTO-turned drive shaft (although some are equipped with electric or hydraulic motors). These pumps typically fall under either the centrifugal or positive displacement categories.

CENTRIFUGAL PUMPS are used on most above-ground tanks and most refulers. These pumps work like the the water pumps in cars- they have a gearbox and use gear oil for lubrication. They possess mechanical seals that, if damaged, allow fuel into the gearbox but do not allow oil into the fuel. Follow manufacturers' guidelines regarding required oil type, amount, and oil change interval.

POSITIVE DISPLACEMENT PUMPS move fuel by capturing a fixed amount of the fluid and pulling it to the pump's wall, then displacing it into a discharge pipe. The volume of fluid captured/displaced remains constant during each cycle of operation. A positive displacement pump can be used on all fuel systems but is most often seen on USTs because of their efficiency in pulling fuel from the tank. Positive displacement pumps are lubricated by the product being pumped - if the pump runs dry, it may burn or become damaged. Mechanical seals and bearings may require additional periodic lubrication. Never use graphite-based lubrications on positive displacement pumps.

NOTE: Pay close attention to the type/amount of lubrication being applied to mechanical parts. Improper lubrication can cause contamination. Follow the manufacturer's recommendations.

Hoses

Hoses used for aviation fueling vary in length dependent upon usage, target flow rates, and the system to which they are attached. On mobile equipment, 50-foot long hose reels are common while longer hoses may be needed for stationary fuel-cabinets dispensing directly to aircraft. Hoses used for loading refuelers are shorter (approximately 10-20 feet in length). Hose diameter varies from 1-3 inches dependent upon hose type and usage.

Hoses are manufactured, tested and certified to meet current standards. NFPA 407 requires that certificates accompanying new hoses be kept on file at the facility throughout the entire duration of time that the hose is in use.

Examine hoses daily for visible defects/damage including cracking, abrasions, cuts, soft spots and leaks. Monthly, the entire length of fuel-systems hoses should be pulled out and examined under pressure - look for cracking, abrasions, cuts, soft spots, blisters, chafing, twists, sharp ends, or any other irregularities that could lead to a failure or leaks.

Hoses purchased as a complete assembly with pre-installed couplings will have "coupling indicators" - marks that help identify any slippage between hoses and couplings when the hoses are under normal operating pressure. Check coupling position monthly and replace hoses with defective couplings s immediately.

Nozzles

Nozzles designed for jet fuel are visibly different than nozzles designed for avgas, reducing the risk of cross-fueling – however, every nozzle has the following:

Dust covers – Dust covers keep out airborne debris and moisture, and, on single-point nozzles, prevent damage to nose seals.

100-micron mesh screens – These screens are the last line of defense against contaminants entering the aircraft and should be checked/cleaned monthly (trace any particulates found back to the source).

Swivels - All nozzles except avgas refueler loading nozzles are equipped with rotating swivels permitting the operator to rotate the nozzle without kinking the hose. check swivels monthly for proper function.

CAUTION: NFPA 407 states that automotive nozzles must never be used for aircraft refueling. Most automotive nozzles are equipped with hold-open devices that can lead to fuel spills. They also do not have a 100 micron mesh screen.

NOZZLES USED FOR REFUELING TURBINE AIRCRAFT

Flare Spout: Avfuel recommends the flare spout nozzle, designed to reduce static, for overwing fueling. Flare spout nozzles do not fit most piston aircraft, thereby reducing the risk of cross-contamination.

Straight Spout: Some turbine helicopters have fuel ports that will not accommodate flare nozzles - straight spout nozzles can be installed as-needed and removed at the conclusion of fueling. Straight-spout nozzles can fit into an aircraft – be cautious when using to avoid cross-fueling.

Single-Point: Single-point nozzles are used for both aircraft underwing fueling and for loading fuel from storage tanks into mobile refueling equipment (sometimes referred to as "bottom loading).

AVGAS NOZZLES

Avgas nozzles used for aircraft refueling have smaller spouts than turbine overwing nozzles -- only 1 inch in diameter.

Avgas bottom-loading nozzles are also smaller than turbine single-point nozzles and connect differently to refuelers, helping prevent cross-contamination when loading fuel -from storage tanks.

Meters

Aviation refueling equipment is equipped with meters (mechanical, electronic or digital) to calculate the amount of fuel flowing through a hose and produce a numerical account. Meters have a "totalizer", which gives the total amount of fuel that flowed through the particular meter. Jet refuelers typically provide this information in whole gallons (whole liters outside the United States) while avgas refuelers typically present this information in 1/10 gallon increments. Some refueler trucks are equipped with printers to provide written documentation (sometimes required by local/state regulations).

Storage systems may also be equipped with meters to measure both inbound and outbound fuel, as well as outbound inventory use or retail sales to the aircraft from cabinets and self-serve systems.

The local AHJ regulates the frequency of meter checks and calibrations for operations selling retail fuel. Calibration is generally required annually. State-certified contractors can calibrate/seal meters, and will place a seal on the meter after certifying/calibrating as well as provide supporting paperwork to keep on file.

Check meters annually to ensure that seals are intact and the date that the meter was last calibrated appears on the seal and/or tag.

Deadman

The deadman device helps control the flow of fuel. It is required during single-point fueling and on systems that load refuelers. Unlike overwing nozzles (which have a trigger similar to an automotive gasoline nozzle that is actuated during fueling) single-point jet nozzles and avgas-refueler-loading nozzles lack a trigger on/off mechanism. These nozzles are instead controlled by a deadman. A deadman consists of a cable or hose approximately the same length as the fueling hose and possesses a control valve (referred to as a deadman valve) regulated by a hand-held device. The operator uses the hand-held device to control fuel flow. Fuel flow should stop within 5% of its maximum flow rate when the button on the hand-held device is released.

The National Fire Protection Association mandates that deadman controls be checked for proper operation DAILY.

FSII

Some refueler trucks and fuel storage systems are equipped with systems to inject fuel system ice inhibitor additives (FSII) into the fuel downstream of the filter vessel. (Please refer to the Avfuel FSII training module for specific information regarding handling of FSII.) The two most common types of injectors are the Hammonds® and the Gammon Viper® injectors.

Injectors must be monitored daily to ensure the proper amount of additive is dispensed. Meters can be installed for this purpose (and allow for the recording of the exact amount of additive being injected). If a meter is not available, detailed records must be kept to track the amount of additive used daily.

Check additive tanks daily to ensure they contain an adequate supply of FSII product. Avfuel recommends checking the supply after each fueling.

All FSII tanks must be equipped with a working desiccant air dryer system to keep moist air from entering the tank and contaminating FSII. Check the desicant dryer daily – if it has changed color, it may no longer be absorbing moisture. If 80% of the dryer has changed color from moisture absorption, replace it immediately.

FSII injection systems should be checked monthly for calibration. The injection rate should be 13-19 ounces per 100 gallons. Avfuel recommends the unit inject in the mid-range (16 ounces per 100 gallons) to ensure adequate additive is introduced. Verify the injection ratio and calibrate the system as needed according to the unit manufacturer's instructions.

FUEL STORAGE SYSTEMS

Proper maintenance of fuel-storage facilities ensures safer and more efficient fuel transfers. Fuel-storage areas are ideally located away from buildings, aircraft or hangars and may contain large quantities of aviation fuel. These areas should be secure and restricted to authorized personnel only and marked clearly with flammable signage. Each storage tank within the fuel-storage facility should be separated and designated by product type.






Fuel transfer to and from storage

Fuel-storage systems range in size and configuration, from self-serving units with aircraft-fueling capabilities to self-contained skid-mounted or midsize storage tanks. Larger airports, may contain complete multi tank fuel storage systems with the capacity to load mobile refueling trucks or send fuel via hydrant systems directly to the ramp. Always check with your fuel storage system manufacturer's manual and your supervisor for all details regarding your particular system.

LET'S REVIEW THE BASIC PROCESS OF FUEL TRANSFER TO AND FROM STORAGE SYSTEMS:

Fuel is delivered to airport fuel storage systems by pipeline or by a transport truck. When fuel is delivered by a transport truck, certain quality checks must be completed and the truck must be bonded to the fuel storage system before fuel hose connections are made for fuel transfer.

During the transfer, fuel passes through butterfly valves, a strainer basket, and into the product pump. The product pump is typically electric powered and transfers fuel on some systems through a product filter. From the product filter, the fuel flows through another butterfly valve, through the piping, a high level shutoff, and finally into the fuel-storage tank.

Other configurations exist for transferring fuel into storage. Some systems require the transport truck to utilize a pump to transfer fuel into your above ground or underground tanks. Some systems allow the gravity of the fuel from the transport truck to move the fuel into the tank below ground.

Inside the storage tank, the product pump drives the movement of fuel through a floating suction, up and out of the tank, through the product piping and through an open gate valve. Then, the product pump moves the fuel back through the filtering system, past the colorimetric test probe, through the meter and open deadman valve, and, finally, through the hose and nozzle, into the refueler.

FUEL-STORAGE SYSTEM COMPONENTS AND INSPECTION PROCEDURES

Routing testing of your system components and keeping up-to-date logs of equipment checks are important parts of your fuel-storage maintenance program. Forms for record keeping are available from Avfuel's Quality Assurance Department.

FUEL STORAGE AREA

Daily, check the general condition of the tank yard. The area should appear clean and landscaping should be well trimmed and free from weeds, lawn grass, and loose grass clippings. Dried weeds and trash are potential fire hazards. Also, check for security, fire and safety deficiencies on a daily basis. Ensure that all gates, fences, electrical boxes, and access doors are locked and in good working condition.

SIGNAGE

Fuel-storage areas should be designated with "flammable" and "no smoking" signage on all four sides of their perimeter, including the main entrance. To fully meet NFPA requirements, the text should be at least three inches tall, red, and appear on a white background. Product identification signage should appear on all sides of fuel storage tanks and follow what does api stand for? API standard color coding. Text on these signs should be at least three inches tall. Avgas 100LL should appear as white text with a red back ground and include a blue band designation while Jet-A should appear as white lettering on a black background with a white band.

Avfuel recommends placing the Department of Transportation (DOT) placard 1203 for Avgas and 1863 for Jet-A on all sides of the fuel-storage area perimeter. Emergency contact information and FBO contact information should also be clearly posted.

Fuel Storage Systems

Always check with your local authority having jurisdiction on specific requirements for your facility.

Monthly, Check signage for overall condition. They should be legible from a distance of 25 feet.

FIRE EXTINGUISHERS

Per the National Fire Protection Association (or NFPA), only BC type extinguishers should be placed on aircraft fueling trucks, airport fuel servicing ramps, aprons, or at airport fuel facilities. ABC or Halon type extinguishers should never be used.

NFPA requires that a minimum of one 20BC type extinguisher be placed in the vicinity of each fuel transfer area and close by the emergency fuel shutoff. The number 20 refers to the square footage that the extinguisher will cover. If the fuel system's flow rate is 200 gallons per minute (gpm) or more, than a wheeled 80BC type extinguisher with a minimum of 125lbs of extinguishing agent is required.

Check with your local authority having jurisdiction for the proper size and type of fire extinguishing equipment required at your facility.

Daily, check that all fire extinguishers are visible, with unobstructed access for immediate use. Remove extinguishers from service if seals are broken or if a low charge is evident on the extinguisher gauge.
Monthly, check fire-extinguisher inspection tag dates, that they are properly charged, and that seals and pins are in place.
Annually, check that extinguisher certifications are current.

PUMPS

Fuel storage systems commonly utilize centrifugal or positive displacement pumps.

Daily, check pumps for leaks and perform all periodic maintenance recommended by the manufacturer.

FILTERS / ELEMENTS / LOW POINT SUMPS

Fuel storage systems are commonly equipped with one or more filter vessels that remove dirt, water, or other contaminants that may be present in the fuel. Once delivered to the airfield, turbine fuel should be filtered at least twice before entering the aircraft. Avgas only requires a minimum of one filtration. Filter vessels contain filter elements. The correct type of filter element must be utilized for each type of product stored in a fuel storage system. All filter vessels should also contain a low-point sump.

Daily, Sump fuel storage systems at each filter vessel's low-point sump. Take care to follow proper sumping techniques and always sump filter vessels with the system turned on so that the vessel is pressurized.
Monthly, Perform a free-water along with a colorimetric or Millipore test on turbine fuel filter systems.
Annually, at a minimum, inspect filter vessel interiors. Avfuel recommends inspecting filter vessel's interiors each time a filter element is changed. Manufacturer guidelines recommend changing filter elements annually.

DIFFERENTIAL PRESSURE GAUGES

All filter vessels should be equipped with a numerical direct read differential pressure gauge or DP Gauge. The DP gauge allows one to evaluate changing conditions of filter elements. Pressure lowers as fuel passes through a filter. The difference between the inlet and outlet pressure on the filter is referred to as the differential pressure. Recording this value daily provides a history or trend regarding the pressure within the filter element so that abnormal conditions can be identified. Lower than normal PSI reading could indicate a defective filter element while a sudden increase may indicate the presence of solid contaminants. Most filter vessel elements are required by the manufacturer to be changed when the differential pressure reaches 15pounds per square inch (PSI) at the maximum rated flow rate of the vessel. In some instances, the filter vessel element may need to be changed based on a different reading depending upon the system's actual flow rate. Contact the Avfuel Quality Assurance Department for more information on correcting DP readings.

Daily, record the differential pressure for each filter vessel. Compare daily values. Always record the differential pressure during your first fueling or when recirculating. DP readings should be observed when the vessel is operating at its maximum flow rate.
Annually, verify that all DP gauges exhibit an accurate reading. Replace or repair defective gauges immediately. Replace DP gauge filters annually if specified by the manufacturer.

WATER DEFENSE SYSTEMS

A water defense system is located near the low point sump of a filter vessel. It turns off the pumping system if bulk water enters the vessel. This type of defense is required on filter/water separator vessels because those types of filters are designed to remove only small amounts of water. Slugs of water can overcome or pass through filter/separators under pressure.

Quarterly, inspect water defense system with a mechanical checking device, if your system has one, per the manufacturer's guidelines.
Annually, test that the water defense system is working properly by injecting water into the system. This should be performed at the same time when the filter is replaced. Always follow the manufacturer's guidelines for testing procedures.

Water defense system inspections are not required on Monitor filter elements

FILTER/SEPARATOR HEATER PROBES

Filter/separator heater probes warm low-point areas of jet fuel filter vessels in colder climates. This prevents water contaminants from freezing so that it can be removed daily. Heater probes are not used with Avgas filters. The system should be kept off when the outdoor temperature is above freezing and also when fuel is completely drained from the filter vessel while it is being serviced.

Annually, heater probes should be checked for proper operation. During colder weather, adjust your heater probe's thermostat to approximately 40 degrees Fahrenheit. Then, check the temperature of the fuel in the low point sump using an API thermo-hydrometer. Compare that reading to the outside temperature. The outside temperature reading should be lower than 40 degrees. An electrician is qualified to repair heater probes as needed.

GROUND REELS, CABLES, AND CLAMPS

Storage systems should be equipped with a grounding reel or cable with a bonding clamp and a grounding rod. Bonding cables are used to reduce potential static charges between equipment used during fuel transfer.

Daily, check reels, cables and clamps for damage or corrosion. Repair or replace defective equipment promptly.
Monthly, check the conductivity of ground reels, cables, clamps and grounding rods with a volt-ohm meter. Continuity between these components and the pumping system should be no greater than 25 ohms.

Safety reminder! Always connect bonding cables before any other connections are made during the fuel transfer process.

HOSES, SWIVELS, NOZZLES

Hoses used for transferring fuel from your fuel-storage facility should be tested and certified to the standards outlined by the American Petroleum Institute (or API). This documentation should be filed at your facility. The API and NFPA recommends utilizing hoses for no more than ten years.

There are two types of nozzles utilized for jet fuel transfers. Avfuel recommends the flare spout for overwing fueling of turbine aircraft and the single-point nozzle for aircraft underwing fueling and fuel transfers between fuel strorage systems and transport or refueler trucks.

There is only one type of nozzle used for avgas aircraft fueling. It has a much smaller spout than the turbine overwing nozzle. The nozzle used to transfer avgas from storage systems to refueling trucks is also different from the nozzle used to transfer jet fuel. This reduces the possibility of accidentally putting the wrong fuel into a tank.

All aviation fuel nozzles should be equipped with dust covers to prevent airborne particles from entering the fuel nozzle when not in use. They also protect nozzle seals from becoming damaged. All nozzles should be equipped with 100-micron mesh screens which further prevent particulate contaminants from entering the aircraft. Only aviation-approved nozzles should be used when fueling aircraft. Automotive fueling nozzles should never be used.

Daily, check the general condition of all hoses. Inspect the hoses for cracking, abrasions, cuts, soft spots, blisters, chafing, twists, sharp ends, or any other irregularities.
Daily, check swivels for damage or defective parts and that they are properly tightened. Avfuel recommends conducting this check during the hose inspection. Look for nicks and cracks in underwing nose seals as well.
Monthy, pressurize the fueling system. Pull the entire length of hose if on a reel and visibly inspect the hoses for any cracking, abrasions, cuts, soft spots, blisters, chafing, twists, sharp ends, or any other irregularities that could lead to a failure or leaks.
Monthly, inspect and clean all nozzle screens. Contaminants should be investigated to find their source. For example, rubber particulates could be the result of a damaged hose lining, seal, or gasket. Replace defective screens promptly.

PUMP AND NOZZLE PRESSURE GAUGES

Your system may be equipped with pump or nozzle pressure gauges used to monitor fueling pressure during fuel transfers.

Daily, for fuel transfer directly from storage systems to aircraft, record nozzle pressure to make sure the fuel storage system is functioning properly.
Annually, verify all gauges for accuracy. Replace or repair defective gauges promptly.

STORAGE TANKS

All storage tanks should be equipped with a sump. The tank sump assists in removing contaminants that may have settled to the low point of the tank. A thief or barrel-style pump is common to tank sumps and uses suction to remove waste from the bottom of the storage tank. A low-point drain is another type of sump. It utilizes gravity and the weight of the fuel to push the settled contaminants out of the bottom of the tank.

Daily, obtain a sump sample from each tank sump. Follow proper sumping techniques.
Monthly, if you have a double wall tank, check the interstitial space for signs of leaks.
Monthly, check your tank bottom with water-indicating paste spread on a gauging stick to determine if water is present. This test can also be conducted to verify the accuracy of electronic water monitoring systems that are contained in some fuel storage tanks.
Monthly, check Fuel System Ice Inhibitor (FSII) levels in tanks containing pre-blended fuel by using a B2 test kit. Verify that the concentration of additive is correct.
Annually, check the interior of your tanks by removing the covers and looking for dirt and tank-lining defects utilizing a handheld mirror. All Jet- A tanks should be epoxy lined, and if it is flaking or showing signs of deterioration, the tanks must be cleaned and repaired promptly. Epoxy keeps tanks from rusting and pitting which can contribute to microorganism contamination.

CATHODIC PROTECTION SYSTEMS

Cathodic protection systems are used for underground steel tanks and piping. They are composed of anodes and are attached to components to help keep them from deteriorating.

Annually, test this system via a business specializing in this type of service. Some newer, underground tanks are fiberglass lined eliminating the need for a cathodic protection system.

FLOATING SUCTION

During outbound fuel transfer from a storage system, a floating suction device allows fuel to be drawn from approximately 6-12 inches below the fuel surface regardless of the surface level. This helps to prevent potential suspended contaminants from entering the fuel that is transferred to a mobile refueler or aircraft. The fuel transfer can take place while suspended contaminants may continue to settle to the bottom of the tank. Once contaminants fully settle to the bottom of the tank they can be easily removed. After fuel is delivered to a storage tank, it is recommended to wait for approximately one hour per foot of fuel prior to transferring the fuel to an aircraft or mobile refueler truck. Floating suction devices are considered standard equipment for jet fuel tanks. However, they may also be used with avgas systems.

The floating suction should possess a mechanical checking device to ensure proper operation. This consists of a cable that is attached to the float and also to the cap on the tank opening. Some test cables are attached to a gauge that can be referenced when fuel is transferred to or from the storage tank.

Monthly, verify that the float is actually floating in the fuel. A float that feels abnormally heavy or a cable with no slack in it in a tank that is known to be half full could indicate a defective float.

PIPING

The most common piping used on new systems is stainless steel. Many systems have a black pipe before filtration. Black pipes should never be used post filtration unless their interiors are epoxy coated. No galvanized or copper piping should be used in the construction of aviation fuel systems.

Daily, check for any visible fuel leaks for any residue, drips, or staining around couplers, flanges, joints, and connection points. Any visible leak should be reported and repaired.

SURGE AND RELAXATION TANKS

Surge and relaxation tanks are safety devices that are found on pumping systems that pump over 200 gallons per minute. They help minimize static charges that can accumulate when fuel flows through higher gallon per minute systems.

Daily, sump the surge and relaxation tanks and discard any visible contaminants.

HIGH LEVEL CONTROLS

High level controls are used on tanks to prevent them from being overfilled. These controls emit a signal indicating if the tank is overfilled and can actually turn off the flow of fuel to the storage tank. Tanks should possess a high level control with an alarm signaling when the tank is 90% full and then configured to turn off fuel flow if the level reaches 95% capacity. Tests can be performed on most alarms to make sure they are functioning properly prior to receiving fuel into storage.

Quarterly, high level controls should be inspected. The overfill shutoff function should be checked for proper operation by starting the pumping system and then activating the high level control. Consult your manufacturer's manual as needed.

METERS

Many systems are equipped with a fueling meter with a numerical register. These are most commonly used to track the amount of fuel transferred from storage to refueler trucks or aircraft.

Monthly, check the calibration tags and seals are in place.
Annually, Avfuel recommends calibrating your fueling meters regardless if it is required by your state or local authority having jurisdiction to ensure its accuracy.

TANK VENTS

Tank vents allow air to escape when fuel is transferred into the tank and air to enter when fuel is transferred out of the tank. Jet-A tanks typically have a screen and avgas tanks have a pressure poppet.

Annually, check Jet-A tank vent screens for cleanliness. Check avgas vents for proper operating poppets.

LINE STRAINERS

A line strainer inhibits larger solid contaminants from entering pumps to prevent damage to filters.

Annually, the strainer screen should be removed, checked, and cleaned.

DEADMAN

A deadman is required for systems that transfer fuel to refueler trucks or provide underwing fueling into aircraft. Single-point jet fuel nozzles and avgas refueler loading nozzles do not have a trigger on/off mechanism. Flow of fuel is controlled by the deadman. The deadman can be turned on or off via a switch that is usually attached to a cable that is approximately the same length as the fueling hose.

Daily, check deadman controls for proper operation. The deadman should turn off fuel flow within 5% of the system's flow rate when released. Do not try to defeat this system. It is a required safety feature by the National Fire Protection Agency.

EMERGENCY SHUTDOWN SYSTEM

All fueling systems should be equipped with an emergency fuel shutdown system in case of a spill or fire. The NFPA also requires at least one additional remote shutoff to be located at a minimum of 20ft but no farther than 100 ft from the fuel transfer area. Make sure all emergency fuel shutoff controls are accessible. All associated signage should be properly displayed and legible. Signage must read EMERGENCY FUEL SHUTOFF in 2 inch high text on a color contrasting background. This sign located at the remote fuel shutoff should be 7 feet tall and include the word push or pull or a directional arrow showing the direction of the shutoff operation.

All employees must be aware of the proper operation and location of emergency-shutoff controls prior to operating a fueling system.

Quarterly, check your offsite remote-shutoff control and complete emergency-shutoff system for proper operation.

SUMP SAVERS OR RE-CLAIMING SYSTEMS

The sump saver is a vessel that allows fuel to be retained from sumping and other fuel testing and returned back into the storage tank. It allows the fuel to settle. When this fuel settles, contaminants will separate from the fuel and collect at the bottom of the container. The fuel is sumped again and the remainder is "saved" by returning it to the tank through a filter. These systems allow approximately 95 % of the product to be recovered. In cold climates Jet A sump savers require the addition of a sump saver heater.

Follow manufactures procedures for operation and maintenance.

Fuel Storage Systems

WASTE TANKS

Waste tanks should be labeled properly with the type of waste product stored inside. Make sure containment around them meets local, state, and federal requirements. Dispose of all waste according to local, state, and federal requirements.

Daily gauge the liquid level of waste-fuel tanks. The tanks should be drained as required to prevent any overflowing or spillage.

SPILL KITS

A container of absorbent material should be readily available in the event of an accidental spill. There are many commercial materials available that are highly absorbent and specifically made for cleaning up aviation fuels.

Daily, check to make sure that your spill kit is full and has all the required materials to be able to clean up a spill based on your particular fuel storage facility.

Adhering to inspection schedules is vital in properly maintaining your fuel-storage facility. This will safeguard the operation of your fueling facility and the integrity of your fuel supply. Diligently perform inspections as required. Your customers are counting on you to provide their aircraft with clean, dry fuel.

MOBILE REFUELING EQUIPMENT

This training module reviews the proper operation and maintenance of mobile refueling equipment used for fuel transfers.

When conducting any type of fuel transfer from a mobile refueling truck to an aircraft, OBSERVE THESE SAFETY PROCEDURES:

- Be aware of any special restrictions for your ramp
- For operating details regarding your specific refueling truck, refer to the original equipment manufacturer (OEM) manual.
- Always wear proper personal protective equipment (PPO)
- Make sure the refueling truck contains a ladder and a spill kit
- Moving aircraft always have the-right-of-way.
- Drive slowly. Check your operation's policies regarding specific speed limits. Also remember - refueler trucks handle differently when they are filled with fuel.
- Never drive over fueling hoses or bonding cables
- Be especially cautious during inclement weather. Rain can cause oils in the tarmac to rise to the surface, making the ramp slippery. Additional braking time is required in these instances. Snow can potentially conceal obstacles that can damage your equipment.
- Approach aircraft slowly. Come to a complete stop and test the brakes approximately 50 feet from the aircraft. After testing the brakes, proceed toward the aircraft at a speed no greater than 5-10 miles per hour.
- Prior to approaching an aircraft, note the location of its engines and fuel vents. Maintain a distance of at least 10 feet from those areas at all times.
- Position your fueling vehicle with a clear path for exiting in the event of an emergency
- Never park in a manner that obstructs aircraft exits or blocks loading areas.
- Meters and gauge panels on refueling trucks must be visible during the fueling process - consider the location of these items on your vehicle when parking. Driving in reverse poses increased risk and is not recommended. If driving in reverse is for any reason necessary, ask another staff member or a marshaller to guide you using pre-established means of communication, such as hand signals. If visual contact is lost, stop the refueler truck's progress until the staff member is visible again.
- Once positioned, engage the parking brakes before exiting the cab of the vehicle.
- Mobile refuelers should always be chocked when parked - regardless of whether or not the engine is running. Make sure that the chocks being used are the proper size for the refueler truck being parked. Otherwise, the chocks may fail to keep the truck from rolling. One set of chocks per vehicle is sufficient. Secure chocks when not in use to prevent damage to the vehicle and the vehicle components.

Depending upon the type of airplane, an overwing fuel transfer for Avgas or Jet-A aircraft refueling may be ncessary. Overwing fueling requires the use of a nozzle with a trigger that regulates fuel flow. The rate of fuel flow can reach 60 gallons per-minute for this type of fueling. Overwing fueling nozzles are equipped with bonding clamps and contaminate screens. Jet fuel nozzles will also be equipped with flare spouts. Automotive nozzles should never be used.

Remember the following guidelines when conducting an overwing fuel transfer:

IN PREPARATION FOR FUELING:

- Properly position the refueling truck and chock the wheels.
- Static-bond the truck to the aircraft's approved bonding point prior to any other fueling operation
- Place the ladder under the area where the aircraft fuel tank opening is located if required.
- Record the register totalizer

- Zero the meter's register
- Open the belly valve on the refueling truck. The belly valve is also called the emergency internal valve. When opened, it allows fuel to exit the tank into product pipes. The belly valve must always be open before engaging the power take-off unit or PTO. This will prevent damage to the product delivery pump. Some trucks automatically open the belly valve when the nozzle is removed from the nozzle holder, while others require a lever to be manually pulled for the valve to open.
- Engage the power take-off unit. This transfers the power from the truck engine to the delivery pump. On some refuelers, the PTO is automatically engaged when the belly valve is opened. Some trucks require the PTO to be engaged by a separate switch. If necessary, adjust the truck throttle to the recommended RPM.
- Place the wing mat over the aircraft's fueling port.
- Open the reel inlet and unwind enough hose to reach the aircraft. Unwind it by carrying it over your shoulder. This will prevent damage to the nozzle's swivel.
- Bond the fuel nozzle to the aircraft.

ONCE READY TO INSERT THE FUELING NOZZLE:

- Do not insert the nozzle too far into the fuel tank.
- Do not use the fuel-tank filler neck as a prop to support the fuel nozzle. The fuel hose and nozzle should be supported at all times and the fuel hose should never be allowed to touch the aircraft.
- Squeeze and hold the fuel nozzle to start the flow of fuel. Check the differential pressure while fueling to make sure the filter system is working.
- Look down into the tank so as not to overfill. If instructed to fuel the aircraft with a certain number of gallons, watch the meter's register and frequently look into the tank to prevent overfilling. If the fuel request is for a top-off and fuel servicing is being carried out on one wing tank at a time, it may be necessary to alternate side-to-side to ensure a more even weight distribution of the fuel, allowing maximum fill capability. Filling the tanks unevenly can be dangerous.

ONCE FUELING IS COMPLETE:

- Reinstall the fuel cap
- CARRY the nozzle back to the hose reel and rewind the hose. DO NOT drag the nozzle on the ground. Dragging a nozzle can cause a spill or spark. Dragging the nozzle may also damage it.
- Stow the nozzle in the holder.
- Close the reel inlet valve.
- Disengage the PTO if necessary
- Close the product belly valve
- Stow wing mat.
- Check and record your register gallons.
- Disconnect and rewind the static cables.
- Stow the ladder
- Remove and stow chocks.
- Apply the service brakes and release the parking brake before driving away

If you are ever unsure how to refuel a particular aircraft, always consult the pilot for special instructions as well as consulting the operating manual and your supervisor.

Mobile Refueling Equipment

Underwing fueling is required for many turbine or Jet A aircraft. It allows for higher fuel flow rates. Flow rates for underwing fuel transfers from mobile refueling trucks to turbine aircraft can exceed 600 gallons per minute. The most common flow rate for turbine underwing refueling is 200-300 gallons per minute. Special safety equipment is needed for this type of fuel transfer including special nozzles, pressure controls and a deadman system. Avgas refueling is never conducted via an underwing fuel transfer.

REMEMBER THE FOLLOWING GUIDELINES WHEN CONDUCTING AN UNDERWING FUEL TRANSFER:

- Properly position the refueling truck and chock the wheels
- Static-bond the truck to the aircraft's approved bonding point prior to any other fueling operation
- Place the ladder under the area where the aircraft fuel tank opening is located if required.
- Record the register totalizer
- Zero the meter's register
- Open the belly valve on the refueling truck.
- Engage the power take-off unit.
- Open the reel inlet to the underwing hose and unwind enough to reach the aircraft fueling adapter.
- Remove dust covers and connect the nozzle to the aircraft fueling adapter and open the nozzle.
- Remove the deadman handle from its receptacle and pull it out. Stand in a location where it is possible to observe the control panel, meter, and aircraft fuel gauges while fueling.
- Squeeze and hold the deadman handle to start the flow of fuel.
- Check the differential pressure while fueling to make sure the filter system is working.

ONCE FUELING IS COMPLETE:

- Release the deadman to stop the flow of fuel.
- Rewind the deadman hose and stow the deadman handle in its receptacle.
- If necessary, disengage the power takeoff
- Close the product belly valve.
- Close the nozzle and disconnect it from the aircraft fueling adapter.
- Replace any dustcovers removed from the aircraft or nozzle,
- Return switches on the aircraft to their original position
- Secure any service panels on the aircraft used to access the single-point receptacle.
- Carry the nozzle back to the hose reel and rewind the hose. Do NOT drag the nozzle on the ground.
- Close the reel inlet.
- Disconnect and rewind the static cables.
- Record your register gallons.
- If necessary, stow ladders and chocks.
- Apply the service brakes and release the parking brake before driving away.

If you are ever unsure how to refuel a particular aircraft, always consult the pilot for special instructions as well as consulting the operating manual and your supervisor.

Fuel Transfers Between Fuel Storage Systems and Refueler Trucks

REMEMBER THE FOLLOWING GUIDELINES WHEN CONDUCTING FUEL TRANSFERS BETWEEN FUEL STORAGE SYSTEMS AND REFUELER TRUCKS:

- A trained line person should always remain onsite during any type of fuel transfer.
- Storage system deadman or safety shutoff controls must be working properly at all times.
- Refueler truck engines must be shut off before any fuel is transferred from a fuel storage system.
- The refueler truck must be bonded to the storage facility before any other connections are made.
- Never overfill a refueler truck. Check with your supervisor for the proper fill level.
- All fuel storage facility daily inspections must be performed prior to any fuel transfer.

IN PREPARATION FOR FUEL TRANSFER FROM FUEL STORAGE TO A MOBILE REFUELER:

- Properly position the vehicle in the fuel storage containment area,
- Apply the parking brake
- Turn off the ignition.
- Chock the truck
- Connect the bonding cable from the storage facility to the refueler truck before any other connections or operations are made.

Now you are ready to make the connection between the fuel storage system hose and the refueler truck fuel transfer point.

- Move the interlock gate open and attach the hose. Remember, as the interlock gate opens, the brake's interlock is automatically engaged. This keeps the truck from moving and prevents an operator from driving the truck while the truck is connected to the storage system.
- Note the difference between jet-fuel and avgas couplers. This prevents the the incorrect fuel type from being transferred.
- Open the shutoff valve behind the bottom-loading adapter and position the loading nozzle handle to "open". This will allow fuel to flow into the refueler truck piping.
- Position the valves on the storage facility for loading fuel.
- Begin filling the refueler truck by engaging the deadman. Check that the deadman is operating properly by using it to start and stop the fuel flow. The bottom loading gauge will indicate pressure when fuel is flowing.
- Check that the high-level shutoff is operating properly by closing the pre-check valve. This should stop product flow into the tank. This is confirmed if the pre-check gauge indicates fuel-farm pressure and the fuel-farm meter completely stops turning. If a problem is indicated, do not fill the tank until the problem is corrected. If no problem is indicated, reopen the pre-check valve and continue the fuel transfer.
- After the fuel transfer is complete, close the pre-check valve.
- Close the shutoff valve behind the bottom-loading adapter.
- Disconnect the loading hose and close the interlock gate.
- Disconnect and rewind the bonding cables.
- Remove the chocks, apply the service brakes, and release the parking brake.

BE AWARE OF THE FOLLOWING WHEN USING TOP-LOADING REFUELER TRUCKS FOR FUEL TRANSFERS:

- Top loading refueler trucks do not have a high-level shutoff.
- Always verify you are transferring the correct product. There is a higher risk of transferring the wrong type of fuel during top loading operations because avgas and jet fuel top-loading drop tubes are similar. Because of this, Avfuel recommends bottom loading refueling trucks whenever possible.
- Top loading commonly entails the use of an overwing nozzle from a fuel storage cabinet.
- Bond the drop tube to the refueler.
- Make sure the drop tube extends to the bottom of the refueler tank. It should be maintained in that position until the tank is fully loaded to avoid splashing. This can create a static charge which could produce a spark.
- Always be aware of dangerous fumes coming from the open tank
- Use all required safety equipment when positioning yourself to observe the capacity of the tank during fueling. Follow your local authority having jurisdiction regarding safety equipment requirements at your facility.

Mobile Refueler Truck Components and Inspection Procedures

General Condition of the Refueler Truck

Daily, conduct a visual inspection of the refueler truck.

SOME ITEMS TO LOOK FOR INCLUDE:

- Underinflated tires or tires that are worn below a safe limit.
- Cracks in mirrors or windows that could impair vision,
- Proper functioning of the horns and all lights, especially the running lights and rotating beacon – these lights make the refueler truck more visible to others on the ramp.
- Leaks on the chassis engine, transmission or axles.
- Properly functioning engine gauges, windshield wipers, parking and service brakes. These items must be checked with the engine running.
- All placards should be clearly visible
- The steering wheel should not have excessive play.

WEEKLY, INSPECT:

- The refueler truck chassis
- Engine oil levels, all fluids including brake and power-steering fluid as well as coolants.
- Belts and hoses
- Check any lights, lenses and the rotating beacon for proper operations as well as breaks, cracks and discoloration.

QUARTERLY:

- Lubricate all systems.
- Check all fluid levels, including the PTO gear box.
- Check all pinion seals, wheel seals, and axle flanges for leaks.
- Service and tune the engine as recommended by your manufacturer.

Always report damaged refueler truck components immediately. The truck may need to be removed from service until repairs are made.

PRODUCT IDENTIFICATION & SAFETY PLACARDS

Product identification placards must be visible at all times. This helps prevent the wrong type of fuel from being transferred to or from fuel storage systems or into an aircraft.

- Jet A is denoted with white lettering on a black background and includes a white band.
- Avgas or 100LL is denoted with white lettering on a red background with a blue band.
- Text should be at least 3 inches high and printed in a color that contrasts with its background to heighten visibility.
- Aircraft refueling trucks are required to post "flammable", "no smoking" and product type signage on both sides and the rear of the vehicle.
- There must be a "No Smoking" sign posted prominently in the cab of every truck.
- Each emergency fuel shutoff location on the refueler truck must have a sign with "Emergency Fuel Shutoff" in letters at least 2 inches high and indicating the method of operation by an arrow or the words "Push" or "Pull". The text must be in a color contrasting sharply with the background.

Monthly, check that all required warning and identification placards are present, are visible from 25 feet, and are in good condition.

FILTER VESSEL SUMPS AND WATER DEFENSE SYSTEMS

Daily, obtain a sump sample from the pressurized filter vessel and record your results. Follow the procedures for a white-bucket or the clear-and-bright test.

Monthly

- Perform a colorimetric test, often referred to as a Millipore test, downstream of the filter vessel on all Jet A refueler trucks. Follow the colorimetric test procedures.
- Also perform a water-detection test. Test results should indicate water does not exceed 15 ppm.

Quarterly, if the water defense system is equipped with an external check feature, perform a test to make sure it is operating properly per the manufacturer's guidelines.

Annually

- Test the water defense system by introducing water to the float-sump area. Check for the proper operation of the float ballast in the presence of a slug of water. DO NOT inject water if you have a monitor type filter.
- Drain the vessel, remove and inspect the filters, and then replace with new elements, installing a new lid gasket. Refer to the filter manufacturer's manual for the element-replacement procedures.

PUMP PRESSURE, NOZZLE PRESSURE & DIFFERENTIAL PRESSURE (DP) GAUGES

All refueler trucks should possess filter vessels equipped with a DP gauge. The DP gauge should be positioned so the operator can view it while an aircraft is being refueled. The DP gauge helps ensure that the filter vessel is functioning properly.

Daily, obtain a reading from the differential pressure gauge during your first fueling of the day or while recirculating the truck. The reading will be more accurate if the system is operating at its maximum flow rate. Comparing these daily readings to historical data is the best way to monitor the filter system for problems.

Annually, verify that all DP gauges are providing accurate readings. Some DP gauges are equipped with filters on the inlet or high pressure side that may need to be replaced annually.

Jet refueler trucks with single-point refueling capabilities are equipped with a nozzle pressure gauge in addition to the DP gauge. This gauge is for monitoring fuel pressure during single-point fueling operations where restricting excessive fuel pressure from entering the aircraft is a crucial concern. Avgas refuelers are not equipped with nozzle-pressure gauges, as they are not equipped with single-point fueling capabilities.

Daily, via recirculation of the fuel or during your first single-point fueling, check the nozzle-pressure gauge and record your results. Fueling pressure should not exceed 40 PSI under consistent flow.

Additional gauges may be present on your refueler truck. Some trucks possess a pump pressure gauge that allows you to monitor the pressure from the product pump.

Annually - Inspect all pressure gauges. Make sure the numbers are readable and there are no leaks. Calibrate if necessary.

TANKS AND TANK SUMPS

Tank sump drains are connected to the low point of the tank. Daily sumping will aid in the removal any contaminants that may have settled to the low point of the tank. Some tanks are equipped with two low point tank sumps.

Always park the refueler truck on a level surface prior to sumping.

Daily, obtain a tank sump sample. Follow the procedures for proper sumping. Perform a white-bucket or clear-and-bright test and record your results.
Monthly, visually inspect the interior of the refueler truck tank for rust, sediment, foreign objects, and condition of the tank coating. A mirror will help you see inside the tank.

******Always wear proper PPE when performing inspections. This includes safety harnesses. Check with your particular operation regarding PPE requirements for these types of inspections.***

HOSES, SWIVELS, AND NOZZLES

Daily, check the general condition of hoses, swivels and nozzles.

- Hoses should be free from cracking, abrasions, cuts, soft spots, blisters, chafing, twists, or any other irregularities that could lead to a failure or leak.
- Nozzle swivels should rotate smoothly and easily, and be free of leaks
- Overwing nozzles must be equipped with 100 micron mesh screens. They should also have dust covers and bonding clips or bayonet plugs attached and should show no sign of leaks. Overwing nozzle triggers should open and close fully without sticking.
- Single point nozzles should be checked daily for leaks and should possess a dust cover and a 100micron mesh screen.

Monthly

- Fully extend all fueling hoses and inspect while under pressure. Inspect them for kinks, blistering, and abrasions. Check the hose connection point at the reel for kinks, bends, leaks or slippage between hose and coupling.
- Check nozzle screens. On an unpressurized avgas or jet overwing nozzle, check the 100-micron mesh screen by removing the nozzle spout. Check this for any holes or tears. Clean the screen of all debris. Replace it if it is damaged. On an unpressurized jet single-point nozzle, the nozzle screen can be inspected by removing the nozzle from the hose swivel coupler. The hose and nozzle must be drained of fuel prior to this inspection.

DEADMAN

Daily, check that deadman controls are working properly. The deadman should accurately start and stop the flow of fuel. Under normal flow conditions, when the deadman is released, flow should cease before 5% of the maximum rated flow is reached. If the refueler's flow rate is 200 gallons per minute, the time it takes to shut fuel flow off to the aircraft should be ten gallons or less from the time of release of the deadman trigger. No one should defeat or override this system for any reason. This is a safety feature required by the National Fire Protection Association or **NFPA**.

GROUND REELS, CABLES, AND CLAMPS

Ground reels, bonding cables and clamps facilitate bonding during fuel transfers. Bonding eliminates static discharge between equipment during aircraft refueling or when fuel is transferred into or out of storage. The NFPA requires bonding clamps or lugs to be attached to all nozzles. Some airport authorities require the additional step of grounding to a ramp grounding lug. This requires two reels or a "Y" cable and an additional clamp. Check with your local authorities having jurisdiction for your specific airport requirements regarding grounding lugs.

Daily, check for damage or corrosion, loose cables or clamps, tighten if needed. Repair or replace damaged clamps or broken and defective cables immediately.

Monthly, check the continuity of the bonding cable and clamp. Continuity can be checked with a volt ohm meter. The continuity reading should be between zero and 25 ohms. Check for the continuity between a pumping system component and the bonding cable clamp.

FIRE EXTINGUISHERS

Each refueler truck should possess a minimum of two 20-BC rated fire extinguishers, one on each side. Check with your local fire department or authority having jurisdiction to determine the exact requirements for your airport. Nothing should obstruct the fire extinguishers at any time.

Daily, check that extinguishers are visible and have unobstructed access for immediate use. Remove from service if the seal is broken or any indication of a low charge is present.
Monthly, Check the inspection tag on your fire extinguishers, and perform other fire-extinguisher checks required by your facility's management.
Annually, fire extinguishers are required to be inspected and certified by an authorized agency or vendor.

TANK TROUGHS AND DRAIN TUBES

Tank troughs and drain tubes allow water that may accumulate on top of the refueler truck tank to drain off. Otherwise, it could potentially seep through manway covers and vents and contaminate the fuel in the tank.

Daily, check troughs for water that may have accumulated on top of the tank. If water is found, perform the penny check. Drop a penny down the trough's drain tubing. If drains are clear of ice or other debris, the penny will drop to the ground. Report any obstructions in the drains immediately so that they may be repaired.

Monthly, even if no water is present, perform a penny test to make certain the drain tube is free of obstructions. If it passes all the way through, the tube is unobstructed.

AIR TANK DRAINS

Many refueler trucks possess air systems used for the braking system or other fueling system components. Trucks with air systems will be equipped with an air compressor in the engine compartment and air reservoir tanks. If the air system is not drained regularly, moisture can build up in the system and can freeze during cold weather leaving the truck immobilized or unable to pump fuel.

Daily, drain reservoir tanks to prevent moisture accumulation and check for leaks. If the air system seems to have excessive moisture, inspect the air dryer assembly. If the dryer is malfunctioning, it will allow larger amounts of water to enter the air system than it is designed to handle. Check with your refueler manufacture for air dryer maintenance instructions.

EMERGENCY INTERNAL VALVES (BELLY VALVES)

Internal valves or Belly valves are valves found inside the refueler truck tank. When the refueler truck is bottom loaded, the high-level shutoff feature enables these valves to automatically close when the tank reaches capacity. The emergency fuel shut off system also has the ability to shut the belly valve, preventing any more fuel from entering or exiting the system. The valves are opened either mechanically or by an air system.

Refueler truck tanks can possess one or two belly valves. When only one valve is present, that valve serves two functions. It is used for bottom loading fuel into the tank from a fuel storage system and supplies fuel to the pump from the tank when transferring fuel into an aircraft. For tanks possessing two belly valves, one valve is used only for bottom loading fuel into the tank and is connected to the high level shut off. The second belly valve is used to supply fuel to the pump and is actuated during fuel transfer to an aircraft. Check with your supervisor regarding the type of system your refueler truck employs.

Monthly, test the internal valve or belly valve to ensure complete closure as required by NFPA 407. Check your mobile refueler manufacturer's instructions regarding how to perform this test.

REFULER TRUCK TANK - BOTTOM LOADING CONNECTION

Most refueler truck tanks can be bottom loaded with fuel from a storage system. This is considered a safer fuel transfer method because top-loading creates more static electricity.

During bottom loading, fuel enters through a connection located at the bottom of the truck tank that is routed through a pre-check and high-level shut-off system. The fuel flowing through the system applies pressure to a pilot valve located on the top of the belly valve. This causes the spring tension on the belly valve's piston to relax and causes the belly valve to open. Once the belly valve is open, fuel is permitted to flow into the tank. When the pressure to the pilot valve ceases, the pilot will close and fuel pressure will build up behind the piston. This pressure will hydraulically force the piston down, seal the valve and stop the fuel flow.

Daily, inspections should include a check of the bottom-loading connection for leaks. A dust cover should always be in place to protect this connection.

HIGH LEVEL SHUTOFF / PRE-CHECK

A high-level shutoff is located on the top of the tank and prevents it from being overfilled during bottom-loading. This system is automatically activated when fuel reaches a pre-determined height in the tank and is required for all bottom loading systems. Bottom-loading refueler trucks should also be equipped with a pre-check system, which ensures that the shutoff system is functioning properly.

There are two types of high-level shutoff systems commonly in use: the 2 line and the 3 line jet level sensor basket. The three line system works by flooding the jet sensor basket, simulating high level has been reached and blocking the flow of the fuel across the sensor and to the pilot valve, forcing the belly valve to close. On the two line system, the pre-check works by cutting off the fuel supply to the jet sensor basket, simulating a full tank, thus removing fuel flow to the pilot valve causing the belly valve to close and fuel flow to cease.

Even if a high level shutoff system is working properly and the belly valve closes, fuel will still be flowing through the jet level sensor at approximately 1 to 5 gallons per minute and will continue to fill the tank's vapor space allotted for thermal expansion. Therefore, if someone defeats the fuel storage system's deadman and walks away from the truck it will eventually overfill.

Daily, engage the pre-check system at the beginning of every loading to verify that the high-level shutoff is working properly.

SPILL KIT

Daily, ensure that the spill kit is full and contain all materials necessary to be able to clean up a spill as required by your specific spill plan. Replenish as needed

FSII INJECTOR SYSTEMS

For refueling trucks equipped with an additive injector,

Daily, check the fluid level in the additive reservoir. Also check the desiccant dryer for efficacy. If 80% of the dryer has changed color from moisture absorption replace with a new dryer.
Monthly, check the fuel system ice inhibitor injection system. The injection rate should be in a range between 13 ounces (minimum) to 19 ounces (maximum) per 100 gallons. Avfuel recommends the unit inject in the mid-range of 16 ounces per 100 gallons to ensure adequate additive is introduced into aircraft requiring FSII. Verify the injection ratio and calibrate system as needed following manufacturer's instructions.

LIFT PLATFORMS

Daily, if your refueler is equipped with a lift platform, check that it is operating properly. Lift platforms should trigger the brake-interlock system when raised; the platform should have an emergency release to enable decent of the platform in the event of an electrical or mechanical failure.

SURGE TANKS

Larger Jet-A refuelers capable of flow rates exceeding 600 gallons per minute may be equipped with a surge or relaxation tank. Tanks should be drained daily to remove any possible water.

EMERGENCY FUEL SHUT-OFF SYSTEM

The emergency fuel shut-off system is the most important safety feature of the truck. Functioning properly, this mechanism will close the internal valve located inside and at the bottom of the tank and stop the flow of fuel going to the product pump. Pulls, push buttons, or switches capable of closing the internal valve are located on each side of the refueler and can be easily and quickly activated by a line man in the event of an emergency.

Monthly, check that the emergency shutoff system is operating properly. These remote pulls, push buttons or switches should perform just like a deadman by stopping product flow within 5% of the actual flow rate at time of release. Check the emergency shut-off system while the product is flowing.

TANK VENTS

Tank vents allow air to escape when filling and air to enter when refueling an aircraft. Vents should be equipped with a cover to keep rain and snow from entering the tank. This cover should be replaced if damaged and removed to check operation of vent.

Monthly, check that all vents are working properly when the PTO is engaged. Also check that vents are working while bottom loading. Consult the Avfuel Quality Assurance Team for vent inspection procedures for your particular truck.

TANK MANWAY COVERS

The dome cover, also referred to as manway cover, is an access point located on top of the tank that allows for inspection of tank walls and cargo contents. No one should ever enter the interior of a refueler tank without confined space entry permits, training and proper breathing equipment.

Manway cover gaskets can deteriorate over time and can become damaged from normal use. The lid should be oriented to fall down if left open and the truck is moved forward. It also is required to be equipped with a double latch system.

Monthly , check that the manway cover gaskets are free of cracks and in good condition. Make sure the lid is facing the correct direction – it should fall to the rear if left open. The lid should have a snug fit when closed and latched.

PTO

A Power Take Off or PTO powers the product pump. It is typically mounted on the side of the transmission and is powered by the refueler truck's engine. When engaged, the PTO turns a driveshaft that is connected to the product pump. In some cases, an electric motor or hydraulic motor can be attached directly to the product pump and engaged via a PTO switch.

For any type of PTO, the switch to activate it can be found in the cab or on the exterior of the truck on a control panel. On some trucks the PTO is engaged when the internal valve is manually opened. Trucks usually have a light indicating when the PTO is in the "on" position.

Daily, check that your pumping system is engaging properly. Your PTO should engage and disengage smoothly without any abnormal noises and the indicator light should work properly. Consult with your supervisor or refer to your operator's manual regarding how to properly engage and disengage the PTO on your particular truck.

PUMP

A product pump can be a positive displacement or centrifugal type pump and moves fuel from the refueler tank to its refueling system.

Quarterly, check lubrication per the manufacturer's recommendations.

PRESSURE CONTROL VALVES

Pressure control valves are utilized on jet refueler trucks equipped for single point fueling. They regulate the pressure of fuel during refueling and protect the aircraft and truck pumping system from damage. The pressure of the fuel flow must be regulated because pumping pressure for a typical refueling truck exceeds the maximum sustained fueling pressure that most aircraft can withstand. Also, sudden fuel flow restriction from valve closure can cause high back pressure in the refueling system in the aircraft. When aircrafts' fill valves are exposed to constant excessive pressure, they are more likely to fail or experience leaks.

Trucks should be equipped with 2 independent pressure control valves. One valve is considered the primary pressure control and the other valve is referred to as the secondary pressure control. If the primary control valve fails, the secondary will regulate the fueling pressure. Because of the hysteresis involved in fluid mechanics, these valves should be programmed with at least a 10PSI difference from each other. This allows one valve to be in control at all times. If the pressures for each valve are set too closely, the valves will fight for primary control of the fueling pressure and potentially cause pressure surges or not provide adequate protection if one of the valves were to fail during refueling. Avfuel recommends adjusting the primary control to 40psi and the secondary to 50psi.

Quarterly, verify the primary pressure on the jet truck under-wing nozzle is 40 PSI and the secondary pressure is set to 50 PSI. Adjust controls as necessary. Refer to your manufacturer's operating instructions regarding how to verify and set primary and secondary pressure controls.

******Never exceed the manufacturer's recommended fueling pressure, at the nozzle, under constant flow.***

METERS

Monthly, check that meter seals are intact. Check that the last date of calibration of the seal is shown on a tag as well as the totalizer reading at the time of calibration.
Annually, meters should be calibrated per your local Authority Having Jurisdiction.

BRAKE INTERLOCKS AND BRAKE OVERRIDE SWITCH

The brake-interlock system is an NFPA-required safety feature that prevents the truck from being driven or moved during fuel transfers. The brake-interlock system is automatically engaged when the refueler storage tank is being filled using the bottom-loading connection or whenever nozzles are removed. The brake-interlock system also can activate when the PTO is engaged for pumping.

Daily, inspect all brake interlocks. Verify that the refueler truck will not move in any of the following circumstances:

- When a hose is connected to the bottom loading connection
- When a fuel nozzle is removed from a reel inlet
- Or, if equipped, the PTO is engaged

Most trucks are equipped with an indication light in the cab notifying the operator that the brake interlock system is activated.

The interlock system must also be equipped with a brake-override switch that can disengage the system. In case of a mechanical problem or if the refueler truck needed to move quickly, one can override the brake interlock system and move the vehicle by activating the brake override switch. The override switch should be safety wired in the normal position so that if used, it will be evident. This would indicate a problem that should be investigated before the refueler is used in service again.

Quarterly a test should be performed to ensure the override switch allows the vehicle to move with a nozzle removed from the interlock, in the event of an emergency.

PARKING BRAKE / EMERGENCY BRAKE

The emergency brake or parking brake locks the refueler truck's wheels in place so the truck will not roll. This brake should be used at all times when the truck is placed into park.

DIESEL OXIDATION CATALYST AND DIESEL PARTICULATE FILTER

Some truck exhaust systems are equipped with a Diesel Oxidation Catalyst or DOC and a Diesel Particulate Filter or DPF to meet federally mandated emission standards. If your refueler has a DOC and DPF there are some important procedures for activating or using the system that are mandated by the NFPA and your local authority. Check with your supervisor and your AHJ for proper operating procedures.

Inspection Schedule

Daily checks should always be performed prior to or during the first aircraft fueling of the day.

DAILY INSPECTIONS

- General Condition
- Filter Sumps / Record Rating
- Tanker Sumps / Record Rating
- Filter Differential Pressure / Record PSI
- Deadman Controls
- Brake (Safety) Interlocks
- Nozzle(s) Fueling Pressure / Record Rating
- Hoses, Swivels, and Nozzles
- Ground Reels, Cables, and Clamps
- Fire Extinguishers
- Tanker Troughs
- Air Tanks (Drain)
- Tanker Bottom Loading – Pre-Check
- Spill Kit
- FSII Desiccant Dryer
- Lift Platforms
- Surge Tanks
- Fuel leaks

CHASSIS WEEKLY INSPECTIONS

- Ensure Oil Level
- Belts, Hoses, Tires
- Fluids (Coolant, Brake, Power)
- Lights Lenses, Beacon

MONTHLY INSPECTIONS

- Filter Membrane Test & Water Test (PPM)
- Bond Cable Continuity Test
- Nozzle Screens
- Fuel Hoses
- Signs and Placards
- Meter Seals
- Fire Extinguishers
- Emergency Fuel Shutoff System
- FSII Calibration - % of injection
- Tanker Interiors
- Tanker Vents & Dome Cover
- Tanker Trough and Drains
- Internal Valve – Integrity Check

QUARTERLY INSPECTIONS

- Vehicle Inspection
- Primary Pressure Control Check
- Secondary Pressure Control Check
- Water Defense (External Check)
- Brake Interlock Override

ANNUAL INSPECTIONS

- Filter Elements (Change)
- Pressure & D.P. Gauges (Calibrate)
- Fuel Meters (Proving Calibration)
- Water Defense System (Tested by Injecting Water)
  Note: do not inject water on monitor elements
- Fire Extinguisher Certification

Trucks at your facility may differ, as may the local regulations and the frequencies of testing and inspections. Check with your manufacturer's manual and your supervisor. Avfuel Corporation has available refueler-vehicle inspection forms which detail the checks that should be performed at regular intervals on both your jet and avgas refueler trucks. The Avfuel vehicle-inspection sheet can be adopted for use by any FBO. Make additions and deletions that are best suited for your particular operation.

AIRCRAFT FUELING AND GENERAL OPERATIONS

Considerations before and during fuel service to ensure the safest possible experience for everyone on the ramp. This course will review fuel orders, misfueling prevention, FSII orders and special fueling situations. Special fueling situations include fueling with passengers on board, "hot" fueling, defueling and fueling during the presence of thunderstorms or lightening.

There are many considerations to account for before and during fuel service to ensure the safest possible experience for everyone on the ramp.

For example, does the customer want jet fuel, or aviation gasoline? Is there enough product in your refueler truck to complete the job? Does the aircraft require FSII? Do you have a written fuel service request? Perhaps the customer needs engine oil checked or added. If the aircraft being serviced is a helicopter, does your truck have the correct fuel nozzle spout to fit the fuel ports? Have you received proper training to service the aircraft in question?

The following procedures should be observed during EVERY fuel service to ensure that safety is never compromised.

- Never approach an aircraft at a speed greater than 5-10 MPH.
- Always test your brakes before making final approach toward an aircraft.
- Your fueling vehicle should be positioned with a clear exit path in the event an emergency arises.
- Note the location of the aircraft's engine and fuel vents and maintain a minimum distance of 10 feet. Park in a manner that gives you a clear view of the vehicle control panel and fueling points; however, take care NEVER to obstruct aircraft exits or block loading areas.
- Always chock the fuel truck.
- Never conduct fueling operations in an enclosed building (including hangars).
- Always bond the fueling equipment to the aircraft prior to making any other connection to the airplane. Fueling nozzle bonding should be utilized if equipped.
- Hoses should be unreeled along paths where they are in no danger of being run over by ground service vehicles and where they will not block passenger access to the aircraft. V9 When an external power supply or generator is supplying power to an aircraft, never allow fuel hoses to cross over or rest on GPU power supply cables.
- Use protective wing mats during all overwing fueling operations.
- Never conduct fueling during aircraft maintenance procedures that could potentially provide an ignition source for fuel vapors. All radio and radar equipment in the vicinityof the fuel operation must be turned off and the switches must not be manipulated.
- Check the vehicle and aircraft fuel system for leaks while under full flow conditions.
- Restrict ramp access to authorized personnel only.

Communication between crew members and operations personnel is critical when taking fuel orders. Poor communication can lead to misfueling, which in turn can lead to catastrophic aircraft equipment failure and even loss of life.

A pilot calls in a fuel request over the radio for 50 gallons of jet for Three Six Five Whisky Bravo. Is the pilot requesting 50 gallons per side - or 50 gallons total? If this request was intended to mean 50 gallons total – or 25 gallons per side – then adding 50 gallons per side could cause weight and balance problems and prevent the aircraft from being able to leave the airport. It could even necessitate a defuel.

THE BOTTOM LINE: if there is even the slightest doubt, ASK.

THE FOLLOWING ITEMS AND INFORMATION MUST BE CONFIRMED BEFORE FUELING COMMENCES:

- Tail Number
- Type of Aircraft
- Grade and quantity of fuel requested

- Special fueling instructions- e.g. fuel positive or negative for fuel system ice inhibitor or other services
- Location of the aircraft

Misfueling happens when the incorrect grade of fuel is delivered to an aircraft. This can damage or destroy aircraft engines and lead to in-flight engine failures. Fatal aircraft crashes have resulted from the delivery of the wrong type of fuel into aircraft.

In an effort to reduce misfueling, the aviation industry has adopted the use of selective couplings and spouts. For example, a duckbill, or J spout, assists in the prevention of misfueling because duckbills are designed to not fit a fuel port of an aircraft that uses aviation gasoline.

However, there are still older aircraft in operation that are not fitted with the special adapter plate, thus, misfueling remains a risk. If a nozzle does not fit into a fuel port opening, stop operations and contact your supervisor immediately before proceeding.

You are the last line of defense in the prevention of a misfueling. Always check aircraft placards for fuel grade, if equipped, and verify fuel orders with the flight crew.

Many day-to-day fueling operations require the use of a step ladder. Choose a good-quality ladder suitable for the task being performed and of a proper duty rating to meet the weight limit needs of your personnel. Observe manufacturer safety instructions and never use unstable or damaged ladders.

FUEL ORDERS FOR JET A WITH FUEL SYSTEM ICE INHIBITOR

When a customer requests Jet with additive, ensure that there is enough FSII in the reservoir to fill the fuel order prior to servicing the aircraft. Always wear proper PPE when handling FSII and be observant throughout your shift of the level in the reservoir. Replace desiccant dryers as necessary and report any suspected injector deficiencies to your supervisor or maintenance department. More information regarding additive may be found in the training module for FSII.

SPECIAL FUELING SITUATIONS

1. Fueling with Passengers on Board

As operators who regularly fuel commercial aircraft are aware, fueling with passengers on board is an accepted practice – however, certain safety regulations must be followed to safeguard passengers, crew members, ground personnel and equipment. The fuel technician, flight crew, cabin crew and ramp agents each have specific roles during the fueling process to ensure safety of everyone present.

General Aviation has fewer written regulations, but safety is still of the utmost concern. Know your state and local authorities' requirements and consider the following when fueling with passengers on board:

- A crew member should always be present
- Smoking is not permitted on board or in the vicinity of the aircraft
- Seatbelts should remain unfastened during fueling
- Exit doors should be open and clear of any obstructions and passenger stairs should be present

2. Defueling

Defueling is the removal of fuel from an aircraft. From a quality control standpoint, defueling poses serious concerns. Because the product removed from the aircraft comingled with the product previously in the refueler tank, there can be no guarantee of fuel quality without a complete recertification test. For this reason, defueled product should only be returned to the aircraft from which it was removed.

If a refuel truck receiving defuel product already has fuel in the tank, that fuel is now comingled with the defuel product and should NOT be used to fuel other customers' aircraft. V35 Any company that defuels should have a documented procedure for handling defueled product specific to that company's operation. Basic guidelines to be followed include:

- Never offload defueled product into your general fuel storage.
- Product should be defueled into a segregated container or dedicated defuel truck and not into a fuel truck used for fueling other aircraft.
- Defueled product should be returned to the same aircraft.
- If defueled product cannot be returned to the same aircraft then it should be considered waste fuel and disposed of accordingly.

3. Hot Fueling

Hot fueling is fueling while an aircraft's engine is running. It is extremely dangerous and therefore not recommended. At many airports it is prohibited entirely. Check with local authority and confirm any restrictions or requirements before performing any hot fueling. More information can be found in FAA SAFO 10020 and in NFPA 407.

4. Fueling During Lightning/Thunderstorms

Fueling during lightning strikes is NOT recommended. Some airports are equipped with detection systems that notify airport operations when lightning strikes are within 8 NM of an airport, most are not. –.

It can be difficult to determine how far a storm is from an airport and whether it is moving toward or away from you. While experience and good judgment are your best guides, NFPA 407 offers this helpful advice: "Sound travels approximately 322 meters per second, or 1/5 of a mile per second. The approximate number of miles to the storm can be determined by counting the seconds between a flash of lightning and the sound of the thunder and dividing the number by five."

In the absence of a specific policy regarding ramp operations and fueling during thunderstorms, we offer the following guidance.
It is generally safe to continue ramp operations when a storm is within 8NM of an airport, though ramp personnel should remain alert for lighting. However, if lightning is present within 5 NM, ramp operations should immediately be suspended until no lightning strikes have been observed for a minimum of 15 minutes.

If ramp operations are suspended while you are overwing fueling, replace aircraft fuel caps to prevent rain water from entering the fuel tanks. If operations are suspended while single point refueling, disconnect the nozzle from the aircraft, turn off any power to the refuel panel, and close the access door to prevent damage by strong winds.