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New Do's and Don'ts about Aircraft Fueling

A review of basic safety concerns involved in aviation fuel handling, provides emphasis on some significant changes to industry standards.

by
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Industry standards governing the operation of airport fuel facilities and into-plane delivery procedures have been restudied in recent months, and some of the previously accepted practices have been revised. As a result of work done by U.S. groups such as the National Fire Protection Association (NFPA), Air Transport Association of America (ATA), Society of Automotive Engineers (SAE), National Air Transportation Association (NATA) and others, there is now more specific information available about aircraft fueling than ever before.

Safety concerns in regard to aviation fuel fall into two areas:

- **Fire safety procedures**
- **Fuel quality control procedures.**

Fire Safety Procedures Established

Standards established by the NFPA enjoy worldwide acceptance as the foremost source of fire safety information. More than 270 standards and codes published by NFPA cover every aspect of fire protection, and each is periodically reviewed and updated to take advantage of current technology. Among the NFPA publications are two of specific interest for this discussion: *NFPA Number 407- Aircraft Fuel Servicing,* (first published in 1951 and most recently reissued in 1990), and *NFPA Number 77- Static Electricity,* (first issued in 1946 and last revised in 1988). These two documents provide much of the basis for the accepted industry policies and procedures to prevent fires and explosions in the handling of aviation petroleum fuels.

NFPA Number 77 - Static Electricity covers the control and prevention of static electricity buildup in all types of machinery and equipment. However, certain aspects of this document are critical to the understanding of the role that static electricity plays in defining the safety standards of aviation fuel storage and dispensing.

Static electricity is defined as "an electrical charge that is significant only for the effects of its electrical field component and that manifests no significant magnetic field component." The possibility of a static spark discharging across a gap of two points not in contact and thus providing a source of ignition for any ignitable fuel vapors present, is that phenomenon which we seek to avoid.

In order for static electricity to be a source of ignition, four separate and distinct conditions must be present:

- There must be a source to generate static electricity.
- There must be a capacity to accumulate the separate charges and maintain a significant difference

of electrical potential.

- The spark discharge must be of adequate energy to jump the existing gap.

- The spark must occur in an ignitable mixture.

The most likely source of static electricity generation of concern to aviation fuel operations is that created by the flowing friction of the fuel through pipes, pumps, filters and delivery nozzles. This static generation source cannot be eliminated, so we must seek to remove one or more of the other conditions to prevent a catastrophe.

Liquid hydrocarbons (aviation gasoline and turbine fuel) can accumulate a static charge and this factor also is beyond our control; however, we can take measures to assure that a significant difference of electrical potential is not allowed to accumulate. In other words, a means of dissipating or relaxing the static charge must be provided.

Bonding and Grounding Provide Charge Relaxation

"Grounding" (or earthing) is the process of connecting a conductive object to the ground, and is a specific form of bonding. Grounding is done to minimize potential differences between objects and the ground.

"Bonding" is the process of connecting two or more conductive objects together by means of a conductor. It is done to minimize potential differences between conductive objects.

NFPA Number 407 — Aircraft Fuel Servicing, Appendix A states, "No amount of bonding or grounding will prevent discharges from occurring inside a fuel tank. Bonding will ensure that the fueling equipment and the receiving tank (aircraft or fueler) are at the same potential and provide a path for the charges separated in the fuel transfer system (primarily the filter/separator) to combine with and neutralize the charges in the fuel. Also, in overwing fueling and in top-loading of cargo tanks, bonding will ensure that the fuel nozzle or the fill pipe is at the same potential as the receiving tank, so that a spark will not occur when the nozzle or fill pipe is inserted into the tank opening. For this reason, the bonding wire must be connected before the tank is opened.

Grounding No Longer Required

Grounding the aircraft or the fuel truck during aircraft fueling or refueler loading is no longer required because:

(1) It will not prevent sparking at the fuel surface (see *NFPA Number 77 Recommended Practice on Static Electricity*).

(2) It is not required by *NFPA Number 77, Recommended Practice on Static Electricity*.

(3) "The static wire may not be able to conduct the current in the event of an electrical fault in the ground support equipment connected to the aircraft and could constitute an ignition source if the wire fuses. If ground support equipment is connected to the aircraft, or if other operations are being conducted that require electrical earthing, then separate connections must be made for this purpose. Static electrical grounding points may have high resistances and therefore are unsuitable for grounding." [Italics added — Ed.]

The U.S. Federal Aviation Administration (FAA) issued *CERTALERT* Number 90-08, dated November 7, 1990, that was directed to all airport certification program inspectors. The subject of this advisory notice was "Revision of NFPA Number 407 Standards: Grounding/Bonding." This notice highlighted a number of reminders pertaining to electrostatic hazards and bonding, but was basically to transmit notice of the important revision to *NFPA Number 407* regarding the deletion of the grounding requirement.

NFPA Number 77 also points out that bonding *is* required when filling a tank truck through an open top port. When filling or emptying a tank truck through a bottom connection however, the bonding is *not* necessary because there is no release of vapor at a point where a spark could occur, regardless of whether the hose or pipe used is made of a conducting or nonconducting material.

Bonding is Needed When Fueling or Defueling Aircraft

When transferring fuel from a storage tank, drum, hydrant, pit or truck, the aircraft should first be bonded to the source, thus providing a low-resistance path to permit reuniting of separated charges; that is, so that charges delivered into the fuel tanks of the aircraft may reunite with charges left on the tank truck or other type of fueler and eliminate any electrical potentials.

When fueling overwing, it is critical that the fuel nozzle be bonded to a metal part of the aircraft that is metallically connected to the fuel tank. Most aircraft have a plug or clip connector point near the fuel tank cap opening to facilitate this bonding. *This connection should be made before the tank cap is removed and not disconnected until the cap has been reinstalled following the fueling operation.*

For single-point and underwing fueling, a separate bonding wire is not necessary, provided the fuel hose is of a conductive type meeting the standards specified in American Petroleum Institute (API) *Bulletin Number 1529*.

The use of plastic funnels or other non-conducting materials can increase the static generation and should be avoided. Similarly, the use of chamois as a filter is extremely hazardous.

Be Aware of Potential Other Sources of Ignition

Operating engines, Auxiliary Power Units (APUs), ground support equipment, radar emissions and lightning discharges are all potential sources of ignition during fueling operations. Fire prevention measures should be directed at eliminating these potential sources that could cause fire and ensuring that they are sufficiently separated from fuel vents or connection points.

Prevention of fuel spillage is of paramount importance to preclude flammable vapors from reaching potential sources of ignition.

The flash point of aviation gasoline has been established at approximately minus 50 degrees F (-46 degrees C), and Jet B turbine fuel as low as minus 10 degrees F (-23 degrees C). Although Jet A or kerosene grade turbine fuels have a minimum flash point of 100 degrees F (+38 degrees C) and do not produce ignitable mixtures with air at normal temperatures and pressures, when heated (or is in a mist form), the mixture can be ignited when temperatures are higher than 100 degrees F.

Auto-ignition is the ignition of a substance at elevated temperatures independently of sparks or other means of ignition. In this respect, turbine fuels have ignition temperatures much *lower* than those of gasoline. While aviation gasolines will auto-ignite at approximately 840 degrees F (449 degrees C), Jet A has been found to have an auto-ignition temperature of only 475 degrees F, (246 degrees C). Temperatures within this range are often present soon after the shutdown of turbine engines or on brake surfaces after landing or extended taxiing.

Making Proper Use of Portable Fire Extinguishers

NFPA Number 407 calls for portable fire extinguishers to be available on the ramp areas where fueling operations are conducted. Extinguishers should be located so that they are not likely to be in probable spill areas, but within convenient reach at a prominent location along a fence or adjacent to a building.

For multiple refueling positions, the recommended maximum distance between fire extinguisher locations is 300 feet (90 meters). If extinguishers are not fixed, they should be located upwind of the aircraft being fueled. In the event of multiple activities, the distance from the aircraft being fueled to the nearest available extinguisher should not exceed 100 feet (30 meters).

If inclement weather or extremely dusty conditions are a factor, extinguishers not in enclosed cabinets may be protected by canvas or plastic covers.

Aviation Fuel Publications Available

The following publications may be obtained form the sources indicated:

National Fire Protection Association (NFPA),1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101, telephone (800) 344-3555
- *NFPA Number 77 Static Electricity*
- *NFPA Number 407 Aircraft Fuel Servicing*
- *NFPA Number 415 Aircraft Fueling Ramp Drainage*

American Society for Testing and Materials (ASTM, 1916 Race Street, Philadelphia, PA 19103
- *Manual of Aviation Fuel Quality Control Procedures*
- *ASTM D910-76, Specifications for Aviation Gasolines*
- *ASTM D1655-77, Specifications for Aviation Turbine Fuels*

Air Transportation Association of America (ATA), 1709 New York Avenue, N.W., Washington, DC 20006, telephone (202) 626-4000
- *ATA Spec Number 103 - Standards for Jet Fuel Quality Control at Airports*

American Petroleum Institute, 2101 L Street, N.W., Washington, DC 20037
- *Bulletin 1529-1982, Aviation Fueling Hose*
- *RP 2003-1982, Protection Against Ignitions Arising Out of Static, Lightning, and Stray Currents.*

British Standards Institution, Linford Wood, Milton Keynes MK 146 LE, United Kingdom
- *BS 3158-1985 Rubber Hoses and Hose Assemblies for Aircraft Ground Fueling and Defueling.*

TMI Accumetric, P.O. Box 11289, 2700 Nuttman Avenue, Fort Wayne, IN 46857, telephone (219) 747-0587
- *Brochure on TMI Accumetric Fuel Contamination Detector*

Gammon Technical Products, P.O. Box 400, 235 Parker Avenue, Manasquan, NJ 08736, telephone (201) 223-4600
- *Wide variety of publications and brochures on fuel testing equipment and procedures.*

Fuel Quality Control

The various methods and procedures for assuring the quality and freedom from contamination of aviation fuels have not changed appreciably over the years. The test equipment available to assure the quality of fuels has changed, however, and the accuracy, ease and speed with which fuel can now be tested has been considerably improved.

The *Manual of Aviation Fuel Quality Control Proce-*

dures, published by the American Society for Testing and Materials (ASTM) in 1989, is the definitive document for acceptable test procedures. This publication details every currently accepted procedure for testing fuels ranging from the "clear and bright" visual examination to various specification checks, water detection and microbial contamination checks. The manual is available from ASTM, and every airport operator and fuel vendor would be well advised to acquire a copy.

ATA has also been active in developing standards and methods for assuring the quality of fuel delivered to its member airlines. Originally published in 1986, ATA *Specification Number 103* entitled "Standards for Jet Fuel Quality Control at Airports" was last revised December 1, 1989. The first paragraph of the introduction summarizes the intent of this document: "The member airlines of the Air Transport Association recognize that the purity of Jet Fuel dispensed into the fuel tanks of their aircraft is an important factor in ensuring their air transportation services are performed with the highest degree of safety. In order to achieve this goal, ATA *Specification Number 103* was developed by a group of airline fueling specialists who considered the views and recommendations of entities in the various facets of the fueling process.

"This Specification identifies certain procedures and safety tests commonly recognized to ensure that the storage and transportation facilities for the handling of jet fuel will preclude introduction of contaminated or impure fuel into airline aircraft fuel tanks. In addition, the Specification includes certain forms designed to record performance of the appropriate tests and inspections."

ATA *Specification Number 103* makes reference to the ASTM document for the various test methods and procedures; however, the detailed procedures and sample record forms provided in *Specification Number 103* provide a step-by-step guideline in conducting and recording the actions necessary to assure a supply of proper specification and uncontaminated fuel to the aircraft. Although this document deals specifically with jet fuel, operators handling aviation gasoline would find it helpful and applicable with only minor additions or revisions required to cover the peculiarities of gasoline.

The sample forms included in *Specification Number 103* are especially helpful because they provide simple and effective means of assuring that the various tests and checks are accomplished and recorded. The use of these standard format records allows quality control auditors and inspectors from various operators to review any fuel supplier and assure that each is performing according to the desired standard.

New Technology Considered For Fuel Testing Use

One company, TMI Accumetric, has developed a portable fuel contamination detector which is claimed to be capable of performing field tests with laboratory accurate results in as little as three to seven minutes.

This device is said to be capable of detecting particulate matter and free water contamination in turbine fuel with accuracy and consistency. The promise of this technology is of sufficient interest to the industry that ASTM has assigned a committee to evaluate the device to determine if it has the capability to perform the desired tests currently accomplished by the ASTM Standard Test Method D 2276-83.♦

About the Author

Robert A. Feeler is an independent technical consultant. He has participated in more than 50 safety audits and related projects with corporate and air carrier operators throughout the world. He is the author of more than 30 articles for various industry publications and is editorial coordinator of the FSF Aviation Mechanics Bulletin.

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