U.S. Department of Transportation
Federal Aviation Administration

Advisory Circular

Subject: AIRCRAFT FUEL STORAGE, HANDLING, AND DISPENSING ON AIRPORTS

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Initiated by: AAS-300

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Change:

1. PURPOSE. This advisory circular (AC) provides information on aviation fuel deliveries to airport storage and the handling, cleaning, and dispensing of fuel into aircraft.

2. DEFINITIONS. Terms having a specific meaning for this AC are listed in appendix 5, Definitions.

3. RELATED READING MATERIAL. Additional information regarding standards and safety of aircraft fuel storage, handling, and dispensing on airports is contained in appendix 6, Reference Material.

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1. INTRODUCTION.

a. Intent of Circular. It is not the intent of this circular to replace company procedures which are tailored to meet requirements imposed due to the use of special equipment or as a result of local regulations. It is devoted chiefly to highlighting procedures and practices which, if not strictly complied with or corrected, may contribute to unsafe fuel, unsafe conditions, and increase the probability of fire and/or accidents.

b. Publications Reviewed. The publications listed in appendix 6, as well as airline, aircraft manufacturing, and fuel servicing company manuals, deal in detail with fire and other hazards associated with aircraft fueling operations. The safety recommendations contained in these documents should be adhered to as appropriate.

2. GENERAL GUIDELINES. Four general guidelines are often used in evaluating fueling facilities:

a. Fuel storage areas are to be fenced and placarded with "Danger - Flammable" and other warning signs to discourage unauthorized entry.

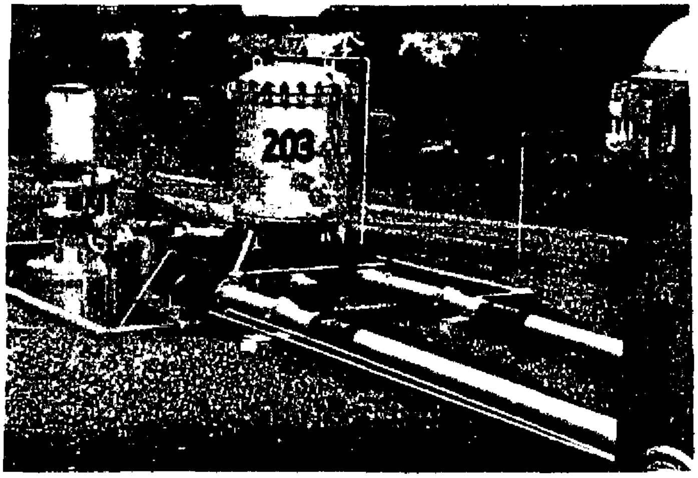
b. All fuel storage tanks, trucks, and dispensers are to be properly marked as to type and/or octane of fuel, and prohibiting smoking. Operable fire extinguishers are to be available at each facility or vehicle.

c. All fuel dispensing units are to be maintained in a clean, operable condition and have grounding cables for static electrical discharge protection.

d. Personnel are to be trained in and are to follow safety procedures for storing, handling, and dispensing fuel, lubricants, and oxygen.

3. BULK FUEL PLANT OPERATIONS.

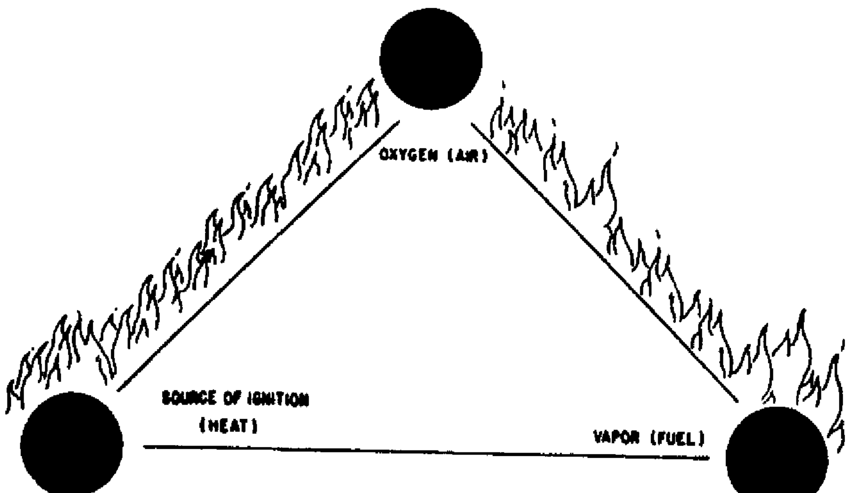
a. Plant Housekeeping. A clean and orderly facilitv is a first essential for fire and accident prevention and for error-free operation. A neat, orderly yard and the clean exterior appearance of the buildings and equipment indicate that the operator has a proper regard for safety. When this orderliness is carried indoors, the foundation for acceptance of safe methods and the elimination of potential hazards has been laid.



A clean and orderly facility which is well marked. The storage tank is underground and the filter and pump are aboveground.

b. Fire Prevention and Control. Bulk fuel plants handle flammable petroleum products, but the fire-frequency record is superior to that of many other commercial establishments. Frequently bulk plant fires neither start in nor involve petroleum products. Their causes are often common to other industrial operations. Regardless of the cause, almost all fires can be prevented or controlled.

4. CAUSES OF FIRE. In the interest of fire prevention, the facility operator should be familiar with the more common causes of bulk plant fires, especially those which involve flammable liquids. Before a fire can occur, three essentials must be present: (1) fuel in the vapor form; (2) air (oxygen); and (3) a source of ignition (figure 1).



Because of the nature of the liquid products handled, fuel vapors may be present at bulk plants in the proper proportion with air to support combustion; e.g., in the case of gasoline, approximately 1 percent to 8 percent vapor by volume in air is combustible. Therefore, it is important to control all sources of ignition where such vapor-air mixtures may be present. All employees involved in aircraft fuel servicing operations should be trained in firefighting methods and tactics, use of appropriate fire extinquishers, and be made aware of those potentially dangerous conditions usually associated with flammable liquid fires. This training could be provided by a qualified company representative or a member of the airport fire department.

5. IGNITION SOURCE CONTROL.

a. Smoking. Smoking should be permitted only in designated safe locations and not on ramps, in hangars, or in proximity to fueling equipment or aircraft. "NO SMOKING" signs should be conspicuously posted where flammable liquid vapors are normally present.

b. Matches and Lighters. "Strike-anywhere" matches and single-action lighters should not be carried in the plant.

c. Open Fires. Open lights or fires should be permitted on the premises only when authorized for maintenance purposes under competent supervision.

d. Power Equipment. Mowers, electric drills, grinders, polishers and other power equipment (except explosion-proof type) should not be operated in areas where flammable vapors may be present; e.g., areas when tanks are being filled by pumping or when the tanks are being ventilated or cleaned.

e. Heating Equipment. Heating equipment should be located so that it would not be exposed to flammable vapors normal to plant operations, or from spills that can occur in the loading or unloading areas. Heating equipment, other than approved unit heaters installed 8 feet above floor level, should be located in a detached building or room designed to have at least a 1-hour resistance to fire. Heating shall be by indirect steam or hot water only. Heating equipment rooms should be kept neat and orderly and should not be used for storage.

f. Static. To minimize sparks from static electricity during loading operations, trucks should be electrically bonded to the loading rack piping by means of a bonding cable. This bond should be made before the loading operation starts and should be maintained until the operation has been completed.

g. Clothing. Clothing worn by fuel-handling personnel can cause static electrical build-up (for example, wearing a wool sweater under a nylon jacket or a combination of wool and a synthetic fabric). Care should be taken to provide fuel-handling personnel with the proper clothing not susceptible to this phenomenon.

h. Electrical Equipment. Electrical equipment, if defective or of the wrong type, may constitute a source of ignition. Therefore, such equipment, as well as circuits and fuses, should be maintained in accordance with local regulations or "The National Electrical Code." Extension cords, portable tools, and appliances should be maintained in first-class condition, and their use should be restricted to designated areas. Any part of the electrical system or equipment installed or used in areas where fuel or its vapors could be present should be of approved explosion-proof design.

i. Rubbish. Combustible rubbish--waste paper, packing material, and oily or paint rags--constitutes a ready fuel source for an accidental fire. Covered metal containers should be provided for the confinement of such rubbish, and be emptied daily. No barrels or drums, empty or full, and no combustible materials shall be permitted within 10 feet of any storage tank.

j. Outside Fire Sources. Frequently, fires endangering a bulk plant originate on adjacent properties. These fires may spread from their source in dry grass and weeds. Good housekeeping, including elimination of grass and weeds, will minimize the spread of outside fires into the plant property.

6. VAPOR CONTROL. When volatile flammable liquids are exposed to the atmosphere, combustible vapor-air mixtures may be formed. Transferring such liquids to an open container releases vapors to the surrounding atmosphere. Whenever possible, this type of operation should be avoided.

a. Truck Filling. Bottom loading is preferred; but if top loading, the use of extension spouts to deliver liquid to the bottom of a tank minimizes the vapors released in the truck loading operation.

b. Switch Fueling. When fuels having a flash point of less than 100°F (37.8°C) are mixed with fuels having a flash point above 100°F (37.8°C), either by addition of the higher flash fuel to the lower flash fuel or vice versa, the resulting fuel-air vapors have new and usually broader flammability characteristics, thus increasing chances of an ignitible mixture. In such cases there is an increased risk of fire and explosion unless adequate precautions are taken to prevent ignition from any source of flammable fuel-air vapors in the fuel tank. The flow rate for fuels with flash points below 100°F (37.8°C) should be one-half the normal rate.

c. Leaks. Volatile flammable liquids which leak from containers or piping are conducive to vapor accumulation. Therefore, valves, pumps, and flanges should be maintained in leakproof condition.

d. Spills. Any spilled product should be removed or covered immediately. In the event of a major spill or overflow, plant operations in the vicinity should cease until the area has been made safe. The fire department should be notified immediately of any major spill or overflow.

e. Cleaning Solvents. Gasoline is a motor fuel, not a cleaning solvent. Gasoline must NOT be used for cleaning. Only petroleum products such as kerosene or stoddard solvent whose flash point is above 100°F (37.8°C) are suitable for cleaning purposes.

f. Ventilation. Natural or mechanical ventilation shall be provided in any building, room, or enclosed space where accumulation of flammable liquid vapors is likely.

7. FIRE-CONTROL PROCEDURES. Usually the number of employees at a bulk plant is small, and personnel such as drivers and mechanics may be at the plant a limited amount of the time. Therefore, in case of emergency, each employee should, as a minimum, be trained to:

a. Alert all other persons who are in the plant.

b. Summon the nearest available fire department.

c. Control the flow of any products which may be involved in a fire. This involves closing valves in the piping system which might release product to the fire area. A knowledge of the operation of such devices as self-closing valves, internal valves, and vents will obviate fear and will avoid delay and error.

8. PERSONAL SAFETY. Freedom from injury is everyone's personal concern and can be achieved only when each individual does his or her part to keep the plant safe by observing correct work procedures. Safety is a day-to-day obligation. It cannot be accomplished on a "fix it tomorrow" or "take a chance this time" basis.

9. PRODUCT PURITY. Maintenance of product purity is essential to safe bulk plant operation. If a petroleum product manufactured for a specific purpose is mixed with one made for another purpose, product usefulness is impaired, and this mixing may constitute a source of danger. Contamination of the product is particularly hazardous. This is of greater concern with respect to aviation fuels due to the vastly changing conditions associated with flight. The maintenance of fuel quality and cleanliness requires vigilance on the part of everyone concerned with the production, transportation, storage, and delivery of aviation fuels.

10. CONTAMINANTS. The common aviation fuel contaminants are water, solids, surfactants, micro-organisms, and miscellaneous contaminants, including the intermixing of different grades or types of fuel. Although the human element causing contamination can never be eliminated, it can be minimized through careful design of fueling facilities, good operating procedures, checks, and adequate training of personnel. The highest levels of cleaniness should be maintained and proper handling practices meticulously observed.

a. Solids. Solid contaminants are generally those which are insoluble in fuel. Most common are iron rust, scale, sand, and dirt. However, metal particles, dust, lint from filter material and rags, gasket pieces, and even sludge produced by bacterial action are included. The maximum amount and size of solids that an aircraft engine can tolerate varies with its type and fuel system. Close tolerance mechanisms in turbine engines can be damaged by particles as small as 1/20th the diameter of a human hair.

(1) Controlling Solids. The best method of controlling solids is to eliminate, or at least limit, their introduction into the fuel. Internal coatings or nonferrous materials, such as aluminum, should be used particularly between the filter and/or filter/separator and the loading point. Alloys containing cadmium, copper, or zinc (galvanized) are not to be used. Covers and caps must be kept tightly closed until ready for use. Care is to be taken to prevent lint from wiping rags or airborne contaminants from entering the fuel system during filling or fueling operations. Dust caps must be replaced after they are used. Pipelines, hydrant systems, and related dispensing equipment must be thoroughly flushed at the maximum obtainable flow before being placed in service--both initially and after any long period of inactivity.

(2) Removing Solids. The most common method of removing solids from fuel is the passage of fuel through a filter and/or filter/separator. These filters, filter/separators, nozzle screens, and other filtering media must be regularly inspected and maintained in order to do their job. There are filters on the market that give alarms or stop the flow of fuel when excessive amounts of contaminants are present.

b. Water. Water occurs in aviation fuel in two forms--dissolved and free or entrained. Water can enter an airport system through leaks in the seals of such items as dome covers, floating roofs, and hatches during rains or when equipment is washed; through leakage during marine transport in tankers and barges; and through condensation of moisture in the air on walls of tanks.

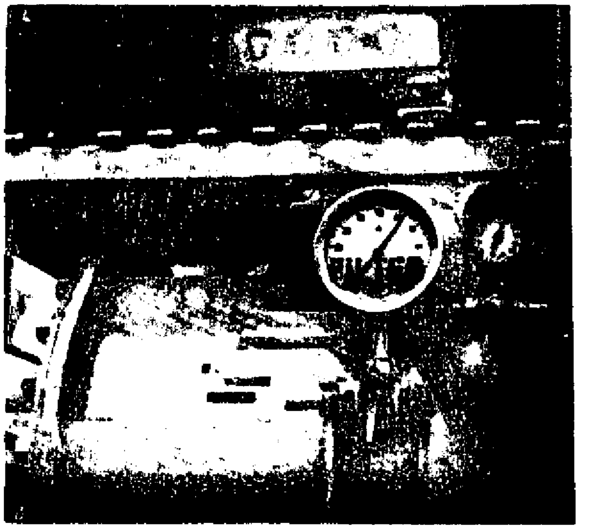
(1) Dissolved water. Dissolved water in fuel is similar to humidity in air. All aviation fuels will dissolve water in varying amounts, depending upon the fuel composition and temperature. Any water in excess of that which will dissolve is called free or entrained water. Dissolved water is not detrimental to aircraft operation as long as it remains in solution. Although dissolved water cannot be removed by filtration, it can become free water with temperature change. Once free, it can thus cause operating problems. As fuel is cooled, water comes out of solution at a rate of about one part per million per degree fahrenheit (1 ppm./ deg. F.). This free water process is analogous to the condensation of water vapor out of air in the form of fog.

(2) Free water. Free water can appear in either bulk quantities or as entrained water. Bulk quantities are often called "water slugs" and, as the name implies, are relatively large in size and are visible as a body or layer. Entrained water is suspended in tiny droplets in fuel, and will cause the reflection of light. When present in large numbers, the fuel appears cloudy or hazy. When a water slug and fuel are violently agitated, as in passing through a pump, entrained water results. This usually will settle out in time depending on droplet size, specific gravity, viscosity of the fuel, and currents within the tank. Because of differing physical properties, a water haze may be found in turbine fuels but seldom is seen in aviation gasolines. Entrained water also may be formed by lowering the temperature of a fuel saturated with dissolved water. Entrained water droplets can unite, or coalesce, to form large drops of free water.

(3) Aircraft engines. Aircraft engines will tolerate a small amount of free water (30 ppm. is usually considered to be the maximum) if it is in a fine, uniformly dispersed state. It is also true that substantial amounts of free drops occur. Most aircraft are protected by filter-heating devices which can deal satisfactorily with dissolved water which comes out of solution, but there is little margin for handling free water. Thus, no free water in the form of water slugs or entrained water can be tolerated in a fuel-handling system and must NEVER be delivered into an aircraft. THE BEST WAY TO MINIMIZE THE AMOUNT OF WATER ENTERING A SYSTEM IS THROUGH INSPECTION AND MAINTENANCE OF EQUIPMENT AND BY MAKING CERTAIN THAT ONLY CLEAN AND DRY FUEL IS RECEIVED.

(4) Measuring devices. Measuring devices to detect free water are available from various oil companies or equipment supply houses.

(5) Water Removal. Water is best removed from jet fuel by passing the fuel through an approved filter/separator. Filter/separators coalesce the fine, entrained water droplets into larger ones which readily settle to the vessel sumps. Tank bottoms and separator sumps must be checked for water on a routine basis and any accumulation removed. Floating suctions and a 2-hour minimum settling period is also recommended to help eliminate water from being introduced into the system. Water will readily settle out of aviation gasoline; therefore, filter/separators are not required for water removal. Keep in mind, however, that filters remain necessary for removal of solids in gasoline.



Abnormal filter differential pressure is indicative of a filter change.

(6) Additives. Additives, such as Ethylene Glycol Mono-Methyl Ether (EGME) which is approved for optional use as an anti-icing additive to turbine fuels, are put in at the refinery, at airport storage facilities or injected by the servicing vehicle.

c. Surfactants. The term "surfactants" is a contraction of the words surface-active agents. These soaps or detergent-like materials--often sulfonates that may occur naturally in the fuel--may be introduced into the fuel by any of the following means: inadvertently by certain refining processes; certain additives; washing off of internal surfaces during passage through distribution system; and storage in a tank or vessel which had previously handled other products. Surfactants are usually more soluble in water than in fuel and reduce interfacial tension between water and fuel. This causes water and dirt to remain in suspension in finely dispersed droplets or particles for an extended period of time. They are attracted to filter/separator elements and can make these elements ineffective. They also tend to plate out on metallic surfaces and adhere to these surfaces until surfactant-rich water droplets are formed which will then run down the side of the vessels and form puddles in the bottom or in the sumps. Surfactants, in large concentrated quantities, usually appear as a tan to dark brown liquid with a sudsy-like water-fuel interface. Surfactants alone do not constitute a great threat to aircraft. However, because they suspend water and dirt in fuel and disarm filter/separator action, they increase the likelihood of aircraft/fuel contamination. Thus, surfactants have become one of the major contaminants in jet fuels and can cause fuel gauge problems.

(1) Limits. No maximum surfactant limit has been established which can be safely tolerated in a fuel. Surfactant contamination of an airport fuel facility is gradual and is dependent upon the volume of fuel handled and the surfactant content of that fuel. For example, a facility handling a large quantity of fuel

containing low levels of surfactant may become more contaminated in time than a low-volume facility with high levels of surfactant. In general, the maximum surfactant level which can be tolerated in fuel is that level where the facility's ability to remove water and solid contaminants is unaffected.

(2) Tests for Surfactants. No simple field tests exist for determining surfactant levels in fuels. However, the "white bucket" test or visual test using a clear glass jar is helpful in detecting the presence of concentrations of surfactants in aviation gasoline and turbine fuel. All that is required is a clean white porcelain bucket or a clear glass jar and water which has been in contact with the fuel in tank bottoms, filter/separators, or other points where surfactants are likely to accumulate. Surfactants, if present, will appear as a brown sudsy water layer on the bottom of the jar or bucket or at the fuel/water interface. Unfortunately, evidence of surfactant is after-the-fact evidence--appearing as a sudsy-like liquid after gross contamination has occurred.

(3) Laboratory Techniques. Laboratory techniques currently available that can indirectly measure to some degree the relative levels of surfactants in a fuel are the Water Separometer Test Modified (WSTM), the Haze Light Transmission Test (HLTT), the Constant Volume Drop Time Test (CVDT), the Minisonic Separometer Test, Micro-Separometer Test and the Water Reaction Test.

(4) Danger Signals. Common danger signals of a surfactant contaminated facility are:

(i) Excess quantities of dirt and/or free water going through the system. Free water content above 15 ppm. in product discharge from a filter/separator is suspect.

(ii) Lacy or heavy scum at fuel-water interfaces drawn from storage tanks or filter sumps.

(iii) Opaque water, including black water, drained from tank bottom and filter sumps.

(iv) Malfunctioning or rapid plugging of filter/separators.

(v) Dark millipores on filter/separator product discharge which do not show usual particulate matter.

(vi) Slow water settling rates in storage tanks.

d. Micro-organisms. Microbial growth can occur where water is present in the fuel. The conditions most favorable to their growth are warm temperatures and the presence of iron oxides and mineral salts in the water. The principal effects of micro-organisms are formation of a sludge or slime which can foul filter/separators and aircraft fueling mechanisms, emulsification of the fuel, creation of corrosive compounds, and offensive odors. Severe corrosion of aircraft fuel tanks has been attributed to micro-organisms, and considerable expense has been incurred removing microbial growths and repairing or replacing corroded aluminum panels in wing tanks.

(1) Microbial Content. Microbial content or number of colonies in a given sample of fuel can be determined in the laboratory. Any evidence of microbial growth or debris, which may appear as a black sludge or slime, or even a vegetative-like mat growth, must be removed from filter/separator cases, fueler tanks, and storage tanks. Growths also appear as dark brown spots on the filter/separator element sock. These elements must be replaced whenever this condition is discovered.

(2) Microbea Prevention. Because microbea thrive in water, a simple and effective method to prevent or retard their growth is to eliminate the water. THE INTRODUCTION OF WATER INTO FUELS MUST BE MINIMIZED, AND FREE WATER MUST BE REMOVED FROM STORAGE TANKS, FILTER/SEPARATOR SUMPS, AND FUELERS WHEREVER IT IS DISCOVERED DURING ROUTINE CHECKS.

e. Miscellaneous Contaminants. Miscellaneous contaminants can include soluble or insoluble materials or both. Fuel can be contaminated by the mixing of fuels; by picking up lead or other compounds from rust and sludge deposits; by zinc from galvanized metals, coatings, or corrosion protection anodes; by additives; or by any other of a number of contaminant sources.

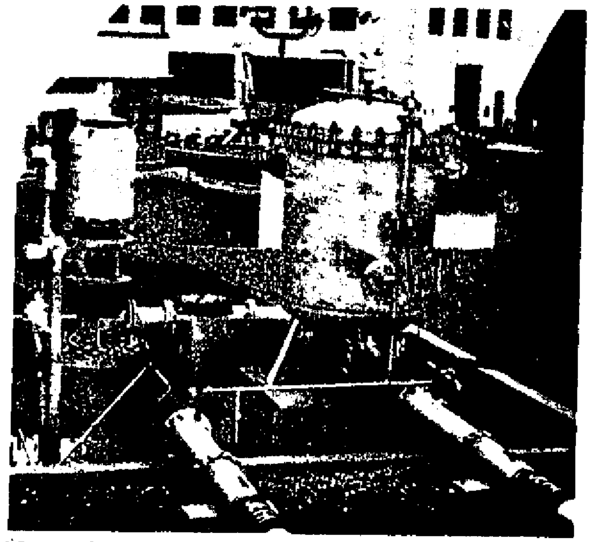
f. Human Error. The greatest single danger to aircraft safety from contaminated fuels cannot be attributed to solids, micro-organisms, surfactants or even water; it is contamination resulting from human error. It is the placing of the wrong grade or type of fuel into an aircraft, the mixing of grades, or any other type of human error that allows off-specification fuels to be placed aboard the aircraft. The possibility of human error can never be eliminated, but it can be minimized through careful design of fueling facilities, good operating procedures and checks, and adequate training of personnel. ANY FUEL WHICH IS SUSPECTED TO BE OFF-SPECIFICATION BECAUSE OF CONTAMINANTS OR MIXING WITH OTHER FUELS MUST NOT BE PLACED ABOARD AN AIRCRAFT. A mistake made in placing fuel aboard an aircraft can be corrected on the spot if the pilot is informed. If the pilot is not informed, an accident may result with tragic consequences.

11. FILTRATION.

a. Aviation Gasoline. Filtration of aviation gasoline shall be provided at the dispensing facility before the fuel is placed aboard an aircraft. In a storage tank-to-truck-to-aircraft setup, an additional filtering at the tank outlet is required.

b. Aviation Jet Fuels. Jet fuel going into storage at airport installations must pass through a filter/separator. Filtration/separation additionally must be provided when fuel is taken out of storage. If tank vehicles or hydrant vehicles are used to fuel aircraft, filter/separators must also be provided when fuel leaves the vehicle also. The product must not be exposed to contamination between the first filter/separator and the aircraft.

c. Clay Filters. Surfactants may be present where fuel product is received into storage directly from a multiproduct pipeline. Here, the installation of clay filter prior to the filter/separator may be necessary. Prefilters, commonly called micronic clay filters, may be installed ahead of the clay filters if fuel contaminant load is such that particle removal by the clay and filter/separator is extremely difficult.



Filter and pump for aviation fuels.

d. Approved Filter/Separators. Filter/separators shall meet standards established by recognized authorities (American Petroleum Institute, military, etc.) for use with the particular product and for the flow rates involved.

12. PRODUCT IDENTIFICATION AND SECURITY. For identification of aviation fuels, the various grades of aviation gasoline are dyed different colors established by international agreement. While jet fuels contain no color dyes, it may be naturally straw-colored. The color and equipment marking codes (see paragraph 18 below) are to be used to positively identify every line, valve, pump, tank, filter, filter/separator, loading and unloading connection, or any other appurtenance where a choice of product is offered. Mechanical coding of couplers should be provided. In addition, airport fixed-storage facilities must be properly protected to prevent intrusion by unauthorized persons.

13. TESTS FOR CONTAMINANTS. Tests for contaminants are to be conducted and interpreted in the field and are to be used as standard procedures in the fuel cleanliness program.

a. Visual Test. The visual test consists of placing a sample of fuel into a clean and dry clear-glass container of at least 1-quart capacity (.94 litres). After allowing the air cloud to rise, the sample is visually examined for a "clear and bright" appearance. These terms have no relation to the natural color of the fuel or any dye coloring which may have been added. Clear means the absence of any sediment or emulsion, such as rust or concentrated surfactant. Bright refers to the fluorescent appearance of fuel which has no cloud or haze such as that caused by fine water droplets. Free water can also be detected as a separate layer on the bottom of the container. It is helpful to swirl the container so that a vortex is created. The free water and dirt, if present, will tend to collect at the bottom beneath the vortex. A similar method using the visual technique, restricted to jet fuels only, employs an ordinary white porcelain or enameled or stainless steel bucket. Fuel samples are visually examined for a clear and bright appearance.

NOTE: Plastic buckets are not recommended because plastic tends to hold a slight static charge that draws particulate matter to the sides.

b. Water Indicator Pastes and Detectors. An effective check for the presence of free bulk water in storage tank bottoms is made by applying water indicator paste to the lower portion of the gauge stick or tape bob. When lowered to the bottom of the storage tank, the paste will change color in the presence of water. To provide for the effect of surfactants which can increase the reaction time, thirty (30) seconds of contact time with the water should be allowed. The highest point of the color change indicates the depth of water present. Water sensitive papers also are available. Water detectors specially made for determining free or entrained water in jet fuels are available. Two popular ones, recommended when a chemical test is requested by a customer or required by local authority, are the HydroKit and the Aqua-Glo II Kit. The HydroKit chemical powder is sensitive to water concentrations down to 30 ppm. The Aqua-Glo II can detect levels of water as low as 1 ppm.

c. Millipore Test. Of the several methods and devices currently available for detecting solid contaminants, Millipore slipstream sampling appears to be the most effective for field use. A 4 to 20 litre (1 to 5 gallon) representative sample (depending on the sensitivity desired) provides sufficient debris from a contaminated fuel so that a visual assessment can be made on the spot or, if desired, a preweighed or matched-weight monitor can be sent to the laboratory for weighing. In either case, only the plain white membrane, 0.8 micrometer porosity, is to be used.

d. Millipore Sample Connections. Millipore sample taps are to be located on the top or side in a straight run of horizontal pipe. The length of sample line and the number of fittings from the sample tap of the Millipore quick-release valve are to be held to an absolute minimum. Only clean, stainless steel pipe, elbows, reducers, and couplers are to be used in making sample connections. Teflon tape is to be used in lieu of pipe joint compound in making threaded connections. Sample valves are to be of a nonlubricated type.

e. Millipore Testing Procedure. Carefully follow Millipore testing procedure instructions of the kit used for visual assessment of Millipore membrane, use the ASTM D-2276 Color Guide or other authorized assessment device.

14. OPERATIONAL CHECKS AND RECORDS OF STORAGE FACILITY AND MOBILE EQUIPMENT. Every possible precaution must be taken to prevent contamination of the tanks and piping by solids, water, or other products. Daily handling procedures must be designed to reveal any malfunctions of equipment or other conditions which would indicate corrective action is necessary. The following covers major items of an operational nature which the operator of an airport fueling facility should check on a MINIMUM daily, weekly, monthly, and demand basis. These inspections include not only

quality control items but also safety and inventory control items and the like. Fire safety needs are adequately defined by National Fire Protection Association (NFPA) Manual 407, Aircraft Fuel Servicing. Complete and accurate operating logs of all phases of the fuel-handling system must be developed to fit the needs of each particular operation. (See appendix 1 for sample airport fuel facility inspection preventive maintenance log and appendix 2 for sample mobile refueler daily and weekly preventive maintenance log.)

a. Daily Inspections. The following items should be checked daily and corrective action or maintenance performed as necessary:

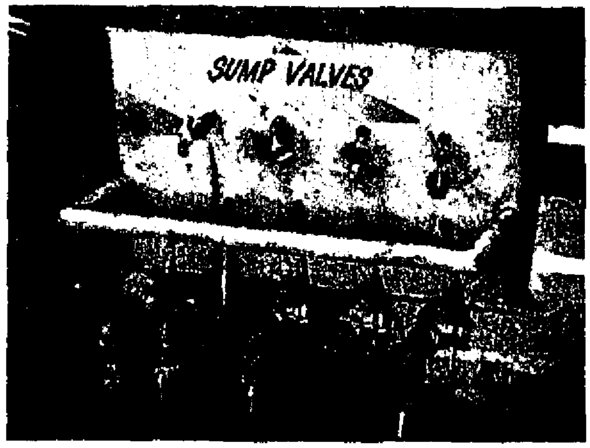
(1) Check the bottoms of all storage tanks for water using a water drawoff connection for aboveground tanks or thief pump for underground tanks and a visual test, or a waterfinding paste on a gauge stick or tape bob.

(2) Check manual water drains of filters for water and other contaminants before and after each receipt of product and after a heavy rainfall. Draw off any accumulation of water.

(3) Check and record filter, filter/separator, and contaminant monitor (if installation is so equipped), also differential pressure while under operating flow conditions.

(4) Check and record the fuel quantity in each storage tank.

(5) Check all mobile refuelers for proper operation, fuel contamination and filter operation.



Mobile refuelers should be sumped daily.

b. Weekly Inspections. The following items should be checked weekly and corrective action or maintenance performed as necessary:

(1) Check and clean all strainer baskets. If breaks are found in a basket, it must be repaired or replaced.

(2) Check and clean the screens in all bottom loading and other hose nozzles. If breaks are found, the screen must be repaired or replaced.

(3) Visually inspect all hoses for abrasions, separations, or soft spots. Damaged or deteriorated hoses must be replaced.

(4) Check the storage tank floating suction and test cables, where applicable, for freedom of operation.

c. Monthly Inspections. The following items should be checked on a monthly basis and corrective action or maintenance performed as necessary:

(1) Check the lubrication and the oil level (in those pumps equipped with a gear box) of the pumps, motors, hose reels, and other machinery requiring lubrication. For hose reels and lubricated valves, use lubricants that will not clog fuel screens in aircraft systems at all aircraft operating temperatures. Make sure the correct seasonal grade of lubricant is used.

(2) Check the action of all valves.

(3) Check the condition and electrical continuity of the static grounding clips, wires, and bonds at the loading racks, pits, and other points of fuel transfer.

(4) Check the emergency shutdown system for proper functioning.

(5) Inspect all fire extinguishers for broken seals, proper pressure, and recharge date. Recharge as necessary.

d. Demand Inspections. The following items should be checked on a demand basis and corrective action or maintenance performed as necessary:

(1) Check the entire fueling facility for clarity and correctness of the product identification system.

(2) Conduct a Millipore check of the cleanliness level of jet fuels discharged at the downstream side of the filter/separator. Conduct a check of monitoring devices as required by manufacturer.

(3) Conduct a thorough inspection of all mobile refuelers.

e. Filter/Separator and Clay Element Replacement.

(1) Filter/separator elements used for jet fuels must be tested, inspected or replaced when any one of the following occurs:

(i) When the pressure differential at full-flow exceeds that recommended by the manufacturer. At rates lower than full-flow, the allowable pressure differential is to be taken from a chart furnished by the manufacturer.

(ii) When a sudden drop in differential pressure occurs under identical operating conditions.

(iii) When it is known that elements have been subjected to the "disarming action" of surfactants.

(iv) When the Millipore filter rating indicates the filter is allowing passage of particulate matter at a rate above the standard applicable to that location.

(v) When there is an indication of free water in the fuel downstream of the filter/separator. This is reason for changing both coalescer and paper separator elements.

(2) Clay elements used for jet fuels are to be changed when any one of the following occurs:

(i) When the differential pressure at full-flow exceeds that recommended by the manufacturer. At rates lower than full-flow, the allowable pressure differential is to be taken from a chart furnished by the manufacturer.

(ii) When the Millipore filter rating indicates filter is allowing passage of particulate matter at a rate above the standard applicable to that location.

(iii) When a visual examination of an element reveals discoloration to have progressed to the inner core of that element. This is accomplished by cutting an element open and observing the color migration.

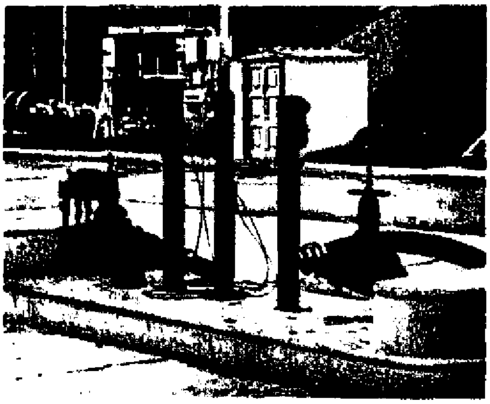
(iv) When a comparison of influent and effluent reveals that the unit is disarmed or spent.

15. RECEIPT OF AVIATION FUELS. A written standard operating procedure (SOP) for receipt of aviation fuels at the particular bulk plant is a prerequisite for a clean, orderly, and error-free operation. The SOP should contain all of the safety requirements of NFPA Standard 407, petroleum company standards, and Department of Transportation requirements. A copy of the SOP should be readily available at the bulk plant for quick reference.

a. Receipt by Truck Transport. Unloading equipment should include separate pipelines and pumps for aviation gasoline from those used for jet fuel, and these lines and pumps should not be cross-connected. Unloading connections should be clearly identified with tags or painted color codes. The truck wheels should be chocked before the unloading begins. Careful adherence to the operating procedure will prevent any error in the delivery.

(1) A comparison by the plant personnel of the carrier's bill of lading with the original order should be made for each delivery.

(2) A check of each cargo compartment for volume and content should be made. A sample of the contents of each compartment, taken in a clean bottle, should be examined for color and odor. The results should be checked with the bill of lading and the original order. (A tag or label should be attached to the sample, and retained in a safe place.)



Truck transport fuel receiving dock.

(3) Check the receiving tank to avoid product intermixture, and ensure that the tank will hold the quantity of product to be delivered. The tank should be gauged. It is never safe to rely on a paper inventory.

(4) The hose should be connected, and the valves should be set so that delivery will be made to the proper tank. A previous valve setting should never be relied on. Ground and bond the truck transport prior to connection.

(5) Check for possible leaks on the delivery hose and lines after the product pump has been started. A recheck of the valve setting and a check of the relief vent on the receiving tank will ensure proper operation and delivery of the product to the proper tank.

(6) The transport driver or plant unloader should remain on hand until the delivery has been completed, and the supervisor should be certain that all truck compartments are empty.

b. Receipt by Railroad Tank Car. The applicable regulations of the Department of Transportation should be complied with as well as the bulk plant standard operating procedures.

(1) Spotting of Cars. The unloader should see that the train crew spots the car accurately at the unloading pipeline. If it is necessary later to move the car, a "car-mover" tool should be used. The brakes should be set securely, or the wheels should be chocked so that the car cannot move and break the piping connections.

(2) The blue sign reading "STOP--TANK CAR CONNECTED" should be placed where any crew coming onto the siding will see it readily.

(3) Before the dome is opened, the unloader should hold the pressure-relief valve open intermittently for the purpose of relieving any internal pressure. He should be careful not to lose his footing while he opens the dome cover. He should PUSH on the wrenches or pry bars--NOT pull them--so that if a tool slips he will fall toward the dome and not off the car.

(4) A check should be made of the volume and contents of the car as well as the car number. A sample of the contents of each car, taken in a clean bottle, should be examined for color and odor. The results should be checked with the bill of lading and the original order. A tag or label should be attached to the sample, and retained in a safe place.

(5) A check of the receiving tank should be made so that product intermixture will be avoided as well as to ensure that the tank will hold the quantity of product to be delivered. It is never safe to rely on a paper inventory.

(6) The valves should be set to deliver to the correct tank. A previous valve setting should never be relied upon. The tank car should be properly grounded and bonded prior to making any connections for unloading. If the bottom connection on the tank is used, the unloader should loosen the cap slowly and check

for leaks. A bucket should be at hand for any leakage. If leakage continues the cap should be tightened, and the emergency valve should be checked by manipulating the lever in the dome. The procedure of loosening the cap may then be repeated. If leakage stops, the cap may be removed and the hose connected. However, if leakage persists, the cap should be tightened and the car unloaded from the dome. When the suction pipe has been placed for unloading through the dome, the opening should be covered with some material such as canvas.

(7) A check should be made for possible leaks in the delivery hose and lines after the product pump has been started. A recheck of the valve setting and a check of the relief vent on the receiving tank will ensure proper operation and delivery of the product to the proper tank.

(8) The unloading operation should be under constant supervision, and unauthorized persons should not be permitted in the vicinity. The plant should never be left unattended while a tank car is connected.

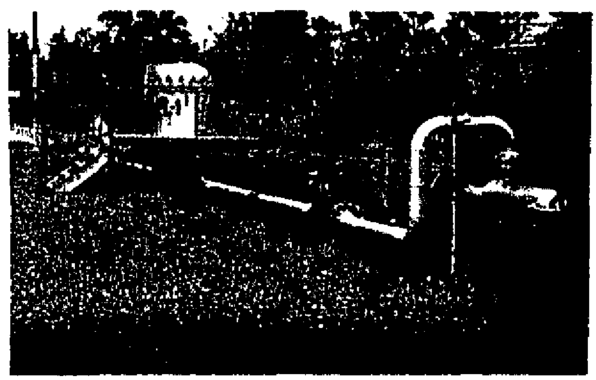
(9) When the delivery has been completed, the unloader should be certain that the car is empty. The delivery hose should be promptly disconnected; the cap should be replaced if the car has been unloaded through the bottom connection, or the dome cover should be secured in place. The blue stop sign should be removed, and the car should be reported EMPTY.

c. Receipt by Pipeline Delivery. Appendix 4 contains an example of an appropriate checklist for receipt of fuel by pipeline delivery.

(1) When aviation fuel is delivered by pipeline, positive identification of the product must be made prior to its being placed in storage tanks.

(2) The product should be passed through a clay filter/separator prior to being stored in tanks.

(3) A check of the receiving tank should be made so that product intermixture will be avoided, as well as to assure that the tank will hold the quantity of product to be delivered.



Pipeline receiving facility.

(4) Upon completion of delivery, the quantity of product delivered should be verified and held for the prescribed time period for water settling.

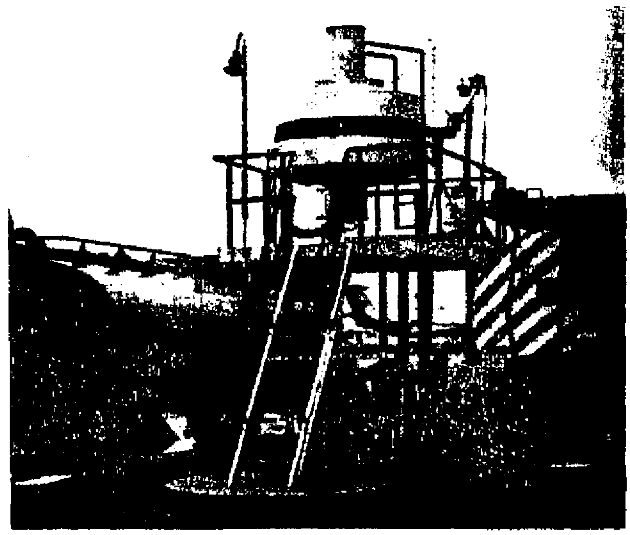
16. <u>LOADING AIRCRAFT FUEL SERVICING TANK VEHICLES</u>. A written SOP for loading aircraft fuel servicing tank vehicles should be available at the bulk plant loading area for use by the vehicle operator when loading the tank vehicle. The SOP should include all of the safety requirements of NFPA Standard 407 and the petroleum company standards.

a. General Requirements.

(1) Filling of the vehicle cargo tank shall be under the observation and control of a qualified and authorized operator at all times.

(2) Required deadman or automatic fill controls shall be in normal operating condition during the filling operation. They shall not be blocked open or otherwise bypassed.

(3) The engine of the tank vehicle shall be shut off before starting tank filling.



Loading facility for mobile aircraft fuel servicing tank vehicles.

(4) The cargo tank shall be grounded and electrically bonded to the fill pipe before the dome covers are opened, and the bonding connection shall be maintained until after the dome covers are securely closed (after filling is completed). Bonding and grounding requirements and electrical continuity tests shall be in accordance with applicable NFPA standards.

(5) No cargo tank or compartment shall be loaded liquid full. Sufficient outage shall be allowed to prevent leakage or overflow from expansion of the contents due to a rise in atmospheric temperature or direct exposure to the sun. The outage shall not be less than 1 percent of the volume of the tank or compartment.

(6) A heat actuated shutoff valve shall be provided in the piping immediately upstream of the loading hose or swing arm connection.

b. Top Loading.

(1) Drop tubes used in top loading or overhead loading of tank vehicles shall be designed to minimize turbulence.

(2) Fixed drop tubes permanently mounted in the vehicle tank shall extend to the bottom of the tank or to inside the sump to maintain submerged loading and to avoid splash loading of the fuel.

(3) Drop tubes attached to loading assemblies extending into the vehicle tank should extend to the bottom of the tank and be maintained in that position until the tank is loaded to provide submerged loading and avoid splashing or free fall of fuel through the tank atmosphere.

(4) Loading arms shall be properly counterbalanced.

(5) A deadman control shall be provided, located so that the operator can observe the liquid level in the tank as it fills.

c. Bottom Loading of Tank Vehicles.

(1) Loading hose for the desired aviation fuel should be identified by color coding and/or labeling and should conform to the safety requirements of NFPA Standard 407. Swivel connections should be provided at each end of the hose to allow free movement to compensate for changes in the attitude of the vehicle connection during loading.

Bottom loading of tank vehicles. Note marking on truck and use of deadman control.

(2) Swinging loading arms should be properly counterbalanced. Swivel joints should be used to allow free movement and to compensate for changes in the attitude of the vehicle connection during loading.

(3) The connection between the tank truck and the arm or hose shall be a self-sealing, leakproof, dry-break coupler which cannot be opened until it is engaged to the vehicle tank companion adapter. It should not be possible to disconnect the hose coupler from the tank vehicle connection unless the internal valving of both components is fully closed.

(4) The bottom loading fitting on the tank vehicle should be of self-sealing, spring-loaded check valve type which will remain in closed position until opened by connecting the companion coupler.

(5) The supply piping terminating at the loading hose or swing arm shall be supported to carry the load imposed by the hose or arm.

(6) Control of the filling of the vehicle cargo tank should be by a preset metered liquid control, a float-actuated shutoff, a sensing or other automatic device, and by a deadman type manual control located at a position where the operator can observe the liquid level in the tank. Any liquid bled from a sensing device during loading shall be returned to the bottom of the cargo tank through a closed system.

(7) If fill control is by means of a liquid level device, a manual precheck system should be provided. Prechecking should check both the level sensing and the shutoff device as an internal system operation. A visible means, such as a pressure gauge, should be provided so that the operator will have a positive signal that the shutoff works.

(8) The fill pipe and valving on bottom loading tank vehicles should be arranged so as to prevent fuel spraying and turbulence in the cargo tank. Inlet baffling may be used to accomplish this.

d. Emergency Remote Control Stations. Each tank vehicle loading station should be provided with an emergency shutoff system. This requirement is in addition to the deadman control required for top loading and for bottom loading. It should be the purpose of this system to shut down the flow of fuel in the entire system or in sections of the system if an emergency occurs. One or more emergency shutoff stations should be provided. Each Emergency Remote Control Station should be placarded at least 7 feet above ground and located so that they can be readily seen from a distance of at least 25 feet.

17. FUELING AIRCRAFT. A written SOP for aircraft fuel from facilities on the particular airport shall be available in the airport manager's office and in each fueling truck. This SOP should include all the safety requirements of NFPA Standard 407 and the particular petroleum company's standards. An abbreviated typical fueling procedure is outlined below.

a. Fueling Procedures - General.

(1) In order to service the aircraft promptly and efficiently upon arrival, the fueling supervisor should obtain as much advance data as possible.

(i) Aircraft arrival and departure times.

(ii) Estimated quantity and grades of product required (fuel, oil, etc.).

(iii) Determine fueling method (Hydrant, Mobile Refueler, Overwing, Underwing, etc.).

(2) Upon aircraft arrival, obtain quantity and grades of products required from airline or aircraft personnel.

(3) The aircraft should not be approached until it is stationary, the main engines have been shut down, and it is ready for servicing.

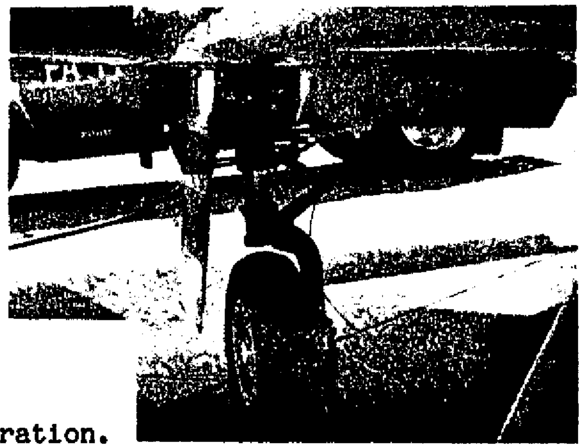
(4) The fueling vehicle should be positioned with a clear path to permit rapid removal in the event of an emergency and to facilitate egress upon completion. Consideration should be given to the location of the fueler's engine and location of the aircraft's fuel vent system. The fueling vehicle should not be positioned where it would obstruct aircraft exits and loading areas.

(5) All fueling operations should be conducted outside hangars or similar enclosed buildings.

(6) After the fueling vehicle is in position, fire extinguishers should be readily available in accordance with NFPA standards.

(7) Grounding/Bonding.

(i) Attach a grounding cable from the fueling vehicle to a satisfactory ground connect.



Proper grounding/bonding is essential for a safe fueling operation.

(ii) Connect a grounding cable from the ground to the aircraft fitting, if one is provided, or any convenient unpainted metal point on the aircraft.

(iii) Bond the vehicle to the aircraft. Where a "Y" or "V" cable permanently attached to the fueling vehicle is used to accomplish (i) and (ii), above, a separate bonding cable is not necessary.

(iv) Bonding and grounding requirements and electrical continuity checks shall be in accordance with applicable NFPA standards.

(8) Hoses should be run out on selected routes which will prevent them from being run over by serving vehicles. Kinking and twisting of hoses should be avoided. Pressure fueling couplings and overwing nozzles should not be dragged over airport surfaces. Dust caps shall be in place at all times when coupling and nozzle are not in use.

(9) Before fueling, check with the airline representative to confirm that all pertinent equipment on the aircraft is positioned ready to receive fuel.

(10) If fueling is performed at night, the fueling area should be well illuminated.

(11) Take fuel sample, if required, under full flow conditions. Ensure that the sample is representative. Also, when required, perform water detection test on sample.

(12) If an aircraft is fueled with passengers on board, an airline representative should be on board to ensure that "No Smoking" rules are observed.

(13) No fueling shall be conducted during any aircraft maintenance that might provide a source of ignition to fuel vapors. All radio and radar equipment must be "off" and switches must not be manipulated.

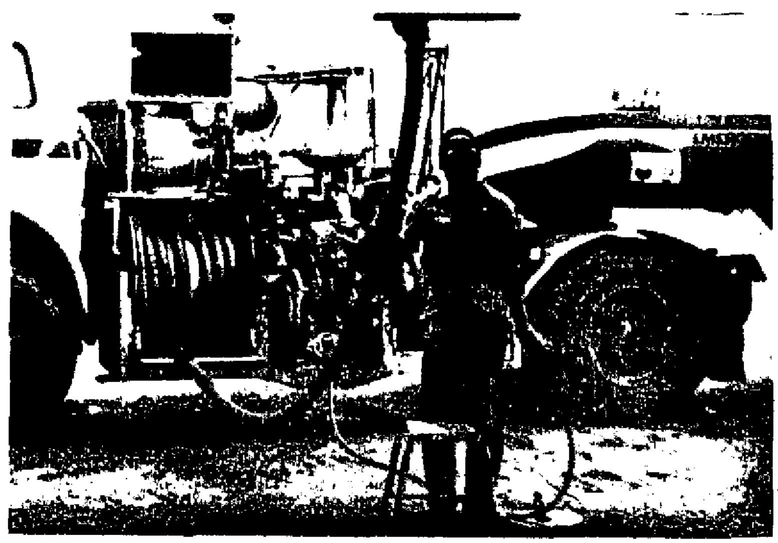
(14) While under full flow, check vehicle and fuel system for leaks, etc.; observe that the filter differential pressure does not exceed acceptable limits. If leaks or signs of leaks occur, all fueling operations must be halted immediately.

(15) Flow rate for fuels with flash points below 100°F (37.8°C) (for example JP-4) should be reduced from the normal rates to decrease static electrical build-up. (See NFPA Standard 407 and FAA Order 8110.34A.)

(16) The operator should be positioned at a point where there is a clear view of the vehicle control panel and aircraft fueling points. The deadman control must always be used and should never be wedged or blocked open or positioned to defeat its purpose.

(17) "No Smoking" signs must be displayed in prominent positions near the aircraft and fueling vehicle.

(18) Unauthorized persons are not permitted in the fueling area under any circumstances.



The fueling operator should be positioned to have a clear view of control panel and all other operations. Note use of deadman control.

(19) Fueling an aircraft which has one engine running is a nonroutine emergency operation. Because of its nonroutine nature, the operation must be reviewed beforehand by the airline and fueling company representatives. Fueling should only be performed if the operation is within the scope of the current airport regulations and all prescribed safety precautions are followed. Fuel must only be loaded on the side opposite to that of the running engine.

b. <u>Fueling Procedures - Underwing Servicing From Fuelers and Hydrant Vehicles</u>.

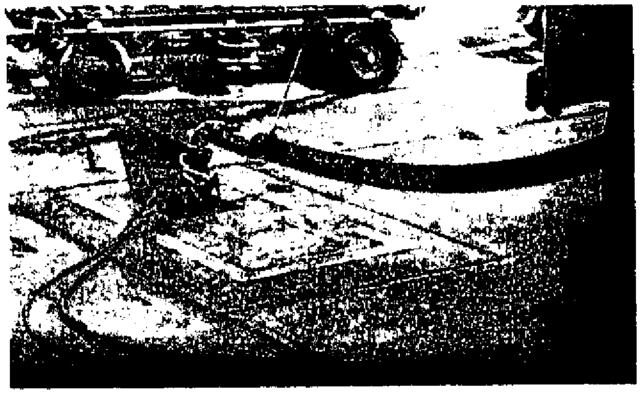
(1) Ground and bond fueling vehicle to ground and to aircraft.

(2) Hydrant Servicers only:

(i) Open hydrant pit cover (check the product grade before connection).

(ii) Place "warning" signs or lights in position at hydrant box.

(iii) Remove dust caps from valve in hydrant box and from coupler of inlet hose.



Ramp hydrant servicer. Note flag marker.

(3) Open aircraft fueling station access door and remove dust covers from hose nozzle and aircraft valves.

(4) Connect delivery hose nozzle to aircraft fueling point, open nozzle and place appropriate aircraft fuel switch to the "on" position, connect the hose coupler to the hydrant valve after checking both valve surfaces to be sure they are clean and dry, then open hydrant coupler and adapter and activate fueling vehicle with deadman control.

(5) Start fueling--keep alert and take all precautions for safety and be sure not to exceed aircraft structural fuel pumping pressure.

(i) Continually monitor the underwing fuel gauges and be in a position to quickly shut off flow in an emergency.

(ii) Never block a deadman valve in the "on" or open position. Under no circumstances shall the nozzle be left unattended during fueling.

Example of deadman control in use.

(6) Never overlook the possibility of an accidental fuel spill or leak from the aircraft or the fueling vehicle.

(7) Upon completion of fueling:

(i) Check fuel quantity dispensed with fuel quantity requested.

(ii) Disconnect hydrant coupler and stow hoses.

(iii) Disconnect hose nozzle and replace dust caps.

(iv) Close fueling station access door.

(v) Remove ladders or lower platform.

(vi) Remove bond cable from aircraft to fueling vehicle and ground cable from ground to fueling vehicle.

(8) Check the filter/separator sump on fueling vehicle for water following the fueling. If an unsatisfactory check is found, request an airline representative to check aircraft sumps, drain any water found, and acknowledge that aircraft is water free.

(9) Remove fueling vehicle from aircraft area as soon as possible after servicing is completed.

c. Fueling Procedures - Overwing. In addition to the procedures given for underwing, where applicable, the following should also be applied.

(1) Always use suitable ladders and mats to avoid damage to aircraft wing. Use extreme care to prevent hose or nozzle from damaging deicer boot or leading edge of wing.

(2) Set wing mat in place.

(3) Connect static bonding wire from nozzle to receptacle, post, or other metal part of plane before opening fuel tank cover.

(4) Open tank access, remove nozzle dust cap and insert nozzle, keeping constant contact between the nozzle and the filler neck while fueling.

Overwing fueling. Note wing mat.

(5) Start fueling--Overwing nozzles should not be equipped with "hold open ratchets" which will prevent nozzle from being unattached during delivery. Make frequent visual checks of tank capacity, taking extreme care to prevent spillage or overfilling.

(6) Upon completion of delivery, quantity in tank should be checked with fuel quantity requested.

(7) Replace and secure tank access caps. Disconnect nozzle static bond wire. Replace nozzle dust cap.

(8) Return hose to fueler reel.

d. Defueling Procedures.

(1) Defueling an aircraft may be required for a load adjustment or maintenance work. The safety procedures are similar to those used in fueling, and the same precautions must be observed.

(2) In making a load adjustment, defueling normally follows shortly after the aircraft has been fueled. This may be caused by a change in flight plans or aircraft loading.

(3) Defueling for maintenance work will normally require the aircraft tanks to be emptied.

(4) Defueled product shall be held in the defueling unit and returned to either the aircraft from which it was removed or to other aircraft of the same customer.

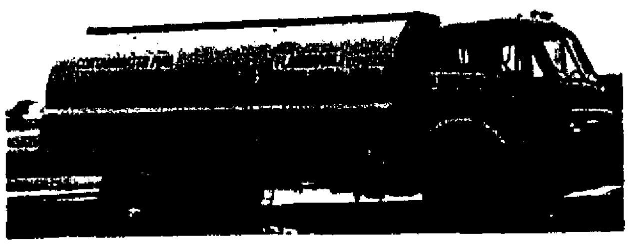
(5) It is desirable to defuel into empty vehicles when possible, but product removed for load adjustment may be defueled into a refueler equipped for this purpose and may be commingled to a fuel of the same type to a ratio of up to 10 percent with the contents of the vehicle.

(6) Defueled product that is withdrawn under the following conditions shall be defueled into an empty refueler and handled as contaminated fuel and not returned to any aircraft.

(i) Known to be or suspected of being contaminated;

(ii) Unknown grade of fuel or mixtures; and

(iii) Fuel removed due to accident or other unusual conditions.



Temporary storage for contaminated fuel. Well marked trucks eliminate errors in fueling.

e. Fuel Spills. Fuel spills present an extremely hazardous fire potential and should be handled as such. Because of the many variables, no two spills will present identical hazards, so no one set of instructions will apply in every case. However, prompt action, good judgment, and initiative will always be required.

(1) If fuel is discovered spilling from fuel service equipment or from the aircraft itself, the fuel servicing shall be stopped immediately by release of the deadman control or by operation of the emergency fuel shutoff. Every spill, no matter how small, should be reported immediately to the supervisor and remedial action taken. The supervisor should determine if the operations in progress can be continued safely or if they should be stopped until the nature of the problem is determined and corrected.

(2) Spill Size.

(i) Any fuel spill presents a potential fire hazard. Pint size spills require no emergency action. Other small spills involving an area from 18 inches to 6 feet in any dimension require, as a minimum of protection, the posting of a fire guard to maintain a restricted area around the spill and to keep out unauthorized persons. The fire guard should be equipped with at least one dry chemical or carbon dioxide extinguisher of 15 pounds or larger. Dry chemical extinguishers are well suited to these circumstances and have a much greater effective range.

(ii) Any spill approximately 6 feet in any dimension or of a continuing nature is extremely hazardous. The airport emergency fire crew should be called at once. If an emergency crew is not available, airport personnel should mobilize all available firefighting equipment as standby protection. The equipment and assistance of other fire protection units should also be requested.

(iii) If the spill is large, the passengers and crew should be directed to evacuate the aircraft. The location of the spill, its direction of flow, the wind, etc., will determine the best evacuation route.

(3) Spill Clean Up.

(i) Small spills should be cleaned up as quickly as possible with absorbent cleaning agents, emulsion compounds, or rags. The use of absorbent cleaning agents or emulsion compounds are preferred because they can be applied with less risk to the cleanup crew. Contaminated absorbents and fuel-soaked rags act as wicks and should be placed in metal containers with self-closing lids until burned at a safe location or otherwise disposed of.

(ii) Large spills of gasoline and JET B fuel (JP-4) should be blanketed with foam. The spill should then be washed away with water and any residue allowed to evaporate before the area is again used for normal operations. These fuels should not be washed down sewers or drains unless no alternative is available, since this merely moves the hazard to another location. If such action must be taken, it should be only on orders from the chief of the airport fire department. If the spillage should get to the sewers, the sewers should be very liberally flushed with water, and operations involving ignition sources should be kept from the vicinity of open drains and manholes. Any fuel that is flushed into the storm sewer system should be collected before it enters a natural waterway. All recoverable fuel spillage should be disposed of properly.

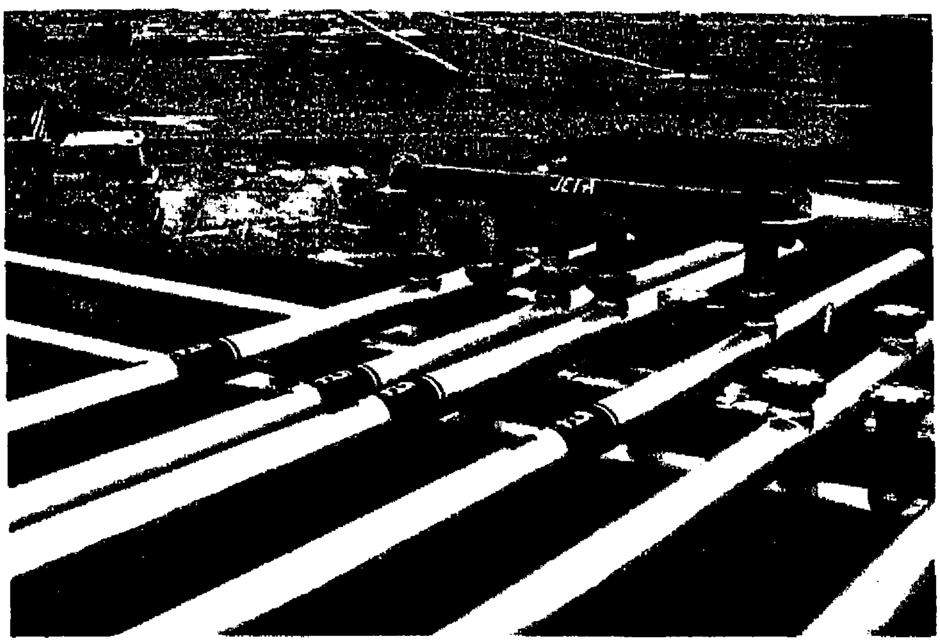
(iii) Kerosene type fuel does not evaporate quickly and hence can be a fire hazard for a prolonged period. It should be blanketed with foam if it is feared that ignition is probable without this protection. In most situations, however, it is better to use an emulsifying agent to remove any oily residue from the surface, and then flush the mixture away.

(4) Every fuel spill should be investigated to determine the cause, whether emergency procedures were properly carried out, and what corrective measures are required.

18. MARKING OF AIRPORT EQUIPMENT FOR FUEL IDENTIFICATION. All airport equipment should be marked to identify the type and grade of aviation fuel being issued and dispensed in order to preclude intermixing or contaminating the fuels. One of the most common accidents related to aviation fuel is the intermixing of jet fuel in an aircraft that requires aviation gasoline (AVGAS). A reciprocating engine will not operate on jet fuel.

a. Fueling Systems. Airport fueling systems should be marked utilizing the marking code described in paragraph 19. Particular attention should be given to marking pumps, valves, and the lines used for loading and unloading fuel. Where space will not permit banding and printing the name on the pipe, fuel service hydrants, hydrant carts, hydrant covers, and pits which hold valves, hydrant connections, hose reels, filters, or other fueling equipment should be painted in the identifying product grade color. Piping systems that are buried or inaccessible should have all exposed valve stems and wheels painted the identifying product grade color and a flag post permanently fixed to the pipeline or a concrete pad near the valve showing the marking code.

b. Fueling Vehicles. To prevent error in identification of fuels in fueling vehicles, marking as shown in appendix 3, with white letters at least 3-inches high, should be painted at the hose outlets and on the doors of the vehicles.



Well marked fuel facility eliminates confusion and errors in fueling.

19. MARKING CODE. A marking code should be used to permit rapid identification under varying visibility conditions. The code is comprised of three systems described below and displayed on the chart in appendix 3.

a. Fuel Naming System.

(1) Aviation Gasoline. The naming system for the four grades of aviation gasoline is made from the general term "AVGAS" followed by the grade marking. The grades are identified by their performance number as recognized by all military and commercial specification; i.e., 80, 100 LL, 100, and 115. AVGAS is a widely used abbreviation of the words "aviation gasoline." The use of the naming system "AVGAS 100" indicates that the aviation gasoline within an airport fueling system meets the minimum requirements of the U.S. military or NATO specifications for that grade.

(2) Jet Fuel. The three classifications of aviation turbine fuels are nearly universally referred to as "Jet Fuels" and are generally described as JET A, JET A-1, and JET B. They are used in "turbojet" and "turboprop" engines. These three classifications are:

(i) JET A - A relatively high flash point distillate of the kerosene type, having a -40°F (-40°C) freezing point (max).

(ii) JET A-1 - A kerosene type similar to JET A but incorporating special low temperature characteristics for certain operations; i.e., -53°F (-47°C) freezing point (max).

(iii) JET B - A relatively wide boiling range volatile distillate having a -58°F (-50°C) freezing point (max). The military terminology is JP-4 when the freezing point is -72°F (-58°C).

In some cases, it may be desirable or necessary to indicate on the marking system some refinement in addition to the designation contained in this circular. Words can be added below the "JET A" to cover these requirements. Also, some manufacturers may desire to show their product brand name on the airport fueling system for a transition period. The brand name could follow behind the product type identification and be separated.

b. Color Code System.

(1) Aviation Gasoline. The naming system for aviation gasoline grades is printed in white letters and numbers on a red background. Red was chosen for the background because it is an indication of the special care which must be taken in the handling of the more volatile fuels.

(2) Jet Fuel. Jet fuels are of two distinct types. The JET A and JET A-1 are low volatility fuels of the kerosene type. JET B is a widecut gasoline type made from parts otherwise used to make both kerosene and gasoline. These three grades vary in color from white to light yellow. Jet engines will operate on all three grades under most conditions, but each grade of fuel has characteristics

which require that it be left separate. It is also desirable to make a clear distinction between the low volatility JET A and JET A-1 fuels and the more volatile JET B. The naming system for the jet fuels is painted in white letters on a black background for contrast to the gasoline color code which is painted in white letters on a red background.

c. Banding System. Circular bands of an identifying color are painted or taped around the piping at intervals as one part of the marking code. They are for use both adjacent to the naming system and by themselves. The circular band was chosen because it appears the same from all directions.

(1) Aviation Gasoline. The color of the single band around the piping or hose is the same color as the dye in the grade of AVGAS flowing through the line. They are red for AVGAS 80, blue for AVGAS 100LL, green for AVGAS 100 and purple for AVGAS 115. A minimum 4-inch wide band is recommended. If the pipeline is painted the color of the AVGAS, then no banding is needed.

(2) Jet Fuel. Black, grey, and yellow bands are used to identify JET A, JET A-1, and JET B, respectively.

APPENDIX 1

Airport Fuel Facility Inspection Log

Airport ____________________ Grade of Fuel ________________ Month ______________

	TANK INSPECTIONS		F/S INSPECTIONS		EQUIPMENT INSPECTIONS						
DATE	FLOATING SUCTION WEEKLY	WATER (DAILY)	WATER (DAILY)	DIFF. PRESSURE (DAILY)	LEAKS (DAILY)	STRAINERS (WEEKLY)	HOSES & NOZZLES (WEEKLY)	FIRE EXTING. MONTHLY	PUMPS & METERS (MONTHLY)	VALVES (MONTHLY)	BONDING & GROUNDING (MONTHLY)
1											
2											
3											
4											
5											
6											
7											
8											
9											
10											
11											
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*Each space must bear the appropriate remark and/or the initials of the inspector.

APPENDIX 2

MOBILE REFUELER
DAILY AND WEEKLY PREVENTIVE MAINTENANCE

Date ____ Make & Model ____ No. ____

Activity ____ Meter Readings ____

This check-off list shall be delivered to the Equipment Maintenance Office daily by person making inspection. Supervisor shall indicate what action has been taken to correct listed deficiencies.

Item No.	I DAILY OPERATIONS	OK	Adjust	Needs Repair
1	Fire Extinguishers (In place, filled, operable)			
2	Static Strap (In contact with ground)			
3	Static Grounding and Bonding Cables (In place and good condition)			
4	Fuel Marker Signs (In place)			
5	Fuel Color Check (Agrees with Fuel Marker Signs)			
6	Hose (Check entire length for cracks, cuts, breaks.)			
7	Hose Nozzles (Remove, inspect and clean strainer and comment on impurities found. Be sure nozzle spout cap is in place.)			
8	Refueler Truck Engine Exhaust Piping (Inspect for leaks and cracks.)			
9	Auxiliary Pumping Engine: (Oil level, leaks, battery water, etc.)			
10	Engine Shrouding (Secure and in place)			
11	Engine Exhaust Piping (Leaks and cracks)			
12	Muffler - Flame Arrestor (Leaks and noise)			
13	All Tank Drain sample and test for water; drain until free of water.)			
14	All Separators (Drain sample and test for water; drain until free of water.)			
15	Leaks (Tanks, piping, valves, pumps, etc.) Remarks:			
16	Emergency Valves (Check for proper operation of controls.)			
	II DURING PUMPING OPERATION			
17	Pumps (Leaks, noise, and overheating)			
18	Meters (Leaks and noise)			
19	Fuel Color Check			
20	Enter Pressure Drop On Refueler Daily Pressure Drop Log (Do not operate if more than 15 lbs.)			
21	Leaks (Tanks, piping, valves, pumps, etc.)			
	III AFTER FILLING REFUELER			
22	Water Check (Allow to settle for 15 min, and then check for water by operating tank water drains.)			
	IV WEEKLY SERVICES			
1	Separator Automatic Drain Valve (Shall not be restricted)			
2	Line Strainer Screens (Remove, inspect and replace.)			
3	General Inspection (Include all of daily operations plus operating checks of equipment.)			
	V GENERAL			
1	(List here any deficiencies not itemized above.)			

This is to certify that I have personally performed all of the above services and that I have completed and filled a work order for indicated repairs.

____
Signature

APPENDIX 3

MARKING OF AIRPORT EQUIPMENT FOR FUEL IDENTIFICATION

CHART 1

MARKING OF AIRPORT EQUIPMENT FOR FUEL IDENTIFICATION

RECOMMENDATIONS FOR AIRPORT INSTALLATIONS

AVIATION GASOLINE GRADES

PRODUCT	LOADING VALVE, JOINTS, VALVES & FITTINGS	PUMP-METER & PIPING FILTER-SEPARATOR	BANDING **	MARKING
AVGAS 115	PURPLE	ALUMINUM ★	1 - PURPLE	AVGAS 115 WHITE LETTERS ON RED
AVGAS 100	GREEN	ALUMINUM ★	1 - GREEN	AVGAS 100 WHITE LETTERS ON RED
AVGAS 100 LL	BLUE	ALUMINUM ★	1 - BLUE	AVGAS 100 LL WHITE LETTERS ON RED
AVGAS 80	RED	ALUMINUM ★	1 - RED	AVGAS 80 WHITE LETTERS ON RED

AVIATION TURBINE FUELS

PRODUCT	LOADING VALVE, JOINTS, VALVES & FITTINGS	PUMP-METER & PIPING FILTER-SEPARATOR	BANDING **	MARKING
JET A (KEROSINE – 40°F)	BLACK	ALUMINUM ★	1 - BLACK	JET A WHITE LETTERS ON BLACK
JET A-1 (KEROSINE –53°F)	GRAY	ALUMINUM ★	2 - BLACK	JET A-1 WHITE LETTERS ON BLACK
JET B (GASOLINE-KEROSINE)	YELLOW	ALUMINUM ★	3 - YELLOW	JET B WHITE LETTERS ON BLACK

★ White is equally suitable.

** If piping is fully painted the color shown under the heading "Loading Valve, Joints, Valves and Fittings", then no banding is necessary.

APPENDIX 4. SAMPLE PROCEDURE FOR PIPELINE DELIVERIES

1. PREPARATION FOR DELIVERY.

a. Change Differential Pressure recording chart.

b. Record Totalizer reading.

c. Turn on Microscan power.

d. Set valve as follows:

(1) Check mainline valve - open.

(2) Differential pressure valves:

(a) Open both line valves.

(b) Close equilizer valve.

(3) Open Microscan valves. (Note that power light is on; no-flow light is out.)

e. Check filter/separator for water.

f. Note and record incoming line pressure.

g. Open delivery valve on proper tank for receipt.

h. Stick tank that is to receive fuel.

i. Telephone Petroleum Company Pumping Station (PCPS).

j. Open Plugaroo valve at agreed opening time.

2. DURING DELIVERY.

a. Every 2 hours, on the odd hour, take a Millipore and record results.

b. Every 2 hours, on the odd hour, check the filter/separator sight glass for water. Drain if necessary.

c. Every 2 hours, on the even hour, telephone PCPS with "delivery" information.

3. TEN MINUTES PRIOR TO END OF DELIVERY. Call PCPS; determine shutdown time.

4. ON SHUTDOWN.

a. When PCPS advises you they have shutdown, close Plugaroo IMMEDIATELY.

b. Set valves as follows:

(1) Close Microscan valves.

(2) Differential pressure valves:

(a) Close both line valves.

(b) Open equilizer valve.

(3) Leave mainline valve open.

(4) Close delivery valve on tank.

c. Record Totalizer reading.

d. Cut off Microscan power.

e. Call PCPS with "shutdown" information.

f. Stick tank 1 hour after close of delivery.

APPENDIX 5. DEFINITIONS

Terms having a specific meaning for this advisory circular are listed below:

a. Aircraft Fuel Servicing Hydrant Vehicle (Hydrant Vehicle) means a vehicle equipped with facilities to transfer fuel between an aircraft fuel hydrant and an aircraft.

b. Aircraft Fuel Servicing Tank Vehicle (Fueler) means a tank vehicle (tank truck; tank, full trailer; tank, semitrailer) designed for and employed in the transportation and transfer of fuel into or from an aircraft.

c. Aircraft Servicing Ramp or Apron means an area or position at an airport used for the fuel servicing of aircraft.

d. Airport Fueling System means an arrangement of aviation fuel storage tanks, pumps, piping, and associated equipment, such as filters, water separators, hydrants, cabinets, and pits installed at an airport designed to service aircraft at fixed positions.

e. Baffle means a nonliquid-tight transverse partition in a cargo tank.

f. Bulkhead means a liquid-tight transverse closure between compartments of a cargo tank.

g. Carcass Saturation means the condition where fuel has permeated the reinforcing materials of a hose carcass.

h. Cargo Tank means a container having a liquid capacity in excess of 100 gallons, used for the carrying of aviation fuels, and mounted permanently or otherwise secured on a tank vehicle. The term "cargo tank" does not apply to any container used solely for the purpose of supplying fuel for the propulsion of the vehicle on which it is mounted.

i. Clear, bright, and dry test, sometimes referred to as clear and bright test, is the simplest test to determine if fuel is free of visible water or particulates. Results are acceptable if fuel, when viewed in glass container or clean white porcelain bucket, appears proper color, clear, sparkling (not murky or hazy), and free of visible water droplets.

j. Compartment means a liquid-tight division in a cargo tank.

k. Deadman Control means a device which requires a positive continuing action of an operator to allow the flow of fuel.

l. Flash Point. The temperature at which a liquid gives of sufficient vapors to form a flammable mixture of fuel and air near the surface which will flame momentarily when exposed to a source of ignition. The flash point is a distinctive characteristic of each discrete flammable or combustible liquid, or mixtures of them.

m. Fueler. (See Aircraft Fuel Servicing Tank Vehicle.)

n. Fueling, as used in this circular, includes all fuel transfer activities, such as fueling, defueling, and draining of aircraft fuel tanks.

o. Fuel Servicing includes fueling and defueling of aircraft fuel tanks but does not include aircraft fuel transfer operations and testing of aircraft fuel systems during aircraft maintenance or manufacturing operations.

p. Fuel Servicing Cabinet means an aboveground structure containing equipment connected to an airport fueling system to enable fuel to be dispensed into aircraft.

q. Fuel Servicing Pit means a pit containing all necessary hose, meters, and auxiliary equipment connected to an airport fueling system to enable fuel to be dispensed into aircraft.

r. Fuel Storage Facilities means tanks and associated facilities for the storage of aviation fuel at an airport. The fuel may be dispensed into aircraft through an airport fueling system or by loading into tank servicing vehicles and thence to aircraft.

NOTE: Primary (main) storage facilities are usually remote from the aircraft servicing ramp or apron. Operating (satellite) storage facilities, when provided, are of smaller capacity than the primary (main) storage facilities and are generally located as close as practical to aircraft servicing ramps or aprons.

s. Head means a liquid-tight transverse closure at the end of a cargo tank.

t. Hydrant means an outlet in an airport fueling system designed to permit the transfer of fuel to a hydrant vehicle or a tank vehicle after the matching fuel connection on the dispensing equipment is properly attached.

u. Overshoot means the quantity of fuel passing through the valve after the deadman control is released.

v. Pressure:

(1) Burst Pressure means the pressure at which any component will rupture.

(2) Design Pressure means that pressure for which a system or component is designed. Design pressure always equals or exceeds the service pressure. The design pressure is not exceeded except during burst or proof pressure test.

(3) Differential Pressure means the difference in pressure between the inlet side of the filter/separator and the discharge side of the filter/separator.

(4) Operating Pressure means the pressure existing in a system under flowing conditions or under static conditions against the pump's maximum no-flow head, excluding surge pressures.

(5) Service Pressure means the maximum pressure, excluding test pressure, to which a system or component may be subjected. It includes any surge pressures which may be developed in the system.

(6) Test Pressure means the pressure to which the system or a component of such system may be subjected to verify the integrity of the system or component. It is usually expressed as a percentage of the service pressure or design pressure.

w. Spark test means a visual check of all (including engine compartment) operating systems of a fueler in a totally dark area to determine if all systems function spark free.

x. Switch Fueling denotes the practice where fuels having a flash point of less than 100°F (37.8°C) are mixed with fuels having a flash point above 100°F (37.8°C) either by addition of the higher flash fuel to the lower flash fuel or vice versa. (For example, fueling with kerosene base fuels into an aircraft tank containing reduced flash point kerosene, or other jet fuel having a flash point of less than 100°F (37.8°C).

y. Tank Full Trailer means a vehicle that is not self-propelled and which has a cargo tank for the transportation of aviation fuel mounted thereon or built as an integral part thereof. It is so constructed that its weight and load rests on its own wheels.

z. Tank Vehicle means any tank truck, tank fuel trailer, or tractor and tank semitrailer combination.

aa. Transfer Pipelines is the piping used to transfer fuel in an airport fueling system.

bb. White bucket test is one variation of clean, bright and dry test. In it, a fuel sample is placed in a clean white procelain (plastic may contribute to static spark potential) bucket to determine visually if fuel is clean, bright, and dry. This test may include addition of several drops of red food coloring to make smaller water droplets visible. Normally, sample is swirled to help concentrate water and other contaminants in center.

cc. Volatility is the tendency of a liquid fuel to evaporate or change to a vapor.

APPENDIX 6. REFERENCE MATERIAL

1. Copies of current edition advisory circulars (AC):

a. AC 00-34, Aircraft Ground Handling and Servicing.

b. AC 20-20, Flammability of Jet Fuel.

c. AC 20-43, Aircraft Fuel Control.

d. AC 150/5210-5, Painting, Marking, and Lighting of Vehicles Used on an Airport.

2. Copies of the following publications may be purchased for a nominal price from the National Fire Protection Association (NFPA), Publication Sales Division, Batterymarch Park, Quincy, Massachusetts 02269.

a. NFPA Publication No. 10, Standards for Portable Fire Extinguishers.

b. NFPA Publication No. 30, Flammable and Combustible Liquid Code.

c. NFPA Publication No. 70, National Electrical Code.

d. NFPA Publication No. 77, Static Electricity.

e. NFPA Publication No. 385, Tank Vehicles for Flammable and Combustible Liquids.

f. NFPA Publication No. 407, Aircraft Fuel Servicing.

g. NFPA Publication No. 410, Standard on Aircraft Maintenance.

h. NFPA Publication No. 415, Aircraft Fueling Ramp Drainage.

3. Copies of the following publications may be purchased for a nominal price from the American Petroleum Institute (API), 2101 L Street, NW., Washington, D.C. 20037.

a. API Safe Practices in Bulk Plant Operations.

b. API Bulletin 1500, Storage and Handling of Aviation Fuels at Airports.

c. API Bulletin 1529, Aviation Fueling Hose.

d. API Bulletin 1542, Aviation Fuels Identification and Airport Equipment Marking and Color Coding, 3rd edition.

e. API Bulletin 1581, Specification and Procedures for Jet Fuel Filter/ Separators.

f. API Bulletin 1584, Four Inch Hydrant System Components and Arrangements.

g. API Bulletin 1800, Corrosion Control at Petroleum Storage/Dispensing Systems.

4. Copies of "Aircraft Fueling Up-to-Date," a nontechnical, easy reading, basic guide to fuel storage and safe aircraft fueling, may be obtained for a nominal charge from Flight Safety Foundation, Inc., 1800 N. Kent Street, Arlington, Virginia 22209.