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NFPA 407
Aircraft Fuel Servicing
1990 Edition

NFPA

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Policy Adopted by NFPA Board of Directors on December 3, 1982

The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years.

There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

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NFPA 407

Standard for

Aircraft Fuel Servicing

1990 Edition

This edition of NFPA 407, *Standard for Aircraft Fuel Servicing*, was prepared by the Technical Committee on Aircraft Fuel Servicing, released by the Correlating Committee on Aviation, and acted on by the National Fire Protection Association, Inc. at its Annual Meeting held May 21-24, 1990 in San Antonio, TX. It was issued by the Standards Council on July 20, 1990, with an effective date of August 17, 1990, and supersedes all previous editions.

The 1990 edition of this document has been approved by the American National Standards Institute.

Origin and Development of NFPA 407

Active work by the National Fire Protection Association leading toward the development of this standard started in 1951. Since that date, the responsible Technical Committee has made every effort to keep the text up-to-date, and progressive editions have been published almost every year from 1955 to 1975. The 21st edition was issued in 1980 and the Technical Committee completed a partial revision in 1984.

The 1990 edition is a complete rewrite which altered the format to divide the design and operational requirements into separate chapters. The requirements for grounding were deleted and requirements for bonding were clarified.

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates explanatory material on that paragraph in Appendix A.

Information on referenced publications can be found in Chapter 4 and Appendix B.

Chapter 1 Administration

1-1 Scope. This standard applies to the fuel servicing of all types of aircraft with liquid petroleum fuel. It does not apply to:

(a) in-flight fueling;

(b) fuel servicing of flying boats or amphibious aircraft on water; or

(c) draining or filling of aircraft fuel tanks incidental to aircraft fuel system maintenance operations or manufacturing.

1-2* Purpose.

1-2.1 The purpose of this standard is to establish reasonable minimum firesafety requirements for procedures, equipment, and installations for the protection of persons, aircraft, and other property during ground fuel servicing of aircraft with liquid petroleum fuels. These requirements are based upon sound engineering principles, test data, and field experience.

1-2.2 The fire hazard properties of aviation fuels vary, but for the purpose of this standard, the same firesafety precautions are specified for all types.

1-3 Definitions.

Aircraft. A vehicle designed for flight that is powered by liquid petroleum fuel.

Aircraft Fuel Servicing. The transfer of fuel into or from an aircraft.

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

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

Aircraft Fuel Servicing Tank Vehicle (Fueler). A vehicle having a cargo tank (tank truck, tank full trailer, tank semitrailer) designed for or used in the transportation and transfer of fuel into or from an aircraft.

Aircraft Fueling Vehicle. A fuel servicing hydrant vehicle or an aircraft fuel servicing tank vehicle.

Airport Fueling System. An arrangment of aviation fuel storage tanks, pumps, piping, and associated equipment, such as filters, water separators, hydrants and station, or aircraft fuel servicing vehicles, installed at an airport and designed to service aircraft at fixed positions.

Approved. Acceptable to the "authority having jurisdiction."

NOTE: The National Fire Protection Association does not approve, inspect or certify any installations, procedures, equipment, or materials nor does it approve or evaluate testing laboratories. In determining the acceptability of installations or procedures, equipment or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items.

Authority Having Jurisdiction. The "authority having jurisdiction" is the organization, office or individual responsible for "approving" equipment, an installation or a procedure.

NOTE: The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner since jurisdictions and "approval" agencies vary as do their responsibilities. Where public safety is primary, the "authority having jurisdiction" may be a federal, state, local or other regional department or individual such as a fire chief, fire marshal, chief of a fire prevention bureau, labor department, health department, building official, electrical inspector, or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the "authority having jurisdiction." In many circumstances the property owner or his designated agent assumes the role of the "authority having jurisdiction"; at government installations, the commanding officer or departmental official may be the "authority having jurisdiction."

Aviation Fuel*. Any petroleum fuel for use in aircraft engines.

Baffle. A non-liquidtight transverse partition in a cargo tank.

Bulkhead. A liquidtight transverse closure between compartments of a cargo tank.

Burst Pressure. See Pressure.

Cargo Tank. A container used for carrying aircraft 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.

Cathodic Protection. A method of controlling or impressing an electrical current to prevent corrosion of metal components of airport fueling systems that are in contact with the ground.

Compartment. A liquidtight division in a cargo tank.

Deadman Control. A device that requires a positive continuing action of a person to allow the flow of fuel.

Electric Hand Lamp. A portable lamp other than a flashlight.

Emergency Fuel Shutoff. A function performed to stop the flow of fuel in an emergency.

Fuel Servicing Station. A unit that includes all necessary equipment to enable the transfer of fuel into or from an aircraft or fueler. This unit can be installed in a cabinet above or below ground.

Fueler. See Aircraft Fuel Servicing Tank Vehicle.

Head. A liquidtight transverse closure at the end of a cargo tank.

Hydrant Valve. An outlet of an airport fueling system that includes a deadman controlled valve and adapter assembly to which a coupler on a hose or other flexible conduit on an aircraft fuel servicing vehicle can be connected.

Hydrant Vehicle. See Aircraft Fuel Servicing Hydrant Vehicle.

Labeled. Equipment or materials to which has been attached a label, symbol or other identifying mark of an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

Listed. Equipment or materials included in a list published by an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation, that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

NOTE: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which do not recognize equipment as listed unless it is also labeled. The "authority having jurisdiction" should utilize the system employed by the listing organization to identify a listed product.

Misfueling. The accidental fueling of an aircraft or refueling vehicle tank with an incorrect grade of product.

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

Pressure:

Burst Pressure. The pressure at which a component will rupture.

Test Pressure. The pressure to which the system or a component of such system may be subjected to verify the integrity of the system or component.

Working Pressure. The maximum allowable pressure, including momentary surge pressure, to which a system, hose, or other component may be safely subjected in service.

Shall. Indicates a manadatory requirement.

Should. Indicates a recommendation or that which is advised but not required.

Tank Full Trailer. A vehicle that is not self-propelled and that 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 rest on its own wheels.

Tank Semitrailer. A vehicle that is not self-propelled and that has a cargo tank for the transportation of aviation fuel mounted thereon or built as an integral part thereof. It is so constructed that when drawn by a tractor by means of a fifth wheel connection, some of its load and weight rests upon the towing vehicle.

Tank Truck. A self-propelled vehicle having a cargo tank for the transportation of aviation fuel.

Tank Vehicle. Any tank truck, tank full trailer, or tractor and tank semitrailer combination.

Test Pressure. See Pressure.

Working Pressure. See Pressure.

1-4 Units. When a value for a measurement as given in this standard is followed by an equivalent value in other units, the first stated shall be regarded as the requirement. A given equivalent value may be approximate.

Chapter 2 Design

2-1 General.

2-1.1 Fueling Hose Apparatus. Nozzle receptacles and hose storage apparatus shall be arranged to avoid kinks and short loops in hoses.

2-1.2 Electrostatic Hazards and Bonding.

2-1.2.1 A provision for bonding shall be incorporated in the design of fuel servicing vehicles and systems to prevent differences in electrostatic potential in accordance with 3-4.

2-1.2.2 Bonding cables shall be constructed of conductive, durable, and flexible material.

2-1.2.3 Bonding connections shall be electrically and mechanically firm. Jacks, plugs, clamps, and connecting points shall be clean, unpainted metal to provide a positive electrical connection.

2-1.2.4 API 1529 Type C or BS 3158 Type C (conductive) hose shall be used to prevent electrostatic discharges but shall not be used to accomplish required bonding. API 1529 Type A, BS 3158 Type A, and hose having a static wire in the hose wall shall not be used.

2-1.2.5* Provision for a 30-second relaxation period shall be incorporated in the design between the filter separator and the discharge outlet.

Exception: This requirement shall not apply to systems designed for fuels with static dissipator additives.

2-1.3 Entrances to fueling areas shall be posted with "NO SMOKING" signs.

2-1.4 Radar Equipment.

2-1.4.1 Aircraft Radar Equipment.

2-1.4.1.1 Surveillance radar equipment in aircraft shall not be operated within 300 ft (90 m) of any fueling, servicing, or other operation in which flammable liquids, vapors, or mist may be present.

2-1.4.1.2 Weather-mapping radar equipment in aircraft shall not be operated when the aircraft in which it is mounted is undergoing fuel servicing.

2-1.4.2* Ground Radar Equipment.

2-1.4.2.1 Antennas of airport flight traffic surveillance radar equipment shall be located so that the beam will not be directed toward any fuel storage or loading racks within 300 ft (90 m). Aircraft fuel servicing shall not be conducted within this 300-ft (90-m) distance.

2-1.4.2.2 Antennas of airport ground traffic surveillance radar equipment shall be located so that the beam will not be directed toward any fuel storage or loading racks within 100 ft (30 m). Aircraft fuel servicing or any other operations involving flammable liquids or vapors shall not be conducted within 100 ft (30 m) of such antennas.

2-1.5 Accessibility to aircraft by emergency fire equipment shall be considered in establishing aircraft fuel servicing positions.

2-1.6 Portable Fire Extinguishers.

2-1.6.1 Portable extinguishers shall be provided in accordance with 2-3.9 and 3-13.

2-1.6.2 Extinguishers shall conform to the requirements of NFPA 10, *Standard for Portable Fire Extinguishers*.

2-1.7* Deadman Controls.

2-1.7.1 The valve that controls the flow of fuel to an aircraft shall have a deadman control. The deadman control device shall be arranged to accomodate the operational requirements of 3-15. The fuel flow control valve shall be one of the following:

(a) The hydrant pit valve;

(b) At the tank outlet on a tank vehicle;

(c) A separate valve on the tank vehicle; or

(d) On the hose nozzle for overwing servicing.

2-1.7.2 Deadman controls shall be designed so as to preclude defeating their intended purpose.

2-1.8 The system shall be designed to minimize surge pressure. The overshoot shall not exceed 5 percent of actual flow rate from the time the deadman is released until the flow stops completely. The control valve shall be located and designed so that it will not be rendered inoperative by a surface accident, power failure, or spill. It shall be fail-safe by closing completely in the event of control power loss.

2-2* Aircraft Fueling Hose Requirements.

2-2.1 Performance Requirements. Hose shall comply with the requirements of API 1529 aviation fueling hose or BS 3158 (*Rubber Hoses and Hose Assemblies for Aircraft Ground Fueling and Defueling*). Couplings shall comply with the requirements of API 1529.

2-2.2 Additional Requirements.

2-2.2.1 Each coupled length of hose shall be tested at the same minimum proof pressure rating for that grade of hose as defined in API 1529.

2-2.2.2 A test certificate shall be provided for each coupled length of hose and shall contain the following:

(a) Manufacturer's name (hose)

(b) Manufacturer's name (couplings)

(c) Hose type

(d) Hose grade

(e) Size and length of hose

(f) Serial number or reference number of hose

(g) Quarter and year of manufacture of hose

(h) Model number of couplings

(i) Sizes of coupling ferrules

(j) Hydrostatic test pressures

(k) Coupled length serial number

(l) Identification of individual coupling the hose

(m) Name and address of company coupling the hose

(n) Date of certification

2-2.2.3 The coupling tests as specified in API 1529 shall be performed on each hose grade, type, and manufacturer.

2-2.2.4 Each coupling of a coupled length of hose shall be permanently marked with a serial number corresponding to its hydrostatic test certificate.

2-2.2.5 The hose at the end of each coupling ferrule shall be permanently marked prior to hydrostatic testing to serve as a reference to determine whether a coupling has slipped during testing or while in service.

2-2.2.6 Hydrostatic Testing. Required hydrostatic testing shall be done in accordance with ASTM D-380, *Standard Methods of Testing Rubber Hose.*

2-2.2.6.1 Following a hydrostatic test, all of the water shall be drained and the hose dried internally. The open ends, including the threads of the couplings, shall be suitably covered to protect the threads and to prevent contamination.

2-2.2.7 A hose that is recoupled for any reason shall be hydrostatically tested and recertified to the same criteria as a newly coupled hose.

2-3 Aircraft Fuel Servicing Vehicles.

2-3.1 Aircraft fuel servicing tank vehicles that are used on public highways shall also comply with NFPA 385, *Standard for Tank Vehicles for Flammable and Combustible Liquids.*

2-3.2 Materials.

2-3.2.1 In addition to any specific requirements in this chapter, only materials safe for use in the service intended and compatible with fuel applications shall be used in the construction of aircraft fuel servicing vehicles.

2-3.2.2 Magnesium shall not be used in the construction of any portion of an aircraft fuel servicing vehicle.

2-3.3 Vehicle Cargo Tanks. Every cargo tank shall be supported by and attached to, or be a part of, the tank vehicle upon which it is carried in accordance with NFPA 385, *Standard for Tank Vehicles for Flammable and Combustible Liquids.*

2-3.4 Static Protection.

2-3.4.1 All metallic components and vehicle chassis shall be electrically bonded to prevent a difference in electrostatic potential.

2-3.4.2 Provision shall be incorporated for the bonding of the tank to the fill pipe or the loading rack as specified in 3-20.2.1. Electrical continuity between the loading rack and fill pipe shall be accomplished as specified in 3-4.

2-3.4.3 Cables shall be provided on the vehicle to permit the bonding operations specified in 3-4.

2-3.4.4 A cable with a clip or plug shall be attached to each overwing nozzle to facilitate compliance with 3-4.2.

2-3.5 Containers and Systems for Flammable Liquids Other than Cargo Tanks.

2-3.5.1 Vehicle fuel tanks and containers for other flammable liquids shall be made of metal and shall be designed, constructed, and located in a manner that will preclude hazardous arrangements. Tanks shall be substantially protected by their location, and fill pipes shall not project beyond the vehicle profile. Tanks and containers shall vent away from sources of ignition during filling. Any arrangement not protected by location shall be listed for this use. The fuel tank arrangement shall allow for drainage without removing it from its mountings.

2-3.5.2 Gravity feed systems shall not be used.

2-3.5.3 All portions of the flammable liquids feed system shall be constructed and located to minimize the fire hazard. The lines shall be made of materials not adversely affected by the fluid or by other materials likely to be encountered; of adequate strength for the purpose; and secured to avoid chafing or undue vibration.

2-3.5.4 The engine air intake shall retain the manufacturer's configuration to prevent the emission of flame in case of backfiring.

2-3.5.5 When provided, the sediment bowl in the fuel supply line shall be of steel or material of equivalent fire resistance.

2-3.6 Engine Exhaust System.

2-3.6.1 The engine exhaust system shall be designed, located, and installed so as to minimize the hazard of fire in the event of:

(a) Leakage of fuel from the vehicle fuel tank or fuel system,

(b) Leakage from the fuel dispensing system of the vehicle,

(c) Spillage or overflow of fuel from the vehicle fuel tank or the cargo tank, or

(d) Spillage of fuel during the servicing of an aircraft.

2-3.6.2 Exhaust system components shall be secured and located clear of components carrying flammable liquids and separated from any combustible materials used in the construction of the vehicle.

2-3.6.3 Suitable shielding shall be provided to safely drain possible fuel spillage or leakage away from exhaust system components.

2-3.6.4 Exhaust gases shall not be discharged where they could ignite fuel vapors that may be released during normal operations or by accidental spillage or by leakage of fuel.

2-3.6.5 A muffler (or silencer) cutout shall not be provided.

2-3.7 Vehicle Lighting and Electrical Equipment.

2-3.7.1 Wiring shall be of adequate size to provide required current-carrying capacity and mechanical strength. It shall be installed so as to provide protection from physical damage and from contact with spilled fuel either by location or by being enclosed in metal conduit or other oil-resistant protective covering. All circuits shall have overcurrent protection. Junction boxes shall be weatherproofed.

2-3.7.2 Spark plugs and other exposed terminal connections shall be insulated to prevent sparking in the event of contact with conductive materials.

2-3.7.3* Motors, alternators, generators, and associated control equipment located outside of the engine compartment or vehicle cab shall be of a type listed for use in Class I, Division 1, Group D locations. (*See NFPA 70, National Electrical Code®.*)

2-3.7.4 Electrical equipment and wiring located within a closed compartment shall be of a type listed for use in Class I, Division 1, Group D locations. (*See NFPA 70, National Electrical Code.*)

2-3.7.5 Lamps and switching devices, other than those covered in 2-3.7.3 and 2-3.7.4, shall be of the enclosed, gasketed weatherproof type. Other electrical components shall be of a type listed for use in Class I, Division 2, Group D locations (*See NFPA 70, National Electrical Code.*)

2-3.7.6 Electrical service wiring between a tractor and trailer shall be designed for heavy duty service. The connector shall be of the positive engaging type. The trailer receptacle shall be securely mounted.

2-3.8 All cabinets housing vehicle auxiliary equipment shall have expanded metal, perforated metal grating type flooring, or open floor to facilitate air circulation within the enclosed space and to prevent accumulation of fuel.

2-3.9 Fire Extinguishers for Aircraft Fuel Servicing Vehicles.

2-3.9.1 Each aircraft fuel servicing tank vehicle shall have two listed extinguishers each having a rating of at least 20B, mounted one on each side of the vehicle.

2-3.9.2 Each hydrant fuel servicing vehicle shall have one listed extinguisher having a rating of at least 20B installed on it.

2-3.9.3 Extinguishers shall be readily accessible from the ground. The area of the paneling or tank adjacent to or immediately behind the extinguisher(s) on fueling vehicles shall be painted with a contrasting color.

2-3.9.4 Extinguishers shall be kept clear of ice, snow, etc. Extinguishers located in enclosed compartments shall be readily accessible and their location shall be clearly marked in letters at least 2 in. (50 mm) high.

2-3.10 Full Trailers and Semitrailers.

2-3.10.1 Trailer connections shall be designed to firmly secure the trailer and to prevent the towed vehicle from swerving from side to side at the speeds anticipated so that the trailer will track substantially in the path of the towing vehicle.

2-3.10.2 Full trailers and semitrailers shall be equipped with brakes on all wheels.

2-3.11 Smoking Restrictions.

2-3.11.1 A "No Smoking" sign shall be posted prominently in the cab of every aircraft fuel servicing vehicle.

2-3.11.2 Smoking equipment such as cigarette lighters and ash trays shall not be provided. If vehicle has such equipment when initially procured, it shall be removed or rendered inoperable.

2-3.12 Cargo Tanks.

2-3.12.1 Cargo Tanks shall be constructed in accordance with NFPA 385, *Standard for Tank Vehicles for Flammable and Combustible Liquids.*

2-3.12.2 Aluminum alloys for high strength welded construction shall be joined by an inert gas arc welding process using filler metals R-GR40A, E-GR40A (5154 alloy) and R-GM50A, E-GM50A (5356 alloy) as conforming to AWS A5.10.

2-3.12.3 Tank outlets shall be of substantial construction and shall be securely attached to the tank.

2-3.12.4 Baffles. Every cargo tank or compartment over 90 in. (2286 mm) long shall be provided with baffles, the number of which shall be such that the distance between any two adjacent baffles, or between any tank head or bulkhead and the baffle nearest it, shall in no case exceed 60 in. (1524 mm). The cross-sectional area of each baffle shall be not less than 80 percent of the cross-sectional area of the tank, and the thickness of such baffle shall be not less than that required for heads and bulkheads of the cargo tank in which installed.

2-3.12.5 Venting shall be in accordance with NFPA 385.

2-3.12.6 Cargo drawoff valves or faucets projecting beyond the frame of a tank vehicle shall be protected against damage.

2-3.13 Fill Openings and Top Flashings.

2-3.13.1 Dome covers shall be provided with a forward mounted hinge, self-latching catches, and fitted with watertight fuel resistant seals or gaskets (designed to prevent spillage or leakage from overturn and prevent water entry). Dome covers shall automatically close and latch with forward motion of the vehicle.

2-3.13.2 Drains from top flashing shall divert spilled fuel from possible sources of ignition, including the engine, the engine exhaust system, electrical equipment, or an auxiliary equipment enclosure.

2-3.13.3 The tank fill openings shall be protected against overturn damage by a rigid member(s) fixed to the tank and extending a minimum of 1 in. (25 mm) above any dome cover, handle, vent opening, or projection of the unit. Overturn protection shall be adequately braced to prevent collapse. The overturn protection shall be designed to channel rain water, snow, or fuel to the exterior of the cargo tank.

2-3.14 Piping, Joints, Flanged Connections, and Couplings.

2-3.14.1 Product piping shall be metal and rated for the system working pressure or at least 125 psi (860 kPa), whichever is greater.

2-3.14.2 Except as provided in 2-3.14.3, all joints shall be welded. Elbows and fittings shall be kept to a minimum and, where used, shall be of the preformed welding type.

2-3.14.3 Flanged connections or approved couplings shall be provided to avoid the need for cutting and welding when servicing or replacing components. Gaskets in flanged connections shall be of a material and design that will resist fire exposure for a time comparable to the flange and bolts.

2-3.14.4 Piping shall be adequately supported.

2-3.15 Outlet Valves and Emergency Shutoff Controls.

2-3.15.1 The outlets of each cargo tank or compartment, including water drawoffs, shall be equipped with shutoff valves located inside the shell, or in the sump when it is an integral part of the shell. The cargo tank outlet shall be designed so that the valve must be kept closed except during loading and unloading operations. The water drawoff connection shall be of a type that cannot be blocked open.

2-3.15.2 The operating mechanism for each tank outlet valve shall be adjacent to the fuel delivery system operating controls and shall be arranged so that the outlet valve(s) can be simultaneously and instantly closed in the event of a fire or other emergency. There shall be at least two emergency shutoff controls, one mounted on each side of the vehicle. These controls shall be quick-acting to close the tank outlet valve in case of emergency. They shall also be remote from the fill openings and discharge outlets and be operable from a ground-level standing position. In addition, all vehicles equipped with a top deck platform shall have an emergency shutoff control operable from the deck.

2-3.15.3 Emergency fuel shutoff controls shall be placarded "EMERGENCY FUEL SHUTOFF" in letters at least 2 in. (50 mm) high and of a color that contrasts with the background for visibility. Method of operation shall be indicated by an arrow or by the word "PUSH" or "PULL," as appropriate. The words "EMERGENCY FUEL SHUTOFF" shall not be used to identify any control or device on the vehicle other than these emergency fuel shutoff controls.

2-3.15.4 Each outlet valve shall be provided with a fusible device that will cause the valve to close automatically in case of fire.

2-3.15.5 A shear section shall be provided, between shutoff valve seats and discharge outlets, that will break under strain unless the discharge piping is so arranged as to afford the same protection and leave the shutoff valve seat intact.

2-3.15.6 Openings in cargo tank compartments that are connected to pipe or tubing shall be fitted with a spring loaded check valve, a self-closing valve, or similar device to prevent the accidental discharge of fuel in case of equipment malfunction or line breakage. Unless such valves are located inside the tank, they shall be equipped with a shear section as described in 2-3.15.5.

2-3.16 Fuel Dispensing System.

2-3.16.1 The valve that controls the flow of fuel from an aircraft fuel servicing vehicle to an aircraft shall have deadman control(s) in accordance with the requirements of 2-1.7.

2-3.16.2 The deadman flow control in the nozzle shall be permitted for overwing fueling. Notches or latches in the nozzle handle that could allow the valve to be locked open shall be prohibited. Each overwing servicing nozzle shall have a cable with a plug or clip for bonding to the aircraft. (*See 3-4.2.*)

2-3.16.3 Nozzles for underwing fueling shall be designed to be securely attached to the aircraft adapter before the nozzle can be opened. It shall not be possible to disengage the nozzle from the aircraft adapter until the nozzle is fully closed.

2-3.16.4 Fuel servicing pump mechanisms shall be designed and arranged so that failure or seizure will not cause rupture of the pump housing, a tank, or of any fuel-containing component. Fuel pressure shall be controlled within the stress limits of the hose and plumbing by means of either an inline pressure controller, a system pressure relief valve, or other suitable means. The working pressure of any system component shall equal or exceed any pressure to which it may be subjected.

2-3.16.5 On tank full trailer or tank semitrailer vehicles, the use of a pump in the tractor unit with flexible connections to the trailer shall be prohibited unless:

(a) Flexible connections are arranged above the liquid level of the tank in order to prevent gravity or siphon discharge in case of a break in the connection or piping, or,

(b) The cargo tank discharge valves required by 2-3.16.1 are arranged to be normally closed and to open only when the brakes are set and the pump is engaged.

2-3.16.6 Hose shall be connected to rigid piping or coupled to the hose reel in a manner that will prevent kinks or undue bending action or mechanical stress on the hose or hose couplings.

2-3.16.7 Aircraft fuel servicing vehicles shall have an integral system or device that will prevent the vehicle from being moved unless all fueling nozzles and hydrant couplers are properly stowed and mechanical lifts are lowered to their stowed position.

2-3.17 Tests.

2-3.17.1 Cargo tanks, at the time of manufacture, shall be tested by a minimum air or hydrostatic pressure of 5 psi (24.4 Kg/m^2) applied to the whole tank (or each compartment thereof if the tanks are compartmented). Such pressure shall be maintained for a period of at least 5 min. during which, if the test is by air pressure, the entire exterior surface of all joints shall be coated with a solution of soap and water, heavy oil, or other material that will cause foaming or bubbling which will indicate the presence of leaks. Hydrostatic pressure, if used, shall be gaged at the top of the tank. The tank shall be inspected at the joints for the issuance of liquid to indicate leaks. Any leakage discovered by either of the methods described, or by any other method, shall be deemed as evidence of failure to meet these requirements.

2-3-17.2 At the time of manufacture the section of the fuel dispensing system that is under pressure during service shall be subjected to a hydrostatic test pressure equal to 150 percent of the working pressure of the system for at least 30 min. and proven tight before it is placed in service. Hose connections may be plugged during this test.

2-3.18 Product Identification Signs. Each aircraft fuel servicing vehicle shall have a sign on each side and the rear to indicate the product. The sign shall have letters at least 3 in. (75 mm) high of a color sharply contrasting with its background for visibility. It shall show the word "FLAMMABLE" and the name of the product carried, such as "JET A," "JET B," "GASOLINE," or "AVGAS."

2-3.19 Loading.

2-3.19.1 No cargo tank or compartment shall be loaded liquid full. The ullage expansion space shall not be less than 1 percent of the volume of the tank compartment. Where local climatic conditions warrant, the ullage expansion space shall be increased to prevent leakage or overflow from expansion of the contents due to a rise in atmospheric temperature or direct exposure to the sun.

2-3.19.2 A heat-actuated shutoff valve shall be provided in the piping immediately upstream of the loading hose or swing arm connection.

2-3.20 Top Loading.

2-3.20.1 Drop tubes used in top loading or overhead loading of tank vehicles shall be designed to minimize turbulence. Drop tubes shall be metallic.

2-3.20.2 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 avoid splashing of the fuel.

2-3.20.3 Drop tubes attached to loading assemblies extending into the vehicle tank shall 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.

2-3.20.4 Loading arms shall be properly counterbalanced.

2-3.20.5 A deadman control shall be provided and located so that the operator can observe the liquid level in the tank as it fills.

2-3.21 Bottom Loading.

2-3.21.1 Loading hose shall conform to the requirements of 2-2. Swivel connections shall 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.

2-3.21.2 Swinging loading arms shall be properly counterbalanced. Swivel joints shall be used to allow free movement and to compensate for changes in the attitude of the vehicle during loading.

2-3.21.3 The connection between the tank truck and the arm or hose shall be a dry-break coupler that cannot be opened until it is engaged to the vehicle tank adapter. It shall not be possible to disconnect the hose coupler from the tank vehicle connection until the internal valves of the vehicle adapter and coupler are fully closed.

2-3.21.4* The bottom loading fitting of the tank vehicle shall be a spring-loaded check valve that will remain in a closed position until opened by connecting the coupler.

2-3.21.5 Aircraft fuel servicing vehicles shall incorporate an integral brake interlock system that will prevent the vehicle from being moved until the bottom loading coupler has been disconnected from the vehicle.

2-3.21.6 The supply piping terminating at the loading hose or swing arm shall be supported to carry the loads imposed.

2-3.21.7 Control of the filling of the vehicle cargo tank shall be by a deadman control so that a fueling operator can monitor the operation while activating the control. In addition, a float-actuated shutoff or other automatic sensing device shall be provided. Any liquid bled from a sensing device during loading shall be piped to the bottom of the cargo tank.

2-3.21.8 The fill pipe and valving on bottom-loaded tank vehicles shall be arranged to prevent fuel spraying and turbulence in the cargo tank.

2-3.22 Emergency Remote Control Stations.

2-3.22.1 Each tank vehicle loading station shall be provided with an emergency fuel shutoff system. This requirement is in addition to the deadman control required by 2-3.20.5 for top loading and by 2-3.21.7 for bottom loading. It shall 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. This system shall be of a failsafe design.

2-3.22.2 Each emergency fuel shutoff station location shall be placarded "EMERGENCY FUEL SHUTOFF" in letters at least 2 in. (50 mm) high. Method of operation shall be indicated by an arrow or by the word "PUSH" or "PULL," as appropriate. Any action required to gain access to the shutoff device (e.g., "BREAK GLASS") shall be clearly shown. Lettering shall be of a color sharply contrasting with its background for visibility. Placards shall be weather resistant, shall be located at least 7 ft (2.1 m) above grade, and shall be positioned so that they can be readily seen from a distance of at least 25 ft (7.6 m).

2-4 Airport Fuel Systems.

2-4.1 Work shall not be started on the construction or alteration of an airport fuel system until the design, plans, and specifications have been approved by the authority having jurisdiction.

2-4.2 The authority having jurisdiction shall inspect and approve the completed system before it is put into service.

2-4.3 General Requirements.

2-4.3.1 Each installation planned shall be designed and installed in conformity with the requirements of this standard and with any additional firesafety measures deemed necessary by the authority having jurisdiction.

2-4.3.2 The system and each of its components shall be designed for the working pressure of the system.

2-4.3.3 Emergency fuel shutoff system shall be designed and installed as an integral part of the airport fuel system. Operating controls for emergency fuel shutoff of the system shall be located to be readily and safely accessible in the event of an accident or spill.

2-4.3.4 In establishing each aircraft fuel dispensing location, consideration shall be given to the accessibility of the location in an emergency by fire fighting personnel and equipment.

2-4.4 Fuel Storage Tanks.

2-4.4.1* Fuel storage tanks shall conform to the applicable requirements of NFPA 30, *Flammable and Combustible Liquids Code*.

2-4.4.2 The authority having jurisdiction shall determine the clearances required from runways, taxiways, and other aircraft movement and servicing areas to any aboveground fuel storage structure or fuel transfer equipment with due recognition given to national and international standards establishing clearances from obstructions. Tanks located in designated aircraft movement areas or aircraft servicing areas shall be underground or mounded over with earth. Vents from such tanks shall be constructed in a manner to preclude collision hazards with operating aircraft. Aircraft operators shall be consulted as to the height and location of such vents to avoid venting flammable vapors in the vicinity of ignition sources, including operating aircraft and automotive equipment permitted in the area.

2-4.5 Emergency Fuel Shutoff Systems.

2-4.5.1 Each fuel system, as required by 2-4.3.3, shall have means for quickly and completely shutting off the flow of fuel in an emergency. This requirement is in addition to the requirement in 2-1.7 for deadman control of fuel flow.

2-4.5.2* The method of fuel transfer (gravity, pumping, or using hydraulic or inert gas pressure) shall be considered in the design of the emergency fuel shutoff system and the location of the emergency fuel shutoff valve.

2-4.5.3 The emergency fuel shutoff system shall include shutoff stations located outside of probable spill areas and near the route that would normally be used to leave the spill area or to reach the fire extinguishers provided for the protection of the area.

2-4.5.4* At least one emergency shutoff control station shall be conveniently accessible to each fueling position.

2-4.5.5 The emergency fuel shutoff system shall be designed so that operation of a station will shut off fuel flow to all hydrants that have a common exposure.

2-4.5.6 Emergency fuel shutoff systems shall be designed so that they will shut off the flow of fuel if the operating energy fails.

2-4.5.7 Each emergency fuel shutoff station shall be placarded "EMERGENCY FUEL SHUTOFF" in letters at least 2 in. (50 mm) high. Method of operation shall be indicated by an arrow or by the word "PUSH" or "PULL," as appropriate. Any action required to gain access to the shutoff device (e.g., "BREAK GLASS") shall be clearly shown. Lettering shall be of a color sharply contrasting with its background for visibility. Placards shall be weather resistant, shall be located at least 7 ft (2.1 m) above grade, and positioned so that they can be readily seen from a distance of at least 25 ft (7.6 m). Valves used to shut off a hydrant for maintenance purposes shall not have placards that could create confusion in an emergency.

2-4.6 Transfer Piping.

2-4.6.1 Underground piping shall be used in the vicinity of aircraft movement areas unless the piping is protected by a substantial barrier guard. Piping shall be protected by suitable sleeves or casings to protect the pipe from shock hazards where it crosses sewer manholes, service tunnels, catch basins, or other underground services. Piping shall be laid on firm supports using clean, noncorrosive backfill.

2-4.6.2 Transfer piping located within buildings not specifically designed for the purpose of fuel transfer shall be located within a steel casing of equal pressure rating of the carrier pipe. This casing shall extend beyond the building and terminate at a low point(s) with an automatic leak detection system. The casing shall be capable of being drained to a safe location.

2-4.6.3 Fuel piping that runs under a building or a passenger concourse shall be protected by a steel casing that encloses only the piping.

2-4.6.4 Piping, valves, and fittings shall be of metal, suitable for aviation fuel service, and designed for the working pressure and mechanically and thermally produced structural stresses to which they may be subjected and comply with ANSI B31.3, *Code for Pressure Piping, Petroleum Refinery Piping*. Deviations from ANSI B31.3 may be authorized by the authority having jurisdiction when engineering data can be presented to justify such deviations.

2-4.6.5 Cast iron, copper, and galvanized steel piping, valves, and fittings shall not be permitted. Ductile iron valves shall be permitted.

2-4.6.6 Aluminum piping, valves, and fittings shall be used only when specifically approved by the authority having jurisdiction.

2-4.6.7 In the selection of pipe, valves, and fittings, the following shall be given consideration:

(a) Working Pressure.

(b) Bending and mechanical strength requirements (including settlement).

(c) Internal and external corrosion.

(d) Impact stresses.

(e) Method of system fabrication and assembly.

(f) Location of piping and accessibility for repair or replacement.

(g) Exposure to mechanical, atmospheric, or fire damage.

(h) Expected period of service and effect of future operations.

2-4.6.8 Gaskets in flanged connections shall resist fire temperatures for a time period comparable to the temperature resistance of flange and bolts.

2-4.6.9 Allowances shall be made for thermal expansion and contraction by the use of pipe bends, welded elbows, or other flexible design. Pressure relief valves shall be provided in lines that may be isolated.

2-4.6.10 Welded joints shall be made by qualified welders in accordance with the standards of the American Welding Society and ANSI B31.3.

2-4.6.11* Isolation valves or devices shall be provided to facilitate dismantling portions of the fueling system. These valves shall be capable of being locked closed.

2-4.6.12 Buried flanges and valves shall not be permitted.

2-4.7 Fuel Flow Control.

2-4.7.1 Hydrant valves shall be designed so that the flow of fuel shall shut off when the hydrant coupler is closed. Hydrant valves shall be of the self-closing dry-break type.

2-4.7.2 The flow control valve shall be an integral part of the hydrant valve or coupler. The fuel control valve shall be arranged so that it shall not be rendered inoperative by a surface accident, spill, or malfuntion and shall shut off the flow of fuel if the operating energy fails. The fuel control system shall be designed to minimize overshoot. The system shall be designed to shut off fuel flow quickly and effectively even though there may be a reduction of pressure downstream of the flow control valve such as could result from a major line or hose break. A screen shall be provided ahead of the valve to trap foreign material that could interfere with complete closure of the valve. The hydrant valve that permits the flow of fuel to the aircraft shall have a deadman control. The use of any means that would permit fuel to flow without the operator activating this control shall be prohibited. The deadman control shall be arranged so that the fueling operator can observe the operation while activating the control.

2-4.7.3* The pressure of the fuel delivered to the aircraft shall be automatically controlled so that it is not higher than that specified by the manufacturer of the aircraft being serviced.

2-4.8 Filter Vessels. All sections of the filtering system shall have electrical continuity with adjoining piping and equipment. In freezing climates, filter separator sumps and associated piping that may contain water shall be protected to prevent freezing and bursting. Heaters shall be constructed of noncorrosive materials.

2-4.9 Electrical Requirements. All electrical equipment and wiring shall comply with the requirements of Article 515 of NFPA 70, *National Electrical Code*.

2-4.10 Fuel Servicing Hydrants, Pits, and Cabinets.

2-4.10.1 Piping, valves, meters, filters, air eliminators, connections, outlets, fittings, and other components shall be designed to meet the working pressure requirements of the system.

2-4.10.2 Fueling hydrants and fueling pits that are recessed below a ramp or apron surface and subject to vehicle or aircraft traffic shall be fitted with a cover designed to sustain the load of vehicles or aircraft that taxi over all or part of it.

2-4.10.3 Fueling hydrants, cabinets, and pits shall be located at least 50 ft (15.2 m) from any terminal building, hangar, service building, or enclosed passenger concourse (other than loading bridges).

2-4.11 Drainage.

2-4.11.1 Aircraft servicing ramps or aprons shall be sloped and drained in accordance with NFPA 415, *Standard on Aircraft Fueling Ramp Drainage*. The ramp or apron shall slope away from the rim or edge of fueling hydrants or fueling pits to prevent flooding.

2-4.11.2 Fueling hydrant boxes or fueling pits that are connected to a ramp drainage system shall be fitted with vapor sealing traps.

2-4.12* Systems provided with cathodic protection shall have appropriate signs, located at points of entry, warning against separation of units without prior de-energization or without proper jumpers across the sections to be disconnected. Isolation flanges shall be installed as required to separate components protected by a cathodic system from those required to be grounded for other electrical requirements.

2-4.13 After completion of the installation (including fill and paving) the airport fuel systems shall be subjected to a temperature-compensated hydrostatic test pressure equal to 150 percent of the system working pressure for at least 4 hrs and proven tight before it is placed into service.

2-5 Fueling at Rooftop Heliports.

2-5.1 Fueling on rooftop heliports shall be permitted only when approved by the authority having jurisdiction.

2-5.2 General Limitations.

2-5.2.1 In addition to the special requirements in this chapter, the heliport shall comply with the requirements of NFPA 418, *Standard on Roof-Top Heliport Construction and Protection.*

2-5.2.2 Facilities for dispensing fuel with a flash point below 100°F (37.8°C) shall not be permitted at any rooftop heliport.

2-5.3 Fueling Facilities.

2-5.3.1 In addition to the special requirements of this chapter, the fuel storage, piping, and dispensing system shall comply with the requirements of NFPA 30, *Flammable and Combustible Liquids Code*, and with applicable portions of this standard.

2-5.3.2 The entire system shall be designed so that no part of the system will be subjected to pressure above its working pressure.

2-5.3.3 The fuel storage system shall be located at or below ground level.

2-5.4 Pumps.

2-5.4.1 Pumps shall be located at or below ground level. Relay pumping shall be prohibited.

2-5.4.2 Pumps installed outside of buildings shall be located not less than 5 ft (1.5 m) from any building opening. They shall be substantially anchored and protected against physical damage from collision.

2-5.4.3 Pumps installed within a building shall be in a separate room with no opening into other portions of the building. The pump room shall be adequately ventilated. Electrical wiring and equipment shall conform to the requirements of Article 515 of NFPA 70, *National Electrical Code.*

2-5.5 Piping above grade shall be steel and, unless otherwise approved by the authority having jurisdiction, shall be suitably cased or shall be installed in a duct or chase. Such piping duct or chase shall be constructed so that a piping failure will not result in the entry of fuel liquid or vapor into the building. All pipe casings, ducts, and/or chases shall be drained. Piping shall be anchored and shall be protected against physical damage for a height of at least 8 ft (2.4 m) above the ground. An isolation valve shall be installed on the suction and discharge piping of each pump. In addition, a check valve shall be installed at the base of each fuel piping riser to automatically prevent the reverse flow of the fuel into the pump room in the event of pump seal failure, pipe failure, or other malfunction. (*See 2-4.6.*)

2-5.5.1 Piping within building shall comply with 2-4.6.2

2-5.5.2 Piping above grade exterior to buildings shall be of steel. Piping shall be located within a steel casing. The pressure rating of the pipe casing shall be equal to the carrier pipe. The casing shall be capable of being drained to a safe location. An automatic leak detection system shall be provided at the casing low point(s).

2-5.5.3 Piping shall be anchored and shall be protected against physical damage for a height of at least 8 ft (2.4 m) above the ground.

2-5.5.4 An isolation valve shall be installed on the suction and discharge piping of each pump. In addition, a check valve shall be installed at the base of each fuel piping riser to automatically prevent the reverse flow of fuel into the pump room in the event of a pump seal failure, pipe failure, or other malfunction.

2-5.6 Nozzles.

2-5.6.1 Overwing nozzles shall conform to 2-3.16.2.

2-5.6.2 Underwing nozzles shall conform to 2-3.16.3.

2-5.7 Hose shall comply with the requirements of 2-2.

2-5.8 Static Electricity. The provisions of 2-1.2 shall be followed, as appropriate, to guard against electrostatic hazards during helicopter fuel servicing operations.

2-5.9 Each fuel dispensing hose shall have a deadman controlled fuel shutoff conforming to requirements of 2-1.7.

2-5.10 Emergency Fuel Shutoff Stations.

2-5.10.1 A system to completely shut off the flow of fuel in an emergency shall be provided. The system shall shut off the fuel at the ground level. The emergency fuel shutoff controls shall be in addition to the normal operating controls for the pumps and deadman control.

2-5.10.2 At least two emergency fuel shutoff stations located on opposite sides of the heliport at exitways or at similar locations shall be provided. An additional emergency fuel shutoff station shall be at ground level near, but at least 10 ft (3 m) from, the pumps.

2-5.10.3 Each emergency fuel shutoff station location shall be placarded "EMERGENCY FUEL SHUTOFF" in letters at least 2 in. (50 m) high. Method of operation shall be indicated by an arrow or by the word "PUSH" or "PULL," as appropriate. Any action required to gain access to the shutoff device (e.g., "BREAK GLASS") shall be clearly shown. Lettering shall be of a color sharply contrasting with its background for visibility. Placards shall be weather resistant, shall be conspicuously located, and shall be positioned so that they can be readily seen from a distance of at least 25 ft (7.6 m).

2-5.11 Fire Protection. Fire protection shall conform to the requirements of NFPA 418, *Standard for Roof-top Heliports*.

2-5.12 Personnel Training. All heliport personnel shall be trained in the operation of emergency fuel shutoff controls and in the use of the available fire extinguishers.

Chapter 3 Operations

3-1 General.

3-1.1 Only authorized personnel trained in the safe operation of the equipment they use, in the operation of emergency controls, and in procedures to be followed in an emergency shall fuel or defuel aircraft.

3-1.2 When a valve or electrical device is used for isolation during maintenance or modification of the fuel system it shall be tagged/locked. The tag/lock shall not be removed until the operation is completed.

3-2* Prevention and Control of Spills.

3-2.1 Fuel servicing equipment shall comply with the requirements of this standard and be maintained in safe operating condition. Leaking or malfunctioning equipment shall be removed from service.

3-2.2 Fuel nozzles shall not be dragged along the ground.

3-2.3 Pumps, either hand or power-operated, shall be used when aircraft are fueled from drums. Pouring or gravity flow shall not be permitted from a container with a capacity of more than 5 gal (18.9 L).

3-2.4 When a spill is observed, the fuel servicing shall be stopped immediately by release of the deadman controls. In the event that a spill continues, the equipment emergency fuel shutoff shall be actuated. In the event that a spill continues from a hydrant system, the system emergency fuel shutoff shall be actuated. The supervisor shall be notified at once, and the operation shall not be continued until the spill has been cleared and it is determined to be safe.

3-2.5 The airport fire crew shall be notified if a spill is over 10 ft (3 m) in any dimension or over 50 sq ft (5 m^2) in area, continues to flow, or is otherwise a hazard to persons or property. This spill shall be investigated to determine the cause, whether emergency procedures were properly carried out, and what corrective measures are required.

3-2.6 Transferring fuel by pumping from one tank vehicle to another tank vehicle within 200 ft (61 m) of an aircraft shall be prohibited.

3-2.7 Not more than one tank vehicle shall be permitted to be connected to the same aircraft fueling manifold unless means are provided to prevent fuel from flowing back into a tank vehicle because of a difference in pumping pressure.

3-3 Emergency Fuel Shutoff.

3-3.1 Access to emergency fuel shutoff control stations shall be kept clear at all times.

3-3.2 A procedure shall be established to notify the fire department serving the airport in the event of a control station activation.

3-3.3 If the fuel flow stops for any reason, it shall first be presumed that an emergency fuel shutoff system has been actuated. The cause of the shutoff shall be corrected before fuel flow is reinstated.

3-3.4 Emergency fuel shutoff devices shall be operationally checked at least every 3 months.

3-3.5 Suitable records shall be kept of tests required by this section.

3-4* Bonding.

3-4.1 Prior to making any fueling connection to the aircraft, the fueling equipment shall be bonded to the aircraft by use of a cable, thus providing a conductive path to equalize potential between the fueling equipment and aircraft. The bond shall be maintained until fueling connections have been removed, thus permitting the reuniting of separated charges that could be generated during the fueling operation.

3-4.2 In addition to the above, when fueling overwing, the nozzle shall be bonded with a nozzle bond cable having a clip or plug to a metallic component of the aircraft that is metallically connected to the tank filler port. The bond connection shall be made before the filler cap is removed. If there is no plug receptacle or means for attaching a clip, the operator shall touch the filler cap with the nozzle spout before removing the cap so as to equalize the potential between the nozzle and the filler port. The spout shall be kept in contact with the filler neck until the fueling is completed.

3-4.3* When a funnel is used in aircraft fueling, it shall be kept in contact with the filler neck as well as the fueling nozzle spout or the supply container to avoid the possibility of a spark at the fill opening. Only metal funnels shall be used.

3-4.4 When a hydrant servicer or cart is used for fueling, the hydrant coupler shall be connected to the hydrant system prior to bonding the fuel equipment to the aircraft.

3-4.5 Bonding and fueling connections shall be disconnected in the reverse order of connection.

3-4.6 Conductive hose shall be used to prevent electrostatic discharge but shall not be used to accomplish required bonding.

3-5 Operation of Aircraft Engines and Heaters.

3-5.1 Fuel servicing shall not be done on an aircraft while an onboard engine is operating.

Exception: In an emergency resulting from the failure of an onboard auxiliary power unit on a jet aircraft and in the absence of suitable ground support equipment, a jet engine mounted at the rear of the aircraft or on the wing on the side opposite from the fueling point may be operated during fueling to provide power, provided that the operation follows written procedures approved by the authority having jurisdiction.

3-5.2 Combustion heaters on aircraft (e.g., wing and tail surface heaters, integral cabin heaters) shall not be operated during fueling operations.

3-6 Internal Combustion Engine Equipment Around Aircraft (Other than Aircraft Fuel Servicing Vehicles).

3-6.1 Equipment, other than those performing aircraft servicing functions, shall not be permitted within 50 ft (15 m) of aircraft during fuel servicing operations.

3-6.2 Equipment performing aircraft servicing functions shall not be positioned within a 10-ft (3-m) radius of aircraft fuel system vent openings.

3-6.3 During overwing aircraft fuel servicing where aircraft fuel system vents are located on the upper wing surface, equipment shall not be positioned under the trailing edge of the wing.

3-7* Electrical Equipment Used on Aircraft Servicing Ramps.

3-7.1 Battery chargers shall not be connected, operated, or disconnected while fuel servicing is being done on the aircraft.

3-7.2* Aircraft ground-power generators or other electrical groundpower supplies shall not be connected or disconnected while fuel servicing is being done on the aircraft.

3-7.3 Electric tools or similar tools likely to produce sparks or arcs shall not be used while fuel servicing is done on the aircraft.

3-7.4 Photographic equipment shall not be used within 10 ft (3 m) of fueling equipment or of the fill or vent points of aircraft fuel systems.

3-7.5 Battery-powered vehicle equipment shall not be operated within 10 ft (3 m) of fueling equipment or spills.

3-7.6 Communication equipment used during aircraft fuel servicing operations within 10 ft (3 m) of fueling equipment or of the fill or vent points of aircraft fuel systems shall be intrinsically safe (*see ANSI/UL 913-1988*).

3-8 Open Flames on Aircraft Fuel Servicing Ramps.

3-8.1 Entrances to fueling areas shall be posted with "NO SMOKING" signs.

3-8.2 Open flames on aircraft fuel servicing ramps or aprons within 50 ft (15 m) of any aircraft fuel servicing operation or fueling equipment shall be prohibited.

3-8.3 The category of open flames and lighted open-flame devices shall include but not be limited to the following:

(a) Lighted cigarettes, cigars, pipes.

(b) Exposed flame heaters, liquid, solid, or gaseous devices, including portable and wheeled gasoline or kerosene heaters.

(c) Heat-producing, welding or cutting devices, and blowtorches.

(d) Flare pots or other open-flame lights.

3-8.4 The authority having jurisdiction may establish other locations where open flames and open-flame devices shall be prohibited.

3-8.5 Personnel shall not carry lighters or matches on their person while engaged in fuel servicing operations.

3-8.6 Lighters or matches are prohibited on or in fueling equipment.

3-9* Lightning Precautions.

3-9.1 Fuel servicing operations shall be suspended when there are lightning flashes in the immediate vicinity of the airport.

3-9.2 A written procedure shall be established to set the criteria for which fueling operations shall be suspended at each airport as approved by the fueling agent and the airport authority.

3-10 Aircraft Fuel Servicing Locations.

3-10.1 Aircraft fuel servicing shall be done outdoors. Aircraft fuel servicing incidental to aircraft fuel system maintenance operations shall comply with the requirements of NFPA 410, *Standard on Aircraft Maintenance*.

3-10.2* Aircraft being fueled shall be positioned so that aircraft fuel system vents or fuel tank openings are not closer than 25 ft (8 m) from any terminal building, hangar, service building, or enclosed passenger concourse other than a loading walkway. Aircraft being fueled shall not be positioned so that the vent or tank openings are within 50 ft (15 m) of any combustion and ventilation air-intake to any boiler, heater, or incinerator room.

3-10.3 Accessibility to aircraft by emergency fire equipment shall be established for aircraft fuel servicing positions.

3-11 Aircraft Occupancy During Fuel Servicing Operations.

3-11.1 If passengers remain on board an aircraft during fuel servicing, at least one qualified person trained in emergency evacuation procedures shall be in the aircraft at or near a door at which there is a passenger loading walkway, integral stairs that are down, or a passenger loading stair or stand. A clear area for emergency evacuation of the aircraft shall be maintained at no less than one additional exit. Aircraft operators shall establish specific procedures covering emergency evacuation under such conditions for each type of aircraft they operate. All "NO SMOKING" signs shall be displayed in the cabin(s) and the rule enforced.

3-11.2 Operators shall determine for each aircraft type the areas through which it might be hazardous for boarding or deplaning passengers to pass while the aircraft is being fueled. Controls shall be established so that passengers avoid such areas.

3-12 Positioning of Aircraft Fuel Servicing Vehicles.

3-12.1 Aircraft fuel servicing vehicles shall be positioned so that a path of egress from the aircraft for fuel servicing vehicles shall be maintained.

3-12.2 The propulsion or pumping engine of aircraft fuel servicing vehicles shall not be positioned under the wing of the aircraft during overwing fueling or where aircraft fuel system vents are located on the upper wing surface. Aircraft fuel servicing vehicles shall not be positioned within a 10-ft (3-m) radius of aircraft fuel system vent openings.

3-12.3 Parking brakes shall be set on fuel servicing vehicles before operators leave the vehicle cab.

3-13* Portable Fire Extinguishers.

3-13.1 During fueling operations, fire extinguishers shall be available on aircraft servicing ramps or aprons.

3-13.2 Each aircraft fuel servicing tank vehicle shall have two listed fire extinguishers, each having a rating of 20B, one mounted on each side of the vehicle.

3-13.3 Each hydrant fuel servicing vehicle shall have one listed extinguisher having a rating of at least 20B installed on it.

3-13.4 Where open hose discharge capacity of the aircraft fueling system or equipment is more than 200 gal per minute (750 L/min), at least one listed wheeled extinguisher having a rating of not less than 80B and a minimum capacity of 125 lbs (55 kg) of agent shall be provided.

3-13.5* Extinguishers shall be kept clear of ice, snow, etc. Extinguishers located in enclosed compartments shall be readily accessible and their location shall be clearly marked in letters at least 2 in. (50 mm) high.

3-13.6* Fuel servicing personnel shall be trained in the use of the available fire extinguishing equipment they might be expected to use.

3-14 Defueling.

3-14.1 The transfer of fuel from an aircraft to a tank vehicle through a hose is generally similar to fueling and the same requirements shall apply. In addition, each operator shall establish procedures to prevent the overfilling of the tank vehicle, which is a special hazard when defueling.

3-14.2 When draining residual fuel from aircraft tanks incidental to aircraft fuel system maintenance, testing, manufacturing, salvage, or recovery operations, the procedures of NFPA 410 shall be followed.

3-15 Deadman Control Monitoring.

3-15.1 The fueling operator shall monitor the panel of the fueling equipment and the aircraft control panel during pressure fueling or shall monitor the fill port during overwing fueling.

3-15.2 Fuel flow shall be controlled by use of a deadman control device. The use of any means that would defeat the deadman shall be prohibited.

3-16* Aircraft Fueling Hose.

3-16.1 Aircraft fueling hose shall be inspected before each day of use. The hose shall be extended as it normally would be for fueling and checked for evidence of blistering, carcass saturation or separation, cuts, nicks, or abrasions that expose reinforcement material and for slippage, misalignment, or leaks at couplings. If coupling slippage or leaks are found, the cause of the problem shall be determined. Defective hose shall be removed from service.

3-16.2 At least once each month the hose shall be completely extended and inspected. Inspect as required in 3-16.1. The hose couplings and the hose shall be examined for about 12 in. (305 mm) adjacent to the couplings. Check for structural weakness by pressing the hose in this area around its entire circumference for soft spots. Hoses that show evidence of soft spots shall be removed from service. Examine the nozzle screens for rubber particles. Presence of such particles indicates possible deterioration of the interior, and the hose shall be removed from service. With the hose still completely extended, it shall be checked at the working pressure of the fueling equipment to which it is attached. Any abnormal twisting or ballooning during this test indicates a weakening of the hose carcass, and the hose shall be removed from service.

3-16.3 A hose assembly that has been subjected to abuse, such as severe end pull, flattening or crushing by a vehicle, sharp bending or kinking, shall be removed from service. It shall be hydrostatically tested prior to use. (*See 2-2.2.1.*)

3-16.4 If inspection shows that a portion of a hose has been damaged, the damaged portion shall be cut off and the undamaged portion recoupled. Two lengths of hose shall not be coupled together. Only couplings that are an exact match for the interior and exterior dimensions of the hose shall be used. Recoupled hose assemblies shall be hydrostatically tested. (*See 2-2.2.1.*)

3-16.5 Before any hose assembly, new or recoupled, is placed in service it shall be visually inspected for evidence of damage or deterioration.

3-16.6 Kinks or short loops in fueling hose shall be avoided.

3-16.7 Suitable records shall be kept of required inspections and hydrostatic tests.

3-17 Maintenance of Aircraft Fuel Servicing Vehicles.

3-17.1 Aircraft fuel servicing vehicles shall not be operated unless they are in proper repair and free of accumulations of grease, oil, or other combustibles.

3-17.2 Leaking vehicles shall be removed from service, defueled, and parked in a safe area until repaired.

3-17.3 Maintenance and servicing of aircraft fuel servicing vehicles shall be done outdoors or in a building approved for this purpose.

3-18 Parking Aircraft Fuel Servicing Tank Vehicles. Parking areas for unattended aircraft fuel servicing tank vehicles shall be arranged to:

(a) Facilitate dispersal of the vehicles in the event of an emergency

(b) Provide at least 10 ft (3 m) of clear space between parked vehicles for accessibility for fire control purposes

(c) Prevent any leakage from draining to an adjacent building or storm drain that is not suitably designed to handle fuel

(d) Provide at least 50 ft (15 m) from any parked aircraft and buildings other than maintenance facilities and garages for fuel servicing tank vehicles.

3-19 Parking Aircraft Fuel Servicing Hydrant Vehicles. Parking areas for unattended aircraft fuel servicing hydrant vehicles shall be arranged to:

(a) Facilitate dispersal of the vehicles in the event of an emergency

(b) Prevent any leakage from draining to an adjacent building or storm drain that is not suitably designed to handle fuel.

3-20 Loading of Aircraft Fuel Servicing Tank Vehicles.

3-20.1 General Requirements.

3-20.1.1 Filling of the vehicle cargo tank shall be under the observation and control of a qualified and authorized operator at all times.

3-20.1.2 Required deadman and automatic overfill controls shall be in normal operating condition during the filling operation. They shall not be blocked open or otherwise bypassed.

3-20.1.3 The engine of the tank vehicle shall be shut off before starting tank filling.

3-20.1.4 To prevent leakage or overflow from expansion of the contents due to a rise in atmospheric temperature or direct exposure to the sun, no cargo tank or compartment shall be loaded liquid full.

3-20.2 Top Loading.

3-20.2.1 When loading tank trucks through open domes, a bond shall be established between the loading piping and the cargo tank to equalize potentials. The bond connection shall be made before the dome is opened and removed only after the dome is closed.

3-20.2.2 Drop tubes attached to loading assemblies extending into the vehicle tank shall 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. Flow rate into the tanks shall not exceed 25 percent of the maximum flow until the outlet is well covered.

3-20.2.3 The level in the tank must be visually monitored at all times during top loading.

3-20.3 Bottom Loading.

3-20.3.1 A bonding connection shall be made between the cargo tank and the loading rack before any fuel connections are made and shall remain in place throughout the loading operation.

3-20.3.2 Fuel flow shall be initiated by the operator activating a deadman control device.

3-20.3.3 The operator shall perform the precheck on each compartment shortly after flow has started to ensure that the automatic high-level shutoff system is functioning properly.

Chapter 4 Referenced Publications

4-1 The following documents or portions thereof are referenced within this standard and shall be considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

4-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 10-1990, *Standard for Portable Fire Extinguishers*

NFPA 30-1990, *Flammable and Combustible Liquids Code*

NFPA 70-1990, *National Electrical Code*

NFPA 385-1990, *Standard for Tank Vehicles for Flammable and Combustible Liquids*

NFPA 410-1989, *Standard on Aircraft Maintenance*

NFPA 415-1987, *Standard on Aircraft Fueling Ramp Drainage*

NFPA 418-1990, *Standard on Roof-top Heliport Construction and Protection*

4-1.2 API Publication. American Petroleum Institute, 1220 L Street NW, Washington, DC 20005

API 1529, *1982 Aviation Fueling Hose*

4-1.3 ANSI Publication. American Standards Institute, 1430 Broadway New York, NY 10018.

ANSI B31.3, *Code for Pressure Piping, Chemical Plant and Petroleum Refinery Piping 1987*

ANSI/UL 913-1988, *Standard for Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III Division 1 Hazardous (Classified) Locations.*

4-1.4. ASTM Publication. American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM D-380, *Standard Test Method for Testing Rubber Hose, 1987*

4-1.5 AWS Publication. American Welding Society, Inc., 550 NW LeJeune Road, PO Box 351040, Miami, FL 33135

AWS-A5.10 1988, *Specification for Bare Aluminum and Aluminum Alloy Welding Electrodes and Rods*

4-1.6 BS Publication. British Standards Institution, 2 Park Street, London England W1A2BS

BS 3158, *Rubber Hoses and Hose Assemblies for Aircraft Ground Fueling and Defueling.*

Appendix A

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

A-1-2 Fire Hazards in Aircraft Fuel Servicing.

(a) Aircraft fuel servicing involves the transfer of a flammable or combustible liquid fuel between a bulk storage system and the fuel tanks of an aircraft. It includes both fueling and defueling. The transfer is usually accomplished by using a tank vehicle, a hydrant vehicle, a fuel servicing cabinet, or a fueling pit. Sometimes drums and pumps are used.

In any event, the movement of the fuel through the pumps, piping, and filters of the transfer system causes it to be charged electrostatically.

If the charge on the fuel is sufficiently high when it arrives at the fuel tank, a static spark could occur which may ignite the fuel vapor.

(b) In overwing fueling, the fuel is discharged through a hose with a hand-held nozzle into an opening in the aircraft fuel tank. The flow and splashing of fuel will cause the generation of static electricity and the production of flammable mists and vapors. Top loading of tank vehicles creates similar hazards.

(c) Underwing servicing, hydrant servicing, and bottom loading of tank vehicles use hoses or flexible connections of metal tubing or piping, and devices to permit temporary connection of fuel transfer lines. These methods minimize the charge generation and misting hazards associated with overwing fueling and toploading.

(d) Other potential sources of ignition that could present a hazard during aircraft fuel servicing include:

1. Operating aircraft engines, auxiliary power units, and heaters
2. Operating automotive or other internal combustion engine servicing equipment in the vicinity
3. Arcing of electrical circuits
4. Open flames
5. Energy from energized radar equipment
6. Lightning.

(e) The autoignition temperatures of turbine fuels (*see A-1-3*) are such that the residual heat of aircraft turbine engines after shutdown or the residual heat of turbine aircraft brakes following hard use can ignite such fuels if they are spilled or sprayed on these surfaces before they have cooled below the autoignition temperatures of the fuels.

(f) Aircraft fuel tank vents are usually located some distance above ground level. Under normal conditions, fuel vapors from the vents are quickly dissipated and diluted safely. Fuel spilling from the vents if a tank is overfilled is a much more serious hazard. Spills resulting from leaks or equipment failure are also a hazard.

(g) Fire prevention measures in aircraft fuel servicing are principally directed toward:

1. Prevention of fuel spillage.
2. Elimination or control of potential ignition sources.

A-1-3 Fire Hazard Properties of Aviation Fuels. The fire hazard properties of aviation fuels may be best described by analyzing: I — Susceptibility to or ease of ignition; II — Fire severity after ignition; and III — Fire control factors.

I. Susceptibility to or Ease of Ignition.

(a) Flash Point.

1. The flash point of standard grades of aviation gasoline has been established at approximately minus 50°F (−46°C) at sea level by the Tag closed-cup method. The flash point of JET B turbine fuel is not regulated by specification, but samples have been tested by the closed-cup

method and found to be as low as minus 10°F (−23°C) at sea level. JET A or kerosene grade turbine fuels have a minimum flash point of plus 100°F (+38°C).

2. Aviation gasoline and JET B turbine fuels give off large volumes of vapor and are capable of forming ignitible mixtures with air even at very low temperatures. Kerosene grades of turbine fuel (JET A) do not produce ignitible mixtures with air at normal temperatures and pressures, but when a JET A turbine fuel is heated above its flash point (or is in the form of a mist), the mixture can be ignited. This condition may develop where temperatures are 100°F (38°C) or higher.

(b) Flammability Conditions.

1. The lower limit represents the minimum concentration while the upper limit defines the maximum amount of fuel vapors in air that will permit combustion. The generally accepted flammability range by volume for most gasolines is 1.4 percent to 7.6 percent. The average figures for JET B turbine fuels are 1.16 percent to 7.63 percent. The average figures for kerosene grade (JET A) turbine fuels are 0.74 percent to 5.32 percent.

2. More significant than the strict flammability range is the temperature range during which it may be possible to have such flammable vapor-air mixtures. At sea level in a storage tank this temperature range for aviation gasoline would be from about minus 50°F to plus 30°F (−46°C to −1°C); for JET B turbine fuels, the range would be from about minus 10°F to plus 80°F (−23°C to 27°C); and for kerosene grade (JET A) turbine fuels from 100°F (+38°C) to 165°F (74°C). It can be seen that the JET B turbine fuels represent the most serious practical hazard under normal temperature conditions.

3. Air enters, as vented tanks are drained, and during such periods the flammable vapor conditions may change drastically. The same change occurs when the aircraft descends in altitude. These facts are important in assessing the degree of hazard that may exist in a tank containing any of these volatile products during or after such air mixing.

4. Under aircraft crash impact conditions where fuel mists are created following tank failures, all of the fuels are readily ignitible at essentially all ambient temperatures. Under these conditions, fuel in mist form presents a hazard equal to fuel in vapor form as far as reaching the flammability limits of the fuel is concerned.

(c) Vapor Pressure.

1. The vapor pressure of these fuels is the pressure of the vapor at any given temperature at which the vapor and liquid phases of the substance are in equilibrium in a closed container. Such pressures vary with the temperature but, most commonly, information on hydrocarbon mixtures is given by the Reid method where the pressures are measured at 100°F (38°C) (ASTM D323). The Reid vapor pressures of average grades of aviation gasoline range from 5.5 to 7.0 psi (38 to 48 kPa). For JET B turbine fuels, the Reid vapor pressure is between 2.0 and 3.0 psi (14 to 21 kPa). JET A (kerosene grade) turbine fuels are about 0.1 psi (0.7 kPa).

2. The practical significance of this characteristic of the three grades of fuel is that the standard grades of aviation gasoline do give off flammable vapors in ignitible amounts at normal temperatures and pressures, but when these vapors are confined the vapor air mixture over the liquid surface most frequently is too rich to be ignited by sparks (being above the upper flammability limit). With JET B turbine fuel, due to its relatively low vapor pressure, the vapor air mixture above the liquid surface under normal temperature and pressure conditions frequently will be within the flammability range. This means that ignition of JET B turbine fuel vapors either within or exterior to a tank may cause violent combustion within the confined space if flame enters. The JET A (kerosene grade) turbine fuels do not give off flammable vapors in ignitible amounts unless the fuel temperature is above 100°F (38°C).

(d) Autoignition Temperature.

1. The autoignition temperature is the minimum temperature of a substance required to initiate or cause self-sustained combustion independently of any sparks or other means of ignition.

2. Under one set of test conditions standard grades of aviation gasoline have ignition temperatures approximating 840°F (449°C). Turbine fuels have ignition temperatures among the lowest found for hydrocarbons and considerably lower than those for aviation gasoline. For instance, the autoignition temperature of a JET B turbine fuel was measured using the same test procedure at approximately 480°F (249°C). A JET A (kerosene grade) turbine fuel under the same test method was found to have an autoignition temperature approximating 475°F (246°C). Temperatures in this range may exist for a considerable period in turbine engines after shutdown or on brake surfaces following hard use.

3. It should be remembered that these figures are derived from reproducible laboratory test procedures, whereas in actual field conditions, these ignition temperatures may be higher.

(e) Distillation Range.

1. The initial and the end boiling points of standard grades of aviation gasoline are approximately 110°F and 325°F (43°C and 163°C). The initial boiling point of JET B turbine fuels is about 135°F (57°C) and the end point is 485°F (252°C). The only marked difference in the distillation ranges of the three fuels under consideration concerns the JET A or kerosene grades of turbine fuel that have initial boiling points of about 325°F (163°C) and end points of about 572°F (300°C).*

2. The boiling range, along with the flash points and vapor pressures of the fuels, indicates the relative volatility of the fuels; the initial and end boiling points show the overall volatility of a fuel through its entire distillation range; the flash point and vapor pressures measure the initial tendency of the fuel to vaporize.

II. Fire Severity After Ignition.

(a) Heat of Combustion.

1. The net heat of combustion of gasoline is normally quoted as about 19,000 Btu/lb (44.19 KJ/kg). For JET B turbine fuels the average is roughly 18,700 Btu/lb (43.50 KJ/kg), while for the JET A (kerosene grades) of turbine fuels it is approximately 18,600 Btu/lb (43.26 KJ/kg).

* Initial and end boiling points as determined by ASTM Method D86-82 (1972).

2. From these figures it can be readily seen that there is little difference in the heats of combustion of these various hydrocarbons that would be of significance from the firesafety point of view.

(b) Rate of Flame Spread.

1. When fuel is spilled there is a marked difference in the rates of flame spread over pools of JET A or kerosene grades of turbine fuel as compared with the other two types. Under these conditions a direct relationship exists between the rate of flame spread and the vapor pressures of the materials. A report dated October 1973 entitled "An Evaluation of the Relative Fire Hazards of JET A and JET B for Commercial Flight" (N74-10709), states: "the rate (of flame spread) for JP-4 (JET B) is about 30 times greater than for aviation kerosene (JET A) at the temperatures most often encountered." This is an important factor in evaluating the severity of the fire hazard encountered under these conditions and is also a factor that would affect the ease of fire control under similar conditions.

This slower rate of flame propagation for JET A or kerosene grades of turbine fuel does not hold, however, where the fuel is released as a fuel mist as is frequently the result of aircraft impact accidents, or where the fuels are heated to or above their flash point. If a flammable or combustible liquid is in mist form or is at a temperature above its flash point, the speed of flame spread in the "mist" or vapor will be essentially the same regardless of the liquid spilled.

III. Fire Control Factors.

(a) Relative Density.

1. The relative density of a material is commonly expressed as related to water at 60°F (16°C). All these fuels are lighter than water; the relative density of aviation gasolines is normally quoted at about 0.70, JET B turbine fuels at about 0.78, and the JET A (kerosene grade) fuels at about 0.81.

2. This means, as far as fire control is concerned, that all of the fuels will float on water. This may be a handicap during fire fighting operations under certain conditions where sizable quantities of spilled fuel may be involved.

(b) Solubility in Water.

1. All three of the fuels are essentially nonsoluble in water. Fires involving all three fuels can be handled with regular foam concentrates (as opposed to alcohol types).

2. The amount of water that may be entrained in the fuel due to water contamination is not particularly significant from a fire hazard viewpoint except that the amount of water increases the static generation hazard of the fuel.

Standard Grades of Aviation Fuels. Standard grades of aviation fuels include:

(a) Aviation gasoline (AVGAS) means all gasoline grades of fuel for reciprocating engine-powered aircraft of any octane rating. It has the general fire hazard characteristics of ordinary automotive gasoline. (MOGAS)

(b) JET A and JET A-1 are kerosene grades of fuel for turbine engine-powered aircraft, whatever the trade name or designation. JET A has a minus 40°F (−58°C) freezing point (maximum); JET A-1 incorporates special low temperature characteristics for certain operations having a minus 53°F (−47°C) freezing point (maximum). JP-8 (identical with JET A except for the additive package) and JP-5 (slightly less volatile than either JET A or JET A-1) are used by certain U.S. military forces. Jet A and JP-8 are known in the United Kingdom and in many former UK areas of influence as AVTUR, whereas JP-5 is similar to the UK designated AVCAT.

(c) JET B is a blend of gasoline and kerosene grades of fuel for turbine engine-powered aircraft, whatever the trade name or designation. JET B is a relatively wide boiling range volatile distillate having a −60°F (−51°C) freezing point (maximum). JP-4 is one grade of JET B fuel as used by the U.S. military forces; JP-4 has identical specifications with JET B as they relate to fire hazards. This fuel is known in the United Kingdom as AVTAG.

A-2-1.2.5 The charge on the fuel can be reduced by the use of a static dissipator additive that will increase the electrical conductivity of the fuel and thereby permit the charge to relax or dissipate more quickly, or by the use of a relaxation chamber that increases the residence time of the fuel downstream of the filter to at least 30 seconds, thereby permitting most of the charge to dissipate before the fuel arrives at the receiving tank.

API Bulletin RP 2003 recommends a 30-second relaxation time for loading tank trucks and refuelers. However, it has not been a common practice to require a similar relaxation time for aircraft refueling, primarily because of the relatively few electrostatic incidents that have occurred during aircraft fueling.

In filling tank trucks or storage tanks, API Bulletin RP 2003 recommends that at least 30 seconds of residence time be provided downstream of a filter in order to allow static charges generated in flowing fuel to relax before fuel enters the tank.

The reason it is possible to fuel aircraft safely with low conductivity fuel without providing 30 seconds relaxation time is primarily due to the different geometry of aircraft tanks compared with tank truck compartments. Flow into the aircraft is normally subdivided into several tanks simultaneously and also distributed into adjoining compartments of each tank by a multihole inlet. Bachman and Dukek[1] conducted full-scale research using a simulated large aircraft tank and concluded that none of the tanks or compartments hold sufficient fuel to allow enough charges to accumulate and create large surface voltages. Slower fill rates per compartment also allow more charge to relax.

Additionally, the inlet system of most aircraft tanks directs fuel towards the bottom of the tank to avoid splashing that would generate more charge. Finally, while the hoses that connect the fueler to the aircraft provide only a few seconds of residence time for charge relaxation at high rates of flow, the actual relaxation volume in the system is significantly greater when a coated screen is used as a second stage water barrier. In this case, the vessel's volume

[1] Bachman, K.C. and Dukek, W. G. (1972) Static Electricity in Fueling Superjets. Exxon Research & Eng. Co. Brochure, Linden, NJ.

after the first stage filter coalescer may represent an additional 15 seconds of residence time for charge relaxation. (The coated screen, unlike other water barriers, does not generate charge.)

A flammable vapor space in the tank due to the presence of Jet B or JP-4 fuels still constitutes a potential hazard and to minimize the chance for static ignition, FAA regulations require that fueling be conducted at half of rated flow when civil aircraft have used such fuels.

A-2-1.4.2 Radar Ignition Hazards.

(a) The beam of radar equipment has been known to cause ignition of flammable vapor-air mixtures from inductive electric heating of solid materials or from electrical arcs or sparks from chance resonant conditions. The ability of an arc to ignite flammable vapor-air mixtures depends on the total energy of the arc and the time lapse involved in the arc's duration, which is related to the dissipation characteristics of the energy involved. The intensity or peak power output of the radar unit is thus a key factor in establishing safe distances between the radar antenna and fueling operations, fuel storage or fuel loading rack areas, fuel tank truck operations, or any operations wherein flammable liquids and vapors may be present or created.

(b) Most commercially available weather mapping airborne radar equipment operates at peak power outputs, varying from 25 kilowatts to 90 kilowatts. Normally this equipment should not be operated on the ground. Tests have shown that the beam of this equipment may induce energy capable of firing flash bulbs at considerable distances. If the equipment is operated on the ground for service checking or for any other reason, the beam should not be directed toward any of the hazards described in A-2-1.4.2(a) that are located within 100 ft (30 m). (WARNING: Higher power radar equipment may require greater distances.)

(c) Airport surface detection radar operates under a peak power output of 50 kilowatts. It is fixed equipment rather than airborne.

(d) Airborne surveillance radar of the type currently carried on military aircraft has a high peak power output. Aircraft carrying this type of radar can be readily distinguished by radomes atop or below the fuselage, or both.

(e) Aircraft warning radar installations are the most powerful. Most of these installations are, however, remotely located from the hazards indicated in A-2-1.4.2(a) and are thus not covered herein. Ground radar for approach control or traffic pattern surveillance is considered the most fire hazardous type of radar normally operating at an airport. The latter equipment has a peak power output of 5 megawatts. Where possible, new installations of this type of equipment should be located at least 500 ft (150 m) from any of the hazards described in A-2-1.4.2(a).

A-2-1.7 Deadman Controls. Deadman controls should be designed so that the operator can comfortably use them while wearing gloves and hold them for the time required to complete the operation. A pistol grip deadman device that is squeezed to operate is better than a small button that must be held by a thumb or finger.

A-2-2 Aircraft Fueling Hose. The section on aircraft refueling hose has been altered extensively by referencing API Bulletin 1529. NFPA 407 formerly contained many requirements for hose, but it was intended only to address features that might be related to a fire or the results of a fire. It was not until 1982 that a comprehensive aircraft refueling hose specification was published by API. Prior to that time, NFPA 407 was the only document in existence.

API 1529 deals with all aspects of hose safety, including the couplings that are acceptable. As of 1989, there is an extensive revision of API 1529 being finalized, and it will incorporate many refinements adopted from the British standard BS3158.

NFPA 407 recognizes the need for an extensive document such as API 1529 and requires hoses that meet that standard. However, it must be recognized that API does no testing and it does not police those manufacturers who claim to sell hose that meets API 1529. The hose user and the cognizant authority in charge may find it prudent to require hose manufacturers to produce copies of test reports or documents that certify that hoses having the identical construction and compounds have been tested and satisfactorily passed all requirements of API 1529.

A-2-3.7.3 Electrical Equipment in Aircraft Fuel Servicing Vehicle Engine Compartments. Equipment contained in the engine compartment or vehicle cab and located 18 in. (457 mm) or more aboveground may be of the general purpose type.

A-2-3.21.4 Optional Precautions Against Misfueling of Aircraft Fuel Servicing Tank Vehicles. The coupler and truck fitting should be equipped with coded lugs or a mechanical device to ensure product selection and to prevent mixing of products. This may not be feasible on over-the-road type tank vehicles.

A-2-4.4.1 Optional Guidance on Fuel Storage Tankage. Where pressure tanks are used, details on construction, spacing, and location should be in accordance with industry good practice and approved by the authority having jurisdiction. When AVGAS, MOGAS, or JET B turbine fuels are stored in bulk quantities in aboveground tanks, they should be stored in floating roof type tanks. Covered floating roof tanks minimize the hazardous flammable vapor-air space above the liquid level. The vapor spaces of underground tanks storing fuels should not be interconnected.

A-2-4.5.2 Discussion of Fuel Transfer Methods. Fuel transfer by pumping is the more common procedure and is normally preferred from a fire protection standpoint because it permits rapid shutdown of fuel flow through pump shutdown. Gravity transfer is the simplest method but is normally limited to relatively low flow rates. Because the static head does exert some pressure in the system, a safety shutdown should include a valve or valves located as close to the tank as practicable.

A-2-4.5.4 Alarms for Emergency Shutoff System. The operation of the emergency shutoff control should sound an alarm at the airport fire crew station and at the fuel storage facility.

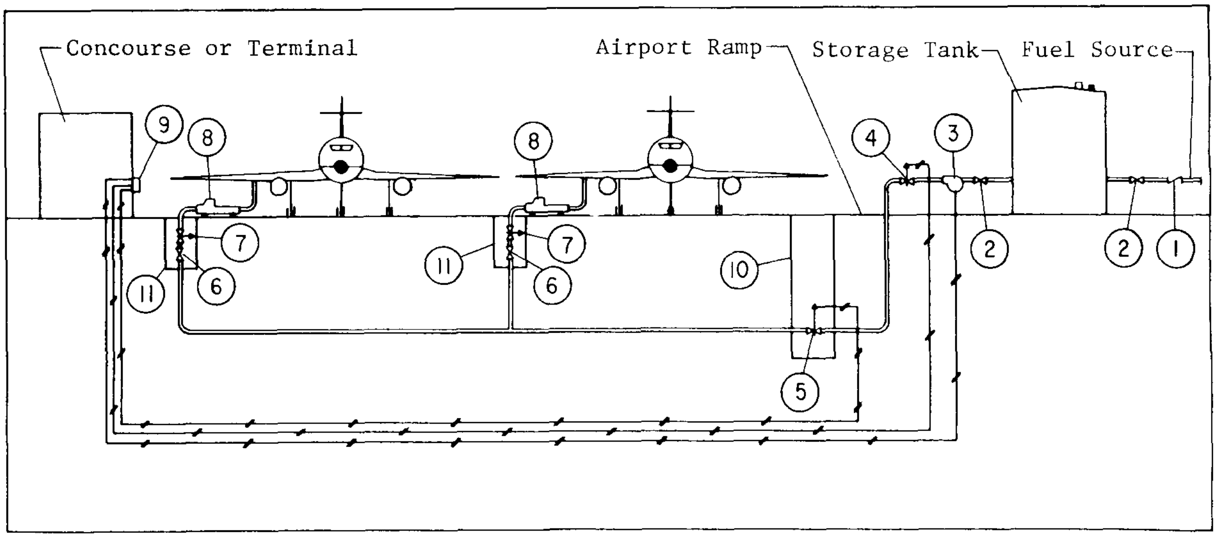

Figure A-2-4.6.11 Typical Fixed Airport Fueling System Isolation Valving, Operating and Emergency Controls

NOTE: No dimensional relationship exists between elements in this figure. Refer to this Code, NFPA 30, NFPA 70, and FAA Regulations for separations and clearances.

1. Check valve at tank inlet
2. Isolation valve at tank inlet/outlet
3. Pumping system
4. Pump discharge control valve or hydrant system shut-off valve (Alternate Location)
5. Hydrant system shut-off valve (Alternate Location)
6. Hydrant shut-off valve
7. Hydrant pit valve
8. Hydrant fueling servicing vehicle
9. Emergency fuel shut-off station
10. Valve box
11. Hydrant pit

A-2-4.6.11 System Component Isolation Guidance. Flanged connections should be provided for ease of dismantling and to avoid cutting and welding after the system has been placed in service. The location of these isolation devices will depend upon the size and character of each system, but the following locations will generally apply:

(a) At each storage tank

(b) At each pump

(c) At each filter separator

(d) At each hydrant or on each hydrant lateral

(e) At each flow regulator or pressure control valve.

A-2-4.7.3 Location of Surge Suppressors. Where surge suppressors are necessary they should be located so that exposure to vehicular traffic, weather conditions, and the result of accidental rupture is minimized.

A-2-4.12 Cathodic protection is recommended for metal components of airport fueling systems and fuel storage facilities that are in contact with the ground. There are two types of cathodic protection:

1. The Galvanic Anode method, which generates its own current.

2. The Impressed Current method which has an external current source.

A-3-2 Handling Fuel Spills. The following actions may be appropriate in the event of a fuel spill although each spill will have to be treated as an individual case because of such variables as the size of the spill, type of flammable or combustible liquid involved, wind and weather conditions, equipment arrangement, aircraft occupancy, emergency equipment and personnel available, etc.

(a) Stop the flow of fuel if possible. If the fuel is discovered leaking or spilling from fuel servicing equipment or hoses, operate the emergency fuel shutoff at once. If the fuel is discovered leaking or spilling from the aircraft at the filler opening, vent line, or tank seams during fueling operations, stop fueling immediately. Evacuation of the aircraft should be ordered when necessary. The aircraft must then be thoroughly checked for damage or entrance of flammable liquid or vapors into any concealed wing or fuselage area and corrective action taken as necessary before being placed in normal operational service.

(b) Notify the airport fire crew if the spill presents a fire hazard. The only normal exceptions are for small spills. Supervisory personnel should be notified to assure that operations in progess may either be continued safely or halted until the emergency is past and that corrective measures can be taken to prevent recurrence of a similar accident.

(c) It may be necessary to evacuate the aircraft if the spill is such as to pose a serious fire exposure to the aircraft or its occupants. Do not permit anyone to walk through the liquid area of the fuel spill. If any person has been sprayed with fuel or had his clothing soaked with fuel, he should go to a place of refuge, remove his clothing, and wash his body. Individuals whose clothing has been ignited should be wrapped in blankets, coats, or other items or be told or forced to roll on the ground.

(d) Mobile fueling equipment and all other mobile equipment should be withdrawn from the area or left as is until the spilled fuel is removed or made safe. No fixed rule can be made as firesafety will vary with circumstances. Shutting down equipment or moving vehicles may provide a source of ignition if no fire immediately results from the spillage.

(e) Aircraft, automotive, or spark-producing equipment in the area should not be started before the spilled fuel is removed or made safe. If a vehicle engine is running at the time of the spill, it is normally good practice to drive the vehicle away from the hazard area unless the hazard to personnel is judged too severe. Fuel servicing vehicles in operation at the time of the spill should not be moved until a check is made that any fuel hose that may have been in use or connected between the vehicle and the aircraft is safely stowed.

(f) If any aircraft engine is operating at the time of the spill, it is normally good practice to move the aircraft away from the hazard area unless air currents set up by operating power plants would aggravate the extent or the nature of the vapor hazard existing.

(g) If circumstances dictate that operating internal combustion engine equipment within a spill area that has not ignited should be shut down, engine speeds should be reduced to idle prior to cutting ignition in order to prevent backfire.

(h) The volatility of the fuel may be a major factor in the initial severity of the hazard created by a spill. Gasoline and other low flash point fuels at normal temperatures and pressures will give off vapors that are capable of forming ignitible mixtures with the air near the surface of the liquid, whereas this condition does not normally exist with kerosene fuels (JET A or JET A-1) except where ambient temperatures are 100°F (38°C) or above, or the liquid has been heated to a similar temperature.

(i) Spills of gasoline and low flash point turbine fuels (JET B) greater than 10 ft (3 m) in any dimension and covering an area of over 50 square ft (5 m^2) or that are of a continuing nature should be blanketed or covered with foam. The nature of the ground surface and the exposure conditions existing will dictate the exact method to be followed. Such fuels should not be washed down sewers or drains. The decision to use a sewer or drain should be restricted to the chief of the airport fire brigade or the fire department. If fuels do enter sewers, either intentionally or unintentionally, large volumes of water should be introduced to flush such sewers or drains as quickly as possible to dilute, to the maximum possible extent, the flammable liquid content of the sewer or drain. Normal operations involving ignition sources (including aircraft and vehicle operations) should be prohibited on surface areas adjacent to open drains or manholes from which flammable vapors may issue due to the introduction of liquids into the sewer system until it can be established that no flammable vapor air mixture is present in the proximity.

NOTE: See NFPA 415, *Standard on Aircraft Fueling Ramp Drainage*, for further information on aircraft fueling ramp drainage designs to control the flow of fuel that may be spilled on a ramp and to minimize the resulting possible danger.

(j) Spills of kerosene grades of aviation fuels (JET A or JET A-1) greater than 10 ft (3 m) in any dimension and covering an area of over 50 square ft (5 m^2) or that are of a continuing nature and that have not ignited may be blanketed or covered with foam if there is danger of ignition. If there is no danger of ignition, an absorbent compound or an emulsion type cleaner may be used to clean the area. Kerosene does not evaporate readily at normal temperatures and must be cleaned up. Smaller spills may be cleaned up using an approved, mineral-type, oil absorbent.

(k) Aircraft on which fuel has been spilled should be thoroughly inspected to assure that no fuel or fuel vapors have accumulated in flap well areas or internal wing sections not designed for fuel tankage. Any cargo, baggage, express, mail sacks, or similar items that have been wetted by fuel should be decontaminated before being placed aboard any aircraft.

A-3-4 Bonding.

Hydrocarbon fuels, such as aviation gasoline and JET A, generate electrostatic charge when passing through the pumps, filters, and piping of a fuel transfer system. (The primary electrostatic generator is the filter/separator that increases the level of charge on a fuel by a factor of 100 or more as compared with pipe flow.) Splashing, spraying, or free-falling of the fuel will further enhance the charge. When charged fuel arrives at the receiving tank (cargo tank or aircraft fuel tank) either of two possibilities will occur: (1) the charge will relax harmlessly to ground, or (2) if the charge or the fuel is sufficiently high, a spark discharge may occur. Whether or not an ignition will follow will depend on the energy (and duration) of the discharge and the composition of the fuel/air mixture in the vapor space, i.e., whether or not it is in the flammable range.

The amount of charge on a fuel when it arrives at the receiving tank, and hence its tendency to cause a spark discharge, will depend on the nature and amount of impurities in the fuel, its electrical conductivity, the nature of the filter media (if present), and the relaxation time of the system, i.e., the residence time of the fuel in the system between the filter (separator) and the receiving tank. The time required for this charge to dissipate is dependent upon the conductivity of the fuels: it may be a fraction of a second or several minutes.

No amount of bonding or grounding will prevent discharges from occurring inside of 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 during aircraft fueling or refueler loading is no longer required because:

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

(2) It is not required by NFPA 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.

For a more complete discussion of static electricity in fuels see NFPA 77, Recommended Practice on Static Electricity.

A-3-4.3 Ordinary plastic funnels or other nonconducting materials can increase static generation. The use of chamois as a filter is extremely hazardous.

A-3-7 Electric Hand Lamps. Electric hand lamps used in the immediate proximity of the fueling operation shall be of the type approved for use in Class I, Division 1, Group D hazardous locations as defined by NFPA 70, *National Electrical Code*. There is no supportable basis for requiring in the petroleum industry the use of approved, listed, or permissible two or three cell flashlights to avoid igniting Class I, Group D vapors.

A-3-7.2 Aircraft Ground-Power Generators. Aircraft ground power generators should be located as far as practical from aircraft fueling points and tank vents to reduce the danger of igniting flammable vapors (that may be discharged during fueling operations) at sparking contacts or on hot surfaces of the generators.

A-3-9 Lightning Precautions. It is impossible to establish exact rules about fueling when there are electrical storms in the vicinity of the airport. The distance of the storm from the airport, the direction it is travelling, and its intensity are all factors to be weighed in making a decision whether to suspend fueling operations temporarily. Experience and good judgment are the best guides. Sound travels about 1/5 of a mile per second (322 m/s). An approximation of the number of miles to the storm can be made by counting the seconds between the flash of lightning and the sound of thunder and dividing this number by five.

A-3-10.2 Aircraft Fuel Servicing Locations. The precautions in 3-10.2 are intended to minimize the danger of the ignition of any flammable vapors discharged during fueling and of fuel spills by sources of ignition likely to be present in airport terminal buildings.

A-3-13 Portable Fire Extinguishers on Aircraft Servicing Ramps or Aprons. Fire extinguishers for ramps where fueling operations are conducted are intended to provide an immediate means of fire protection in an area likely to contain a high concentration of personnel and valuable equipment. The prominent and strategic positioning of portable fire extinguishers is essential so that they may be of a maximum value in the event of an emergency. Extinguishers should be located so that they will not be in probable spill areas. For normal single parking configurations, extinguishers specified for protection of fuel servicing operations should be located along the fence, at terminal building egress points, or at emergency remote control stations of airport fixed- fuel systems. To provide accessibility from adjoining gates, particularly when more than one unit is specified, extinguishers may be located approximately midway between gate positions. When this is done, the maximum distance between extinguishers should not be over 300 ft (90 m). Where the specified extinguishers are not located along the fence, but are brought into the servicing area prior to the fueling operation, they should be located upwind not over 100 ft (30 m) from the aircraft being serviced. For protection of fuel servicing of aircraft that are double or triple parked, extinguishers should be located upwind not over 100 ft (30 m) from the aircraft being serviced.

A-3-13.5 Protection of Extinguishers Against Inclement Weather. During inclement weather, extinguishers not in enclosed compartments may be protected by canvas or plastic covers. If icing occurs the extinguisher should be sprayed with deicing fluid.

A-3-13.6 Training of Personnel on Utilizing Extinguishers. Fuel servicing personnel should be given adequate training with extinguishers so as to use such equipment effectively in an emergency. Such training should be given on fires of the type that may be encountered on the job. To assure prompt action in the event of a spill or other hazardous condition developing during fueling operations, aircraft servicing personnel should also be trained in the operation of emergency fuel shutoff controls. Each new fuel servicing employee should be given indoctrination training covering these and similar safety essentials that relate to his employment. Follow-up and advanced training should be given as soon as the employee is sufficiently acquainted with the work to benefit from such training. Supervisors should be given training in the more technical aspects of firesafety so that they may know the "why" for these and similar requirements and have an appreciation for the supervisors' responsibility for the safety of their operation.

A-3-16 Aircraft Fueling Hose. Failure of aircraft fueling hose in service is a possible source of fuel spillage and a potential fire hazard. Principal reasons for failure of aircraft fueling hoses are:

(a) Using damaged hoses

(b) Using aged hoses

(c) Exceeding pressure limits

(d) Improper installation.

Appendix B Referenced Publications

B-1 The following documents or portions thereof are referenced within this standard for informational purposes only and thus are not considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

B-1-1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 30-1990, *Flammable and Combustible Liquids Code*

NFPA 70-1990, *National Electrical Code*

NFPA 77-1988, *Recommended Practice on Static Electricity*

NFPA 407-1990, *Standard for Aircraft Fuel Servicing*

NFPA 415-1987, *Standard on Aircraft fueling Ramp Drainage*

B-1-2 API Publications. 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*

B-1-3 BS Publications. 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*

B-1-4 Other Publications.

An Evaluation of the Relative Fire Hazards of JET A and JET B for Commercial Flight (N74-10709), National Technical Information Service, U.S. Dept. of Commerce, Springfield, VA 22151

B-2 Bibliography.

B-2-1 API Publication. American Petroleum Institute, 2101 L Street, NW, Washington, DC 20037.

STD 2000-1973, *Venting Atmospheric and Low-Pressure Storage Tanks*

B-2-2 ASTM Publications. American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM D86-77, *Distillation of Petroleum Products*

ASTM D910-76, *Specifications for Aviation Gasolines*

ASTM D1655-77, *Specification for Aviation Turbine Fuels.*

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