

NFPA No.

407

AIRCRAFT FUEL SERVICING 1972



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NATIONAL FIRE PROTECTION ASSOCIATION
International

60 Batterymarch Street, Boston, Mass. 02110

Official NFPA Definitions

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**Standard for
Aircraft Fuel Servicing**

**Including
Aircraft Fueling Hose, Aircraft Fuel Servicing Tank
Vehicles and Airport Fixed Fueling Systems**

NFPA No. 407—1972

1972 Edition of No. 407

This Standard, prepared by the NFPA Sectional Committee on Aircraft Fuel Servicing and submitted to the Association through the NFPA Committee on Aviation, was adopted in this edition on May 16, 1972 by the NFPA at its 76th Annual Meeting held in Philadelphia, Pa. The present text supersedes the 1971 Edition.

The changes made in this edition include revisions to Paragraphs 101; 111; 121.k; 281; 601.a; 618; 618.a; 619.c. (Note); 621.a; 626.a; 642; 644; 661; 673.a; 673.b; 733; and 770. In addition, title changes have been made to Part VI and Sections 620 and 640; all of section 650 has been revised; a new Paragraph 673.d. has been added; and Figure 2A has been altered.

The 1971 Edition of this Standard was approved by the American National Standards Institute and designated as USAS Z119.1-1972. This 1972 Edition is being submitted for similar approval by ANSI. The ANSI designation and date of approval will be printed on the front cover of copies of this edition printed after approval has been received.

Origin and Development of No. 407

Active work by the National Fire Protection Association leading towards the development of these recommendations started in 1951. Since that date, the responsible Sectional Committee has made every effort to keep the text up-to-date and progressive editions have been published almost every year since 1955. This is the 17th Edition of the Standard. It is being used widely as the basis of good practice in the interest of fire prevention by aircraft operators and airport managements nationally and internationally. In the U.S.A., the Federal Aviation Administration has issued an Advisory Circular (AC 150/5230-3) entitled Fire Prevention During Aircraft Fueling Operations (4-8-69) which references this text.

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Scope: To promote fire safety during the operation, maintenance, servicing and storage of aircraft and in the operation of airports and associated functions. The Committee is a policy-making Steering Committee of the NFPA Sectional Committees organized to handle specific technical problems in the aviation field. Reports prepared by the Sectional Committees are circulated for letter ballot to the members of this Committee and the results reported to the Annual Meeting of the Association.

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Scope: To develop fire safety recommendations for procedures and equipment for aircraft fuel servicing. This Sectional Committee reports to the Association through the Aviation Committee.

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**Standard for
Aircraft Fuel Servicing
Including**

**Aircraft Fueling Hose, Aircraft Fuel Servicing Tank
Vehicles and Airport Fixed Fueling Systems**

NFPA No. 407—1972

Part I. General and Definitions

100. Scope:

101. This Standard applies to fuel servicing of all types of aircraft on the ground. It does not apply to: (a) air-borne fueling; (b) fueling of flying boats or amphibious aircraft on the water; or (c) draining and filling aircraft tanks during fuel system maintenance operations.

102. Fueling aircraft involves the transfer of flammable liquids under conditions which are often fire hazardous. Operational requirements make it necessary for fueling crews to perform their duties efficiently and quickly under all types of weather conditions, at all hours, and concurrent with a number of other aircraft servicing operations. The increasing fuel capacities of modern air transports and military aircraft aggravate the problem and make it imperative to establish basic fire safety procedures. Parts I through IV herein are intended to help prevent accidental fuel spills and to eliminate and control fuel vapor ignition sources as far as is presently practicable. It is recognized that there are certain hazards (especially the operation and use of internal combustion engine operated aircraft servicing equipment and ground power generators in close proximity to fueling operations) over which positive control cannot be presently established for practical reasons. Specific cautions are given herein with regard to these hazards.

103. Part V covers the design and maintenance of aircraft fueling hose. Part VI applies to tank vehicles designed for or employed in the transfer of standard grades of aviation fuel into or from an aircraft. Part VII covers Airport Fixed Fueling Systems. Part VIII deals with Fueling on Elevated Heliports. Appendix A gives information on the Fire Hazard Properties of Aviation Fuels and Appendix B gives data on the Generation of Static Electricity on Aircraft on the Ground.

110. The General Nature of the Fire Hazard:

111. From a fire hazard standpoint, aviation gasoline does not differ radically from ordinary gasoline. Jet fuels require safety precautions similar to those recommended for aviation gasoline.*

112. The vapor densities of aviation fuels are such that released vapors, particularly under calm wind conditions, may travel considerable distances along the ground and collect in depressions where they may not readily dissipate. The concentration of fuel vapors in the area surrounding the aircraft under normal atmospheric conditions depends upon wind velocity and rate of fueling. Every effort should therefore be made to prevent fuel spillage which represents the greatest hazard.

NOTE: See Standard on Airport Ramp Fire Hazard Classifications and Precautions (NFPA No. 411; ANSI Z215.1) for further information on the extent of the normally hazardous areas during fuel servicing operations.

113. Principal ignition sources likely to be present during aircraft fuel servicing are:

- a. Electrostatic sparks (see Section 220)
- b. Operating aircraft engines, auxiliary power units, and heaters (see Section 230)
- c. Operating automotive or other internal combustion engine servicing equipment in the vicinity (see Section 240)
- d. Arcing of electrical circuits (see Section 250)
- e. Open flames (see Section 260)
- f. Energy from energized high frequency radar equipment (see Section 270).

g. The autoignition temperatures of turbine fuels 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 to a safe temperature.

*See Appendix A for further information on the fire hazard properties of aviation fuels.

114. Effective fire prevention measures are directed toward the elimination or control, as far as practicable, of (1) spillages, (2) release of excessive flammable vapors, and (3) ignition sources.

120. Definitions.

121. Whenever the following terms are used in this publication, they shall have the meaning defined herein.

a. AIRCRAFT FUEL SERVICING HYDRANT VEHICLE (Hydrant Vehicle). A vehicle equipped with facilities to transfer fuel between an aircraft fuel hydrant and an aircraft.

b. AIRCRAFT FUEL SERVICING TANK VEHICLE (FUELER). Any vehicle (tank truck, tank full trailer, tank semitrailer, tank vehicle) designed for or employed in the transportation and transfer of fuel into or from an aircraft.

c. AIRCRAFT SERVICING RAMP OR APRON. An area or position at an airport used for the fuel servicing of aircraft.

d. BAFFLE. A nonliquid-tight transverse partition in a cargo tank.

e. CARCASS SATURATION. This refers to the condition where fuel has permeated the reinforcement materials of a hose carcass.

f. CARGO TANK. Any container having a liquid capacity in excess of 100 gallons, used for the carrying of flammable liquids, and mounted permanently or otherwise secured upon 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 tank vehicle upon which it is mounted.

g. COMPARTMENT. A liquid-tight division in a cargo tank.

h. DEADMAN CONTROL. A device which will prevent the flow of fuel from the system to any hose, including the hose between a hydrant and a hydrant cart, unless the control is held open by an operator. Deadman controls should be designed to discourage or prevent blocking open.

i. FIXED FUELING SYSTEM. An arrangement of aviation fuel storage, pumps, piping, and associated equipment, plus dispensing hydrants, cabinets and/or pits at an airport designed to service aircraft from locations established by the installation of the equipment.

j. **FUELER.** (See Aircraft Fuel Servicing Tank Vehicle.)

k. **FUEL SERVICING.** Fuel servicing includes fueling and defueling of aircraft fuel tanks but does not include aircraft fuel transfer operations and testing aircraft fuel systems during aircraft maintenance and overhaul operations.

l. **FUELING SERVICING CABINET.** A boxlike structure above the surface of the ground with hose, meters and auxiliary equipment from which it is possible to dispense fuel into aircraft without any additional equipment.

m. **FUEL SERVICING PIT.** A pit (usually covered by a substantial grating or plate flush with the surface of the ramp) containing hose, meters and auxiliary equipment which make it possible to dispense fuel into aircraft without additional equipment.

n. **FUEL STORAGE FACILITIES.** Fuel storage for airport fixed fueling systems may be provided in one and/or both of the following ways:

(1.) **MAIN (PRIMARY) STORAGE FACILITIES.** Tanks for the storage of aviation fuel and associated facilities. Main storage facilities are generally located remotely from aircraft servicing and movement areas.

(2.) **OPERATING (SATELLITE) STORAGE FACILITIES.** Operating storage facilities, when provided, are of smaller capacity than the main storage facilities and are generally located as close as practical to aircraft servicing ramps.

o. **HEAD AND BULKHEAD.** A liquid-tight transverse closure at the end of a cargo tank or between compartments of a cargo tank.

p. **HYDRANT.** An outlet in a fixed fueling system designed to permit the transfer of fuel only after the matching fuel connection on dispensing equipment is properly attached.

q. **PRESSURE:**

(1) **BURST PRESSURE.** This is the pressure at which any randomly selected component will rupture.

(2) **DESIGN PRESSURE.** Design pressure is that pressure for which a system or component is designed. Design pressure shall always be equal to or exceed the service pressure, which includes surge pressure. The design pressure should never be exceeded except during pressure test.

(3) **OPERATING PRESSURE.** The pressure existing in a system under flowing conditions or static conditions against pump's maximum no-flow head but excluding surge pressures.

(4) **SERVICE PRESSURE.** The maximum pressure, excluding test pressure, to which a system or component may be subjected. It includes any surge pressures which may be developed in the system.

(5) **TEST PRESSURE.** This is the pressure to which the system or a component of such system is tested to verify the integrity of the system or component. It is usually expressed as a percentage of the service pressure or design pressure.

r. STANDARD GRADES OF AVIATION FUEL. A fuel of whatever octane rating used in aircraft, including aviation gasoline (AVGAS) and blends of hydrocarbons commonly referred to as jet fuels (such as JET A, JET A-1, JET B, JP-4, JP-5 or their equivalents). For further information on this subject see Appendix A on Fire Hazard Properties of Aviation Fuels (Ground Handling).

s. TANK FULL TRAILER. A vehicle that is not self-propelled which has a cargo tank mounted thereon or built as an integral part thereof and used for the transportation of flammable liquids, and so constructed that practically all of its weight and load rests on its own wheels.

t. TANK SEMITRAILER. A vehicle that is not self-propelled which has a cargo tank mounted thereon or built as an integral part thereof, and used for the transportation of flammable liquids, and so constructed that when drawn by a tractor by means of a fifth wheel connection, some part of its load and weight rests upon the towing vehicle.

u. TANK TRUCK. Any single self-propelled motor vehicle equipped with a cargo tank mounted thereon, and used for the transportation of flammable liquids.

v. TANK VEHICLE. Any tank truck, tank full trailer, or tractor and tank semitrailer combination.

w. TRANSFER PIPELINE. Piping used to transfer fuel between the main storage facilities, the operating storage tanks (if any), and the hydrant.

130. Related NFPA Publications.

131. Attention is also directed to the following NFPA publications which include information related to fire safety in aircraft fuel servicing and are further referred to in this Standard:

a. NFPA No. 10 (ANSI Z112.1). Standard for the Installation of Portable Fire Extinguishers.

b. NFPA No. 10A. Recommended Good Practices for the Maintenance and Use of Portable Fire Extinguishers.

c. NFPA No. 11. Standard for Foam Extinguishing Systems.

d. NFPA No. 12. (ANSI A54.1). Standard on Carbon Dioxide Extinguishing Systems.

e. NFPA No. 15. Standard on Water Spray Fixed Systems for Fire Protection.

f. NFPA No. 16. Standard on Foam-Water Sprinkler and Foam-Water Spray Systems.

g. NFPA No. 17. Standard for Dry Chemical Extinguishing Systems.

h. NFPA No. 30. Flammable and Combustible Liquids Code.

i. NFPA No. 70 (ANSI C1). National Electrical Code.

j. NFPA No. 77. Recommended Practice on Static Electricity.

k. NFPA No. 385. Recommended Regulatory Standard for Tank Vehicles for Flammable and Combustible Liquids.

l. NFPA No. 410C. Recommendations on Safeguarding Aircraft Fuel System Maintenance.

m. NFPA No. 411. (ANSI Z215.1). Standard on Airport Ramp Fire Hazard Classifications and Precautions.

n. NFPA No. 415. Standard on Aircraft Fueling Ramp Drainage.

o. NFPA No. 416. Standard on Construction and Protection of Airport Terminal Buildings.

p. NFPA No. 505. (ANSI B56.2). Standard for Type Designations, Areas of Use, Maintenance and Operation of Powered Industrial Trucks.

q. NFPA No. 512. Truck Fire Protection Recommended Good Practices.

Part II. Aircraft Fueling

200. Intent:

201. These recommendations are intended to represent good practice requirements for fire safety in fueling aircraft while on the ground. (See Part I, General and Definitions)

210. Spill Prevention and Control:

211. Careful operation of fuel servicing equipment in compliance with these recommendations will minimize the number of accidental spills. Proper training of fuel servicing personnel is essential. Proper maintenance of the equipment is another essential. Every spill, no matter how small, should be investigated as to its cause so that remedial action may be taken. Employees shall report each spill to supervisory personnel. Every spill should be treated as a potential fire source and the spilled fuel removed by one of the methods detailed in Paragraph 212.

212. In the event of a fuel spill the following actions may be appropriate 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 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 (see Paragraph 618.f. or 733.a.). 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 vapors into any concealed wing or fuselage area before being placed in normal operational service.

b. **Notify the Fire Department** if the spill presents a fire hazard. (The only normal exceptions are for small spills — see Subparagraphs 212.c. and d.). As indicated in paragraph 211 supervisory personnel should also be notified to assure that operations in progress 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. Small Priming Spills involving an area less than 18 inches in any dimension are normally of minor consequence although ramp personnel manning ramp fire extinguishers during start-up procedures should stand by until the aircraft is dispatched. Occasionally such small spills will ignite from engine exhaust sparks or heat but the amount of fuel is so small as not to require application of an extinguishing medium unless the spill is in close proximity to ramp personnel or equipment which might be endangered.

d. Other Small Spills of not over 10 feet in any dimension or not over 50 square feet in area and not of a continuing nature should have a fire guard posted. The fire guard should be provided with at least one ramp fire extinguisher having a rating as described in Paragraph 289. a. If the spill is not ignited either absorbent cleaning agents (such as diatomaceous earth, emulsion compounds or rags) may be used to absorb the spilled fuel. The use of absorbent cleaning agents or emulsifiers is preferred to rags as they can be applied with less personnel hazard. This is particularly true in the case of spills of aviation gasoline and similar low flash point fuels. Contaminated absorbents and fuel soaked rags should be placed in metal containers with self-closing lids until they can be disposed of by burning at a safe location. An exception to this method may be authorized if the spill occurs in an area where no operations are in progress or will be conducted until ample opportunity is provided for volatile fuels to evaporate harmlessly. In such an event, the area should be roped off to prevent unauthorized entry. Fuels that will not evaporate in air readily (such as kerosine) must be removed by one of the methods indicated above and note should be taken of the fact that some types of ramp surfacing are adversely affected by liquid fuel contact.

e. Larger spills of over 10 feet in any dimension and over 50 square feet in area or of a continuing nature normally require handling by the airport fire brigades or local fire department. They should be summoned immediately. Anyone in the spill hazard area should leave it at once. Only general guidance can be given, but the following procedures should be considered in the event of this type of spill following the alerting of the responsible fire brigade or department.

(1). 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 may be ignited should be told or forced to roll on the ground or be wrapped in flame smothering blankets to aid in the extinguishment of any such clothing fires.)

(2). 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 fire safety will vary with circumstances. "Shutting down" equipment or moving vehicles may provide a source of ignition if no fire immediately results from the spillage.

(3). Neither any idle aircraft nor any idle automotive or spark producing equipment in the area should 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 it from the hazard area unless the hazard to personnel is judged too severe. (Fuel servicing vehicles in operation at the time of the fire should not be moved until a check is made that any fuel hose which may have been in use or connected between the vehicle and the aircraft is safely stowed.)

(4). If any aircraft engine is operating at the time of the spill, it is normally good practice to move the aircraft 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.

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

(6). The volatility of the fuel may be a major factor in the initial severity of the hazard created by a spill. Aviation gasoline and other low flash point fuels at normal temperatures and pressures will give off vapors which are capable of forming ignitable mixtures with the air near the surface of the liquid whereas this condition does not normally exist with kerosine fuels (JET A or JET A-1) except

where ambient temperatures are in the 100°F range and the liquid has been heated to a similar temperature.

(7). Spills of aviation gasoline (Avgas) and low flash point turbine fuels (Jet B) greater than 10 feet in any dimension and covering an area of over 50 square feet or which are of a continuing nature should be blanketed or covered with foam. The spills should then be washed from critical areas with water and allowed to evaporate before the site is again used for normal operations. The nature of the ground surface and the exposure conditions existing will dictate the exact method to be followed. Such fuel should not normally be washed down sewers or drains unless no alternative is available or unless exposure conditions are such that this would obviously be the safest procedure. If such action is taken, the decision to do so 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 undergrounds as quickly as possible to dilute, to the maximum possible extent, the flammable liquid content of the underground. 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 Standard on Aircraft Fueling Ramp Drainage (No. 415) for further information on aircraft fueling ramp drainage designs to control the flow of fuel which may be spilled on a ramp and to minimize the resultant possible danger therefrom.

(8). Spills of kerosine grades of aviation fuel (JET A or JET A-1) greater than 10 feet in any dimension and covering an area of over 50 square feet or which are of a continuing nature and which 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 clear the area. The emulsified residue can be safely flushed away with water. Kerosine 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.

(9). With either type of fuel it may be possible to wash the fuel with water spray nozzles to a safe location, but caution should be used since ground surface contamination is normally of considerable concern in the proximity of aircraft operations.

(10). Aircraft on which fuel has been spilled must 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.

220. Elimination and Control of Electrostatic Sparks:

NOTE: For detailed information on static electricity see NFPA Recommended Practice on Static Electricity (No. 77) published in Volume 9 of the National Fire Codes and in separate pamphlet form.

221. Procedures with Aircraft Fuel Servicing Vehicles:

When tank trucks or hydrant vehicles are used for servicing in aircraft, the following bonding and grounding procedures shall be followed:

a. Connect a grounding cable from the vehicle to a satisfactory ground.

b. Connect a grounding cable from the ground to the aircraft grounding fitting, if one is provided, or to another convenient unpainted metal point on the aircraft. Do not make this connection to a propeller, a radio antenna or to the highly stressed components of the landing gear where scratches could initiate metal failure.

c. Bond the vehicle to the aircraft. Where a "Y" or "V" cable permanently attached to the fueling vehicle is used to accomplish steps a. and b., a separate bonding cable is not necessary. Do not depend solely on conductive hose to accomplish this bonding.

d. With *overwing* servicing, connect a bonding cable from the fuel nozzle to the aircraft.

(1). Where aircraft and fuel nozzles are equipped with "plug and jack" bonding facilities, the nozzle bonding "plug" shall be in positive wiping contact with the aircraft

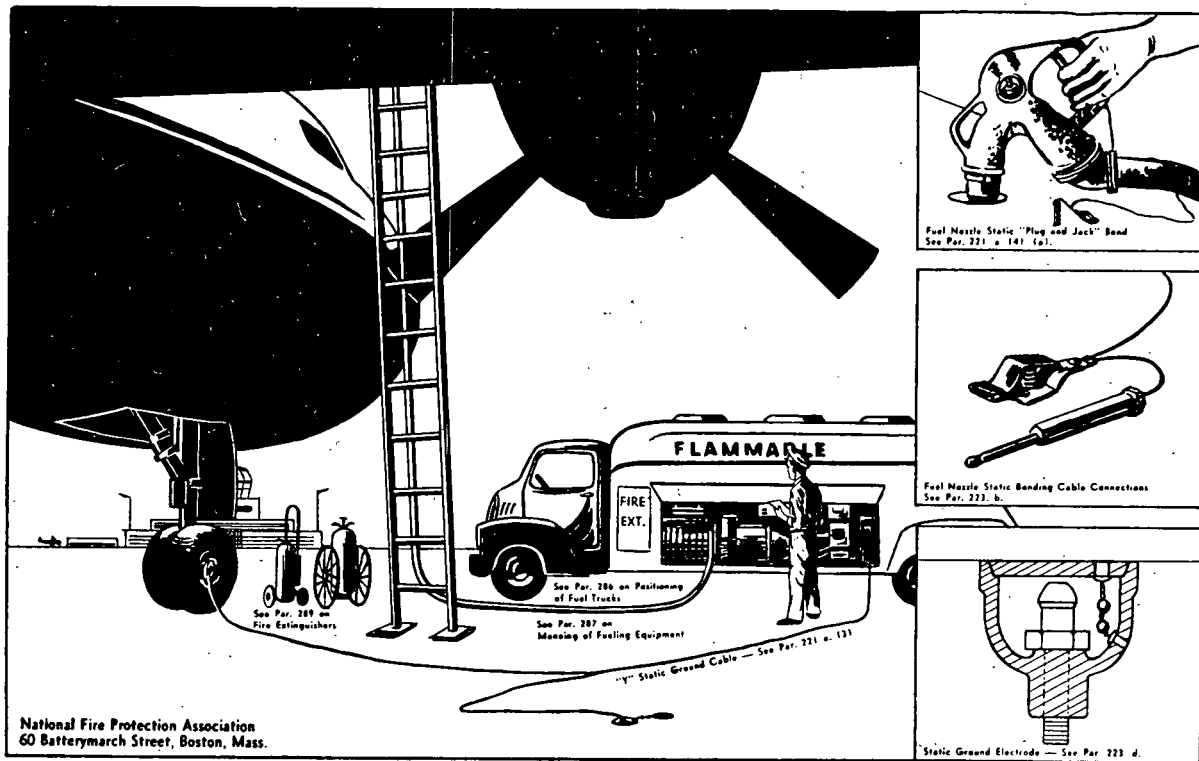


Figure 1. A typical over-the-wing fuel servicing operation from an aircraft fuel servicing tank vehicle showing static grounding and bonding recommendations and certain other details.

"jack" before the aircraft fuel tank filler cap is opened. This bond between the nozzle and the aircraft is most essential and shall be maintained throughout the fueling operation — until after the fuel tank filler cap has been closed.

(2). When fueling aircraft not having bonding "jacks" and in fueling all aircraft having fabric covered wings, the bonding clip at the end of the nozzle bond wire shall first be touched to the tank filler before it is opened to assure that no difference in electrostatic potential exists between the two elements. The nozzle shall be equipped with a strong bond wire having a spring clamp which shall then be firmly attached to a bonding post or other uninsulated metallic part of the aircraft and this contact shall be maintained throughout the fueling operation (until the flow of fuel has been discontinued and all measuring completed).

NOTE: During overwing fuel servicing operations, the almost unavoidable presence of flammable vapors in the air in the immediate proximity of open fuel intakes may create a fire hazardous condition. Any leakage or spillage increases the area of the hazard. Protection against electrostatic spark ignition of such flammable vapor-air mixtures as may be created at fuel intakes during this fuel servicing necessitates control over the accumulation of such charges and good practice dictates the draining of any electrostatic charges that have accumulated on the aircraft or the fuel dispenser. A bonding cable between the fueling nozzle and the airframe (as shown in Figure 1) will minimize the possibility of a static spark at the fill opening. With *underwing* servicing, the fill opening is closed until the filler nozzle is properly connected. The mechanical metal-to-metal contact between the aircraft fitting and the nozzle eliminates the need for a separate bonding connection at this point.

e. Disconnect in reverse order on completion of fuel servicing.

222. Procedures with Fueling Pits or Cabinets: When a pit or cabinet is used for fuel servicing, grounding of the fuel piping is normally provided for in the construction. The procedure to be followed in this case is as follows:

a. Connect a bonding cable from a satisfactory bonding connection at the dispenser to the aircraft. (See Paragraph 221.c.)

b. For overwing servicing connect a bonding cable to the aircraft. (See Paragraph 221.d.)

c. Disconnect in reverse order on completion of fuel servicing.

223. Procedures Using Drums: Where aircraft are serviced with flammable liquids from drums by means of hand-operated or power-driven pumps, the procedures outlined in Paragraph 221 shall be followed. Gasoline and other low flash point flammable liquids shall not be handled in open buckets.

224. Procedures on Ice, Sandy, or Desert Terrain, etc.; Where fuel servicing operations are conducted on ice, sandy or desert terrain, or wherever it may not be practicable to secure a satisfactory ground, the authority having jurisdiction may waive the requirements for grounding the aircraft and the fuel dispenser. The requirements for bonding the aircraft and the fuel dispenser and of bonding overwing nozzles to the aircraft shall *not* be waived. Under these conditions, reliance is placed on equalizing rather than draining static charges that may accumulate on the aircraft, fuel dispenser, fuel hose and nozzle. It is important that objects possessing different electrostatic potentials not be brought into contact with this equipment in a manner which may produce a spark gap in the proximity of a flammable vapor-air atmosphere.

225. Procedures Using Funnels. When a funnel is used in filling an aircraft fuel tank it shall be bonded to the aircraft and to the nozzle as specified in Paragraph 221.d.(2). and the aircraft shall be grounded.

CAUTION: Use only metal funnels. Plastic or other non-conducting materials increase static generation and should never be used. The use of chamois as a filter is also extremely hazardous and should be discouraged.

NOTE: See also Section 740 on the importance of electrostatic bonding of filter separators.

226. Aircraft Structural Bonding: The bonding connection recommended herein assumes that all adjoining aircraft structural (plate) surfaces of metal covered aircraft are bonded so that a single point bond will satisfactorily equalize all static charges on adjoining surfaces.

227. Equipment for Electrostatic Bonding, Grounding:

a. Bonding cables must be of flexible, durable design and material. If a protective covering is provided to minimize the danger of hand injury, it may be loose fitting or

bonded to the cable during manufacture. Preformed cable reduces the risk of hand injury without requiring a covering.

b. The plug and jack assembly and the spring clamp shall be of unpainted metal.

c. The bonding system (cables and connections) shall be tested for electrical resistance when initially secured and inspected for continuity and integrity periodically as required by frequency of use and type of cable. (At least a monthly check is recommended.)

d. Grounding electrodes, consisting of pipes or rods 1/2-inch to 3/4-inch in diameter, of galvanized iron, steel or copperweld steel, driven into the ground to reach below the permanent ground moisture level (normally 6 ft. long) are customarily used. The top of the rod should be level with the surface of the apron or ramp, with a dished out area around the rod for attachment to the leads. Flush type terminal fittings which minimize tripping hazards are available. Since the conductivity of the soil varies in different locations, due principally to the moisture content of the soil, it may, in certain locations, be necessary to employ ground rods longer than 6 ft. in length. Tie down bolts imbedded in concrete ramps have sometimes been found to be satisfactory as grounding electrodes, but when using this type of ground the connection shall be made to the *eye bolt*, not the tie down ring, and all such eye bolts shall be tested initially (and yearly thereafter, preferably during dry seasons) to assure that they actually do constitute a satisfactory grounding medium. (See also Paragraph 227.f. and Figure 1.)

e. An adequate number of suitable grounding connections shall be provided on aprons and ramps where fuel servicing operations may be conducted.

f. As low a resistance as possible should be secured and maintained. 10,000 ohms is a practical recommended maximum when determined by standard procedures.

g. All bonding and grounding connections shall be firm and to clean, unpainted metal parts.

228. Light Aircraft Servicing. When the fuel flow is not over 25 gallons per minute, the requirements herein for bonding and grounding during fueling may be waived by the authority having jurisdiction.

Methods of Measuring Resistance to Ground

Reference: Paragraph 227.f.

There are several methods of measuring the resistance to ground of buried metallic structures. Two satisfactory methods that are practical and may be accomplished by relatively inexperienced personnel are given below.

1. The first method is to connect a 24 volt aircraft battery in series with the ground electrode to be measured, a multi-range ammeter and a buried metallic structure such as a water pipe. The resistance of the water line will be so small in comparison with the resistance of the ground electrode, that for all practical purposes the total circuit resistance can be considered to be the resistance of the latter. All connections should be cleaned thoroughly (filed) to assure a good metal to metal contact. The circuit resistance can readily be determined by reading the battery voltage and the milliamperes flowing in the circuit.

Thus

$$R = \frac{1000E}{I}$$

where R is in ohms

E is in volts

I is in milliamperes

Since there will be, in general, a potential difference between the ground electrode and the water pipe (usually from 0.15 to 0.60 volt), a reading should be obtained and then a second reading with the polarity of the battery reversed should be recorded. An average of these two readings will give approximately the correct reading.

2. The second method requires three sets of readings to be taken between three ground electrodes. Let R_1 = resistance of first electrode in ohms; R_2 = resistance of second electrode in ohms; and R_3 = resistance of third electrode in ohms. Then measuring the resistance between all 3 pairs of the three electrodes as outlined in the first method there results: $R_1 + R_2 = A$; $R_1 + R_3 = B$; $R_2 + R_3 = C$, where A, B and C are the calculated values of $\frac{I}{1000E}$ for the three pairs respectively.

Solving the above simultaneous equations there results —

$$R_1 = \frac{A + B - C}{2}$$

$$R_2 = \frac{A + C - B}{2}$$

$$R_3 = \frac{B + C - A}{2}$$

Inaccuracies arise in the above mentioned methods due to stray currents, polarization, and back emfs. However, for the purpose intended, they are sufficiently accurate to recommend their use by maintenance personnel. A higher degree of accuracy could be obtained using A.C. as a source of power; however, this is not normally as readily available on airport aprons as an aircraft battery.

Instruments specifically designed to measure ground resistances directly are commercially available.

230. Aircraft Engines, Auxiliary Power Units, and Heaters.

231. Operating engines on an aircraft must be considered potential sources of ignition. Except as provided herein, fuel servicing shall not be done on an aircraft unless all its engines are completely stopped. On jet aircraft having engines mounted at the rear of the fuselage, the authority having jurisdiction may waive this restriction provided that they establish procedures that will assure safety when fueling while an engine or engines are running.

232. Turbine-powered auxiliary power units installed aboard aircraft may be operated during fueling provided that in the design and installation adequate attention is given to the fuel vapor and ignition hazards that may be involved.

233. Combustion heaters on aircraft (i.e., wing and tail surface heaters, integral cabin heaters, etc.) shall not be operated during fueling operations.

240. Safeguards Against Hazards Incident to Automotive Equipment Operation:

241. No vehicles, other than those performing aircraft servicing functions, shall be permitted within 50 feet of aircraft during fuel servicing operations.

242. All vehicles performing aircraft servicing functions, other than fuel servicing (e.g. baggage trucks, air conditioning vehicles, etc.), shall not be driven or be parked under aircraft wings while fueling is in progress. Drivers shall be thoroughly instructed as to the hazards inherent in operating or parking such vehicles in close proximity to fueling operations. [Aircraft servicing normally requires mechanized equipment and it is most often impractical to suspend such operations during fueling. Minimum precautions dictate superior ramp vehicle maintenance† (to avoid arcing across vehicle electrical terminals, emission of sparks or backfire flames from exhausts, prevention of vehicle ignition system short circuits, etc.) and schooling of vehicle operators in recognizing potentially hazardous conditions such as spills.]

†For industrial tractors see NFPA Standard for Type Designations, Areas of Use, Maintenance and Operation of Powered Industrial Trucks (NFPA No. 505; ANSI B56.2); for other vehicles, see NFPA Truck Fire Protection (NFPA No. 512).

250. Prevention of Arcing of Electrical Circuits:

251. During fuel servicing, aircraft batteries shall not be raised or lowered nor shall battery chargers be connected, operated or disconnected.

252. 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. Ground power generators shall not be placed under wings or within five feet aft of the trailing edge of wings. The act of connecting or disconnecting ground power generators shall not be accomplished while aircraft fueling is in progress.

253. Electric hand lamps or flashlights used in the immediate proximity of the fueling operation should be of the type approved for use in Class I, Group D, Division 1 hazardous locations (as defined by the National Electrical Code, NFPA No. 70; ANSI C1).

254. No electric tools, drills, buffers or similar tools likely to produce sparks or arcs shall be used during fueling operations.

255. Photographic flash bulbs or electronic flash equipment shall not be used within 10 feet of fueling equipment or of the fill or vent points of aircraft.

260. Elimination of Open Flames:

261. Open flames and lighted open flame devices shall be prohibited on the passenger ramps and in other locations within 50 feet of any aircraft fuel servicing operation. Local airport management shall establish other locations where open flames and open flame devices shall be prohibited. Included in the category of open flames and lighted open flame devices are the following:

a. Lighted cigarettes, cigars, pipes, etc. (All entrances to fueling areas from adjacent buildings should be posted with "NO SMOKING" signs.)

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

c. Welding or cutting torches, blowtorches, etc.

d. Flare pots or other open flame lights.

262. Cigarette lighters or "strike anywhere" matches shall not be carried or used by anyone while engaged in fuel servicing operations.

270. Control of High Frequency Radar Equipment:

271. The beam from high frequency radar equipment can 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.

272. 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. Such equipment shall not be operated when the aircraft in which it is mounted is being fueled. 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 Paragraph 271. which are located within 100 feet. [WARNING: Higher power radar equipment (e.g. AN/MPS-14 and AN/APS-20B) may require greater distances.]

273. Airport surface detection radar operates under a peak power output of 50 kilowatts. It is fixed equipment rather than airborne. Antennas for airport surface detection radar equipment shall be located so that the beam will not be directed toward any fuel storage or loading racks located within 100 feet. No aircraft fueling operations or any operations involving flammable liquids or vapors shall be conducted within 100 feet of such antennas.

274. Airborne surveillance radar of the types currently carried on military aircraft has a high peak power output. Aircraft carrying this type of radar can be readily distinguished by radomes atop and/or below the fuselage. Airborne surveillance radar shall not be operated within 300 feet of any of the hazards described in Paragraph 271.

275. Aircraft warning radar installations are the most powerful. Most of these installations are, however, remotely located from the hazards indicated in Paragraph 271 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 on an airport. The latter equipment has a peak power output of 5 megawatts. Antennas shall be located so that the beam will not be directed toward any fuel storage or loading racks within 300 feet. No aircraft fueling operations or any operations involving flammable liquids or vapors shall be conducted within this 300 foot distance. Where possible, new installations of this type equipment should be located at least 500 feet from any of the hazards described in Paragraph 271.

280. Additional Precautions:

281. Fueling Locations

- a. Aircraft fuel servicing shall be done outdoors.

NOTE: See Section 460 of NFPA No. 410C for aircraft fuel transfer operations and testing aircraft fuel systems during aircraft maintenance and overhaul operations.

- b. It is recommended that aircraft be so positioned that aircraft fuel system vents or fuel tank openings are not closer than 25 feet from any terminal building, hangar, service building, or enclosed finger (other than movable loading bridges), or within 50 feet of any combustion and ventilation air intake to any boiler, heater, or incinerator room facing the ramp side of the terminal or finger, to minimize the danger of ignition of flammable vapors discharged during fueling operations by sources of ignition likely to exist in such buildings.

- c. Accessibility to aircraft by emergency fire equipment shall be considered in establishing fuel servicing positions. Double or triple parking of aircraft at passenger loading stations should be avoided wherever possible. When

such parking is necessary, clear lanes for emergency fire equipment access must be maintained.

282. Outage Space: Fuel expansion space should be left in each aircraft fuel tank to prevent overflow in event of temperature increase. A three per cent outage space is recommended. (Fuel expansion is at the rate of one per cent for each 14°F. rise in the temperature of the liquid fuel.)

283. Concurrent Operations: During fueling operations, no aircraft maintenance shall be conducted which will provide a source of ignition for fuel vapors.

284. Fueling During Enplaning and Deplaning of Passengers: Operators should determine for each aircraft type the areas through which it might be hazardous for enplaning or deplaning passengers to pass while fueling. Care should be taken that passenger paths avoid such areas.

285. Aircraft Occupancy. If passengers remain on board an aircraft during fuel servicing, a responsible cabin attendant shall be in the aircraft at or near a door at which there is a passenger loading stand, a passenger loading bridge or a set of integral stairs which are down. A "NO SMOKING" sign shall be displayed in the cabin and the rule enforced. Food and cabin servicing may be done during fueling but care should be taken to prevent dangerous blocking of cabin egress facilities if the aircraft is occupied. The attendant should promptly notify fueling personnel if fuel vapors are detected in the passenger compartment or of any condition which might be a potential hazard. Upon such notification, fueling should be stopped until the condition is corrected.

286. Positioning of Aircraft Fuel Servicing Vehicles: A clear path shall be maintained to permit rapid removal of aircraft fuel servicing vehicles from an aircraft in an emergency. Vehicles and equipment shall not be located where they would obstruct egress from occupied portions of the aircraft in the event of fire. Hand brakes shall be set on vehicles before operators leave the cab or vehicle. Aircraft fuel servicing vehicles shall be positioned so they can be moved promptly (assuming all aircraft fuel hoses have been disconnected and racked) and so located that vehicle engines are not under the wing.

287. Operation of Fueling Equipment:

a. Compatible with design, during fueling operations there shall be adequately trained personnel available to quickly shut off the flow of fuel from the servicing equipment in an emergency.

b. Only competent and qualified operators shall be permitted to operate the equipment (see Paragraph 401).

c. To assure prompt action in the event of a spill or other hazardous condition developing during fueling operations, it is recommended that other aircraft servicing personnel be trained in the operation of emergency fuel shutoff controls (see Paragraphs 618 and 733).

d. Locking of self-closing nozzles or dead man controls in an open position, even momentarily, shall be prohibited.

e. Kinks and short loops in fueling hose should be avoided. The hose should not be stretched with the complete weight of the hose off the ground as this places extra strain on the nozzle coupling (see Part V for further details of hose handling).

f. The fuel nozzle should never be allowed to drag along the ground.

288. Lightning Storms: Extreme caution should be used in fueling during lightning and electrical storms. Operations shall be suspended during severe disturbances.

289. Fire Extinguishers on Ramps Where Fueling is Conducted: 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 event of an emergency (see Paragraph 733.b.) Portable extinguishers shall comply with the Standard for the Installation of Portable Fire Extinguishers (NFPA No. 10; ANSI Z112.1).

a. **Extinguisher Recommendations:** (See NFPA No. 10 for explanation of ratings of extinguishers.) For the

protection of fuel servicing operations, extinguishers shall have the ratings indicated herein based on the open hose discharge capacity of the aircraft fueling system in service:

(1). Where said capacity does not exceed 200 gallons per minute, at least one approved extinguisher having a minimum rating of 20-B shall be provided.

(2). Where said capacity is in excess of 200 gallons per minute, but not over 350 gallons per minute, one approved extinguisher having a minimum rating of 80-B shall be provided.

(3). Where said capacity is in excess of 350 gallons per minute, two approved extinguishers, each having a minimum rating of 80-B shall be provided.

NOTE: The "open hose discharge capacity" is the "broken hose" capacity, not the actual delivery rate of any particular operation.

(4). Extinguishers of over 50 pounds gross weight should be of wheeled type or be mounted on carts to provide mobility and ease of handling.

(5). Stationary type fire extinguishing systems having adequate hose line coverage of the fuel servicing area and a fire extinguishing capability on Class B fires equal to or greater than that specified for the portable extinguishers in Paragraph 289.a.(1). or (2). may be used in lieu of the portable equipment, provided that one portable device having at least $\frac{1}{2}$ the rating specified in the referenced paragraphs is also available or, in the case of the condition described in Paragraph 289.a.(3)., that one approved extinguisher having an 80-B minimum rating is also available. Any stationary system provided shall conform to the applicable sections of one of the following NFPA Standards:

(a). Foam Extinguishing Systems (NFPA No. 11)

(b). Carbon Dioxide Extinguishing Systems (NFPA No. 12; ANSI A54.1)

(c). Water Spray Fixed Systems (NFPA No. 15)

(d). Foam-Water Sprinkler and Foam-Water Spray Systems (NFPA No. 16)

(e). Dry Chemical Extinguishing Systems (NFPA No. 17)

b. Extinguisher Locations:

(1). Fire extinguishers should be positioned or located so that they will not be in probable spill areas.

(2). 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 (see Paragraph 733.b.) 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 be not over 250 feet. 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 feet from the aircraft being serviced.

(3). For protection of fuel servicing of aircraft that are double or triple parked, extinguishers should be located upwind not over 100 feet from the aircraft being serviced.

(4). Hose line stations of stationary extinguishing systems shall be located so that they are easily accessible and so that the hose supply available shall adequately cover the probable spill hazard area.

(5). Extinguishers should be protected from ice, snow, etc., by canvas covers, enclosed compartments or other suitable means wherever necessary. Extinguishers located in enclosed compartments shall be readily accessible and their location shall be clearly marked in letters at least 2 inches high.

c. Extinguisher Maintenance: Extinguishers shall be maintained in accordance with the Recommended Good Practice for the Maintenance and use of Portable Fire Extinguishers (NFPA No. 10A).

Part III. Aircraft Defueling

300. Recommendations:

301. Defueling operations are similar to fueling operations and present approximately the same fire hazards. Draining operations present greater fire hazards because the procedures are more difficult to accomplish and because drainage provisions are seldom convenient. Normally, initial drainage will be accomplished by suction with a hose inserted at the fuel tank filler neck utilizing pumping equipment. Following this, remaining liquid must normally be drained from the fuel piping system, most often from the sumps or central valves in the system. Final draining shall be done with temporary pipe or hose connected into vented drums or covered containers.

302. The safeguards listed herein for electrostatic bonding and grounding during fueling apply equally during defueling. The necessity for providing static bonds at such points of possible spark gap where flammable vapors may be present remains obligatory despite the relatively small amounts of fuel and slow rates of delivery experienced in this draining operation.

303. Variations between different types of aircraft preclude the establishment of standard procedures but the same principles apply in all cases.

NOTE: See Section 460 of NFPA Recommendations on Safeguarding Aircraft Fuel System Maintenance (No. 410C) for further information on fuel transfer equipment and operations.

Part IV. Fuel Servicing Personnel

400. Fire Safety Training:

401. A new employee shall be given indoctrination training covering these and similar safety essentials that relate to his employment. Follow-up and advance training shall be given as soon as the employee is sufficiently acquainted with the work to benefit from such training. Supervisors shall be given training in the more technical aspects of fire safety so that they may know the "why" for these and similar requirements and have an appreciation for proper safety supervision. All men shall be given adequate training with extinguishers and extinguishing equipment 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.

410. **Manning of Fueling Equipment:** *See Paragraph 287.*

Part V

Aircraft Fueling Hose

500. General:

501. Failure of aircraft fueling hose in service is a possible source of fuel spillage and a potential fire hazard.

502. Principal reasons for failure of aircraft fueling hoses are:

a. Exceeding design pressure limits — such as the development of a combination of surge and operating pressures that are greater than the design pressure of the hose.

b. Using damaged hoses — which may have been mishandled or abused by dragging hose over rough surfaces, flattening or crushing by vehicles, sharp bending or kinking, excessive end pull, dropping hose from aircraft wings or platforms.

c. Using aged hoses — which may have experienced structural or material deterioration in service.

d. Improper installation — such as unsuitable splices, makeshift field repairs, or faulty coupling installations.

503. Only fueling hose specifically built for aircraft fuel servicing and labeled in accordance with Paragraph 512 shall be used when such hose is obtainable. When aircraft fuel servicing hose so labeled is not obtainable to meet the conditions of a specific service, other hose meeting the performance requirements of this Part may be used. Fueling hoses shall be in continuous length except in those cases where existing manufacturing processes do not permit a piece of hose to be made as long as required. Where two or more sections of hose are required to obtain necessary length, the number of all hose sections shall be held to an absolute minimum. When affixing couplings to new or used hose, the coupling size shall match the hose's outside dimension, inside dimension, and thickness. Coupled hose and recoupled hose assemblies shall withstand test pressures according to Paragraph 520.

504. Aircraft fueling hose above 2 inches nominal inside diameter shall have swivel couplings between the hose and the nozzle which shall permit free rotation of the nozzle, regardless of pressures, to avoid kinks in the hose.

510. Fuel Hose Design:

511. Fueling hose shall be fabricated of materials that are resistant to the action of aviation fuels. The hose cover shall be suitable for the requirements of the service for which it is designed, and resistant to damage by the hazards indicated in Paragraph 502.b.

512. Each coupled length of hose shall have at least one inlaid label or an embossed brand which shall furnish the manufacturer's name or trademark, date of manufacture (quarter and year), hose specification identification (e.g., Aircraft Fueling Hose), and the design pressure of the hose. Where hose length exceeds 25 feet, labels as described herein shall be provided at intervals of 25 feet or less.

513. All fueling hose shall have a design pressure of not less than the service pressure to which it will be subject but in no case shall hose 2 inches nominal inside diameter and larger have a design pressure less than 125 psig. The minimum burst pressure shall be five (5) times the design pressure. The burst pressure test shall be run in accordance with the Standard Methods of Testing Rubber Hose (D380-65), published by American Society for Testing and Materials (1916 Race Street, Philadelphia, Pa. 19103).

520. Hydrostatic Test Requirements:

521. Before placing in initial service, new hose assemblies shall be hydrostatically tested at a minimum of one and one-half ($1\frac{1}{2}$) times the design pressure.

522. Recoupled hose shall be hydrostatically tested at a minimum of one and one-half ($1\frac{1}{2}$) times the design pressure before being returned to service.

523. If hose in service or hose in storage ready for service is hydrostatically tested, a test pressure of one and one-quarter ($1\frac{1}{4}$) times the service pressure is recommended. It is permissible to perform this hydrostatic test by fully extending the hose without removing the hose from the fueling vehicle.

524. Suitable records shall be kept of hydrostatic tests.

530. Fuel Hose Hydrostatic Test Procedure:

531. The following hydrostatic test procedures are given as a guide. (For full details consult the Standard Methods of Testing Rubber Hose (D380-65) published by American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103.)

a. Liquid, such as, but not limited to, aviation fuel, water, Stoddard solvent, or mineral spirits may be used to perform the hydrostatic test. The liquid shall:

(1) Not be harmful to the hose.

(2) Not contaminate the aviation fuel when the hose is placed in service.

(3) Be used in accordance with safe handling procedures.

b. Connect the hose to a test pump capable of producing sufficient pressure for the intended test. Fit the opposite end of the hose with a cap having a small air bleeder valve. Be sure that all connections are tight and then introduce liquid into the hose through the pump end. At the same time elevate the capped end, with the vent valve open to bleed off air. When the hose is full of liquid and all air is eliminated (which will be indicated by a solid stream of liquid from the vent) close the vent valve.

c. Place hose in a straight line position and perform the following pressure tests: With pump, raise the pressure in the hose to the proper pressure recommended in Paragraph 520 and check for leaks in the system. If the coupling leaks, other than at the hose/coupling juncture, release pressure, tighten the coupling and again bring the pressure up as indicated above and hold for one minute. Replace any length of hose showing a bulge, distortion, or leakage; undamaged sections may be salvaged in accordance with the provisions outlined in Paragraph 551.b. (1).

540. Hose Inspection Requirements:

541. Hose in daily use should be inspected daily. Hose used less frequently should be inspected once each day it is used.

550. Fuel Hose Inspection Procedure:

551. The following minimum preventive maintenance and inspection program is recommended:

a. Visual Inspection of Aircraft Fueling Hose to be Made by Designated Personnel:

(1) Inspect the outside cover of the hose while completely extended. Any blistering, saturation, cuts or nicks which have damaged the reinforcement material or abrasions which expose a significant amount of reinforcement material shall be removed from service. The damaged portion shall be scrapped. Undamaged portions may be salvaged by recoupling. See Paragraph 551.b.(1).

(2) Check carefully the hose couplings while the hose is completely extended. Inspect for coupling slippage and for signs of leakage. Coupling slippage is evidenced by a misalignment of the hose and coupling and/or a scored or exposed area where the slippage has occurred. If such a condition is found, the hose shall be immediately removed from service. The coupling shall be removed and the cause of the slippage, misalignment and/or coupling leakage shall be determined. If the hose is found satisfactory, it may be recoupled after removing the end portion. See Paragraph 551.b.(1).

(3) Examine the hose while completely extended for about 12 inches immediately behind each coupling. Check for structure weaknesses by pressing the hose in this area around its entire circumference and feeling for soft spots. Since the greatest percentage of hose failures are in this section, a careful examination is therefore of utmost importance.

(4) With hose still completely extended, test hose at operating pressures. Any abnormal twisting or ballooning of the hose during this test indicates a weakening of the hose carcass; hose showing such weakness should be withdrawn from service. Good sections of the hose may be salvaged. See Paragraph 551.b.(1).

(5) Nicks or cuts in outer cover of fueling hose do not necessarily indicate need to replace the hose unless rubber in the immediate area is loose or reinforcement material is exposed.

b. Salvage of Good Sections of Hose and Attachment of Couplings:

(1) After a hose has been withdrawn from service, it may be possible to salvage a portion of such hose. If, on inspection, it is determined that a section of the hose is satisfactory, and is in a usable, continuous length (see paragraph 503), the damaged section of the hose may be cut off and the undamaged section recoupled. Such end portion shall be removed beyond any point indicating carcass saturation but in no case less than the amount of the hose which was inserted into the coupling. After such repair, the hose shall be given a hydrostatic test to verify the integrity of the coupling connection. The test pressure shall be as stated in Paragraph 522.

c. Periodic Inspection of Nozzle Screens:

(1) Examine the contents of the nozzle screens for particles of the inner lining. On new hose, particles of rubber left in the hose during the manufacturing process may appear during the first week of use. The appearance of such rubber particles more than twice during the first week or any one time after the first week indicates that the interior of the hose is deteriorating and the hose shall be immediately scrapped and replaced.

Part VI

Aircraft Fuel Servicing Vehicles

600. General

601. Scope:

a. This Part gives minimum requirements for the design and construction of vehicles for the servicing of aircraft with standard grades of aviation fuel (see Paragraph 121.r) operated by the vehicle motor and for facilities for loading the cargo tanks of these vehicles.

b. Additional safeguards may be necessary for vehicles used for the handling of other than standard grades of aviation fuel or vehicles designed to discharge fuel by other than a power takeoff from the motive power engine (See Paragraph 619.d.).

c. Aircraft fuel servicing tank vehicles which are used on public highways must also comply with the requirements of the NFPA Recommended Regulatory Standard for Tank Vehicles for Flammable and Combustible Liquids (NFPA No. 385).

602. **Magnesium:** Magnesium shall not be used in the construction of any portion of an aircraft fuel servicing tank vehicle.

610. Cargo Tanks, Piping and Connections.

611. Cargo Tanks:

a. **Cargo Tanks Constructed of Mild Steel:** Tanks constructed of mild steel shall comply with the material specifications in Article 22 of the NFPA Recommended Regulatory Standard for Tank Vehicles for Flammable and Combustible Liquids (NFPA No. 385).

b. **Cargo Tanks Constructed of Low Alloy Low Carbon (High Tensile) Steel:** Tanks constructed of low alloy, low carbon steel, commonly known as high tensile, shall comply with the material specifications in Article 22 of the NFPA

Recommended Regulatory Standard for Tank Vehicles for Flammable and Combustible Liquids (NFPA No. 385).

c. Cargo Tanks Constructed of Aluminum: Tanks constructed of aluminum shall comply with the material specifications in Article 22 of the NFPA Recommended Regulatory Standard for Tank Vehicles for Flammable and Combustible Liquids (NFPA No. 385).

612. Piping, Joints and Flanged Connections:

a. Product discharge piping shall be of metal and rated for at least 125 psi design pressure.

b. Except as provided in Paragraph 612.c., all joints shall be welded. Elbows and fittings should be kept to a minimum and, where used, should be of the preformed welding type.

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

d. Brackets or supports shall be used to provide rigidity to the piping and to support it if any section or component is removed for servicing.

e. In cargo tanks constructed of aluminum alloys, all joints in and to tank shells, heads and bulkheads shall be welded. All welded aluminum joints shall be made in accordance with recognized good practice, and the efficiency of a joint shall not be less than 85 per cent of the annealed properties of the material in question. 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 American Society for Testing and Materials Specification No. B285-62T (American Welding Society Specification No. A5.10-62).

613. Test:

a. At the time of manufacture every cargo tank shall be tested by a minimum air or hydrostatic pressure of 3

pounds per square inch 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 minutes, during which, if the test is by air pressure, the entire exterior surface of all the joints shall be coated with a solution of soap and water, heavy oil, or other material suitable for the purpose, foaming or bubbling of which will indicate the presence of leaks. Hydrostatic pressure, if used, shall be gauged 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 above described, or by any other method, shall be deemed as evidence of failure to meet the requirements of this specification.

614. Tank Outlets:

- a. Outlets shall be substantially made and so attached to the tank.
- b. Sight glasses (to determine water condensation quantities) at sump drains shall not be permitted.

615. Bulkheads and Baffles:

a. Bulkheads:

(1). Aircraft fuel servicing tank vehicles used solely on an airport shall not be required to have bulkheads or compartments except that the airport authority having jurisdiction may consider the need for compartments to limit the amount of spill which might result from a tank rupture. Where bulkheads or compartments are used in a cargo tank having a total capacity in excess of 3,000 gallons, no one compartment should exceed 2,500 gallons (with a construction tolerance of 10 per cent for capacities of individual compartments or tanks).

(2). Cargo tanks with compartments carrying different types of aviation fuel or different grades of the same type of fuel shall have an air space between compartments. Such air spaces shall be equipped with drainage facilities which are maintained in operative condition at all times. Each compartment carrying a different grade of fuel shall have independent delivery systems to dispense the fuels.

b. Baffles:

(1). Every cargo tank, and every compartment over 90 inches in length shall be provided with baffles, the num-

ber of which shall be such that the linear distance between any two adjacent baffles, or between any tank head or bulkhead and the baffles nearest it, shall in no case exceed 60 inches.

(2). The cross sectional area of each baffle shall be not less than 80 per cent 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.

616. Vents

a. Normal Venting

(1). Each cargo tank or tank compartment shall be provided with a normal vent or vents having a minimum through area of .44 square inches. The pressure vent shall be set to open at no more than 1 psig. Pressure and vacuum vents shall be designed to prevent loss of liquid through the vent in case of vehicle upset.

(2). If the tank is designed to be loaded or unloaded with the dome cover closed, the vent or vents shall be designed to limit the vacuum to one pound per square inch and the tank pressure to 3 psig on the basis of the maximum product transfer rate. Unless effective protection against overflowing is made, the pressure vent must also have sufficient liquid capacity to prevent the pressure from exceeding 3 psig in case of accidental overflowing. The pressure vent may be pressure operated or mechanically interlocked with the tank valve.

NOTE: Normally a vent will handle approximately 25 to 30 times as much vapor as liquid.

b. Emergency Venting for Fire Exposure.

(1). **Total Capacity.** Each cargo tank or tank compartment shall be provided with one or more devices with sufficient capacity to limit the tank internal pressure to 5 psig. This total emergency venting capacity shall be not less than that determined from Table 1, using the external surface of the cargo tank or tank compartment as the exposed area.

(2). **Pressure-Actuated Venting.** Each cargo tank or tank compartment shall be equipped with pressure-actuated vent or vents set to open at not less than 3 psig. The minimum venting capacity for pressure-actuated vents

TABLE 1
MINIMUM EMERGENCY VENT CAPACITY IN CUBIC FEET
FREE AIR/HOUR (14.7 PSIA AND 60°F.)

| Exposed Area Square Feet | Cubic Feet Free Air per Hour | Exposed Area Square Feet | Cubic Feet Free Air per Hour |
|-----------------------------|------------------------------------|-----------------------------|------------------------------------|
| 20 | 15,800 | 275 | 214,300 |
| 30 | 23,700 | 300 | 225,100 |
| 40 | 31,600 | 350 | 245,700 |
| 50 | 39,500 | 400 | 265,000 |
| 60 | 47,400 | 450 | 283,200 |
| 70 | 55,300 | 500 | 300,600 |
| 80 | 63,300 | 550 | 317,300 |
| 90 | 71,200 | 600 | 333,300 |
| 100 | 79,100 | 650 | 348,800 |
| 120 | 94,900 | 700 | 363,700 |
| 140 | 110,700 | 750 | 378,200 |
| 160 | 126,500 | 800 | 392,200 |
| 180 | 142,300 | 850 | 405,900 |
| 200 | 158,100 | 900 | 419,300 |
| 225 | 191,300 | 950 | 432,300 |
| 250 | 203,100 | 1,000 | 445,000 |

NOTES: Interpolate for intermediate sizes.

The venting capacities have been calculated on the basis of 75% of the square feet of the total exposed area of the cargo tank, using the formulas for heat input contained in the NFPA Flammable and Combustible Liquids Code (No. 30). The derivation of these formulas is also explained in NFPA No. 30.

shall be 6,000 cubic feet of free air per hour (14.7 psia and 60°F.) at 5 psig. Pressure-actuated devices shall be designed so as to prevent leakage of liquid past the device in case of surge or vehicle upset but shall function in case of pressure rise when in upset position.

(3). **Fusible Venting.** If the pressure-actuated venting required by (2) does not provide the total venting capacity required by (1), additional capacity shall be provided by adding fusible venting devices each having a minimum area of 1.25 square inches. The fusible vent or vents shall be actuated by elements which operate at a temperature not exceeding 250°F. when the tank pressure is between 3 and 5 psig. When fusible venting devices are used no less than two such devices shall be used on any cargo tank or tank compartment over 2,500 gallons in capacity, and at least one such device shall be located close to each end of the cargo tank or tank compartment.

c. Flow Testing and Marking of Vents.

(1). Each venting device shall be flow tested in the ranges specified in the applicable preceding paragraphs. The actual rated flow capacity of the vent in cubic feet of free air per hour at the pressure in psig at which the flow capacity is determined shall be stamped on the device. The fusible vent or vents shall have their flow rating determined at 5 psig differential.

NOTE: For purposes of calibration, the venting devices may be tested with water or other media. When water is used, the cubic feet of air per hour may be considered to be 27 times the cubic feet of water per hour.

(2). These flow tests may be conducted by the manufacturer, if certified by a qualified impartial observer, or may be delegated to an outside agency.

NOTE: Information on suitable methods for conducting such tests is provided in API RP — 2000, available from the American Petroleum Institute, 1801 K Street, N.W., Washington, D.C. 20006.

d. Location of Vents.

(1). Vents should be located near the center of the tank or compartment to minimize surge spillage when the vehicle is stopping or accelerating.

617. Fill Openings and Top Flashing:

a. Filler opening dome covers shall be provided with a forward mounted operating hinge, self-latching catches to hold the cover closed, and fitted with water-tight seals or gaskets designed to prevent spillage or leakage from overturn or the weather.

b. Flashing shall be provided around filler opening dome covers to prevent spilled fuel from draining near possible sources of ignition including the engine, the engine exhaust system, electrical equipment or into any portion of the vehicle housing auxiliary equipment.

c. The tank filler openings shall be protected against overturn damage by a rigid member or members firmly fixed to the tank and extending a minimum of 1 inch above any dome cover, handle, vent opening or projection of the unit. Overturn protection shall be adequately braced to prevent

collapse. Where overturn protection creates a trough or pocket apt to collect rain water or snow, it should have a drain that is either exterior to the cargo tank or one that complies with 618.e.

618. Outlet Valves and Emergency Shutoff Controls:

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

b. 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 fire or other emergency. There shall be at least two quick-acting emergency tank outlet valve shut-off controls, remote from each other (preferably on opposite sides of the vehicle) and from the fill openings and discharge outlets, which can be conveniently operated from a ground level standing position. In addition, all vehicles equipped with a top deck platform shall have an emergency tank outlet valve shut-off control conveniently accessible from the deck.

c. Each discharge valve shall be provided with a standard fusible device which will cause the valve to close automatically in case of fire.

d. In every case there shall be provided, between shut-off valve seats and discharge outlets, a shear section which will break under strain unless the discharge piping is so arranged as to afford the same protection and leave the shut-off valve seat intact.

e. All openings into cargo tank compartments connected to pipe or tubing (which extends through the cargo tank and where such tubing is subject to undetected breakage or failure) shall be plugged unless the pipe or tubing is 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. Such valves should be located inside the tank or, if outside

the tank, should be equipped with a shear section as described in 618.d.

f. All emergency tank outlet valve shut-off controls shall be outlined by a contrasting color panel, such as high visibility yellow, at least one foot square. These controls shall also be indicated by the words "EMERGENCY SHUT-OFF" in letters at least two inches high. Method of operation shall be indicated by an arrow or the words "PUSH" or "PULL" as appropriate. The word "EMERGENCY" shall not be used in the identification of any control or device other than the tank outlet valve shut-off controls.

g. Where a deadman valve is used to monitor aircraft fueling, the time of closure shall assure a minimum "overshoot" while minimizing surge pressure upstream of the deadman valve. "Overshoot" is defined as the quantity of fuel passing through the valve after the deadman control is released. Where the valve closure may be affected by low downstream pressure, "overshoot" shall be determined with a reduction of downstream pressure such as would result from a major line break.

619. Hose, Nozzles and Pumps: (See also Part V)

a. Nozzles used for over-wing fueling shall be so designed that the operator must hold the valve open by hand to allow fuel to flow. The use of any device which permits flow of fuel when the hand of the operator is removed from the nozzle control shall be prohibited. Any notches in the handles of over-the-wing fuel dispensing or defueling hose nozzles shall be filed down or otherwise modified to prevent locking the nozzles open.

b. Underwing nozzles shall be designed so that they must be securely and completely seated in the mating connection on the aircraft before the poppet valve can be opened. It shall not be possible to disengage the nozzle from the aircraft fitting until the poppet valve is fully closed.

c. Aircraft fuel servicing tank vehicles equipped for underwing fueling shall be provided with a deadman controlled fuel shutoff. The location of the deadman control shall correspond to the position of the fuel service man during normal aircraft fueling procedures. The deadman control

operation shall stop flow in the minimum time compatible with maintaining upstream surges within reasonable limits. If a valve is used, a screen should be provided on the supply side of such valve to trap foreign material that could lodge in the valve and prevent complete closure. The use of any device which permits overriding the deadman control is prohibited.

Note: On hydrant vehicles, the deadman control of the hydrant valve provides similar protection.

d. The fuel servicing pump shall be driven from the motive power engine by means of electrical, hydraulic or mechanical drive. Direct drive through a solid shaft or universal is desirable. If belt drive is used, cogged belts and pulleys are recommended in preference to ordinary "V" belts and pulleys. Fuel servicing pump drive mechanisms shall be arranged to prevent rupture of the pump housing in event of pump failure or seizure. It is recommended that fuel pressure be controlled within the stress limits of the hose and plumbing by means of either an engine speed controller or a system pressure-relief valve. The rated working pressure of any system component shall equal or exceed any pressure, including surge pressure, to which it may be subjected.

NOTE: Valves and plumbing should be designed to minimize surges when the nozzle closes.

e. On tank full trailer or tank semi-trailer units the use of a pump on the tractor unit with flexible connections to the trailer shall be prohibited unless:

(1). 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

(2). The cargo tank discharge valves required by 618. are arranged to be normally closed and to open only when the brakes are set and a control is held manually by an operator. The manual control must be of the "deadman" type so that the valves will close at once if the control is released.

f. Where provided, hose reels shall be of sufficient size for the length and diameter of the hose to be used.

g. Hose shall be connected to rigid piping or coupled

to the hose reel in a manner which will prevent undue bending action or mechanical stress on the hose or hose couplings.

NOTE: A padded "U" bolt (with a minimum 1-in. curvature) or reel stop is a satisfactory method to accomplish this objective on reels. On rigid piping, springs or swivel connections may be employed.

h. Aircraft fuel servicing vehicles which may be used for underwing fueling shall be equipped so that the vehicle cannot be driven away when the hose is connected to the aircraft.

620. Fuel Servicing Vehicle Chassis, Assembly, Protection Systems and Equipment:

621. Tires:

a. All aircraft fuel servicing vehicles shall be equipped with rubber tires on all wheels.

622. Assembly:

a. Every cargo tank shall be adequately supported upon and securely attached to or be a part of the tank vehicle upon which it is carried.

623. Static Protection:

a. Cargo tanks, and vehicle chassis, shall be electrically bonded.

b. Drag chains or straps are not recommended.

c. Provision shall be made in the tank structure of the vehicle for the bonding of vehicle to the fill pipe during truck loading operations.

d. A static discharge cable shall be provided to enable grounding and bonding during aircraft servicing as recommended in Part II, Section 220.

e. There shall be attached to each over-the-wing hose nozzle a cable with clamp or plug to provide for the bonding connection as recommended in Part II, Section 220.

f. Conductive type fuel hose is not an acceptable method of securing static bonding or grounding.

624. Protection Against Collision:

a. Drawoff valves or faucets projecting beyond the

frame at the rear of a tank vehicle shall be adequately protected against collision by bumpers or similar means.

625. Vehicle Lighting and Electrical Equipment:

a. All wiring shall be fully insulated, adequately supported, and protected against chaffing. Terminal connections shall be firmly attached with snap or screw-type connections. Wiring shall be sized to provide sufficient current-carrying capability and mechanical strength. All circuits shall have overcurrent protection.

b. Equipment contained in the engine compartment or vehicle cab and located 18 inches or more aboveground may be of the general-purpose type. Spark plugs and other terminal connections shall be suitably insulated to prevent sparking in the event of contact with conductive materials.

c. All motors, alternators, or generators and associated control equipment located outside of the engine compartment or vehicle cab shall be of a type approved for use in Class I, Group D, Division 1 hazardous locations.*

d. Electrical equipment and wiring located within a closed compartment shall meet the requirements for Class I, Group D, Division 1 hazardous locations.* Adequate air circulation shall be provided in closed compartments to prevent overheating.

e. Electrical service wiring between the tractor and cargo tank on a semi-trailer vehicle shall be designed for heavy-duty service. The cable shall mate with a multi-connector plug terminal mounted on the cargo tank. The connector shall have a positive engaging device (e.g., twist-lock or screwed coupling collar).

f. Lamps and switching devices, other than those covered in Paragraphs 625.b. and d., shall be of the enclosed and gasketed type which are of weather-tight construction. Electrical wiring shall be in metallic raceways, aluminum sheathed cable (Type ALS), or mineral insulated cable (Type MI). Other electrical components shall be designed to meet the requirements for Class I, Group D, Division 2 locations.*

*For further information, see National Electrical Code (NFPA No. 70-1971; ANSI C1-1971).

626. Vehicle Fuel System:

a. Vehicle fuel tanks shall be so designed, constructed and installed as to present no unusual hazard and no part of any fuel tank or container or intake pipe shall project beyond the over-all width of any tank vehicle upon which it is mounted. Fuel tanks mounted outside the frame of the vehicle, or in exposed locations shall be of the approved type. All fuel tanks shall be so arranged as to vent during filling operations and to permit drainage without removal from their mountings.

b. The use of a gravity feed fuel system shall be prohibited.

c. All portions of the fuel-feed system, including carburetor, pumps, and all auxiliary mechanisms and connections shall be constructed and installed in a workmanlike manner, and so constructed and located as to minimize the fire hazard, with no readily combustible materials used therein, and shall, except for Diesel fuel connections, be well separated from the engine exhaust system. A pressure-release device shall be provided where necessary. The fuel-feed lines shall be made of materials not adversely affected by the fuel to be used or by other materials likely to be encountered, of adequate strength for their purpose and well secured to avoid chafing or undue vibration. Joints depending upon solder for mechanical strength and liquid tightness shall not be used in the fuel system at or near the engine, or its accessories, unless the solder has a melting point of not less than 340°F., or unless a self-closing, thermally controlled valve set to operate at not exceeding 300°F., or other equivalent automatic device, shall be installed in the fuel line on the fuel-tank side of such joint.

d. The engine air intake shall be equipped with an effective flame arrester or an air cleaner having effective flame arrester characteristics, substantially installed and capable of preventing emission of flame from the intake side of the engine, in event of backfiring.

e. When provided, the sediment bowl in the fuel supply line shall be of steel or of materials of equivalent fire resistance.

627. Exhaust System:

a. The exhaust system, including muffler (or silencer) and exhaust line shall have ample clearance from the fuel system and combustible materials, and shall not be exposed to leakage or spillage of product or accumulations of grease, oil or gasoline.

b. The exhaust system, including all units, shall be constructed and installed in a workmanlike manner. A muffler (or silencer) cutout shall not be used.

c. No portion of the exhaust system shall be located beneath or near the servicing platform, or any part of the cargo delivery system. Where required, adequate shielding shall be installed so that fuel spillage from the cargo tank vent, or overflow systems, cannot come in contact with the exhaust systems.

628. Vehicle Brakes:

a. Vehicle brakes shall be of acceptable commercial quality for this type of vehicle service.

b. Each full trailer, and semi-trailer, shall be equipped with reliable brakes on all wheels, and adequate provision shall be made for their efficient operation from the driver's seat of the vehicle drawing the trailer, or semi-trailer.

629. Full Trailers and Semi-Trailers:

a. Trailers shall be firmly and securely attached to the vehicle drawing them, in a manner conforming with recognized good practice.

b. Trailer connections shall be such as to prevent the towed vehicle from whipping or swerving from side to side dangerously or unreasonably and shall cause the trailer to follow substantially in the path of the towing vehicle.

630. Cabinets Housing Vehicle Auxiliary Equipment:

631. All cabinets housing vehicle auxiliary equipment shall have expanded metal, perforated metal or grating type flooring to facilitate air circulation within the enclosed space and to prevent accumulation of spilled liquid or other combustible materials.

640. Fire Extinguishers for Aircraft Fuel Servicing Vehicles:

641. Extinguishers shall comply with the Standard for the Installation of Portable Fire Extinguishers (NFPA No. 10, ANSI Z112.1).

642. There shall be at least two extinguishers mounted on each aircraft fuel servicing vehicle. Each extinguisher shall have a rating of not less than 20-B. At least one extinguisher shall be readily accessible from either side of the vehicle. Extinguishers shall be mounted in a location remote from probable fire hazards.

643. Extinguishers should be protected from ice, snow, etc., by canvas covers, enclosed compartments or other suitable means where necessary. Extinguishers located in enclosed compartments shall be readily accessible and their location shall be clearly marked in letters at least 2 inches high.

644. Fire equipment provided on aircraft fuel servicing vehicles may be used to augment equipment required for protection of fueling operations (see Paragraph 289 in Part II).

650. Operation of Fuel Servicing Vehicles

651. Fueling and Defueling of Aircraft. Refer to Parts I, II, and III of this Standard for procedures for aircraft fueling and defueling.

652. Maintenance.

a. Aircraft fuel servicing vehicles shall not be operated unless they are in proper repair and free of accumulations of grease, oil, or other combustibles in other than normal storing and transfer tanks and lines.

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

653. Filling and Discharging:

a. An attendant shall be present and shall observe filling operations at all times and shall not block open or render inoperative any safety control equipment supplied (see Section 670).

b. The motor of tank vehicles shall be shut down during cargo tank and vehicle fuel tank filling operations.

654. Smoking and Open Flames:

a. No open flames shall be allowed within 50 feet of fuel servicing equipment including:

- (1) Lighted cigarettes, cigars, pipes, etc.
- (2) Exposed flame heaters, snow-melters (liquid, solid, or gaseous devices, including portable and wheeled gasoline or kerosene heaters).
- (3) Welding or cutting torches, blowtorches, etc.
- (4) Flare pots or other open flame lights.

b. A "NO SMOKING" sign shall be displayed prominently in the cab of every aircraft fuel servicing vehicle.

c. Smoking equipment such as cigarette lighters and ash trays shall not be installed. If vehicle has such equipment when initially procured, it must be removed or rendered inoperable.

655. Fuel Servicing Vehicle Garaging: Aircraft fuel servicing vehicles shall not be stored, parked, or serviced in hangars or any other building not specifically approved for such purposes.

656. Parking Fuel Servicing Vehicles. Parking areas for aircraft fuel servicing vehicles shall be arranged to:

- a. Facilitate dispersal of the vehicles in event of emergency;
- b. Provide reasonable accessibility for fire control purposes;
- c. Prevent any leakage from draining to an adjacent building;
- d. Minimize exposure to damage from out-of-control aircraft; and
- e. Provide at least 50 feet from any airport terminal building, aircraft cargo building, aircraft hangar, or other airport structure housing the public which have windows or doors in the exposed walls.

660. Marking:

661. Each aircraft fuel servicing vehicle shall be conspicuously and legibly marked to indicate the nature of the cargo. The marking shall be on each side and the rear

thereof in letters at least 3 inches high on a background of sharply contrasting color, optionally, as follows:

a. With a sign or lettering on the vehicle with the word **FLAMMABLE**, or

b. With the name **GASOLINE**, or the name of the fuel being handled.

670. Tank Vehicle Loading:

671. Top loading or overhead loading of tank trucks will be done by:

a. Filling the vehicle cargo tank shall be under the control of an operator at all times. A "deadman" type manual control shall be provided, located so that the operator can observe the liquid level in the tank.

b. 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 through atmosphere of the fuel, or

c. 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 overshoot or splash loading of the fuel.

d. Drop tubes used in top loading or overhead loading of tank vehicles shall have a diverter designed to minimize turbulence.

672. Bottom loading of the tank vehicle will be provided by:

a. Loading hose suitable for the service in accordance with Part V herein, equipped with swivel connections at each end as necessary to avoid kinks or sharp bends in the hose, or

b. Loading swing arms of metal supported by counterbalancing and having adequate flexibility by swivel joints to allow free movement for the changing level of the fuel vehicle connection in loading.

c. The hose or swing arm will terminate at the tank vehicle connection with a self-sealing, leak-proof dry-break

coupler which cannot be opened until it is securely engaged to the vehicle tank companion adapter. It shall not be possible to disconnect the hose coupler from the tank vehicle connection unless the internal valving of both components is fully closed.

d. The supply piping terminating at the loading hose or swing arm shall be supported in a manner to carry the load imposed by the hose or arm.

e. A shutoff valve, self-closing by manual or heat actuated release, shall be provided in the piping immediately upstream of the loading hose or swing arm connection.

f. Curbs or guards should be provided, if necessary, to prevent collision with and damage to the piping and fixed equipment by moving vehicles.

g. The bottom loading adapter of the tank vehicle shall be of self-sealing spring-loaded check valve type which will remain in closed position until opened by use of the companion coupler. The coupler and adapter, where feasible (usually not feasible for over-the-road type transports handling motor fuel), should be equipped with coded lugs or a mechanical device to prevent connection between equipment having different fuel assignments. The product selection position number shall be as follows: (1) AVGAS Grade 100/130; (2) Spare; (3) AVGAS Grade 115/145; (4) JET A or A-1 Aviation Turbine Fuel; (5) JET B Aviation Turbine Fuel or JP-4; (6) Spare.

h. To prevent overfilling, control of the maximum fill condition in the vehicle cargo tank shall be provided by a preset metered liquid control, a float actuated shutoff, a sensing or other automatic device, or by a deadman type manual control located at a position where the operator can observe the liquid level in the tank. Any liquid bled from a sensing device during loading shall be returned to the bottom of the cargo tank through a closed system.

i. Where maximum fill condition control is provided by liquid level device, a means of prechecking the level control system shall be incorporated using a manual valve. Prechecking shall check both the level sensing and shutoff device as an integral system operation. A visible means, such as a pressure gauge, shall be provided so that the operator will have a positive signal that the precheck works.

j. On fuel servicing tank vehicles equipped for bottom loading, the fill pipe and valving shall be such as to prevent the fuel spraying in the cargo tank and to minimize liquid turbulence. Inlet baffling may be used to accomplish this.

673. Emergency Remote Control Stations:

a. Each tank vehicle loading station shall be provided with an emergency shutoff system. This requirement is in addition to the deadman control required in Paragraph 671.a, for top loading and permitted in Paragraph 672.h, 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 should an emergency occur.

b. One or more emergency shutoff stations shall be provided.

c. The location of these control stations will depend upon local conditions but should be governed by consideration of the following:

(1). The stations should be located outside probable spill areas but as close as practical to the tank vehicle loading positions.

(2). The stations should be located near likely paths of egress of personnel from the tank vehicle loading area.

(3). The stations can well be combined with the location of other emergency equipment, such as portable or wheeled extinguishers.

(4). Each station location shall be placarded **EMERGENCY FUEL SHUTOFF** and indicate method of operation (e.g., PULL).

d. The emergency shutoff system shall be designed and constructed so that delivery of fuel will be shut off if an emergency shutoff station control is operated or if the control operating energy source fails.

Part VII

Airport Fixed Fueling Systems

700. General:

701. Scope:

a. This Part covers airport fixed fueling systems designed or employed in the transfer of standard grades of aviation fuel into or from an aircraft. It is intended to provide minimum fire safety recommendations for these systems.

b. The applicable portions of Parts I through VI shall be followed.

c. Each installation shall be studied individually to determine whether additional fire safety measures are necessary. Plans and specifications shall be approved by the authority having jurisdiction prior to commencing any work on the construction or alteration of a fixed fueling system.

710. Basic Considerations:

711. From a fire safety viewpoint, the basic considerations of an airport fixed fueling system are:

a. The service pressure to which the system and its components may be subjected shall not exceed the design pressure rating. Surge pressures may be controlled by the use of pressure regulating equipment, slow closing valves, surge suppressors and/or other devices properly placed in the system.

b. System components should be designed and installed in accordance with accepted industry safe practices.

c. System components should be designed and installed so as to permit safe operation without placing an abnormal demand on the abilities of operating personnel.

d. Emergency shutoff mechanisms should be installed as an integral part of the system. They should be so located as to be readily accessible in the event of an accident or spill.

e. Fuel dispensing equipment should include a dead-man type control.

f. Emergency control devices shall be so constructed and designed that they shall shut off the delivery of fuel upon operation or the failure of the operating energy.

g. Sources of ignition in the vicinity of the fueling operation should be controlled in accordance with the recommendations set forth in Part II and other portions of these recommendations.

h. Consideration should be given to the need for accessibility by emergency fire equipment as detailed in Paragraph 281 of Part II of these recommendations when establishing aircraft fuel servicing locations and laying out airport fixed fueling systems.

720. Fuel Storage and General Transfer:

721. Construction, Spacing and Location of Fuel Storage Tankage:

a. The construction and spacing of fuel storage tankage shall meet the requirements of NFPA No. 30* for Class I flammable liquids.

NOTE: 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.

b. The authority having jurisdiction shall determine the clearances required from the center line of airport runways to any aboveground fuel storage structures or fuel transfer equipment with due recognition given to national and international standards establishing clearances from obstructions. Tanks located in aircraft movement areas or aircraft servicing areas shall be of the underground type or mounded over with earth with depth and type of cover determined by consideration of aircraft wheel and impact loads. Vents from such tanks shall be constructed in a manner to minimize collision hazards with operating aircraft and the authority having jurisdiction shall be consulted as to the height and location of such

*Flammable and Combustible Liquids Code published in National Fire Codes and in pamphlet form.

vents with care to avoid venting flammable vapors in the vicinity of any existing ignition sources, including operating aircraft and automotive equipment permitted in the area.

c. When JET B turbine fuels are stored in bulk quantities in aboveground tanks, they should be stored in floating roof type tanks.

NOTE: Floating roof tanks eliminate the hazardous flammable vapor-air space above the liquid level until the liquid level falls to a point where the roof rests on the roof supports.

d. The vapor spaces of underground tanks storing JET B turbine fuels should not be interconnected.

722. Types of Fuel Transfer Systems: Fuel transfer may normally be accomplished by any one of three methods: (1) pumping, (2) gravity, or (3) hydraulic or inert gas pressure on the storage tank. Regardless of the method employed, means for controlling flow in event of emergency is necessary and shall be provided.

a. 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.

b. 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.

c. Hydraulic or inert gas transfer, by applying pressure on the storage tanks, imposes some of the same conditions as are present in the gravity system and a safety shutdown should include a valve or valves located as close to the tank as practicable. Proper design and engineering should include consideration of means to relieve hydraulic or gas pressure from the system in case of an emergency.

723. Transfer Piping:

a. Locate transfer piping outdoors. Underground piping shall be used in the vicinity of aircraft traffic zones unless the piping is protected by a substantial barrier guard.

b. Fuel piping shall not run under buildings or passenger loading fingers (excluding movable loading bridges) except when run in buried steel casings enclosing only the fuel piping. Piping shall be protected by suitable sleeves or casings where necessary to protect the pipe from shock hazards or where it crosses sewer manholes, service tunnels, catch basins or other underground services. Piping should be laid on firm supports using clean, noncorrosive, backfill. Corrosion protection shall be provided where necessary.

NOTE: Running piping containing Class I flammable liquids in tunnels, even when used exclusively for such piping, is inadvisable because of the likelihood of formation of flammable vapor-air mixtures in the confined space should a leak occur.

c. Piping, valves and fittings shall be of metal, suitable for aviation fuel service, and designed for the working pressures and mechanically and thermally produced structural stresses to which they may be subjected. The minimum requirements of the American National Standards Institute Code for Pressure Piping, Petroleum Refinery Piping (B31.3-1966) shall be used as a basic guide. Deviations may be authorized by the authority having jurisdiction when engineering data can be presented to justify such deviations.

(1). Cast-iron piping and fittings shall not be used where subject to fire exposure.

(2). Aluminum piping and fittings may be used subject to the approval of the authority having jurisdiction.

(3). In the selection of pipe, valves and fittings, the following shall be given consideration:

(a). Service pressure (including surge pressures).

NOTE: Where surge suppressors are necessary they should be located so that exposure to vehicular traffic, weather conditions and results of accidental rupture is minimized.

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

(c). Allowance for internal and external corrosion with the external corrosion protection evaluated based on the type of corrosion protection system used, if any, and

internal corrosion considered in connection with purity of the fuel handled.

- (d). Impact stresses.
- (e). Method of fabrication and assembly.
- (f). Location of piping and accessibility for repair or replacement.
- (g). Possibility of mechanical, atmospheric or heat (fire) damage to exposed pipe, valves and fittings.
- (h). Expected period of service and effect of future changes in fuel specifications on materials used.

(4). Gaskets in flanged connections should resist fire temperatures for a time period comparable to the flange and bolts. Spiral-wound or other metallic asbestos-filled gaskets of stainless steel or Monel and all metal zero ring gaskets of dead-soft aluminum or Monel are suitable.

(5). Provide allowances for thermal expansion and contraction by the use of pipe bends, welding elbows or other flexible design. Provide hydrostatic relief valves in long lines which may be valved off.

(6). Welded joints should be made up by qualified welders, under close supervision, and with all necessary safeguards observed. Provide flanged connections for ease of dismantling and to avoid cutting and welding after the system has been placed in service.

730. Valving:

731. System Component Isolation: Isolation valves or devices shall be provided to minimize the quantities of fuel which will be released when it is necessary to dismantle portions of the fueling system for maintenance purposes. The location of these 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.

When a valve is closed for maintenance purposes, it shall be placarded until the maintenance work has been completed.

NOTE: The valve called for in Paragraph 731.e., may be omitted if the flow regulator or pressure control valve is located at or beneath the hydrant valve and an isolation valve is installed on the hydrant lateral, on the supply side of both valves.

732. Hydrant Valves:

a. In addition to the isolation valve specified in Paragraph 731.d., each hydrant shall be so designed that the flow of fuel shall be shut off when the hydrant coupler is disconnected or when the hydrant valve fails due to impact or tension loads beyond its design strength.

b. Except in systems having not over 3 outlets and a flow rate of not over 60 gallons per minute per outlet, each hydrant shall have a deadman type, shutoff valve. The location of the deadman control shall correspond to the position of the fuel serviceman during normal aircraft fueling procedures. Where a deadman valve is used, the time of closure shall assure a minimum "overshoot" while minimizing surge pressure upstream of the deadman valve. "Overshoot" is defined as the quantity of fuel passing through the valve after the deadman control is released. Where the valve closure may be affected by low downstream pressure, "overshoot" shall be determined with a reduction of downstream pressure such as would result from a major line break. The shutoff valves, which may be an integral part of the hydrant valve, should be located as close as possible to each fuel hydrant on the supply side thereof, but shall not be positioned so the valves could be rendered inoperative by a surface accident, spill or malfunction which could necessitate shutdown of the system by the remote control devices. A screen should be provided on the supply side of these valves to trap foreign material that could lodge in the valves and prevent complete closure.

733. Emergency Shutoff System:

a. Every hydrant fueling system must have a means for quickly and completely shutting off fuel flow in an emer-