NFPA No.

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AIRCRAFT FUEL SERVICING 1967

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Official NFPA Definitions

Adopted Jan. 23, 1964. Where variances to these definitions are found, efforts to eliminate such conflicts are in process.

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SHOULD is intended to indicate recommendations or that which is advised but not required.

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Units of Measurements

Units of measurements used here are U. S. standard. 1 U. S. gallon = 0.83 Imperial gallons = 3.785 liters. One foot = 0.3048 meters. One inch = 25.40 millimeters. One pound per square inch = 0.06805 atmospheres = 2.307 feet of water. One pound = 453.6 grams.

Standard for

Aircraft Fuel Servicing

Including Recommendations on

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

NFPA No. 407 — 1967

1967 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 by the NFPA at its 1967 Annual Meeting held May 15-19 in Boston, Mass. The present text supersedes the 1966 Edition.

The changes made in this edition altering the 1966 text include revisions or new material to the title and to Paragraphs 121, 224 (Note), 221.e., 223.a., 224 (new), 261, 262, 513, 616.d. (new), 618.e., 627.c., 673.c.(4)., 711.a., 721.c. (Note), 723.a., 723.c., 723.c.(3)., 723.c.(3).(a)., and the caption to Figure 2A. Some of these revisions are editorial in nature while others represent significant changes or additions.

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 every year since 1955. This is thus the Thirteenth 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.

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Standard for

Aircraft Fuel Servicing

Including Recommendations on

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

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Part I. General

100. Scope:

101. These recommendations are intended to apply to the fuel servicing of all types of aircraft on the ground. They do not apply to airborne refueling or to fueling of flying boats on the water.

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 gives recommendations on 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 sets forth recommendations on Airport Fixed Fueling Systems. Appendix A gives information on the fire hazard properties of aviation fuels.

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 the same safety precautions 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 NFPA Standard on Airport Ramp Fire Hazard Classifications and Precautions (No. 411) 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 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.

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*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. Related NFPA Publications.

121. 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 (USA Standard 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. (USA Standard A54.1). Standard on Carbon Dioxide Extinguishing Systems.

e. NFPA No. 15. Standard on Water Spray 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 (USA Standard 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. 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. 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)

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 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 minimum rating of 20-B (see 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 ignitible mixtures with the air near the surface of the liquid whereas this condition does not normally exist with kerosene fuels (JET A or JET A-1) except where ambient temperatures are 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 fuels 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 fuels (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 clean 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*:

221. Over-the-Wing Fuel Servicing: During over-the-wing 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. (Note: 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.

NOTE: See paragraph 224 for light aircraft servicing.

a. Procedures with Aircraft Fuel Servicing Vehicles: When aircraft fuel servicing vehicles are used for over-the-wing fuel servicing the following specific procedures apply (see Figure 1):

(1). Connect a grounding cable from the vehicle to a satisfactory ground.

(2). Connect a grounding cable from the ground to the aircraft (on landing gear axle or other convenient unpainted metal part, excluding propeller or radio antenna).

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*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.

(3). Connect a bonding cable from the vehicle to the aircraft. (Do not depend solely on conductive hose to accomplish this bonding.)

NOTE: The most practical way of accomplishing Items (1) to (3) is to use a "Y" or "V" cable permanently connected to the vehicle.

(4). Connect a bonding cable from the fuel nozzle to the aircraft.

(a) 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 "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).

(b) 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 cap 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: Disconnect in reverse order on completion of fuel servicing.

b. Procedures with Fueling Hydrants, Pits or Cabinets: When a hydrant, pit or cabinet is used for over-the-wing 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:

(1). Connect a bonding cable from a satisfactory bonding connection at the dispenser to the aircraft. (Do not depend solely on conductive hose to accomplish this bonding.)

(2). Connect a bonding cable from the fuel nozzle to the aircraft. [Follow same instructions as given in Paragraph 221.a.(4)(a) or (b)].

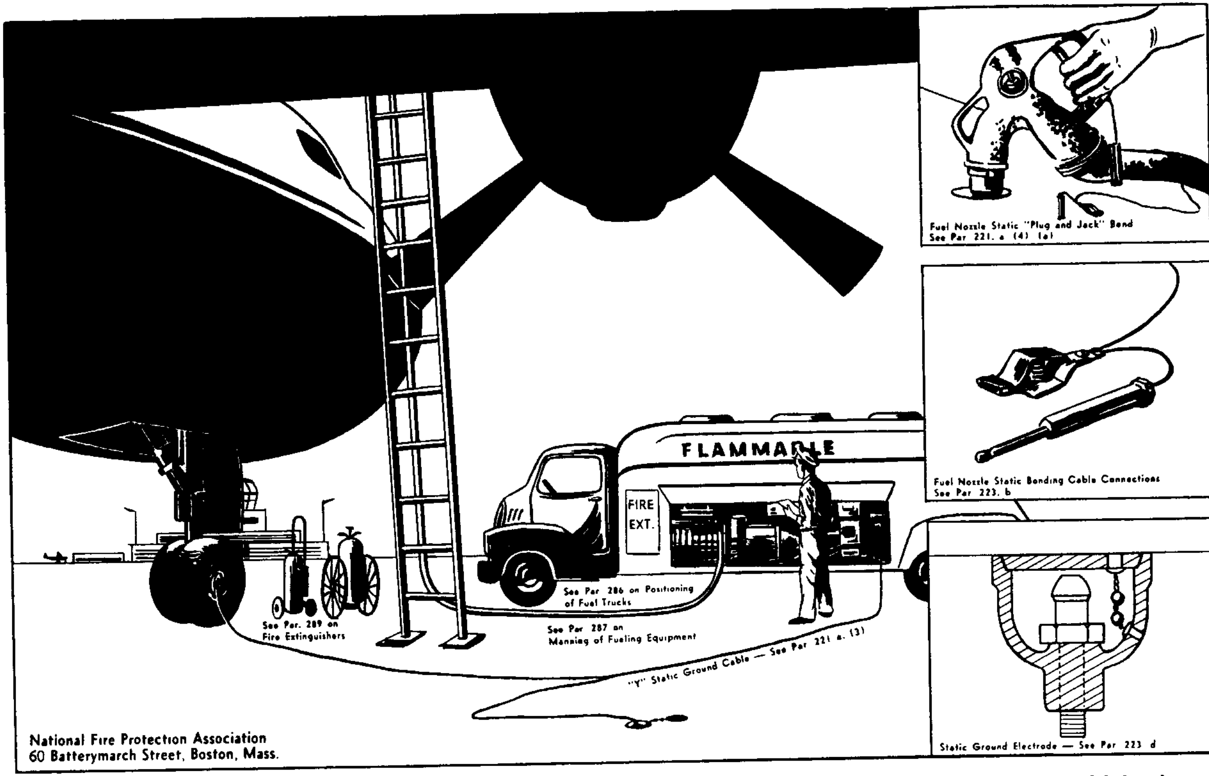

Figure 1. A typical over-the-wing fuel servicing operation from an aircraft fuel servicing tank vehicle showing static grounding and bonding recommendations and certain other details.

NOTE: Disconnect in reverse order on completion of fuel servicing.

(3). Where mobile dispensing carts are used in connection with fixed fueling equipment, they shall be grounded as required for conventional aircraft fuel servicing vehicles.

c. **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.a. shall be followed. Gasoline and other low flash point flammable liquids shall not be handled in open buckets.

d. **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 aircraft and the fuel dispenser shall be connected by a bonding cable and the procedures described in Paragraph 221.a. (4). followed. 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.

e. **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.a.(4).(b). 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.

f. **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.

222. Under-Wing Fuel Servicing. With under-wing 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. Bonding and grounding of the aircraft and fuel servicing vehicle (see Paragraph 221) is still required.

223. 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 ½-inch to ¾-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 223.f. and Figure 1.)

e. An adequate number of suitable grounding connec-

Methods of Measuring Resistance to Ground
Reference: Paragraph 223. 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 —

$$R_1 = \frac{A + B - C}{2} \qquad R_2 = \frac{A + C - B}{2} \qquad R_3 = \frac{B + C - A}{2}$$

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.

tions 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.

224. 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.

230. Aircraft Engines and Heaters:

231. Fuel servicing shall not be done on an aircraft until the aircraft's engines (or engine) have been stopped (ignition OFF).

> NOTE. 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.

232. 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.]

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*, USA Standard C1).

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

255. Photo flash bulbs shall not be used in the immediate vicinity of the aircraft during fuel servicing.

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

†For industrial tractors see NFPA Standard for Type Designations, Areas of Use, Maintenance and Operation of Powered Industrial Trucks (NFPA No. 505); for other vehicles, see NFPA Truck Fire Protection (NFPA No. 512); both published in National Fire Codes and in separate pamphlet form.

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.** All aircraft fuel servicing shall be done outdoors. It is recommended that aircraft be so positioned that aircraft fuel vents or fuel tank openings should be not closer than 50 feet from any terminal building, hangar, service building or enclosed finger (other than movable loading bridges) to minimize the danger of ignition of flammable vapors discharged during fueling operations by sources of ignition likely to exist in such buildings. 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 but where necessary suitable lanes shall be left to assure accessibility by emergency fire equipment.

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 aboard an aircraft during fueling, an attendant shall be present at the cabin door and passenger loading steps shall remain in place. 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.e. (3).]. Portable extinguishers shall comply with the Standard for the Installation of Portable Fire Extinguishers (NFPA No. 10, USA Standard Z112.1).*

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*Published in National Fire Codes and in pamphlet form.

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 ½ 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, USA Standard A54.1)*

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

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

*Published in National Fire Codes and in pamphlet form.

(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.e. (3).] 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).*

*Published in National Fire Codes and in pamphlet form.

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.*

*The Flight Safety Foundation (468 Park Avenue, South, New York, New York 10016) has published a helpful booklet for training purposes under the title "Aircraft Fueling Up to Date." Copies of this booklet are available from the FSF for 75 cents a copy with discounts for quantity orders in excess of 500. The National Safety Council publishes "Safetygraph No. 31" on "Aircraft Fuel Servicing" which is a helpful training aid covering this subject.

Part V

Aircraft Fueling Hose

500. General:

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

502. Principal reasons for failure of aircraft fueling hoses are the development of product surge pressures beyond the designed working pressures of hose; mishandling, such as dragging hose over rough surfaces; flattening or crushing by vehicles; continual exposure to severe weather; lifting hose to wing of aircraft with excessive end pull; dropping hose to ground from aircraft wings or truck platforms; and sharp bending or kinking of hose. In the past, splicing of hose on reels by inserting rigid pieces of pipe or makeshift field repairs of hose have been other causes for fueling hose failures. Sudden opening and closing of valves creating surge pressures in the hose have caused leaks at weaker points.

503. Only fueling hose specifically built for aircraft fuel servicing shall be used. Fueling hoses shall be in continuous lengths 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 any necessary length, the number of hose sections shall be held to an absolute minimum. All couplings shall be standard male and female screw couplings and be affixed by machine or be of equivalent dependable design.

504. Aircraft fueling hose above 2 inches 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.

512. Fueling hose shall be designed for a *minimum* working* pressure of not less than 125 pounds per square inch and shall have a *minimum* burst pressure of 650 pounds per square inch. Coupled new hose assemblies shall not burst, leak or develop cover blisters when subjected to a proof pressure of 250 pounds per square inch.

513. Each length of fueling hose shall have at least one inlaid label which shall furnish the manufacturer's name or trademark, date of manufacture (quarter and year), material specification number, the working pressure of the hose and the lot identification number. Where hose length exceeds 25 feet, labels as described herein shall be provided at intervals of 25 feet or less.

520. Fuel Hose Inspection Procedure:

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

a. Daily 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 fabric or abrasions which expose fabric shall be cause for immediate removal and scrapping of the hose.

(2). Carefully check 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

*The working pressure means the maximum normal surge pressure for which the hose is designed. The working pressure shall not be greater than 20 percent of the minimum design burst pressure. All surge pressures shall be measured at the nozzle.

recoupled but a satisfactory hydrostatic test should be made before it is returned to service.

(3). Examine the hose while completely extended for about 12 inches immediately behind each coupling. Check for structure weakness 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 unnatural 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 and discarded or pass a satisfactory hydrostatic test before being returned to service. Repeat inspections as in 521. a. (1), (2) and (3) above.

(5). If a hose is damaged by outside mechanical means, it shall be withdrawn from service immediately. If on inspection it is determined that the undamaged 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 but a satisfactory hydrostatic test should be made before it is returned to service.

(6). 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 fabric braids are cut.

b. 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 once or twice during the first week of use may not be serious. However, the occurrence of 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.

530. Fuel Hose Hydrostatic Test Procedure:

531. The following hydrostatic test procedures are given to guide those interested in conducting such tests. (For full details consult the Standard Methods of Testing Rubber Hose (D380-59) published by American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa.).

a. Connect the hose to a hydrostatic test pump capable of producing 500 psi. 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 water into the hose (at main pressure) 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 water, and all the air is eliminated (which will be indicated by a solid stream of water from the vent) close the vent valve. (Mineral spirits or stoddard solvent may be used instead of water where desired and where appropriate precautions are taken.)

b. Place hose in a straight line position and perform the following pressure test: Hose that has been in service will be subjected to hydrostatic pressure of 150 pounds per square inch. Raise the pressure in the hose to the proper pressure with the pump and check for leaks in the system. If the coupling leaks, release pressure, tighten the coupling clamps and again bring the pressure up as indicated above and hold for one minute. Examine hose for leaks especially near the couplings and record the results. Retire for repair or replace any length showing leakage of any amount.

c. Release pressure from the hose; drain off all water (or mineral spirits) and remove test fixtures. Upon successful completion of these tests, the hose is considered satisfactory for further service.

d. Hose that is to be returned to service should be internally washed with methanol to remove moisture where water has been used as the test agent*. Where mineral spirits have been used drain hose thoroughly before returning to service.

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*Methanol has a flash point of approximately 52°F and a wide explosive range of from 7.3 to 36 percent by volume. Extreme care is required to safeguard this operation and it should only be conducted outdoors at a location remote from ignition sources.

Part VI

Aircraft Fuel Servicing Tank Vehicles

600. General

601. Scope:

a. This Part applies to tank vehicles designed for or employed in the transfer of standard grades of aviation fuel (See Paragraph 602. f.) into or from an aircraft. It is intended to provide minimum recommendations for the design and construction of these vehicles and their appurtenances.

b. Additional safeguards may be necessary for tank 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. In addition to the requirements outlined in this standard, aircraft fuel servicing tank vehicles which are subject to use on public highways should comply with the provisions of the NFPA Recommended Regulatory Standard for Tank Vehicles for Flammable and Combustible Liquids (No. 385).

602. Definitions:

a. Aircraft Fuel Servicing Tank Vehicles. Any motor vehicle (tank truck, tank full trailer, tank semi-trailer, tank vehicle) designed for or employed in the transportation and transfer of fuel into or from an aircraft.

b. Baffle. A non-liquid-tight transverse partition in a cargo tank.

c. 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 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.

d. Compartment. A liquid-tight division in a cargo tank.

e. **Head and Bulkhead.** A liquid-tight transverse closure at the end of a cargo tank or between compartments of a cargo tank.

f. **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).

g. **Tank Full Trailer.** Any vehicle with or without auxiliary motive power, equipped with 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.

h. **Tank Semi-Trailer.** Any vehicle with or without auxiliary motive power, equipped with 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.

i. **Tank Truck.** Any single self-propelled motor vehicle equipped with a cargo tank mounted thereon, and used for the transportation of flammable liquids.

j. **Tank Vehicle.** Any tank truck, tank full trailer, or tractor and tank semi-trailer combination.

603. **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. Joints:

a. Joints shall be welded in accordance with recognized good practice and the efficiency of any joint shall be not less than 85 per cent of that of the adjacent metal in the tank.

b. Mild steel and low alloy low carbon steel may be used in the construction of a single tank, provided each material, where used, shall comply with the minimum requirements of its respective specifications for that section of the tank.

c. 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).

*Published in National Fire Codes and in pamphlet form.

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 number 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, 1271 Avenue of the Americas, New York 20, New York.

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.

618. Valves and Emergency Discharge 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 provided 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 hand-operated or foot-operated fail-safe 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.

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. Tank-Vehicle Chassis, Assembly and Appurtenances:

621. Tires:

a. All aircraft fuel servicing tank 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. No lighting device other than electric lights shall be used on tank vehicles. Lighting circuits shall have suitable overcurrent protection (fuses or automatic circuit breakers). The wiring shall have sufficient carrying capacity and mechanical strength, and shall be secured, insulated, and protected against physical damage, in keeping with recognized good practice.

b. The ignition wiring shall be substantially installed with firm connections and spark plug and all other terminals shall be suitably insulated to prevent sparking in event of contact with conductive materials. The ignition switch shall be of the enclosed type.

c. Electrical equipment *for the operation of pumps or other devices used for the handling of fuel, and operating fuel handling accessories,* shall meet the following requirements:

(1). Generators, alternators or motors having general purpose enclosures may be mounted in the vehicle engine compartment, provided no portion of such generator, alternator or motor, is less than 18 inches above the ground. Generators, alternators or motors located elsewhere shall be of the type approved for Class I, Group D, Division 1 hazardous locations.*

(2). Wiring installed in the vehicle engine compartment which pertains to the electrical equipment discussed in this subparagraph 625. c. shall be substantially installed, with all terminals firmly connected and insulated to prevent sparking from vibration or shorting. Wiring methods for installations elsewhere shall be of a type conforming to installations in Class I, Group D, Division 1 hazardous locations.* All junction boxes and conduit entrances shall be sealed.

(3). Switches, overload protection devices and other sparking equipment shall be of the type approved for Class I, Group D, Division 1 hazardous locations.*

*As defined by the National Electrical Code (NFPA No. 70, USA Standard C1) published in National Fire Codes and in separate pamphlet form.

(4). Where any generator, alternator or motor is located within an enclosed space, adequate provision shall be made for air circulation to prevent overheating and possible accumulation of explosive vapors.

(5). Electrical equipment and wiring shall be protected from spillage from cargo tank or side racks.

d. Light shall be provided on the top deck area and in compartments containing pumps, motors, hose reels or other special control equipment and shall be of the type approved for Class I, Group D hazardous locations.

626. Vehicle Fuel System:

a. 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 Tank Vehicles:

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

642. There shall be at least two extinguishers mounted on each aircraft fuel servicing tank 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 tank vehicles may be used to augment equipment required for protection of fueling operations (see Paragraph 289 in Part II).

650. Operation of Tank Vehicles (Other Than When Fueling Aircraft):

NOTE: The recommendations contained in Parts I, II and III herein shall be used as a guide in aircraft fueling and defueling operations.

651. Proper Repair:

a. Tank vehicles shall not be operated unless they are in proper repair, devoid of accumulation of grease, oil or other combustibles, and free of leaks.

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*Published in National Fire Codes and in pamphlet form.

652. 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.

c. The cargo tank shall be bonded to the fill pipe when cargo tank loading operations are in progress. The bond wire connection shall be made prior to opening the dome covers. It shall be maintained in place during the entire filling operation and the dome covers shall be securely closed before the bond wire is disconnected from the cargo tank.

d. No cargo tank or compartment shall be loaded liquid full. Sufficient space (outage) shall be left vacant in every case to prevent leakage from or distortion of such tank or compartment by expansion of the contents due to rise in temperature of the cargo. The outage shall be not less than 1 per cent of the volume of the tank or compartment. Greater outage may be desirable in some locations and local authorities should establish outage requirements suited to their service conditions, figuring that fuel expansion is at the rate of about 1 per cent for each 14 deg. F. rise in the temperature of the liquid fuel. Permanent markers should be installed and sealed in each vehicle to assure that no tank or compartment is overfilled once the outage space desired is fixed by the operating authority.

653. 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 (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.

654. Aircraft fuel servicing tank vehicles shall not be stored, parked or serviced in any hangar or building other than one specifically approved for such purposes.

655. Mass parking of aircraft fuel servicing tank vehicles should be arranged to:

a. Facilitate dispersal of the vehicles in event of emergency;

b. Provide reasonable accessibility for fire control purposes; and,

c. Prevent any leakage from draining to an adjacent building.

d. Minimize exposure to damage from out-of-control aircraft.

660. Marking:

661. Each aircraft fuel servicing tank 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 Paragraph 510 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.

k. 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. Emergency remote control station(s) shall be provided. It shall be the purpose of such station(s) to shut down, by appropriate means, the flow of fuel in the entire system or in sections thereof as may be considered desirable from a fire safety viewpoint.

b. Emergency remote control devices shall be of the fail-safe type (see Paragraph 711. f.).

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).

Part VII

Airport Fixed Fueling Systems

700. General and Definitions:

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.

702. Definitions as Used Herein:

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

b. **Aircraft Servicing Ramp or Apron.** An area or position at an airport used for the servicing of aircraft, including fuel servicing from a hydrant, pit or aircraft fuel servicing hydrant vehicle.

c. **Fixed Fueling System.** An arrangement of aviation fuel storage tankage, piping, dispensing hydrants, cabinets, or pits at an airport designed to service aircraft from locations established by the installation of the equipment.

d. **Fuel 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 without any additional equipment.

e. Fuel Servicing Pit. A pit (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 without additional equipment.

f. 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 standard grades 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.

g. Hydrant. An outlet in a fuel transfer pipeline designed to permit the movement of fuel only after the matching fuel connection on dispensing equipment is properly attached.

h. Maximum Service Pressure. The maximum service pressure to which a system or system component may be subjected including any surge pressures which might be developed in the system.

i. Transfer Pipeline. Piping used to transfer fuel between the main storage facilities, the operating storage tanks (if any) and the hydrant.

710. Basic Considerations:

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

a. The working pressure to which the system and its components may be subjected shall not exceed the design pressure rating. Surge pressures which exist 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 deadman 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.

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

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

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 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 Standard Code for Pressure Piping ASA B31.3-1966, Petroleum Refinery Piping, shall be met or exceeded for airport fixed fuel system service, and the following shall specifically apply:

(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). Operating, surge and test pressures.

(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.

724. **Testing:**

a. After completion of the installation (including fill and paving), that section of the pressure piping system between the pump discharge and the connection for the dispensing facility shall be tested for at least thirty minutes

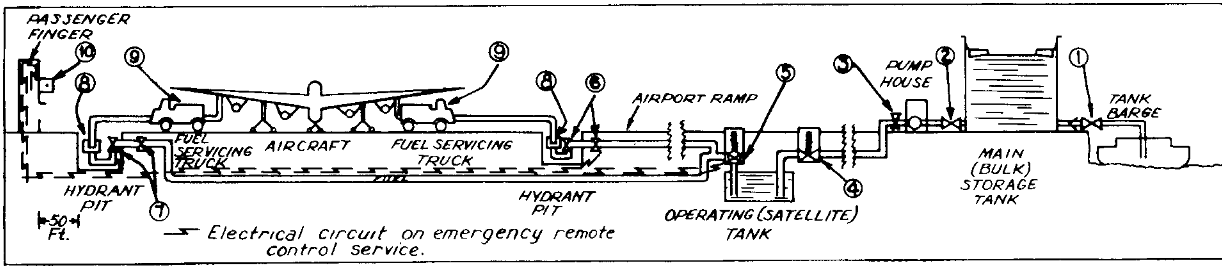

Figure 2A. Typical fixed airport fueling system showing recommended isolation valving, operating, and emergency controls.

1. Check and isolation valve at barge connection.
2. Isolation valve at bulk tank outlet. (Par. 731.a).
3. Isolation valve or pump control (main storage). (Par. 731.b.).
4. Isolation valve at satellite tank inlet. (Par. 731.a.).
5. Isolation valve or pump control (satellite storage). (Par. 731.a.).
6. and 7. Alternate locations for operating flow control valves remotely operated by deadman control from fueling position. (Par. 732.b.).
8. Hydrant coupler valve. (Par. 731.d. and 732.a.).
9. Hydrant vehicle. (Section 770).
10. Emergency remote control station (Par. 733) to operate valve or pump at 5.

at a pressure fifty per cent above the maximum design operating pressure and proven tight. Thereafter, leakage tests shall be conducted annually in the same manner at a pressure 50 per cent above the maximum operating pressure.

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 hand-operated or foot-operated, fail-safe, 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