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Standard for

FUELING AIRCRAFT

on the Ground

June

1959

Seventy-five cents*

NATIONAL FIRE PROTECTION ASSOCIATION

International

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National Fire Protection Association

International

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The National Fire Protection Association was organized in 1896 to promote the science and improve the methods of fire protection and prevention, to obtain and circulate information on these subjects and to secure the cooperation of its members in establishing proper safeguards against loss of life and property by fire. Its membership includes two hundred national and regional societies and associations (list on outside back cover) and seventeen thousand individuals, corporations, and organizations. Anyone interested may become a member; membership information is available on request.

This pamphlet is one of a large number of publications on fire safety issued by the Association including periodicals, books, posters and other publications; a complete list is available without charge on request. All NFPA standards adopted by the Association are published in six volumes of the **National Fire Codes** which are re-issued annually and which are available on an annual subscription basis. The standards, prepared by the technical committees of the National Fire Protection Association and adopted in the annual meetings of the Association, are intended to prescribe reasonable measures for minimizing losses of life and property by fire. All interests concerned have opportunity through the Association to participate in the development of the standards and to secure impartial consideration of matters affecting them.

NFPA standards are purely advisory as far as the Association is concerned, but are widely used by law enforcing authorities in addition to their general use as guides to fire safety.

Definitions

The official NFPA definitions of shall, should and approved are:

SHALL is intended to indicate requirements.

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

APPROVED refers to approval by the authority having jurisdiction.

Units of measurements used here are U. S. standard. 1 U. S. gallon = 0.83 Imperial gallons = 3.785 liters.

Approved Equipment

The National Fire Protection Association does not "approve" individual items of fire protection equipment, materials or services. The standards are prepared, as far as practicable, in terms of required performance, avoiding specifications of materials, devices or methods so phrased as to preclude obtaining the desired results by other means. The suitability of devices and materials for installation under these standards is indicated by the listings of nationally recognized testing laboratories, whose findings are customarily used as a guide to approval by agencies applying these standards. Underwriters' Laboratories, Inc., Underwriters' Laboratories of Canada and the Factory Mutual Laboratories test devices and materials for use in accordance with the appropriate standards, and publish lists which are available on request.

Standard on

Fueling Aircraft on the Ground

NFPA No. 407 — June 1959

This standard, prepared by the NFPA Sectional Committtee on Aircraft Maintenance and Servicing and submitted to the Association through the NFPA Committee on Aviation, was adopted by the NFPA at its 1959 Annual Meeting held June 1-5. The present text supersedes the 1958 Edition.

History

Active work by the National Fire Protection Association leading towards the development of these recommendations started in 1951.

Much of the interest and controversy delaying first issuance of these recommendations for four years centered on the technical justification, if any, for static *grounding* (as opposed to static *bonding*) recommendations specified in Article 220 herein. No truly adequate test program has been conducted to establish with certainty the need for this protection up to June 1959 although efforts are continuing to secure the desired research. In the interim, prudent operators are urged to follow these recommendations.

Earlier editions of this text were published in 1955, 1956, 1957 and 1958.

1959 Changes

Changes of more than editorial significance acted on in 1959 are:

1. Revision of Section 210 on spill prevention and control.
2. Revision of Paragraph 281 on fueling locations.
3. Revision of Paragraph 286 on positioning of aircraft fuel servicing vehicles.
4. Revision of Paragraph 289 on fire extinguishers on ramps where fueling is conducted.
5. Insertion of new Paragraph 504 on swivel couplings on fuel hose.
6. Revision of Paragraph 513 on marking of fueling hose.
7. Revision of Paragraph 618.f. on marking of emergency controls on aircraft fuel servicing tank vehicles.
8. Revision of Paragraph 619.d. on fuel pressures delivered by fuel pumps on aircraft fuel servicing tank vehicles.
9. Revision of Section 640 on fire extinguishers for aircraft fuel servicing tank vehicles.
10. Minor editorial changes have been made in Paragraphs 103, 602.f., 611.a., and 611.b.

In 1959 the NFPA also adopted *Tentatively* a Standard on Airport Fixed Fueling Systems which is currently published in pamphlet form designated as NFPA No. 407A-T (25 cents per copy).

Special attention is invited to the NFPA Manual covering "Fire Hazard Properties of Aviation Fuels" (NFPA No. 413M).

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Fueling Aircraft on the Ground

NFPA No. 407 — June 1959

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. These recommendations 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. In 1959 a Tentative text on Airport Fixed Fueling Systems was adopted by the NFPA and this is published in pamphlet form as NFPA No. 407A-T.†

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

†Available from the Association for 25 cents per copy.

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.

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).

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.

*See NFPA Manual No. 413M for further information on the Fire Hazard Properties of Aviation Fuels (50 cents).

Part II. Fueling Recommendations

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, the type of flammable liquid involved, the wind and weather conditions, equipment arrangement, aircraft occupancy, the 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.). 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 cor-

rective 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 involving an area of from 18 inches to 6 feet in any dimension should have a fire guard posted equipped with at least one ramp fire extinguisher having a minimum rating of 20-B as set forth in Paragraph 289.a. If the spill is not ignited either absorbent cleaning agents (such as diatomaceous earth, emulsion compounds or rags) may be used to absorb the spilled fuel. The use of absorbent cleaning agents or emulsifiers is preferred to rags as they can be applied with less personnel hazard. This is particularly true in the case of spills of aviation gasoline and similar low flash point fuels. Contaminated absorbents and fuel soaked rags should be placed in metal containers with self-closing lids until they can be disposed of by burning at a safe location. An exception to this method may be authorized if the spill occurs in an area where no operations are in progress or will be conducted until ample opportunity is provided for volatile fuels to evaporate harmlessly. In such an event, the area should be roped off to prevent unauthorized entry. Fuels that will not evaporate in air readily (such as kerosene) 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, covering an area greater than 6 feet in any dimension, normally require handling by the airport fire brigade or local fire department and they should be summoned immediately and all personnel in the area evacuated to a safe distance. 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 severity of the hazard created by a spill. Aviation gasoline and other low flash point fuels present significantly a greater hazard than do kerosene grades of fuel.

(7). Spills of aviation and low flash point fuels covering an area greater than 6 feet in any dimension

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.

(8). Kerosene grades of fuel which have been spilled but not ignited may be blanketed or covered with foam if it is feared that equipment in the area could cause ignition. In other, and most situations, it is probably better to use an approved emulsion compound on the kerosene to render the surface of the fuel free of oily residue and then wash this mixture down drains if provided. The higher flash point and lower volatility of kerosene permits such handling without the same hazard that exists with aviation gasoline. Kerosene also will not readily evaporate and this makes disposal difficult unless the preceding procedure is used.

(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. *Bonding* of the fuel nozzle at the tank filler opening should prevent the development of a static charge sufficient to create a spark hazard in the vapor-hazard area around the fill opening. *Grounding* of the aircraft and fuel dispenser, as indicated below, should drain any latent static charges that may not have "bled" to ground through rubber tires.

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).

(3). Connect a bonding cable from the vehicle to the aircraft.†

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.

*For detailed information on static, see NFPA No. 404 published in National Fire Codes Vol. VI and in separate pamphlet form.
†Conductive type fuel hose is not a satisfactory method of accomplishing the procedures outlined and is, therefore, not recommended.

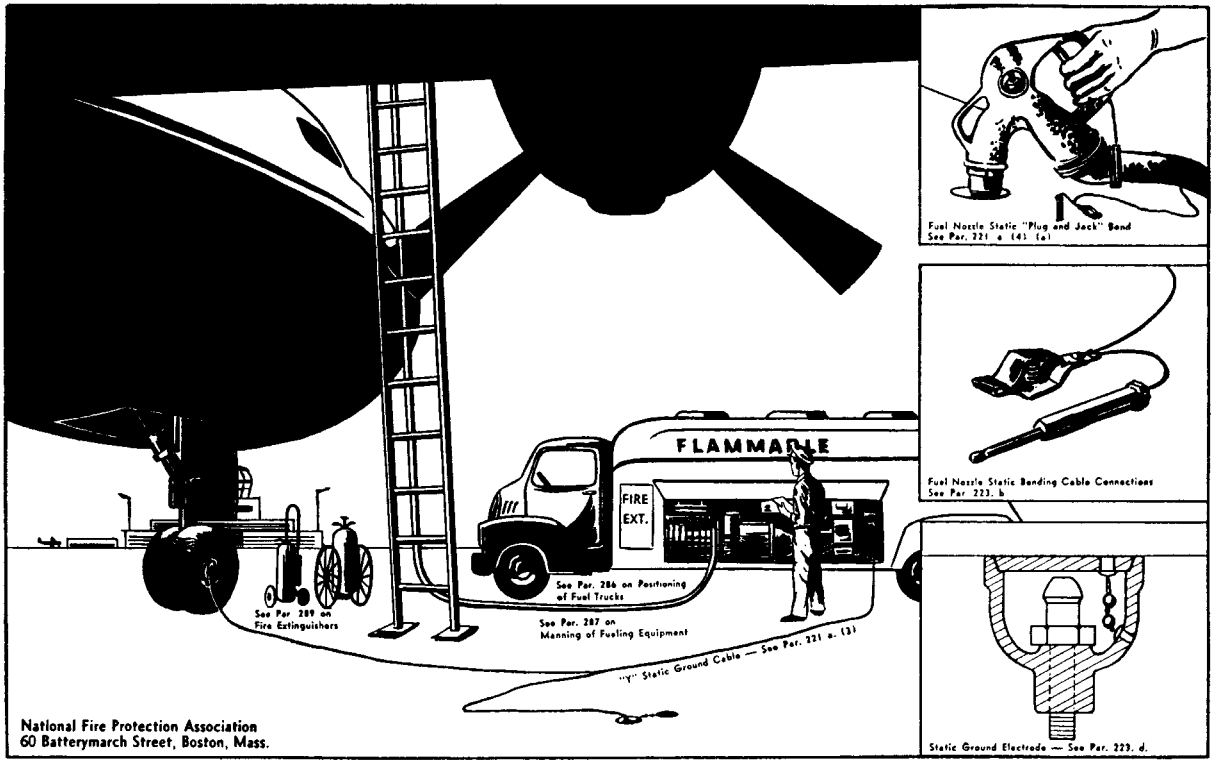

Figure 1. A typical over-the-wing fuel servicing operation from an aircraft fuel servicing tank vehicle showing static grounding and bonding recommendations and certain other details.

(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 grounding cable from a satisfactory grounding connection (at the dispenser or elsewhere) to the aircraft.†

(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)].

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.

†Conductive type fuel hose is not a satisfactory method of accomplishing the procedures outlined and is, therefore, not recommended.

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 Chamois Filters: The practice of using chamois should be discouraged as its use is hazardous under any conditions. Where a chamois is used to filter the fuel, an increase in the static hazard results from the passage of fuel through the material. The nozzle, chamois filter and funnel shall be bonded to the aircraft as specified in paragraph 221. a. (4). (b) and the aircraft shall be properly grounded.

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-the-Wing Fuel Servicing: For under-the-wing fuel servicing, the chance of an electrostatic spark ignition of flammable vapors is greatly reduced since the "in-the-wing" fitting is completely closed as is the mating nozzle and "splash filling" is avoided. The fuel does not flow until the complete attachment is made and electrostatic bonding is normally provided in the design of the nozzle and tank fitting. However, grounding and bonding of the aircraft and fuel servicing vehicle as required in Paragraph 221 (except for nozzle-to-aircraft bond) is still necessary.

223. Equipment for Electrostatic Bonding, Grounding:

a. Bonding and grounding cables shall be bare or covered with a loose flexible plastic or rubber covered protective sleeve (transparent or otherwise). Cable shall be of a gauge which will be satisfactory from the durability standpoint (as influenced by mechanical strains and usage). (Speedometer, preformed steel or equivalent cable will minimize danger of employee hand injury where a protective sleeve is not employed.)

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 connections shall be provided on aprons and ramps where fuel servicing operations may be conducted.

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

*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 $\frac{1000E}{I}$ 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.

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

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).

232. Aircraft combustion heaters 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.

†For industrial tractors see NFPA Standards for the Use, Maintenance and Operation of Industrial Trucks (NFPA No. 505); for other vehicles, see NFPA Truck Fire Protection (NFPA No. 512); both published in National Fire Codes Vol. VI and in separate pamphlet form.

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*).

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

255. Aircraft electrical switches which control units in wing or tank areas should not be operated during fueling operations except in an emergency.

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

257. Electrical equipment in fuel pits 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*).

> NOTE: See also Section 240 for internal combustion engine equipment which may have electrical sparking hazards.

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 ft. of aircraft undergoing fueling. Local airport management shall establish other locations where open flames and open flame devices shall be prohibited. Included in the category of open flames and lighted open flame devices are the following:

*Published in National Fire Codes, Vol. V and in pamphlet form.

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. "Strike-anywhere" matches and cigarette lighters shall not be permitted on persons engaged in fueling 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 not be located within 100 feet of any fuel storage or loading racks and no fueling operations or any other operations involving flammable liquids or vapors shall be conducted within the 100 foot distance.

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 for this equipment shall not be located within 300 feet of any fuel storage or loading racks and no fueling operations or any operations involving flammable liquids or vapors shall be conducted within the 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 at least 50 feet from any building 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 about one per cent for each 14°F. of temperature rise.)

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. **Manning of Fueling Equipment:** Adequate manpower shall be constantly available to quickly shut off the flow of fuel from the servicing equipment at vehicles (see

Paragraph 618). Fuel nozzles used in over-the-wing fueling hose assemblies shall be designed so that the nozzle will close and the flow of the fuel will stop when the hand of the operator is removed; blocking nozzles in an open position even momentarily shall be prohibited. Only competent and qualified operators shall be permitted to operate the equipment (see Paragraph 401). It is recommended that other aircraft servicing personnel be trained in the operation of emergency fuel shutoff controls in the event of a spill or other hazardous condition. Kinks and short loops in the fueling hose should be avoided. The fuel nozzle should never be allowed to drag along the ground. 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 on hose handling.)

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. Portable extinguishers shall comply with the Standard for the Installation, Maintenance and Use of Portable Fire Extinguishers (NFPA No. 10).*

a. **Extinguisher Recommendations:** (See NFPA No. 10 for explanation of ratings of extinguishers.) Recommendations for extinguishers for the protection of fuel servicing operations are:

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

(2). When the rate of fuel flow per hose is in excess of 200 gallons per minute, but not over 350 gallons per

*Published in National Fire Codes, Vol. IV and in pamphlet form.

minute, one approved extinguisher having a minimum rating of 80-B shall be provided.

(3). When the rate of fuel flow per hose is in excess of 350 gallons per minute, two approved extinguishers, each having a minimum rating of 80-B, shall be provided.

(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)*

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

(d). 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. To provide accessibility from adjoining gates, particularly when more than one unit is specified, extinguishers may be located approximately midway

*Published in National Fire Codes, Vol. IV and in pamphlet form.

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.

Part III. 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.

Part IV. 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 Fourth Avenue, New York 16, New York) has published a helpful booklet for training purposes under the title "Aircraft Fueling." Copies of this booklet are available from the FSF for 50 cents a copy with discounts for quantity orders in excess of 500.

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 2 inches inside diameter or larger 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 approximately 25 foot intervals.

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 Tentative Methods of Testing Rubber Hose (D 380-57T) published by American Society for Testing Materials, 1916 Race St., 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.

*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.).

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 and blends of hydrocarbons commonly referred to as jet fuels (such as JP-1, JP-2, JP-3, JP-4, JP-5 or their equivalent).

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 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 Liquids (NFPA No. 385)*.

*Published in National Fire Codes, Vol. VI and in separate pamphlet form.

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 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 of Testing Materials Specification No. B285-57T (American Welding Society Specification No. A5.10-57).

613. Test:

a. At the time of manufacture every cargo tank shall be tested by a minimum air or hydrostatic pressure of 3 pounds per square inch applied to the whole tank (or each compartment thereof if the tanks are compartmented). Such pressure shall be maintained for a period of at least 5 minutes, during which, if the test is by air pressure, the entire exterior surface of all the joints shall be coated with a solution of soap and water, heavy oil, or other material suitable for the purpose, foaming or bubbling of which will indicate the presence of leaks. Hydrostatic pressure, if used, shall be gauged at the top of the tank. The tank shall be

*Published in National Fire Codes, Vol. VI and in separate pamphlet form.

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 1,500 gallons, no one compartment should exceed 1,200 gallons (with a construction tolerance of 10 per cent for capacities of individual compartments or tanks).

(2). Cargo tanks with compartments carrying standard grades of aviation fuel with different octane ratings shall be provided with an air space between compartments and this air space shall be equipped and maintained with drainage facilities operative at all times.

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. Each cargo tank or compartment shall be provided with a vacuum and pressure operated vent with a minimum effective opening of 0.44 square inch, and shall also be provided with an emergency venting facility so constructed as to provide a minimum free-venting opening having a net area in square inches equal to 1.25 plus 0.0025 times the capacity of the cargo tank or compartment in gallons. If the emergency venting facility operates in response to elevated temperatures, the critical temperature for such operation shall not exceed 200°F.

b. If the emergency venting facility operates in response to pressure, the required vent area is to be established by an internal pressure not in excess of 50 per cent of the hydrostatic test pressure to which the vessel was subjected in accordance with Paragraph 613.a.

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 dur-