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407-T
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Aviation

Fueling Aircraft On the Ground

Fire Safety Recommendations

Adopted Tentatively, May 1954

NOTICE

June 1954

At the 1954 NFPA Annual Meeting action was taken to adopt as a tentative standard these recommendations on "Fueling Aircraft on the Ground." The text reproduced herein includes certain amendments to the text previously printed in the 1954 NFPA Advance Reports and in NFPA Pamphlet No. 407-P. Action authorizing these amendments was taken at the Annual Meeting by voice vote.

This pamphlet has been prepared and is being circulated for the purpose of affording all concerned ample opportunity to review and comment on these recommendations before the scheduled preparation of a final draft by the Committee for proposed action at the 1955 NFPA Annual Meeting to be held May 16-20 in Cincinnati, Ohio. In its present form, NFPA No. 407T is *not* an official standard of the Association.

All suggestions for improvements should be forwarded to the Association prior to September 15, 1954 to receive full Committee consideration.

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NATIONAL FIRE PROTECTION ASSOCIATION

INTERNATIONAL

Executive Office: 60 Batterymarch St., Boston 10, Mass.

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 over a hundred and eighty national and regional societies and associations (list on outside back cover) and fifteen 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; a complete list is available without charge on request. 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 National Fire Protection 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.

Fueling Aircraft on the Ground
Fire Safety Recommendations
NFPA No. 407-T—1954

At the 1954 Annual Meeting of the National Fire Protection Association action was taken to adopt as a tentative standard these recommendations on "Fueling Aircraft on the Ground." The tentative recommendations are designed to assure maximum fire safety in the operations covered herein. This 1954 text replaces all previous drafts issued by the Association and published in NFPA Aviation Bulletins of the 78 series and in NFPA Pamphlet No. 407-P. This issue also contains a number of amendments which alter the text as preprinted for the NFPA Annual Meeting in the NFPA Advance Reports, 1954.

Publication of the tentative text and the circulation of this pamphlet is undertaken for the sole purpose of affording all interested persons opportunity to review, criticize and comment on the recommendations looking forward to further detailed evaluation by the Committee preparatory to the preparation of a report seeking final adoption of the text, scheduled for the 1955 NFPA Annual Meeting to be held in Cincinnati, Ohio, May 16-20. All comments should be received prior to September 15, 1954 to receive full consideration.

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Representation is **organizational, not personal, and is for coordination purposes only.

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This Sub-Committee of the NFPA Committee on Aviation and Airport Fire Protection was appointed in 1953 to facilitate handling the development of this Proposed Tentative Standard which has been under consideration by the full Committee since 1951. The Association is deeply grateful to these men for their cooperation and work in the interest of fire prevention and protection.

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American Petroleum Institute, Aviation Technical Service Committee

American Petroleum Institute, Subcommittee on Static Electricity and Stray Currents

Civil Aeronautics Administration, U. S. Department of Commerce

National Advisory Committee for Aeronautics, Subcommittee on Aircraft Fire Prevention

National Fire Protection Association, Committee on Flammable Liquids

National Fire Protection Association, Committee on Static Electricity

National Safety Council, Air Transport Section

National Truck Tank and Trailer Tank Institute

United States Air Force

Complete accord could not be secured between all concerned because of the lack of some fundamental data, particularly concerning the behavior, under a variety of atmospheric and terrain conditions, of static electrical charges on aircraft after landing and at rest. The Committee has endeavored to sponsor research on this subject but to date has not been successful in initiating a comprehensive program with a qualified laboratory. The text herein represents, therefore, the best judgment of the majority of interested persons at this time but is subject to continuing study and review.

Individual contributors outside the membership of the NFPA Committee on Aviation and Airport Fire Protection whose assistance has been particularly appreciated include the following:

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Foreword

Active NFPA work concerning the preparation of fire safety recommendations on fueling aircraft on the ground started in 1951 with the publication of NFPA Aviation Bulletin No. 78 covering this subject. This Bulletin was issued solely for the purpose that the recommendations contained therein might receive full Committee consideration at a scheduled meeting held January 21, 1952. Its issuance followed coordination between the Executive Office of the NFPA and the work undertaken on this same subject by the Air Transport Section of the National Safety Council. The Council issued, in 1952, Data Sheet D-A-4 under the title "Aircraft Ground Fuel Servicing Fire Hazards."

At the 1952 Annual Meeting of the Association a special paper was presented on "Static Electricity During Transfer of Flammable Liquids" by Mr. George F. Prussing in which definite issue was taken with the static grounding requirements contained in Civil Air Regulations, in NFPA No. 404 covering "Static Electricity in Aircraft Operations and Maintenance" (1950) and the NSC Data Sheet D-A-4 (1952). A revised draft of our previous Aviation Bulletin No. 78 was then issued in June 1952 under the designation No. 78-A incorporating the recommendations of Mr. Prussing and the comments that had been received from the Aviation Technical Service Committee of the American Petroleum Institute. This revised draft was submitted for balloting to the full NFPA Committee on Aviation and Airport Fire Protection with the result that 28 voted affirmatively for NFPA No. 78-A and 22 voted negatively. This seriously split vote indicated the need for technical data on the subject of electrostatic hazards and protection and in July 1952 the Committee requested the Civil Aeronautics Administration to undertake a specific aircraft static research project (see NFPA Aviation Bulletin No. 78-B).

During 1952 and 1953 the Civil Aeronautics Administration consulted with other governmental agencies on the problem, including the National Advisory Committee for Aeronautics, the United States Air Force, the United States Navy and the National Bureau of Standards. The NFPA was advised under date of May 1, 1953 (see NFPA Aviation Bulletin No. 78-C) that the CAA was discontinuing further efforts to gather aircraft electrostatic research data since they had been informed by the Air Material Command, U. S. A. F. that that agency had conducted "an extensive engineering study" of the subject and that the measures established were comparable to the static protection recommendations contained in NFPA Pamphlet No. 404 (1950).

In December 1953 a redraft of NFPA recommendations was prepared and circulated in Aviation Bulletin No. 78-D reinstating the static grounding recommendations deleted in Bulletin 78-A. This redraft was fully considered at a meeting of the Sub-Committee on Fueling Aircraft held January 26-27, 1954 and the present text herein constitutes a refinement of the conclusions reached at that meeting and the 1954 Annual Meeting of the Association. The present text, however, is not an official NFPA standard, has only been Tentatively Adopted and is being circulated in its present form for further consideration and comment.

Fueling Aircraft on the Ground

Fire Safety Recommendations

NFPA 407-T—1954

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. "All weather" flying and the demand for "on-time" performance have made 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 aggravatés the problem and makes it imperative to follow certain basic fire safety procedures. These recommendations are intended to reduce the occurrence and danger of accidental fuel spills and to eliminate and control fuel vapor ignition sources insofar as is presently practical. 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.

110. The General Nature of the Fire Hazard:

111. From a fire hazard standpoint, aviation gasoline does not differ radically from ordinary gasoline. Some jet fuels (such as JP-1) are kerosene type hydrocarbons and thus less hazardous. Other jet fuels, being blends (such as JP-3 and JP-4) require the same safety precautions recommended for aviation gasoline since their flammable vapor hazards are practically identical with those of gasoline.

112. In general, gasoline has a flash point of about minus 40°F. JP-3 and JP-4 jet fuels (MIL-F-5624A) have flash points of approximately 30°F. and minus 10°F. respectively while JP-1 (MIL-F-5616) has a flash point of about 110°F.

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 for both types of fuel most likely to be present during aircraft fuel servicing are:

a. Electrostatic sparks

b. Operating aircraft engines

c. Operating automotive or other internal combustion engine servicing equipment in the vicinity

d. Arcing of electrical circuits

e. Open flames

f. Energy from energized high frequency radar equipment.

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.

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:

211. Careful operation of fuel servicing equipment in compliance with these recommendations will prevent the majority 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 extensive fuel spills on the ground, a fire guard shall be immediately posted to establish and maintain a restricted area around the spill and to keep unauthorized personnel from entering the area. To insure safe debarking of all passengers following a bad spill, fueling equipment, and all other equipment, in the vicinity which would constitute a fire hazard should be withdrawn or left "as is" until the spill is removed or made safe. No fixed rule can be made on this subject since fire safety will vary with individual circumstances. However, it should be remembered that "shutting down" equipment or moving vehicles may provide the ignition source if no fire immediately results from the spillage. Neither any idle aircraft nor any idle automotive or spark producing equipment in the area of the spill shall be started before the spill is cleaned up. If the vehicle engine is running at the time of the spill it is normally good practice to remove it from the hazard area after being sure that any fuel hose in use or connected to an aircraft is safely stowed.

213. Small spills may be absorbed by rags or oil absorbents. Large spills should be blanketed or covered with foam. They should then be washed from critical areas with water or allowed to completely evaporate before the site of the spill is again used for normal operations. (The nature of the ground surface and exposure conditions will dictate the method to be followed.) Fuel should not be washed into sewers or drains. If spillage should enter sewers, adequate flushing should be accomplished at once. The use of carbon tetrachloride on fuel spills in an effort to render the fuel nonflammable is not recommended because it is only partially and temporarily effective.

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 proxim-

*For detailed information, see NFPA Pamphlet No. 404, "Static Electricity in Aircraft Operations and Maintenance," 15 cents per copy.

ity 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 will 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, will drain any latent static charges that may not have "bled" to ground through rubber tires.

a. **Procedures with Mobile Fuel Trucks:** When mobile fuel trucks are used for over-the-wing fuel servicing the following specific procedures apply (see Figure 1):

(1). Connect a grounding cable from the truck 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 truck 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 truck.

(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).

†Conducuve type fuel hose is not a satisfactory method of accomplishing the procedures outlined.

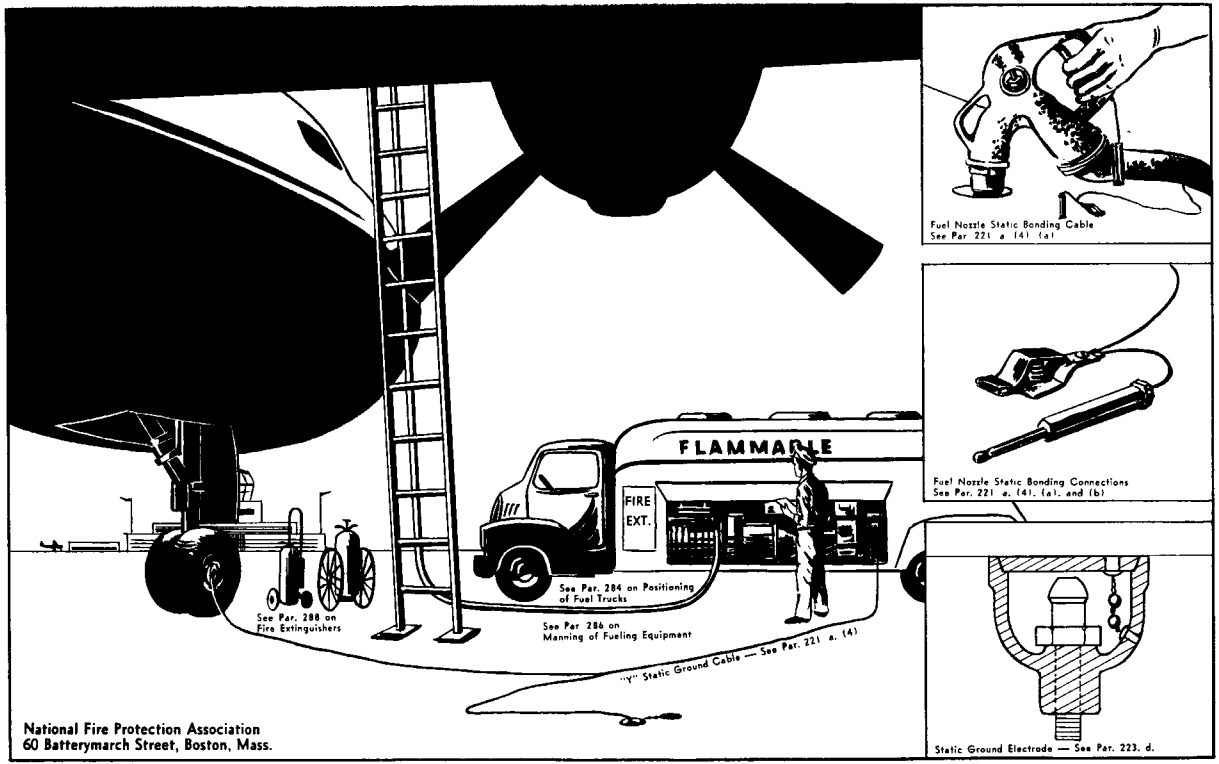

Figure 1. A typical over-the-wing tank truck fuel servicing operation showing static grounding and bonding recommendations and certain other details.

(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 battery-type clip which shall then be firmly attached to the lip of the metal tank filler neck (or adjacent, uninsulated metallic part of the aircraft such as fill point access door) 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 the grounded dispenser frame or connection 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)].

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

(3). Where mobile dispensing carts are provided on hydrant fueling systems, they shall be grounded as required for mobile fuel trucks.

c. 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.

d. Procedures Using Drums: Where aircraft are serviced with flammable liquids from drums by means of

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

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.

e. 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.

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 and 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.)

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

c. The *bonding* system (cables and connections) shall be tested for electrical resistance when initially secured and monthly thereafter. As low a resistance as possible should be secured and maintained. Continuity of bonding cables may be easily checked with a simple buzzer and dry cell battery. The use of bare stranded bonding wire is desirable since breaks can then be visually detected.

d. Grounding electrodes, consisting of pipes or rods ½-inch to ¾-inch in diameter, of galvanized iron, steel or copper weld steel, driven into the ground to reach below the permanent ground moisture level (normally not more than 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 Par. 223.f. and Fig. 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-scale ammeter (calibrated) 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

(Footnote continues next page.)

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

(Footnote continued from previous page.)

(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.

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 hot surfaces of the generators. Ground power generators shall not be placed under wings or just 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).

†For industrial tractors see NFPA Pamphlet No. 505B,C., "Standards for the Maintenance and Safe Operation of Industrial Trucks," 25 cents per copy. For other vehicles, see NFPA Pamphlet No. 512 "Truck Fire Protection," 25 cents per copy.

254. No electric tools, drills, buffers or similar tools liable 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. No open flames or lighted open flame devices shall be permitted within 50 feet of aircraft undergoing fueling, including:

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. Matches and cigarette lighters shall not be permitted on persons engaged in fueling operations.

270. Control of High Frequency Radar Equipment:

271. High frequency radar equipment mounted in aircraft shall not be operated during fueling operations. Fueling operations shall not be conducted within 100 feet of energized airborne radar equipment or within 300 feet of energized ground radar equipment installations.

280. Additional Precautions:

281. Fueling Location: All aircraft fuel servicing shall be done outdoors, separated by 50 foot distances from buildings or other aircraft to minimize the danger of ignition of flammable vapors discharged during fueling operations by sources of ignition liable to exist in such buildings or other aircraft.

282. Outage Space: Fuel expansion space should be left in each 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: No concurrent aircraft maintenance operations shall be conducted which might provide a potential source of ignition for fuel vapors being discharged during fueling operations.

284. Positioning of Fueling Trucks: A clear path shall be maintained to permit rapid removal of fueling equipment from an aircraft in an emergency. Fuel servicing vehicles shall not be located where they would obstruct egress from occupied portions of the aircraft in the event of fire. The hand brake shall be set on the fuel servicing unit before the operator leaves the cab. The expected flow of vapors and of fuel spills on wings will be toward the trailing edge (except where wind conditions direct vapor travel in other directions). Fuel servicing vehicles and other gasoline or electric powered vehicles or equipment shall be positioned so that in event of spillage or excessive vapor travel, the fuel or its vapor will not flow on or near the equipment and create a fire hazard. Fueling trucks may be positioned under wings only outboard of the outboard engine, in a position where it can be moved promptly without backing and located so that the vehicle engine is not under the wing. (See Figure 1)

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. **Manning of Fueling Equipment:** Adequate manpower shall be available to quickly shut off the flow from the servicing equipment (trucks, hydrants, pits or cabinets) in an emergency. Fuel nozzles used in over-the-wing fueling hose assemblies shall be self-closing 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 in all types of fueling operations except for under-the-wing fueling where cam operated nozzle valves are required to be blocked in the open position but where in-the-tank controls will automatically prevent over-filling. Only competent and qualified operators shall be permitted to operate the equipment (See paragraph 401). 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 Figure 1)

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

288. **Fire Extinguishers:*** Class "B" fire extinguishers of both the quick smothering and final blanketing types are desirable. The amount of hand extinguishing equipment available should be related to the quantity of fuel likely to be spilled due to accidental overflow, hose or coupling failure, etc. and the availability of major fire apparatus (aircraft rescue and fire fighting equipment**) and fixed fire fighting equipment.† At least a fifty pound carbon dioxide extinguisher or a thirty pound dry chemical extinguisher is recommended for the quick smothering unit. A thirty-three gallon foam extinguisher is recommended as a minimum for the final blanketing type. It is recommended that all ramp extinguishers be mounted on mobile carts or be of the wheeled type and at least one such extinguisher shall be

*For detailed information on fire extinguishers, see NFPA Pamphlet No. 10, 50 cents a copy.

**For detailed information on aircraft rescue and fire fighting equipment, see NFPA Pamphlet No. 403, 50 cents a copy.

†For detailed information on airport fixed fire fighting equipment, see NFPA Pamphlet No. 409, 50 cents a copy.

located within 100 feet of each fueling location (closer if weather conditions or ramp traffic would handicap movement of extinguishers in an emergency). Where hose reel fire protection equipment is installed for ramp fueling protection, this type protection is preferred to portable extinguishers if adequately supplied from bulk cylinder or tank sources and is particularly recommended where fuel dispensing is at a rate in excess of 100 gallons per minute. Such fixed equipment, however, only replaces the type of hand extinguisher supplying the same extinguishing agent. (See Figure 1)

Part III. Defueling 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

401. **Fire Safety Training:** 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.

Appendix A

Preventive Maintenance and Inspection of Aircraft Refueling Hose

A-1. A frequent source of fuel spillage and, therefore, a frequent cause for increased fire hazard in aircraft refueling, is the failure of aircraft refueling hose in service.

A-2. Most aircraft refueling hose is built specifically for this type of service and is mounted on reels. The NFPA recommends that each fuel hose in this service be a continuous length. If not continuous, such hose may be made-up of two sections coupled with standard male and female screw couplings. The use of hose clamps is prohibited.

A-3. Principal reasons for failure of aircraft refueling hose are mishandling, such as dragging hose over rough surfaces, flattening or crushing by vehicles, continual exposure to severe weather, lifting hose to wings 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 of refueling hose failures. Sudden opening and closing of valves creating surge pressures in the hose have caused leaks at weaker points.

A-4. Safe fuel delivery from aircraft refuelers or other fixed or mobile fuel dispensing equipment is highly dependent upon the integrity of the hose used.

A-5. The following minimum preventive maintenance and inspection program is therefore recommended.

(a). Continual Hose Inspection Record: Each section of hose should be labelled and identified at time of purchase and a Record Card initiated and maintained to show its progressive preventive maintenance and inspection. This record card should contain: