NFPA No.

403

AIRCRAFT RESCUE & FIRE FIGHTING SERVICES AT AIRPORTS 1966

One Dollar

NATIONAL FIRE PROTECTION ASSOCIATION
International
60 Batterymarch Street, Boston, Mass. 02110

3M-6-66-FP
Printed in U.S.A.

National Fire Protection Association
International

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Suggestions for

Aircraft Rescue and Fire Fighting Services at Airports and Heliports

NFPA No. 403 — 1966

1966 Edition of No. 403

These "Suggestions," prepared by the NFPA Sectional Committee on Aircraft Rescue and Fire Fighting and submitted to the Association through the NFPA Committee on Aviation, were adopted by the Association at its Annual Meeting held May 16–20, in Chicago. This edition supersedes all previous editions of NFPA No. 403. The changes in this 1966 Edition as compared with the latest earlier edition (1965) will be found in the following Paragraphs 246, 314.a., b., c., e., f., 322, 329 and 393 and Table No. 1.

Origin and Development of No. 403

Committee work leading to the development of these suggestions by the Association commenced in 1947 following a request from the Civil Aeronautics Board (U.S.A.) for information on what constituted "adequate" ground fire fighting equipment and personnel for airports served by air carrier aircraft.

NFPA Committee work continued during 1948 and in 1949 the Association adopted a tentative text at its Annual Meeting held in San Francisco, California. In 1952 a revised text was submitted for final adoption by the Association, and unanimously accepted. Since its original adoption, this text has been revised periodically with editions issued in 1954, 1955, 1956, 1957, 1958, 1959, 1960, 1961, 1962, 1965, and in this current (1966) edition.

In June, 1948, the International Civil Aviation Organization distributed ICAO Circular 4 — AN/3 which contained the recommendations on this subject. In February 1955, the ICAO reproduced the 1954 editions of this text and NFPA No. 402 in ICAO Circular 41 — AN/36. These publications are now obsolete. During December 1956, the ICAO sponsored a meeting of a specially constituted international "Panel on Aircraft Rescue and Fire Fighting Services at Aerodromes" to develop "specifications or further guidance material" on the subject.

A subsequent Panel Meeting was held in 1962. The current recommendations of ICAO are contained in "Annex 14" (Aerodromes) to the Convention on International Civil Aviation (available at $2.00 per copy from ICAO, International Aviation Building, 1080 University Street, Montreal 3, Quebec,

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Canada, and from their Regional Offices in France, Peru, Senegal, Thailand, and the United Arab Republic) in English, French, and Spanish editions. ICAO Aerodrome Manual, Part 5 (Equipment, Procedures, and Services) contains an extensive chapter on Rescue and Fire Fighting (35 pages) and Part 6 (Heliports) discusses Rescue and Fire Fighting as practiced in the United Kingdom and U.S.A. Each of these publications is available in the same languages from the same source at $1.25 each.

Table of Contents

Suggestions for

Aircraft Rescue and Fire Fighting Services at Airports and Heliports*

NFPA No. 403 — 1966

Article 100. Introduction

110. Application

111. This material pertains solely to aircraft rescue and fire fighting services at airports and heliports. This material does not include fire protection facilities for airport structures (*i.e.*, hangars, shops, terminals, other airport buildings, etc.) although the services suggested herein might constitute valuable fire protection for such structures and their contents in many instances. Vehicles designed for aircraft rescue and fire fighting services at airports are specialized pieces of equipment; consideration given to the structural fire fighting capability of these vehicles may be only to the extent that any design features or equipment added do not detract from their primary purpose.

112. Heliports designed *exclusively* for handling helicopter operations are generally limited in area and are separately evaluated as regards helicopter rescue and fire fighting services. For the purposes of this text, the term "heliport" shall include all areas exclusively used for helicopter operations, including such areas referred to as "helipads" and "helistops." Heliports may be located at ground level, on platforms constructed specifically for the purpose, or on the roofs of buildings. The degree of fire protection suggested depends on the size of the helicopters, the number of occupants, the maximum operational fuel load of the helicopters using the facility, personnel available for rescue and fire fighting purposes and the frequency of operations. Suggestions for heliport aircraft rescue and fire fighting services are contained in Paragraphs 214, 315 and Table 2.

*See Appendix for a bibliography of other helpful information on aircraft rescue and fire fighting and airport fire safety.

120. Type of Aircraft Operations Safeguarded

121. The threat of fire is ever present and may occur at any time when an aircraft is involved in either operational or servicing accidents. Experience has shown that severe problems of rescue are encountered when fire occurs incident to operational accidents. Fire is especially apt to occur immediately following ground impact in operational accidents (but may occur at any time during rescue operations) because of the nature of the aircraft fuel and lubricants used, the latent heat of operating aircraft engines, exhaust flames and hot gases, the possibility of sparks being created through disturbance of electrical circuits or from friction, or the discharge of accumulated electrostatic charges at time of ground contact. The outstanding characteristic of aircraft fires is their tendency to reach lethal intensity within a very short time after outbreak. This not only handicaps rescue efforts but also presents a severe hazard to the lives of those involved in the accident and anyone attempting their rescue.

122. All aircraft do not have identical crash impact fire dangers. For example, aircraft with fuel cells well segregated from ignition sources and with properly designed plumbing generally have less impact fire dangers than other aircraft which lack these design features. Rescue opportunities in aircraft may vary with the nature and adequacy of the exit facilities provided. In addition, fire and rescue problems at each airport will differ somewhat due to the various types of aircraft operations, the scope of operations and other special factors. Each individual airport should consider the application of these suggestions to its own needs and increases made in the scale of protection where a fire protection engineering analysis justifies. The application of these suggestions to airports is thus subject to discriminating use, although experience has indicated that the suggestions contained herein will provide a minimum degree of protection in most situations. Where preplanning permits designating nearby military or other airports for handling emergency landings (to which aircraft experiencing in-flight difficulties might be diverted to take advantage of the scale of protection or other safety factors), this fact should be considered in planning the minimum protection needs for the airport in question, recognizing that unanticipated accidents may still occur.

130. Location of Accidents

131. The possibility of aircraft accidents is constantly present throughout the extent of air routes. The accident potential is greatest, however, on the movement areas of airports or heliports or in their immediate vicinity due to the concentration of air traffic, letdown, landing, taxiing, take-off, fueling, and maintenance operations. For this reason, the provision of special means to deal with incidents on and in the immediate vicinity of such movement areas is of primary importance. It is within such limits that there are the greatest opportunities of saving life and property.

140. Nature of Suggestions

141. These suggestions are designed to give guidance on the amount and type of services considered helpful to provide aircraft rescue and fire fighting protection at civil airports and heliports. Some of the terminology used is defined in Appendix A.

150. Administrative Control

151. Aircraft rescue and fire fighting on the movement area of an airport should be under the administrative control of airport management *except* where the aircraft rescue and fire fighting services at airports are organized as a part of a municipal (or similar regional) or a federal fire service and are thus under the *direct* administrative jurisdiction of the Chief of the municipal regional or federal Fire Department. Under the latter conditions close liaison with airport management is essential to integrate fire department and aircraft operations to assure effective and safe response of emergency equipment on the movement area of the airport.

152. Where aircraft rescue and fire fighting services are not under the direct administrative jurisdiction of the Chief of a municipal, regional or federal fire service, airport management should exercise administrative control whether such management is a governmental agency, a private corporation or an individual, and irrespective of how the aircraft rescue and fire fighting services are financed and/or organized. Airport management should also have administrative duties in connection with aircraft rescue and fire fighting services within the reasonably accessible environs of the airport movement area *where* there is no conflict with the administrative jurisdiction of suitably organized and equipped municipal, regional or federal fire services.

153. Regardless of the administrative control of aircraft rescue and fire fighting services on the airport, a prearranged high degree of mutual aid (joint defense measures) is desirable between such services on airports and any municipal (or similar regional) fire or rescue agencies serving the environs of the airport. An "area emergency plan" is desirable and airport management should encourage and offer instruction to cooperating agencies on the special problems and techniques associated with aircraft rescue and fire fighting.

154. The services of other available airport personnel not used for aircraft rescue and fire fighting should be utilized to perform specific duties during an emergency, such as: aircraft evacuation; scene security; first aid assistance; escort duty; transportation; etc.* These special crews should operate during an emergency under the direction of the officer in charge of the rescue and fire fighting services. Training should be under the direction of airport management or the authority having administrative jurisdiction of the aircraft rescue and fire fighting services. Insurance coverage for such personnel while assisting in emergencies should be considered in the planning. After evacuation and completion of fire and rescue operations, the operator is responsible for the security of the aircraft unless a legally appointed accident investigation authority assumes responsibility.

*See Standard Operating Procedures, Aircraft Rescue and Fire Fighting, NFPA No. 402.

Article 200. Basis for Suggestions

210. Airport Indexes

211. To provide generally applicable indexes useful in determining the suggested minimum amounts of extinguishing agents, airports are grouped into two basic classes. Airports used *exclusively* by "General Aviation" aircraft (small personal and executive type aircraft) are classified into Index A or Index B depending on the number of annual aircraft movements at the airport (see Note for exception). Airports used by "Air Carrier" aircraft (commercial aviation) are grouped into five Indexes (see Table 1, pages 403–22, 403–23).

NOTE: At airports used *exclusively* by "General Aviation" (and private airports used by industrial or commercial interests) protection should be comparable to at least Index 4 in Table 1 if they accommodate executive or charter aircraft of the four engine (reciprocating) or twin engine (turbine) types operating at a frequency of 150 monthly movements or more.

212. These Indexes are used in Table 1 (pages 403–22, 403–23) to establish the suggested minimum quantities of extinguishing agents. Heliports are separately treated in Table 2 (page 403–26). The minimum amounts of extinguishing agents in Tables 1 and 2 indicate amounts suggested for the "survivable" type of aircraft accident and to provide a reasonable degree of mobile fire protection for airport ramp and movement areas. Basically, these amounts of extinguishing agents are provided for fire control or extinguishment to afford opportunity for rescue operations in fire accidents or incidents.

213. To determine the "Index" into which an airport falls, the factors outlined in Section 310 should be checked by an analysis of information obtainable locally on the number of movements, the aircraft in use, and the projected route segments flown (which affects directly the imposed aircraft fuel loads). At airports where figures reflecting the annual air carrier movements are not readily available, reference may be made to publications of governmental agencies (such as the Federal Aviation Agency in the U.S.) which normally publish such figures and offer projections of future movements to permit advance planning.

214. As indicated in Paragraph 212, the "Indexes" used in Table 1 do not apply to heliports. It is suggested that heliports provide fire protection as outlined in Table 2. The purpose of the protection suggested is basically aimed at life safety for the occupants of the helicopter in event of an accident followed by fire. Since automatic protection is not feasible, heliport management and service personnel should be trained in the use of this equipment to afford maximum benefits. An auxiliary purpose is to provide protection to the heliport itself, especially for platform or roof-top heliports. It is widely recognized that fires may follow helicopter accidents and that this experience is a helicopter design problem.

NOTE: This material is concerned with helicopter rescue and fire fighting. However, the importance of designing crash-fire-worthiness into future helicopters cannot be stressed too strongly. Cellular or breakaway fuel tanks to limit fuel spillage and all other possible construction safety features should be incorporated in new helicopter design.

220. Applicability of Index

221. It is not anticipated that the total fuel load of each aircraft will be involved in fire following each and every accident. The amounts of fuel shown in the point system used in Paragraph 312.a. merely indicate the relative fire danger from fuel exposure which might be involved in an accident during takeoff or on the ramp. While the fuel load aboard an aircraft generally governs the potential magnitude of the fire risk, it should also be clearly understood that lubricating oils, flammable hydraulic fluids, alcohol, combustible fabrics or cargoes, magnesium parts, etc., may provide the initial fuel or contribute significantly to fire spread. Conversely, installed fire protection devices designed to operate on impact may eliminate or lessen the magnitude of the potential fire hazard.

222. Personnel provided to man the aircraft rescue and fire fighting equipment will vary not only with the design of the equipment, the number of units and similar factors, but also with the distribution of the traffic over each 24-hour period and the duty hours of the personnel assigned. For personnel suggestions refer to Section 390.

223. The suggested minimum amounts of extinguishing agents in Tables 1 and 2 should be provided on the airport or heliport *regardless* of the availability of other fire fighting equipment off the airport or heliport.

230. Basis for Equipment

231. In view of the lack of uniformity in the size and type of rescue and fire fighting equipment in use throughout the world, an attempt has been made to standardize on vehicles in Table 1. This equipment should meet the NFPA Standard for Aircraft Rescue and Fire Fighting Vehicles, No. 414 (see also Sections 320, 330 and 340 herein). Table 1 suggests the number of vehicles as well as the total amounts and discharge rates of extinguishing agents to be available. The former suggestions give the minimum number of vehicles to be provided in each of the Indexes. As a study of Table 1, Indexes 1–5 will indicate, three basic fire fighting vehicles are proposed. This does not preclude the use of other vehicles, but is a guide in purchasing future equipment. By standardizing on vehicles, a readily recognized advantage is that it is feasible to add to existing equipment as increased operations may require without creating obsolescence.

232. A number of commercially available vehicles with a gross weight of 7,999 pounds or less are available which will meet the recommendations of Parts III and V of NFPA No. 414 and be suitable for the service indicated in Table 1, lines a, b, and c of all Indexes and lines d, e, and f of Indexes A and B.

233. Vehicles designed to meet Parts II and IV of NFPA No. 414 are recommended to serve for the major foam fire fighting vehicles indicated in Table 1, lines d, e, and f of Indexes 1 through 5. Vehicles designed to meet Part VI of NFPA No. 414 are recommended to serve for the tank vehicles indicated in Table 1, lines g, h, and i of Indexes 2 through 5. Vehicles having greater load carrying capacity meeting Part II of NFPA No. 414 are also available and may be used where larger mobile water carrying capacities are desired (see particularly Paragraph 312.b.) and where multiple units are available to assure that "out-of-service" time of any one vehicle will not adversely affect the protection on the airport.

240. Types of Extinguishing Agents

241. In order to establish the types of extinguishing agents suggested for aircraft rescue and fire fighting, it is desirable to consider certain basic principles concerning the various agents available for the purpose. These are summarized in Paragraphs 242 through 246.

242. Water

a. Water is recognized as the best cooling agent universally available for the control of fire and for personnel protection from heat but the ability of water to effect extinguishment is limited on large flammable liquid based fires of the type usually encountered in accidents involving aircraft. Therefore, it is not suggested as the sole agent available for this type of fire fighting on airports.

NOTE: See the NFPA Guide for Aircraft Rescue and Fire Fighting Techniques for Fire Departments Using Conventional Fire Apparatus and Equipment (No. 406M) where specialized equipment is not available.

b. Water spray may be used effectively for the protection of trapped personnel in aircraft accidents involving fire and for the protection of rescue and fire fighting personnel from severe radiant heat conditions and its availability is therefore considered desirable. This is usually entirely practical through the use of adjustable valves and nozzles on equipment designed essentially to dispense foam.

c. The use of straight water streams discharged at high velocity is not considered desirable for aircraft rescue and fire fighting except where it is desired to "sweep" fuel spills from hazardous areas.

d. Wetting agents added to water improve its extinguishing efficiency on flammable liquid based fires but care must be exercised to assure compatibility if foam is a supplementary agent.

243. Foam

a. Foam used for aircraft rescue and fire fighting consists of an aggregation of bubbles of lower specific gravity than oil or water possessing tenacious qualities for covering and clinging to vertical or horizontal surfaces. It should be able to cool hot surfaces, flow over a burning liquid surface and form a long lasting, air-excluding blanket that seals off volatile flammable vapors from access to air or oxygen. Good quality foam should be homogeneous, resisting disruption due to wind and draft or heat and flame attack. It should be capable of resealing in event of mechanical rupture of an established blanket. Foam, when applied to the fuselage of an aircraft, insulates, cools and reflects radiant heat, providing protection to occupants. There are two kinds of foam:

(1). Chemical Foam — A foam which is produced by the reaction of an alkaline salt solution (usually bicarbonate of soda) and an acid salt solution (usually aluminum sulphate) to form a gas (carbon dioxide) in the presence of a foaming agent which causes the gas to be trapped in bubbles to form a foam.

(2). Mechanical Foam (Air Foam) — A foam which is produced by the physical agitation of a mixture of water, air and a foam liquid concentrate. The concentrates are produced in two approved strengths: one is for use in a nominal proportion of 3 per cent in water and a second for use in a nominal 6 per cent proportion. Both types can be used to produce a suitable mechanical foam but the manufacturer of the foam-making equipment should be consulted as to the correct concentrate to be used in any particular system (the proportioners installed must be properly designed and/or set for the concentrate being used). Mixing foam liquids of different types or different manufacture should not be done unless it is established that they are completely compatible.

b. Mechanical foam (air foam) is particularly suited for aircraft rescue and fire fighting because the basic ingredients, water and foam liquid concentrate, can be carried in bulk to the scene of the accident and brought into operation with the minimum of delay. The most serious limitation of foam for aircraft rescue and fire fighting is the problem of quickly supplying large quantities of foam to the fire in a gentle manner so as to form an impervious fire-resistant blanket on large flammable liquid spills. The hazards of disrupting established foam blankets by turbulence, water precipitation and heat baking can be overcome by firemen's training and the purchase of a good quality of the basic foam ingredient.

c. Mechanical foam (air foam) may be produced in a number of ways. The methods of foam production selected should be carefully weighed considering the techniques of employment best suited to the equipment concerned, the rates and patterns of discharge desired and the manpower needed to properly dispense the foam capabilities of the vehicles. The principal methods of foam production in use are:

(1). Nozzle Aspirating Systems. Foam is produced by pumping a proportioned solution of water and foam liquid concentrate under high pressure into a specialized discharge appliance or nozzle which draws in atmospheric air and mixes it mechanically with the solution. Various devices are used to shape the discharge pattern between a straight stream and a spray.

(2). In-Line Foam Pump Systems. A proportioned solution of water and foam liquid concentrate is injected at atmospheric or higher pressure into a positive displacement type pump which sucks in atmospheric air and mixes it with the solution to generate foam. The foam is formed in the discharge piping or hose as in the in-line aspirating and in-line compressed air systems. Nozzles serve only to distribute the foam in various patterns.

(3). In-Line Aspirating Systems. An inductor in the pump discharge line receives a proportional solution of water and foam liquid concentrate under pressure, or water only if the inductor is designed also to draft the correct amount of foam liquid concentrate. The liquid in passing through the inductor draws in atmospheric air which is mixed with the solution to form foam in the discharge lines. Nozzles serve only to distribute the foam in various patterns.

(4). In-Line Compressed Air Systems. These are similar to in-line aspirating systems except that air under pressure is injected into the solution. The air is supplied by a compressor on the vehicle.

d. Foam is currently applied in two principal pattern configurations, solid stream and dispersed patterns. Normally both methods of application are available using variable nozzles. Training and experience will determine the best method of application under a given set of circumstances. Foam when dispersed in wide, uniformly dispersed patterns (sometimes called "fog-foam" or "snow-foam") is used principally for direct application to a large area of burning fuel or while securing the rescue area. It falls very gently on the surface, giving radiation protection to the fire fighter and cooling and smothering the fire in a short time. Solid streams of foam are used principally for fire situations requiring long distance reach or where the foam may be deflected from a solid barrier to facilitate gentle application. Solid stream foam is not recommended for close-in rescue operations.

e. The quality of water to be used in making foam may affect foam performance. No corrosion inhibitors, freezing point depressants or any other additives should be used in the water supply without prior consultation and approval of the foam liquid concentrate manufacturer.

f. Where foam-compatible dry chemical is used as a supplementary agent, it is important to establish that the foam used affords a maximum degree of compatibility. [See also Paragraph 245.b.(1)..]

244. Carbon Dioxide

a. Carbon dioxide provides a means of quickly "knocking down" flammable liquid fires when applied at a proper rate and in sufficient quantity. It has excellent flooding characteristics and penetrates to otherwise inaccessible areas. It leaves no residue. As atmospheric conditions (particularly wind direction and velocity) may interfere with the smothering effect of carbon dioxide and as the cooling effect may not always be sufficient to prevent reignition of flammable vapors by hot or burning materials, a supplementary cooling and blanketing agent (foam or water) is normally necessary. Fireman's training has a great influence on the effective use of carbon dioxide. When liquid carbon dioxide is discharged to the atmosphere a portion is converted to "dry ice" at minus 110° F.

b. The following subparagraphs define "high pressure" and "low pressure" carbon dioxide:

(1). "High pressure" carbon dioxide is carbon dioxide stored in pressure containers at atmospheric temperatures. At 70° F. the pressure in this type of storage is 850 pounds per square inch. On airports, "high pressure" carbon dioxide is preferably limited to portable extinguishers and small cylinder systems used for standby protection on ramps and flight lines. The use of "high pressure" carbon dioxide cylinders manifolded together has not proved to be as effective for aircraft rescue and fire fighting work as "low pressure" equipment.

(2). "Low pressure" carbon dioxide is carbon dioxide stored in an insulated pressure container at controlled low temperatures, usually at 0° F. At this temperature the pressure in this type of storage is 300 pounds per square inch. Low pressure is used where large storage capacity and high discharge rates are required, as in aircraft rescue and fire fighting operations. The lower liquid temperature and higher discharge rate combine to produce greater cooling effect and longer reach.

c. Carbon dioxide is normally used in aircraft rescue and fire fighting service in one of the following ways:

(1). When foam is the principal agent, carbon dioxide, preferably "low pressure," is employed as a supplementary agent, either initially (before foam is applied) when the fires are in their incipient stages, or, subsequently to control or extinguish fires in concealed or inaccessible locations or to check "running" fires.

(2). As a combined agent with foam, "low pressure" carbon dioxide is applied in large quantities (1,000 lbs. or more) at a minimum discharge rate of 1,000 lbs. per minute. Table 1 indicates that "low pressure" carbon dioxide may be used in lieu of foam compatible dry chemical to effect the quickest fire control or extinguishment with foam as the principal agent. Quantitatively, two pounds of "low pressure" carbon dioxide should be provided for every one pound of foam compatible dry chemical recommended in the Table.

245. Dry Chemicals

a. There are a number of chemical compounds offered on a proprietary basis which are referred to as "dry chemical" fire extinguishing agents. Historically, sodium bicarbonate based compounds were initially so described, but in recent years a number of other chemicals have been tested and found as, or more effective (e.g., potassium bicarbonate base, monoammonium phosphate base, etc.). Such chemicals have proven effective as a means of quickly "knocking-down" flammable liquid fires when applied with the proper technique at an adequate rate and in sufficient quantity. They have good "flooding" characteristics and can penetrate to otherwise inaccessible areas. They have good shielding effects against radiant heat and good range under *normal* outdoor conditions. However, particularly during rescue operations, it is necessary to guard against the reignition of flammable vapors. The permanency of extinguishment with dry chemical may also be affected by atmospheric conditions, particularly where air currents or wind conditions are adverse, but firemen's training has a great influence on this contingency.

b. Dry chemicals as currently used in aircraft rescue and fire fighting service may be employed in one of the following ways:

(1). When foam is the principal agent utilized, *regular* (not necessarily foam-compatible) dry chemicals are employed as a supplementary medium (usually in relatively small quantities) before the foam is applied and when the fires are in their incipient stages. Regular dry chemical may also be used subsequently to control or extinguish fires in concealed or inaccessible locations, or to check "running" fires where foam is *not* being used simultaneously. Care must be taken when using regular dry chemical in conjunction with foam to avoid deleterious effects on the foam and somewhat greater quantities of foam may be needed to overcome the tendency of the foam to breakdown due to the admixture. Foam-compatible dry chemicals are now available and have been "listed" by nationally recognized fire testing laboratories; it is anticipated that within a short time most dry chemicals (regardless of their base composition) will be of the foam-compatible type. New foam liquid concentrates "listed" by these same laboratories will also be tested to assure they will meet these compatibility features. It is thus important that where foam is used and dry chemical is to be employed as a companion agent simultaneously, only "listed" foam-compatible dry chemical be used.

(2). Some limited use has been made of large quantities of dry chemicals (quantities of over 1,000 lbs.) discharging the agent through turrets at rates of 1,000 pounds per minute or more, but experience to date has not established this technique or the equipment requirements. Present day usage is thus limited to handline applications and, with proper training, good results can be achieved as indicated in Paragraph 245.a.

246. Perfluorinated Surfactant with Dry Chemical

a. There has been developed a perfluorinated surfactant (popularly called "Light Water" in the United States) which is suitable for use in conjunction with potassium bicarbonate-based dry chemical (see Paragraph 245) in specially designed, commercially available equipment as a fire extinguishing system effective on petroleum fires. Dichlorodifluoromethane is used in the system to act as a foaming agent for the surfactant. Nitrogen is used to secure the effective discharge of the dry chemical. The surfactant material is specified under a U. S. Military Specification entitled "Fire Extinguishing Agent, 'Light Water', Liquid Concentrate (MIL-F-23905A(WP)" dated 26 March 1965, with Amendment 1, dated 13 August 1965). The potassium bicarbonate-based dry chemical referred to is specified under a U. S. Military Specification entitled "Fire Extinguishing Agent, Potassium Dry Chemical" (MIL-F-22287). Both agents are essentially nontoxic as used in this application. The surfactant (meaning a surface active material) is in an aqueous solution (25 per cent concentration in water) and is a fluorochemical material and a polymer.

b. As presently constructed in commercially available equipment, the perfluorinated surfactant and the dichlorodifluoromethane are dispensed from one or two "twin "nozzles. The potassium bicarbonate-based dry chemical (under nitrogen pressure) is dispensed from the other nozzle. The two nozzles are connected by a bar to facilitate handling by one operator. The "twin" agent systems are independent of each other, with discharge controlled at the nozzles by the operator. Operating instructions are clearly indicated on the equipment.

c. The utility of the perfluorinated surfactant-dry chemical equipment is to obtain a quick "knock-down" of flammable-liquid fires (achieved principally by the potassium bicarbonate-based agent) and to secure a "vapor-sealing" effect to reduce subsequent "flashover" of fuel vapors exposed to lingering open flames or heated surfaces (achieved principally by the surfactant). The surfactant solution floats on the surface of hydrocarbon fuels, creating a film (barely visible) which reduces the release of vapors and the subsequent reignition hazard. There appears to be no problem of agent compatibility between the surfactant and the dry chemical agent. Application is limited to handlines (not turrets). Selective discharge of the agents requires training to assure optimum use of the combined agents, particularly the sequencing and timing of application of the two media. The amount of agents that can be practically carried versus the desired rates-of-discharge restricts the time of discharge, requiring skillful employment. Whenever possible, protein foams should be applied following use of this equipment to further "secure" the fire and fuel spill area, whether or not extinguishment has been effected, particularly when rescue operations are in progress or when additional fuel spillage is being experienced from leaking tankage or lines.

247. Other Agents

a. Several vaporizing liquid extinguishing agents effective on flammable liquid fires under proper conditions have been used and others have been proposed for aircraft rescue and fire fighting but inadequate technical data prevents making any positive recommendations on their use up to this time. Where it is deemed advisable to use vaporizing liquid extinguishing agents care should be taken to assure that any toxic vapors produced will not constitute a hazard during rescue operations.

248. Summary on Agents

a. The information given in Paragraphs 242–246 indicates that no single agent has all the qualities needed to accomplish speedy and permanent extinguishment of all aircraft fires. Foam, applied as discussed in Paragraph 243.d. is, however, the most effective medium found to date and is therefore the principal extinguishing agent upon which reliance is placed for this service. For further suggestions, see Article 300.

b. The types and quantities of extinguishing media suggested in Tables No. 1 and 2 are based on the conclusions indicated in Paragraph 247.a.

250. Magnesium Fire Control

251. The presence of magnesium alloys in aircraft structures introduces an additional problem to fire extinguishment in cases where this metal becomes involved in an aircraft fire. None of the agents available for this application (see Paragraphs 242–246) is capable of securing positive extinguishment of burning magnesium under all conditions and experience proves that a definite reignition hazard to flammable liquid vapors exists from burning magnesium following almost complete control over other ignited materials. The only practical methods of overcoming this difficulty are: (1) by the removal of the magnesium from the fire area where accessible and identifiable; (2) by the localized application of special magnesium extinguishing agents or covering with sand or dirt; (3) by cooling with water or foam (this process liable to temporarily intensify flame spread until the application is sufficient to produce the degree of cooling required); or (4) by blanketing the exposed flammable liquids with foam and allowing the magnesium to burn itself out.

252. The form and mass of magnesium in normal airframe components of conventional aircraft is such that ignition does not normally occur until it has been subjected to considerable flame exposure (as from a fire involving aviation fuels or ordinary combustibles). This fact indicates that the problems with magnesium fire control on such aircraft normally occur following, rather than preceding, rescue opportunities. Exceptions include thin forms of magnesium frequently employed in rotary aircraft airframes, powerplant magnesium components which may be ignited by powerplant fires and magnesium wheels or landing gear components which may be ignited following friction heating or brake fires.

253. Magnesium fires attacked in their incipient stages may be controlled under some conditions by the application of special magnesium fire extinguishing agents as indicated in Paragraph 251 but generally where a mass of magnesium becomes involved the application of large volumes of coarse water streams provides the best ultimate control method. Attacking magnesium fires this way, however, is undesirable where the primary fire control technique is with foam as the coarse water streams would have the effect of breaking down foam blankets in the area. Thus volume application of foam is indicated during the critical period when flammable liquid spills present the primary hazard with the aim to so cover exposed flammable liquid spills to prevent or eliminate their vapor hazard. Following completion of rescue and all possible salvage, it is, however, frequently advisable to apply coarse water streams to still-burning magnesium components even if the immediate result might be a localized intensification of flame and considerable sparking. In this connection it is sometimes feasible to segregate burning magnesium components from the main fuel spill area with shovels or cranes to permit separate fire control treatment of this material.

Article 300. Suggestions

310. Protection for Aircraft Operations

311. To evaluate the desired scale of protection, the following "formula" may be used:

$$\text{Suggested Fire Protection for Aircraft Operations} = \frac{\underset{\text{(Annual No. of Aircraft Movements)}}{\text{Potential}} + \underset{\text{(Maximum Single Aircraft Capacity)}}{\text{Life Hazard}} + \underset{\text{(Maximum Single Aircraft Fuel Load)}}{\text{Fire Risk}}}{\underset{\text{(No. of Vehicles, Adequacy of Agents, Rates of Discharge, etc.)}}{\text{Rescue and Fire Control Facilities}} + \underset{\text{(Equipment Suitability and Availability, Communications, Personnel Skills)}}{\text{Rescue and Fire Control Proficiency}}}$$

312. Airports Used by Air Carrier Aircraft

a. For airports used by air carrier aircraft (commercial aviation), the following "point system" should be used for determining the "index" into which an airport falls (see Table 1):

FACTORS	POINTS	TO FIGURE TOTAL
Total Annual Number of Air Carrier Movements*		
150,000 or more	100	
100,000 to 150,000	80	
50,000 to 100,000	60	
25,000 to 50,000	50	
7,500 to 25,000	40	
2,500 to 7,500	20	
Under 2,500	10	
Maximum Single Aircraft Capacity**		
150 or more	60	
125 to 150	50	
100 to 125	40	
75 to 100	30	
40 to 75	20	
Under 40	10	
Maximum Single Aircraft Fuel Load***		
25,000 U.S. Gallons or more	60	
15,000 to 25,000	50	
7,500 to 15,000	40	
4,000 to 7,500	30	
1,500 to 4,000	20	
Under 1,500	10	
Total Allocated Points (See Table 1)		

See footnotes next page.

Footnotes to Chart in Paragraph 312.a.

*Based on figures available from airport management, the control tower, or a national regulatory agency. It is desirable to project the number of movements a year or more in advance to keep ahead of airport fire safety needs. A "movement" is a take-off or a landing.

**Based on maximum seating capacity of largest aircraft operating at the airport at a frequency of 150 monthly movements or more.

***Based on maximum imposed fuel loads (not maximum capacity) of aircraft operating at the airport at a frequency of 150 monthly movements or more.

b. While this "point" system has general application, consideration should be given to all related factors in applying these minimum protection suggestions as indicated in Paragraph 122. Airports having over 200,000 movements or airports accumulating over 200 points and/or having such problems as excessive response times to reach various locations on large airports, parallel runways, special airport approach or departure hazards, operation of experimental aircraft, extreme high density seating in aircraft using the airport, or multiple daily frequency of heavily loaded overseas flights, should consider increasing these suggested minimums as may be necessary.

313. Airports Used Exclusively by General Aviation

a. As indicated in Section 211, airports used exclusively by general aviation (small personal and executive aircraft), the minimum protection suggested in Table 1 is based on the number of annual movements only; one (Index "A") being for airports having under 50,000 aircraft annual movements, the second (Index "B") for airports having a greater number of annual movements. At some of the smaller general aviation airports, the provision of 30 pound dry chemical fire extinguishers on each airport maintenance vehicle and 150 pound dry chemical wheeled extinguishers at each fueling area may be preferable to mounting all the fire fighting equipment on one vehicle for which a driver might not be available or which might have to be garaged at a location not readily accessible to operating personnel at the time of the accident. At general aviation airports and at private airports serving industrial or commercial interests where executive or charter aircraft of the four engine (reciprocating) or twin engine (turbine) types are accommodated with a frequency of 150 monthly movements or more, the minimum protection provided should be at least to the scale of Index 2 of Table 1, or greater, if indicated by the basic formula in Paragraph 311.

Table 1

Suggested Minimum Amounts of Extinguishing Agents at Airports for the Protection of Aircraft Operations

		GENERAL AVIATION(*)		AIR CARRIER AIRPORTS				
Airport Indexes		**A**	**B**	**1**	**2**	**3**	**4**	**5(†)**
Total Allocated Points Based on Airport Indexes for Air Carrier Airports (see Par. 211, 311, and 312).		Under 50,000 Movements	Over 50,000 Movements	Under 40 Points (See Par. 312)	40–60 Points (See Par. 312)	70–110 Points (See Par. 312)	120–170 Points (See Par. 312)	180–more Points (See Par. 312)
RESCUE VEHICLES	**a.** No. of Vehicles Suggested	**Either** 1	1	1	1	1	1	1 or 2
	b. Total Approved Foam-Compatible Dry Chemical in Pounds (**)	500	300	300	300	500	500	1,000
	c. Minimum Rates of Discharge in Pounds per Minute	500	300	300	300	500	500	500
FIRE FIGHTING VEHICLES	**d.** No. of Vehicles Suggested	**Or** 1	1	1	1	2(††)	2(††)	2(††)
	e. Total Water for Mechanical (††) Foam Production in U. S. Gals.	300	300	750	750	1,500	3,000	3,000
	f. Total Minimum Rates of Discharge in Gals. per Minute	150	150	400	400	750	1,500	1,500

Table 1 (Continued)

		GENERAL AVIATION(*)		AIR CARRIER AIRPORTS				
Airport Indexes		**A**	**B**	**1**	**2**	**3**	**4**	**5(†)**
Total Allocated Points Based on Airport Indexes for Air Carrier Airports (see Par. 211, 311 and 312).		Under 50,000 Movements	Over 50,000 Movements	Under 40 Points (See Par. 312)	40–60 Points (See Par. 312)	70–110 Points (See Par. 312)	120–170 Points (See Par. 312)	180–more Points (See Par. 312)
TANK VEHICLES	**g.** No. of Vehicles Suggested	0	0	0	1	1 or 2(††)	1 or 2(††)	1 or 2(††)
TANK VEHICLES	**h.** Total Water in U.S. Gals. (††)	0	0	0	1,000	2,000	2,000	4,000
TANK VEHICLES	**i.** Total Min. Rates of Discharge for Transfer into Fire Fighting Vehicle(s)	0	0	0	400	750	750	1,500
Amounts of Approved Foam Liquid Concentrate for fire fighting, 2/3rds to be Carried on Vehicles. (Quantities for Training and Runway Foaming Not Included.) (See Par. 314.d – f.)	3%	35	35	90	210	420	600	840
	6%	65	65	160	370	735	1,050	1,470

(*) General Aviation Airports classified on Annual Aircraft Movements only (see also Paragraph 211 and 313).

(**) Alternate use is authorized of "low pressure" carbon dioxide (see Paragraphs 244.c.(2) and 314.a.) or of a system employing perfluorinated surfactant with potassium bicarbonate-based dry chemical (see Paragraphs 246 and 314.a.).

(†) See Paragraph 312.b. for increased protection needs in some special cases.

(††) At least two fire-fighting vehicles should be available for the reason indicated in Paragraph 322. The fire control efficiency of each fire-fighting vehicle (designed in accordance with NFPA No. 414) is generally proportional to the foam-producing capacity of the unit and the rates of foam discharge available. It is accordingly recommended that as much of the combined total of water suggested in lines "e" and "h" be placed on the fire-fighting vehicles as is feasible. Three gallons of water carried on such vehicles may be considered the equivalent of four gallons carried on water tank vehicles (see Section 340).

314. Extinguishing Agent Suggestions

a. Table 1 indicates the quantities of water (for foam production) and the quantity of approved foam-compatible dry chemical that are suggested for minimum protection on airports classified according to the Airport Index. The amount of dry chemical suggested may be replaced with "low pressure" carbon dioxide at a ratio of two pounds of carbon dioxide to one pound of dry chemical [see Paragraph 244.c.(2)]. Alternate use may also be made of a system employing a perfluorinated surfactant with potassium bicarbonate-based dry chemical equipment in quantities giving equal or better fire extinguishing performance to the foam-compatible dry chemical specified.

b. The rates of discharge suggested in Line c. of Table 1 indicate the desired minimum rates in pounds per minute of dry chemical discharged from handline nozzles [see Paragraph 245. b.(2)]. Where dry chemical is replaced with carbon dioxide, the rates of discharge should be approximately two times that suggested for dry chemical. Where dry chemical is replaced with a handline system employing a perfluorinated surfactant with potassium bicarbonate-based dry chemical (see Paragraph 246), the rates of discharge should be adjusted to assure equal or better fire extinguishing effectiveness than with dry chemical alone, or with carbon dioxide. The rates of discharge suggested in Line f. of Table 1 indicate the total desired minimum rates of water and foam liquid concentrate (not "expanded" foam) for foam production in U. S. gallons for the number of vehicles recommended. It is suggested that equipment be so designed that it is possible to discharge 75 per cent of the amount of waterfoam liquid solution specified from elevated turret nozzles. The rates of discharge suggested in Line i. of Table 1 for tank vehicles indicate the desired minimum rates of discharge in U. S. gallons for transfer of water to fire fighting vehicles.

c. The amounts of water (for foam production) and of foam-compatible dry chemical suggested in Lines b., e., and h. of Table 1, are based on their being immediately available for application from properly designed and equipped mobile aircraft rescue and fire fighting vehicles stationed on the airport (see Sections 320–350) and manned by thoroughly trained and equipped aircraft rescue and fire fighting crews (see Section 390 and Article 600). Any alternate agent or agent system authorized in the two-asterisk footnote (**) to Table 1 shall also be available as indicated in the preceding sentence. It is suggested that the dry chemical (or alternate agent or agent system) be carried on the light rescue vehicle(s) described in Section 330. The agent quantities suggested in Table 1 are designed to provide for a mobile rescue and fire fighting striking force which offers the minimum practicable capability for achieving the rescue and fire control functions. Where water tank trucks (Section 340) are relied upon to supply the water suggested in Line h. of Table 1, they should be so designed and operated that they can reach accident sites in time to supply the fire fighting vehicles with the additional water specified and discharge it at rates specified in Line i. to permit uninterrupted rescue and fire fighting operations. It is also suggested that water hydrants, strategically located on the airport, be provided to refill tank and fire fighting vehicles readily.

d. The amounts of approved foam liquid concentrates suggested in Table 1 indicate the minimum desired amounts in U. S. gallons to be provided at the airport. It is suggested that two-thirds of this amount be carried on the vehicles to support a major fire fighting operation with the remaining one-third to be carried in stock for recharging the vehicles to assure prompt return to full service condition. For example, sufficient foam liquid concentrate should be carried on the fire fighting vehicle(s) to satisfy the total water capacity of the fire fighting vehicle(s) and the tank vehicle(s). An equal amount of foam liquid concentrate should be carried on the tank vehicle(s) (in tanks or in cans) to permit rapid in-service refilling of the foam tanks on the fire fighting vehicle(s). This will allow for two complete applications of the water suggested in Table 1 in the event of a major fire suppression operation. Additional foam liquid concentrates should be carried in stock in accordance with Paragraphs 314.e. and f. following.

e. Extinguishing agents (except water for foam production) should be carried in stock to resupply vehicles in sufficient amounts commensurate with resupply times from suppliers. A minimum of one additional charge for all vehicles should be maintained, and where delivery time from suppliers exceeds 24 hours, supplies should be increased accordingly. This condition will vary at different airports, and no definitive quantities can thus be recommended. Care should be exercised in stocking agents to assure that stocks are rotated on a "first in, first out" basis.

f. Consideration should also be given to quantities of agents (except water for foam production) for the purpose of training

Table 2 — Heliport Fire Protection Suggestions

Heliport Category	Water for Foam Production		Foam Compatible Dry Chemical (Rating)*	Additional Water for Foam if Heliport Is Elevated
	Amount of Water	Total Rate of Discharge		
	Gallons	GPM		Gallons
H-1	None**	None**	2–20B:C Extinguishers (Minimum Capacity: 30 lbs. of agent per extinguisher on wheels with a minimum 6-ft. hose and nozzle)	None**
H-2	500†	100	2–20B:C Extinguishers (Minimum capacity: 30 lbs. of agent per extinguisher on wheels with a minimum 6-ft. hose and nozzle) **or** 1–160B:C Wheeled Extinguisher (Minimum capacity: 150 lbs. of agent)	1000†
H-3	1500†	200 from two 100 gpm nozzles or from one mobile unit with a turret	2–20B:C Extinguishers (Minimum capacity: 30 lbs. of agent per extinguisher on wheels with a minimum 6-ft. hose and nozzle) **and** 1–160B:C Wheeled Extinguisher (Minimum capacity: 150 lbs. of agent)	1500†

*See NFPA Standard on Installation of Portable Fire Extinguishers (No. 10).

**Many times a water supply meeting the suggestions for Category H-2 may be readily available. In such cases it should be made available assuming personnel are available to utilize the equipment in event of an emergency.

†This amount of water should be immediately available from a hydrant (standpipe), pressurized tank, reservoir, or mobile vehicle so that it can be dispensed at the rates indicated and at a satisfactory pressure. Additional water should be available to provide a continuing rescue and fire fighting capability wherever feasible.

in addition to that reserved for fire suppression. Where it is anticipated that runways will be foamed for aircraft emergency landings, additional foam liquid concentrate should be carried in stock to assure that the supplies reserved for fire fighting are not reduced below the amounts suggested in Paragraphs 314.d. and e. (See also NFPA Guide for Foaming Runways for Crash Protection, No. 420M.)

315. Protection at Heliports

a. Table 2 indicates the quantities of water (for foam production) and the quantity of dry chemical that are suggested for heliports categorized as follows:

H-1 — This category includes all heliports where the helicopters using the facility carry less than 6 persons, have operational fuel loads of less than 100 gallons.

H-2 — This category includes all heliports where the helicopters using the facility normally carry passengers (less than 12), have operational fuel loads of less than 200 gallons, and where the number of movements exceeds an average of 4 movements per day over any 3-month period. (Where the frequency of movements is less than that specified, the decision as to whether to apply these suggestions should be based on a judgment of the heliport management and any regulatory agency having jurisdiction.)

H-3 — This category includes all heliports where the helicopters using the facility normally carry 12 or more passengers and have operational fuel loads of more than 200 gallons regardless of the frequency of movements.

NOTE: Where an airport is also used as a heliport the fire and rescue protection suggested by Table 1 would apply.

b. For effective use of the fire protection recommended for heliports in categories H-2 and H-3, it is important that the extinguishing equipment be capable of discharging the agents at the rates indicated. The foam rates are those which provide the maximum nozzle flow rate capable of being handled by one man. The amount of agents and rates suggested should be sufficient in the hands of trained operators to provide initial fire control thus permitting occupants to evacuate or be rescued assuming that they are not incapacitated or killed on impact. Additional water is recommended to permit complete extinguishment.

NOTE: Where a standpipe or other continuous water supply of sufficient pressure and volume is available it should be used to supply the foam system. If a continuous water supply of adequate volume but insufficient pressure is available, an automatic booster pump should be provided.

c. Fire extinguishers, foam nozzles, hose reels, etc., located on heliports should, where necessary, be in weatherproof above-grade cabinets, clearly marked as to their contents. Cabinets shall be located beyond but within 5 feet of the boundary line defining the landing and take-off area and shall not protrude into the normal approach-departure paths. These cabinets should be located diametrically opposite each other.

d. Foam nozzles shall be light in weight and capable of discharging foam, dispersed pattern foam, or water spray.

e. Roof-top heliports should be provided with landing pad water and fuel drainage facilities designed basically in accordance with the NFPA Standard on Aircraft Fueling Ramp Drainage (No. 415) modified as may be needed to fit the special conditions inherent in roof-top facilities. Oil separators and collector tank(s) may be necessary. Local regulations regarding pollution of water disposal systems should be checked.

f. Roof-top heliports should have at least two means of egress located remote from each other.

g. Fueling and helicopter maintenance facilities are not recommended on roof-top heliports.

h. An automatic alarm should be provided to indicate foam system operation and to summon aid.

320. Fire Fighting Vehicle Suggestions

321. These vehicles should be constructed to comply with the provisions of Parts II and IV of the NFPA Standard for Aircraft Rescue and Fire Fighting Vehicles (NFPA No. 414).

322. It is desirable to have more than one such vehicle available to facilitate attacking aircraft fires from more than one point or quarter or as an aid to expedite rescue. At airports in Indexes 3 through 5 (see Table 1), consideration should be given to providing the total quantity of water for mechanical foam production (including that recommended for Tank Vehicles) on two fire fighting vehicles wherever feasible. This has the advantage of reducing both the number of vehicles and the manpower requirements. (See also Footnote (††) to Table 1.)

NOTE: Having two vehicles available is particularly important when dealing with air carrier aircraft because: (1) of the need to insulate the fuselage with foam to maintain its integrity as a shield for the occupants against flame impingement and radiated heat from fuel spill fires during the evacuation and rescue period, and (2) the need to make and maintain a rescue path or paths from aircraft exit point(s) to permit the safe evacuation and rescue of the occupants. An analysis should be made to determine procedural policies for rescue, fire control and extinguishment prior to making a decision on the number of vehicles required, being realistic, at the same time, as to how the number of vehicles will influence manpower requirements and vehicle maintenance. (See also Article 600.)

As indicated in Table 1 the fire control efficiency of each fire fighting vehicle is generally proportional to the foam producing capacity of the unit and the rates of foam discharge available. As an example in Index 5, two 2,500-gallon capacity fire fighting vehicles would be preferable to two 1,500-gallon capacity units. The additional 2,000 gallons of water thus carried on these fire fighting vehicles can be credited against the amount specified for the tank vehicles on a ratio of 3 gallons to 4 gallons.

323. The "payload" capacity (fire fighting and rescue equipment and manpower) of the vehicles used in this service should be compatible with the desired performance characteristics established for vehicles in the various weight classes specified in NFPA No. 414. It is particularly important that the vehicle not be overloaded to reduce the required acceleration, speed, or vehicle flotation (as measured by weight distribution on the tires) below the acceptable minimums set forth in the referenced document.

324. The off-pavement (runway or taxiway) performance of each specialized vehicle should be established by test at each airport during the variable weather and terrain conditions experienced at each airport to establish, prior to an actual emergency, the capabilities and limitations of the vehicle for off-pavement response to accident sites. In addition, periodic tests should be run to determine the maintenance of the other performance requirements of the vehicle as originally designed.

325. All essential vehicles (those designed to reach the scene first and the major units should be provided with two-way radio facilities to assure communication opportunities with Airport Control. (See Section 370.)

326. Overall vehicle dimensions should be within practical limits having regard to local standard highway practices, width of gates and height and weight limitations of bridges, and other local considerations.

327. Simplicity of vehicle operation (particularly operation of extinguishing agent discharge facilities) is highly important because of the time restrictions imposed upon successful aircraft rescue and fire fighting operations and the need to keep to the minimum the crew required. It must be remembered that fast blanketing of the fire area is essential. Hand hose lines are thus usually not enough for fires involving larger types of aircraft (over 30,000 lbs.); elevated turrets or similar devices having large discharge capacities are needed to quickly blanket the fire and knock down the bulk of the flames (see Par. 314.b.). Hand lines are used primarily for covering rescue parties, for controlling the fire in the rescue area, and for spot cooling of the fuselage to avoid heat suffocation to trapped occupants.

328. See also Section 350.

329. Improvements in vehicle and equipment designs over recent years have increased the fire fighting efficiency of such units and have made many older aircraft fire fighting vehicles comparatively less efficient. Before procuring any used vehicle for this service, the possible saving in initial cost should be carefully weighed against the lower maintenance cost, the reduced manpower requirements, and the greater fire fighting efficiency that can be expected from new equipment built in accordance with the NFPA Standard on Aircraft Rescue and Fire Fighting Vehicles (No. 414). Foam fire fighting equipment purchased for this service should be tested in accordance with the NFPA Standard for Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles (No. 412).

330. Light Rescue Vehicle Suggestions

331. The rescue vehicle(s) suggested in Table 1 should comply with Parts III and V of NFPA No. 414. Operationally, the rescue vehicle should be the first unit to reach an accident site. It is considered extremely important that this vehicle be so designed that it can be operated and handled by one man and that this one man can place in operational readiness the extinguishing equipment while en route so that there will be no delay in placing the vehicle in service upon arrival. Experience has proven that the availability of such a vehicle has been most valuable in attacking fires in their incipient stages; in many cases, extinguishment or control has been achieved by this single unit prior to the arrival of the larger fire fighting vehicles and in other cases, a successful holding action has been accomplished. The amount of agent carried on this light vehicle (normally foam-compatible dry chemical) will depend on its load capacity, but extreme care should be exercised to prevent overloading the vehicle and thus detracting from its acceleration, speed, flotation and traction capabilities. (See Paragraph 325 and Section 370 with regard to communications equipment.)

332. Rescue tools (see Section 360) should be carried by this vehicle. Caution should be exercised in connection with this recommendation, however, that the addition of the rescue tools does not overload the vehicle or interfere with the vehicle's performance. In cases where it is not possible to carry the desired rescue tools on this vehicle without overloading the unit, it is suggested that a separate vehicle having the same performance capability be provided, equipped with the rescue tools and equipment designed to aid in the evacuation of crews and passengers from aircraft in distress.

333. See Paragraph 329.

340. Water Tank Vehicle Suggestions

341. Water tank trucks (sometimes referred to as "Nurse Trucks"), as suggested in Table 1, are designed to augment the quantity of water available on the fire fighting vehicles. Where airports elect to have multiple fire fighting vehicles to carry the total minimum water (for foam production) suggested in lieu of tank vehicles, three gallons of water carried on such vehicles can be considered the equivalent of four gallons carried on water tank vehicles. Since the function of water tank vehicles is to replenish the water supplies of the fire fighting vehicles, tank vehicles should also be designed in accordance with Part VI of NFPA Standard for Aircraft Rescue and Fire Fighting Vehicles (NFPA No. 414). The operational purpose of these vehicles will dictate their performance needs in each instance with the overall concept of their being able to maintain the fire fighting capability of the fire fighting unit(s) without interruption at the discharge rates of the latter equipment as long as the water supply permits.

342. Water tank trucks should be equipped with a pump or pumps and hose for relaying water to the fire fighting equipment or for direct application on the fire. It is desirable that pumps have sufficient capacity to replenish the fire fighting vehicle having the largest rate of discharge when that vehicle is operating at maximum capacity. Proper type and sufficient quantity of hose should be provided to transfer the water content of the tank vehicle to the major rescue and fire fighting vehicle.

343. Auxiliary supplies of foam compounds, combination straight and dispersed pattern foam nozzles, and water spray nozzles might also be carried on the tank truck.

344. See also Section 350.

345. See Paragraph 329.

350. Suggestions for Fire Fighting Equipment on Vehicles

351. No attempt is made here to detail water pump capacities, pump inlet and outlet plumbing, foam proportioners and controls, the location of elevated nozzles and their operation, hose reel locations, or other design details of foam or supplementary agent equipment mounted on the equipment provided. It is recognized that all these items require careful engineering and that the details of the fire control equipment must be compatible with the discharge rates recommended in the Tables, the manpower available in each instance, and the objective of providing maximum capability for the vehicles in their primary function of rescue. (See Part IV of NFPA No. 414.)

352. Vehicles provided for this service should be designed to permit uninterrupted pump discharge even when maneuvering the vehicle during the rescue operation. This may be accomplished by providing an independent pumping engine(s), or, if the vehicle engine(s) is (are) also used for pumping, by providing a specially designed transmission or engine-powered take-off. Use of such a transmission or power take-off should not result in more than a slight decrease in pump pressure, as well as not interrupting extinguishing agent discharge while vehicle movement is being accomplished. (See Part IV of NFPA No. 414.)

353. Wherever possible, optimum benefits are normally achieved with mobile equipment by approaching civil aircraft fires from the windward position but this is not always possible. This dictates that turrets and hand lines should be so located and operable to be efficient in any position (or any angle of vehicle approach) to avoid any waste of time (turrets total traverse of at least 200° and hand lines on reels or hose bed). Ground sweep nozzles (discharging foam under the front bumper on the vehicle) are desirable. (See Part IV of NFPA No. 414.)

354. At airports adjacent to water or swampy areas or where snow, ice or unusual terrain may affect fire and rescue activities, special consideration should be given to these factors.

360. Accessory Equipment Suggested

361. The following equipment shall be provided and properly mounted on the fire fighting vehicles or secured in a compartment:

One extension ladder — 2 section folding "A" type, capable of being extended 12 feet. This ladder to be of lightweight alloy, aluminum or magnesium, 24-inch minimum width and mounted in quick release brackets on the apparatus and readily accessible from the ground. This ladder not intended for evacuation use.

Flat step aircraft emergency evacuation stairs, 18 feet in length and 24 inches wide. Upper end to be equipped with door or hatch notches to permit use at varying heights of aircraft doors. The stairs to be provided with a folding guard rail. Stairs to be mounted in quick release brackets on the side of the apparatus applicable to airports in indexes 4 and 5 only.

Two portable electric hand spotlights with a minimum of 25,000 beam candle power rating.

Two axes, 6-pound fire department type, with serrated cutting edges.

60 feet steel center cable, ¾-inch diameter, with safety lock eye hooks at each end of the cable.

One adjustable hydrant wrench.

One set double male and double female connectors to fit fill connections used on the vehicle.

Two spanner wrenches, universal type.

Two spanner wrenches for handling hose couplings.

Two (2) approved 30-pound portable dry chemical extinguishers.

One (1) 36-inch crowbar.

One (1) 36-unit first aid kit.

One (1) canvas roll to include the following:

- One (1) 24-inch bolt cutter
- Two (2) cutting knives, parachute "V" type (Stebco or equal)
- One (1) hand axe with serrated face and insulated handle (Atlas 463)
- One (1) cable cutter AT-501-C (Aircraft Tools, Inc.) or equal
- Two (2) Dzus fastener keys
- One (1) cold chisel, 1 inch
- One (1) ball peen hammer, 2 lb.
- One (1) lineman's side cutting pliers, 8 inch
- One (1) hacksaw, with 6 extra blades
- One (1) tool kit, automotive, for emergency servicing.

NOTE: Any special tools required for servicing pump or equipment shall be provided, but not normally carried on vehicle.

362. See NFPA No. 414, Part V for rescue vehicle accessory equipment.

370. Communications and Alarms Suggested

371. The provision of two-way radio communication, special telephone and general alarm systems is desirable between Airport Control and the Airport Fire Station. Dependable transmission of essential emergency signals is a vital necessity. Mobile vehicles considered essential for the effective rescue and fire fighting service should be provided with two-way radio equipment (see Paragraph 325). Consistent with the individual situations at each airport, communication and alarm equipment should serve the following purposes:

a. Provide for direct communication between Airport Control and the Airport Fire Station to ensure the prompt alerting and despatch of rescue and fire fighting vehicles and personnel in event of an alert or incident.

b. Provide for emergency signals to ensure the immediate summoning of auxiliary personnel not on stand-by duty at the Airport Fire Station (see Paragraph 154).

c. As necessary, provide for the summoning of cooperating public protective agencies (public fire departments, ambulance and medical services, police or security personnel) and others located on or off the airport.

d. Provide for communication by means of two-way radio with all radio-equipped aircraft rescue and fire fighting vehicles.

380. Related Airport Features

381. The installation of underground water service mains with flush type hydrants along aprons and in front of administration and service areas is suggested. Underground water service mains for the movement area are also desirable wherever economically feasible. The construction of ramps, cisterns, docks, etc., to permit utilization and access to natural water sources available should not be overlooked.

382. Consideration should be given at all airports, depending on local conditions, to provide for ready access to such natural water supplies (lakes, ponds, streams, etc.) as may be available in the immediate vicinity and provision should be made on at least one unit of the fire fighting equipment available for drafting and pumping from such water supplies to augment the capabilities of the aircraft rescue and fire fighting vehicles.

383. Depending on the location of the airport and local topography, consideration should be given to the provision of suitable quick exits around the perimeter of the airport for aircraft rescue and fire fighting vehicles and to provide good approaches to access roads beyond the airport boundary for as far a distance as is necessary or practical. Particular attention should be given to the provision of ready access to the undershoot and overrun areas.

384. Aircraft rescue and fire fighting vehicles normally should be garaged at a central station. This station should be heated (where necessary) to assure immediate starting of garaged vehicles and should be located so:

a. That access to the movement area is unobstructed.

b. That vehicle running distance to active runways is the shortest possible consistent with local regulations regarding clearances of structures from landing areas.

c. That visibility of flight activity is normally obtainable.

d. That auxiliary personnel, trained for aircraft rescue and fire fighting, will be able to reach their stations without unnecessary delay.

e. That direct communication with Airport Control be available.

390. Personnel Suggestions

391. All personnel provided for aircraft rescue and fire fighting duties should be fully schooled in the performance of their duties under the direction of a designated Chief of Emergency Crew.

392. Personnel: Men recruited for aircraft rescue and fire fighting services should be of a high physical standard, resolute, possess initiative, competent to form an intelligent assessment of a fire situation and, above all, must be well trained and fully qualified. Ideally, every man should be capable of sizing up changing circumstances at an aircraft accident and to take the necessary action without detailed supervision. Where, of necessity, the available manpower displays limited capacity to use initiative, the deficiency must be made good by the provision of additional supervisory staff of a superior grade who will be responsible for exercising control of their crews. The officer responsible for the organization and training of the fire service should be an experienced, qualified and competent leader.

393. In the interest of providing immediate response capabilities of all vehicles recommended in Table 1, the following *minimum* manpower shall be provided during flight operations:

a. A fully trained driver-operator for the light rescue vehicle.

NOTE: Since it is anticipated that this vehicle will be the first unit to arrive, it is recommended that the officer in charge respond with this vehicle. This will allow an early appraisal of conditions in order that he can better direct fire fighting operations.

b. A fully qualified driver-operator for each of the other vehicles recommended in Table 1.

c. A fully trained turret operator for each major fire fighting vehicle recommended in Table 1.

NOTE: Where water requirements for tank vehicles in Table 1 are carried on fire fighting vehicles, it is not considered necessary to furnish a separate turret operator for these vehicles under immediate response requirements. (Other fully trained fire fighting personnel should be readily available* to provide handline operation capabilities of the major fire fighting vehicles. At airports falling into Index 4 and 5 of Table 1, serious consideration should be given to providing this additional personnel on an immediate response basis.)

*"Readily available fire fighting personnel" are personnel trained in and assigned to fire fighting duties but who may have other duties on the airport and respond to an emergency upon call.

d. In order to determine training and qualifications of the fire fighting personnel, refer to Training Procedures outlined in Article 600.

394. Movement and utilization of aircraft rescue and fire fighting equipment and of other emergency equipment at the time of emergency should be governed by the principles set forth in "Standard Operating Procedures, Aircraft Rescue and Fire Fighting" (NFPA No. 402).

395. It is suggested that equipment be manned and placed at predetermined emergency stations on the movement area prior to any landing or take-off attempted under any abnormal flight or weather conditions which might increase the accident potential during such operations.

396. All authorized personnel should be given suitable identifying insignia to prevent any misunderstanding as to their right to be in the fire area or on the movement area of an airport during an emergency.

397. The following fire fighters' personal equipment is suggested:

a. Bunker suit with heat insulative interliners for coat and trousers to afford full arm, body and leg protection, outer garment to be water repellent and flame resistant.

b. Protective gloves of chrome leather with heat insulative interliner and gauntlet wrist protection.

c. Standard fireman boots with wool lining.

d. Fireman helmet with plastic full vision face shield and front and neck protective aprons.

398. Full-time aircraft rescue and fire fighting personnel, where available, may profitably be assigned airport fire prevention duties (inspections and fire-guard functions) and be responsible for the routine maintenance of all airport fire equipment if suitable arrangements are provided to alert them for instant duties when away from the central fire station and if suitable transportation is available, when needed, to assure timely response to alarms.

Article 400. — Ambulance and Medical Facilities

410. Suggested Provision for Ambulances

411. The availability of ambulance and medical facilities for the removal and after-care of casualties arising from an aircraft accident should receive the careful consideration of airport managements and should form part of the overall emergency plan established to deal with such emergencies.

412. The extent of the facilities to be provided should be determined by the type of traffic and the maximum number of passengers likely to be involved in the largest aircraft normally using the airport.

413. Any decision regarding the provision of ambulances on the airport proper should consider the ambulance facilities available in the proximity of the airport and the possibility of assembling this equipment to meet within a reasonable period of time a sudden demand for assistance of the scale envisaged. It is also important to consider the suitability of such ambulances for movement on the terrain in the vicinity of the airport. Where it is decided that the provision of an ambulance or ambulances on the airport is necessary, then consideration should be given to the following:

a. The vehicle to be provided should be of a type suitable for movement on the terrain over which it may reasonably be expected to operate and should provide adequate protection for the casualties.

b. As a measure of economy, the vehicle may be one which is used for other purposes, provided such other uses will not interfere with its availability in the event of an accident. Any dual purpose vehicle should be easily modified to permit the carriage of stretchers and other medical equipment. In a case where auxiliary personnel are relied on for fire fighting and rescue purposes the ambulance vehicle could be used for the transport of such personnel to the scene of the accident and then assume its role as an ambulance.

420. Suggestions for Organization of Medical Assistance Program

421. The provision of a first aid room on the airport for the reception and treatment of casualties may be desirable. Such a room should be equipped to the standard considered necessary to meet the local requirement which will of course take into account the availability and proximity of hospital services with whom predetermined arrangements should exist for the reception and handling of casualties arising from an aircraft accident.

422. The emergency plan should provide for the summoning of doctors in the event of an accident and for the recruitment and training in first aid of as many people as possible from airport staffs who may be prepared to undertake such duties either on a voluntary basis or on such other basis as may be determined locally. It is especially desirable that personnel manning ambulances should be trained in medical first aid (see Section 154).

423. The usefulness and efficiency of any ambulance and first aid organization to be provided on an airport may be greatly assisted if it is used to deal with incidents whether of a minor or major character arising during the normal routine working of the airport. By so doing a situation is avoided whereby trained personnel and a useful organization may be left untried and unused over very long periods.

Article 500. — Reports

510. NFPA Reports

511. Each operation of aircraft rescue and fire fighting equipment should be carefully reported and analyzed and one copy of each such report should be sent to the National Fire Protection Association, 60 Batterymarch St., Boston, Mass. 02110. The form reproduced in Appendix C is the Official Report of the Association and full size copies are available from the NFPA.

Article 600. Training Procedures
Aircraft Rescue and Fire Fighting Personnel at Airports

610. Introduction

611. Instances when personnel whose protection duties consist solely of the rescue and fire fighting services for aircraft movements are actually called upon to face a serious situation involving major rescue and fire fighting operations are relatively infrequent. Normally, they will experience numerous standbys to cover ramp and other aircraft movements and servicing operations (under circumstances where the possibility of a serious accident may reasonably be anticipated) plus a few actual minor incidents. Under such conditions they are seldom called upon to put their full knowledge and experience to a supreme test. It follows, therefore, that only by means of a most carefully planned, and rigorously followed program of training can there be any assurance that both men and equipment will be able to deal with a major aircraft fire should the necessity arise.

612. Training of aircraft rescue and fire fighting personnel falls into two broad categories: (1) basic training in the use and maintenance of equipment (see Section 630); and (2) tactical training which covers the deployment of men and equipment to accomplish control of a fire to permit rescue operations to proceed (see Section 640).

620. The Training Program

621. The officer responsible for the training program must endeavor to maintain the interest and enthusiasm of his crews at all times. In certain respects this will not be too difficult. There are so many factors affecting aircraft rescue and fire fighting procedures which, as far as possible, must be anticipated, staged and practiced, that the officer has an opportunity of sustaining the interest of his students indefinitely. Each new type of aircraft using the airport brings with it new problems which must be assessed and incorporated into the training program. Other more routine aspects of training become less interesting over a long period and here it is essential that the officer should ensure that each man realizes to the full the need of such training. For example, it is a fundamental practice in the rescue and fire fighting service that each man satisfies himself, when on duty, that the equipment he may be called upon to use is serviceable. This particular aspect of a man's duty could deteriorate after a long period of comparative inaction unless the man is really convinced of the importance of this task. The entire training program must be designed to ensure that both men and equipment are at all times fully efficient. This represents a very high standard to achieve but anything less than full efficiency is not only not good enough but may be dangerous both to those in need of aid and those who are seeking to give such aid.

630. Basic Training

631. Fire and Fire Extinguishment: All rescue and fire fighting personnel should have a general knowledge of the causes of fire, the factors contributing to spread of fire and the principles of fire extinguishment. Only when armed with such simple knowledge can they be expected to take intelligent action when confronted with a serious fire situation. It must be known, for instance, that certain types of fire require a cooling agent while others need blanketing or smothering action, and equally, that certain of the media used extinguish by cooling, while others blanket or smother a fire (see Section 240). The scope of instruction will vary with the intelligence of the trainees. In most cases, the simpler this instruction is kept, the more successful it is likely to be. In no case should enthusiasm, engendered by the interest value of the subject, be allowed to carry the instruction beyond its practical application.

632. Types of Extinguishing Agent Employed: It is essential that the agents employed shall be thoroughly understood. In particular, every opportunity should be given to use the agents on actual fires to understand by experience not only the virtues but also the limitations of each agent. Each routine equipment test should be used as a training exercise in the proper handling of the equipment and the correct application of the particular agents involved.

633. Handling of Equipment: All rescue and fire fighting personnel must be capable of handling their equipment, not only under drill ground condition, but also in rapidly changing circumstances. The aim must always be to ensure that every man is so well versed in the handling of all types of equipment that, under stress conditions, he is able to operate it in an automatic manner. This can be accomplished in the initial state of training by employing the "change-round" technique during standard drills, and later by training involving the use of two or more pieces of equipment simultaneously. Particular attention should be paid to actual operation. This form of training is, of course, a continuing commitment.

634. Care of Equipment: A thorough knowledge of all equipment is essential in order to insure its intelligent handling and to insure thorough maintenance which is essential to guarantee operational efficiency under all circumstances. It is important that every fire fighter shall satisfy himself that any pieces of equipment which he may be called upon to use will work satisfactorily and, in the case of auxiliary equipment, that it is in its correct storage position. The importance of correct storage of small equipment to insure that it can be instantly located cannot be overstressed. Officers responsible for training are advised to hold periodic compartment drills when individual crew members are required to produce immediately a particular item. All rescue and fire service equipment must be regularly tested or inspected and careful records must be maintained of the circumstances and results of each test. Some items of equipment can be repaired locally and training in such subjects should be provided.

635. Local Terrain: A thorough knowledge of the airport and its immediate vicinity is essential. Training should include instruction in the use of alternative routes where obstacles, natural or artificial, may be encountered. The existence in any part of the area of ground which may from time to time become impassable should be known to all crew members and, where these features are not permanent, arrangements should be made for the current circumstances to be made widely known. Each man must have a complete knowledge of the availability of local water supplies.

636. Aircraft Familiarization Training: The importance of this aspect of training cannot be overemphasized. Rescue and fire fighting personnel may be called upon to effect a rescue from an aircraft interior under adverse conditions, working in an atmosphere heavily laden with smoke and fumes. (If self-contained breathing apparatus is supplied careful training in its use is essential.) It is also essential that every man should have an intimate knowledge of all types of aircraft normally using the airport. This knowledge cannot be acquired solely from a study of diagrams which are issued by many operators. There is no substitute for a periodic inspection of the aircraft, paying particular attention to position and locking mechanism of all exits, both normal and emergency, and to the internal layout and seating arrangements. So far as is practicable, fire fighters should be allowed to operate the emergency exits and certainly should be fully conversant with the method of opening all the main doors. An elementary knowledge of aircraft construction is highly desirable since such knowledge is invaluable if, as a last resort, forcible entry is necessary. The cooperation of the engineering staff of the aircraft operators should be sought on this aspect of training.

637. First Aid: Every member of the rescue team should, if at all possible, be trained and periodically requalified in first aid. The prime reason for this qualification is to ensure that casualties are intelligently handled so that injuries are not needlessly aggravated.

638. Search and Rescue

a. The training program should provide instruction in search procedures, not only in enclosed spaces of an aircraft, but also for procedures for systematic searching of the area in the immediate vicinity of an aircraft accident and also in the path of the aircraft.

b. As a broad principle, it should be taught that the persons involved in a fire are most frequently found near an exit, *i.e.*, doors and windows, or in lavatories and compartments, etc.

c. Rescue is always best effected by way of a normal channel, if available. For example, it is easier to carry a person through a doorway than to manipulate him through a window. The main cabin door of an aircraft should always be attempted first. Should the door be jammed it will usually be found quicker to force it by applying leverage at the right spot than to achieve entry and rescue through another form of opening. Success in this form of operation requires a full knowledge of the locking mechanism and direction of travel of the door concerned. Forcible entry through other than normal channels should only be attempted when it is obvious that regular means cannot be employed. Pressurized cabins offer tough resistance to penetration by an axe or even power-operated saws. Properly designed axes and power saws are of value in making forcible entry, in some cases, but expert knowledge in handling such tools is a prime requisite to successful use in an actual emergency.

d. All fire fighters should be trained in rescue procedures. The working space inside a cabin is necessarily somewhat restricted and it will generally be found advisable to restrict the number of rescuers working inside the aircraft and work on a chain or "buddy" principle.

e. Where possible, the airport emergency organization should provide for the availability of personnel other than rescue and fire fighting personnel, for the handling of casualties from the moment they are removed from the aircraft (see Section 154).

f. All rescue personnel should be trained in fireman's lift and other forms of rescue.

640. Tactical Training

641. When personnel are well versed in the handling of fire fighting equipment they should receive training in tactics to be adopted at aircraft fires. Teamwork is a primary essential.

642. This training is a continuing commitment and must be absorbed to the point where compliance with the initial action called for is automatic, in the same sense that hose-laying to a well-trained fire fighter is automatic and will, therefore, follow even when working under stress. Only when this is achieved, will the officer-in-charge be in a position to assume complete control of the situation.

643. Tactical training is designed to deploy men and equipment to advantage in order to establish conditions in which people may be rescued from an aircraft which is involved in, or liable to become involved in, fire. The object is to isolate the fuselage from the fire, cool the fuselage, establish and maintain an escape route and achieve the degree of fire control necessary to permit rescue operations to proceed. This is fundamental and must be stressed in the training program. The service to be provided is primarily life saving but the personnel must be trained in fire fighting because aircraft involved in a serious accident frequently are involved in fire simultaneously. Until all the occupants of the aircraft are accounted for, fire fighting operations must be directed to those measures which are necessary to permit rescue to be carried out. This includes fire precautionary measures at those incidents where no fire has broken out. When the life saving commitment has been met it is necessary, of course, to utilize all available resources to secure protection of property.

644. The main attack on the fire will normally be by means of mass application of foam or, alternately, by the combined use of foam-compatible dry chemical or carbon dioxide and foam.

Where foam alone is used as the principal agent a suitable back-up agent must be available to deal with pockets of fire which may be inaccessible to direct foam application. This will generally be provided in the form of dry chemical or carbon dioxide extinguishing agents to be used on running liquid fuel fires or in enclosed spaces, such as wing voids, in an engine nacelle, or wheel well. (See Section 240 and Article 300.)

645. The following points should be covered in the tactical training program:

a. The Approach: Equipment should approach the incident by way of the fastest route in order to reach the incident in the shortest possible time. This is quite frequently not the shortest route as, speaking generally, it is preferable where possible to travel on a paved surface than to approach over rough ground or grassland. Equipment recommended for this service is basically designed for on- and off-pavement service* but speed is vital and the quickest route, rather than necessarily the most direct route, is the one to be selected. When nearing the scene of the incident a careful watch must be maintained for occupants who may be dashing away from the aircraft or who may have been flung clear and are lying injured in the approaches. This applies particularly at night, of course, and calls for intelligent use of spot or floodlights.

b. Positioning of Equipment: The positioning of equipment, both airport and assisting equipment, is important in many respects and regard should be had to the following factors: The equipment operator must be in a position to view the fire ground; the equipment must not be placed in a position of hazard due to spillage of fuel or due to slope of ground or wind direction; no one unit should deny approach to the scene for other emergency vehicles, such as ambulances; equipment must be positioned to operate effectively on the fire, particularly as regards rescue operations, but not be so positioned that it might be trapped by fire.

c. Positioning of Light Fire Fighting and Rescue Vehicle(s):

(1). Normally, the light rescue vehicle (see Section 330) reaches the accident site first and is used to initiate rescue and

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*See NFPA Standard for Aircraft Rescue and Fire Fighting Vehicles (No. 414).

fire fighting at the earliest possible moment. Hopefully, the mission of its crew is to prevent fire outbreak and initiate rescue operations, to control or extinguish the fire in its incipient stage to permit rescue, or, alternately, to try to secure a rescue path, to size up the rescue and fire fighting problem and to be in a position to direct the positioning of the major appliances upon arrival.

(2). The light rescue vehicle should be positioned to permit the most rapid access to the principal egress route from the aircraft in distress except when it is obvious that occupants are evacuating safely without assistance and the fire or threat of fire is otherwise located.

(3). Since the light rescue vehicle has limited extinguishing capability, caution must be taken to avoid placing the vehicle in untenable locations in event of sudden extension of the flame front or an explosion. After the vehicle's extinguishing capacity has been exhausted and assuming incomplete control, the vehicle should be withdrawn from a position which might be subsequently occupied to advantage by later-arriving fire fighting equipment.

d. Position of Major Fire Fighting Vehicles:

(1). Major units equipped with turrets for the mass application of the extinguishing media should be positioned as to make effective use of the turret streams. It is vitally important to avoid wastage of the limited amounts of agent available so that turrets should be used only when they are being effective. Normally, hand lines control the rescue paths so it is equally important to locate equipment to permit the effective employment of these lines. Proper positioning of apparatus is, in fact, often the key to successful operations.

(2). The main initial object is to insulate and cool the fuselage and to safeguard the escape routes. The type and number of nozzles available will vary with the type and the scope of the equipment provided. NFPA Charts 403–2A and 403–2B on the Principles of Fire Fighting for Civil Aircraft (copies available at 15 cents each) illustrate some useful techniques.

(3). The initial discharge of foam should cover and be along the line of the fuselage and then directed to drive the fire outwards. When selecting the best position to accomplish this purpose, always remember that the wind has considerable influence upon the rate of fire and heat travel. The position should be chosen with this in mind, thus utilizing the wind, whenever possible, to assist in the main objective. Except in unusual circumstances hose streams should not be directed towards the fuselage at right angles as this may tend to drive burning fuel toward the occupied areas handicapping survival of trapped occupants. Similarly, care must be exercised to avoid the possibility of disturbing a foam blanket by the careless application of additional foam or any other agent. Foam should always be laid on a liquid fuel fire so that it gently forms a blanket with the least possible turbulence to the fuel surface.

(4). There are two basic methods of applying foam. One involves the use of a straight stream which can be applied directly or indirectly on a surface at some distance. The second is to use a spray or diffused stream at close range. Often, foam can be applied to a fire area by deflecting from another surface, such as against the contour of the fuselage. This has the advantage of simultaneously insulating the fuselage by building up a foam cover. Whenever foam equipment is being subjected to a periodic routine check the opportunity should be taken to train crew members in these methods of application. It is important that such training be carried out on actual fires so that personnel will obtain an assessment of the value, as well as the limitations, of the agent so applied and familiarize himself with the heat conditions he will experience. These drills should be carried out at intervals of not more than one month.

(5). Officers responsible for training should decide on the optimum positioning of equipment best suited to their available resources under each simulated condition and then take steps to train their crews accordingly. At a fire there is little time for individual briefing of crew members and while the initial layout may have to be adjusted to cope with the existing circumstances, it is very important for the crews to know exactly what their first action should be well in advance. It should always be remembered that this layout of equipment should be standard practice at an aircraft incident even when fire has not broken out and under these conditions, at least one nozzle should be manned and in readiness to go into instant action should the occasion arise.

650. Additional Comments

651. Conservation of Extinguishing Media: The quantities of extinguishing agents available at an aircraft accident are normally very limited. Accordingly it is essential that the minimum of wastage is permitted. This calls for complete coordination between pump and nozzle operators. The personnel engaged in fire fighting should cease using extinguishing media as soon as it is certain beyond doubt that equipment is not serving a useful purpose. Simple hand signals can be employed to achieve the necessary liaison. Such signals would not be required, however, where the design of the equipment permits remote control.