AIRCRAFT RESCUE AND FIRE FIGHTING EQUIPMENT FOR AIRPORTS

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As Recommended by the National Fire Protection Association Committee on Aviation and Airport Fire Protection

Section 100—Introduction

101. These recommendations are predicated solely on the requirements for aircraft rescue and fire fighting equipment for airports and do not include fire protection facilities which might be required for airport structures (i.e. hangars, shops, terminal buildings, etc.) although much of the equipment specified herein would be of considerable value for such commitments.

102. Where aircraft are involved in accidents on the movement area or in the vicinity of an airport, experience has shown that the most severe problems of rescue are encountered when fire occurs. The threat of fire is ever present and occurs very frequently in aircraft accidents. Fire may occur before or immediately following ground impact or at any time during rescue operations owing to the nature of the fuels and lubricants used, the latent heats of operating aircraft engines, and the possibility of sparks being created through disturbance of electrical circuits in the wreckage. The outstanding characteristic of aircraft fires is their tendency to reach lethal intensity within a very short time after outbreak and this not only serves to handicap rescue efforts but also presents a severe hazard to the lives of those involved in the accident and anyone attempting their rescue.

103. 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 in their immediate vicinity due to the concentration of air traffic, let down, 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.

104. These recommendations are designed to supplement the National Fire Protection Association publication entitled "Suggested Standard Operating Procedures, Aircraft Rescue and Fire Fighting" as adopted by the Association and made available to the public.*

105. Aircraft rescue and fire fighting on the movement area of an airport is the primary responsibility of the airport management, whether a governmental agency, a private corporation, or an individual, and irrespective of how such activities are financed and/or administered. Airport management also has primary responsibility for aircraft rescue and fire fighting

*Copies available from the NFPA Executive Office, 60 Batterymarch St., Boston 10, Massachusetts, U.S.A. ($.25)

within the reasonably accessible environs of the airport movement area where there is no conflict with the primary responsibility of other suitably organized and equipped public protective agencies. A prearranged high degree of mutual aid (joint defense measures) is required between airport rescue and fire fighting organizations and any public protective agencies serving the immediate vicinity. An "area emergency plan" will be established and airport management will be expected to provide educational instruction on the special problems and techniques associated with aircraft rescue and fire fighting to cooperating public agencies.

106. These recommendations are prepared for international application. The aeronautical terminology used is defined in Appendix C.

Section 200—Basis for Recommendations

201. To provide a workable index useful in determining the minimum amounts of fire extinguishing agents required for aircraft rescue and fire fighting, aircraft are grouped into the following weight "Classes":

Class No.	Aircraft Maximum Gross Weight Ranges	Approximate Fuel Capacity Ranges†	Normal Number of Occupants
I	Under 3,000 lbs.	Under 70 gals.	1 to 4
II	3,000 to 8,500 lbs.	70 to 150 gals.	4 to 6
III	8,500 to 15,000 lbs.	150 to 500 gals.	5 to 10
IV	15,000 to 26,000 lbs.	500 to 1,000 gals.	10 to 25
V	26,000 to 50,000 lbs.	1,000 to 2,000 gals.	25 to 40
VI	50,000 to 90,000 lbs.	2,000 to 4,000 gals.	30 to 45
VII	90,000 to 130,000 lbs.	4,000 to 6,000 gals.	45 to 60
VIII	Over 130,000 lbs.	Over 6,000 gals.	Over 60

Obviously not every aircraft will fit precisely into the above "Classes" but they do apply generally (see Appendix "D"). Obviously also, not all of the aircraft which do conform to the "Class" groupings have identical crash impact fire dangers. (For example, aircraft with bladder type fuel cells well segregated from ignition sources and with properly designed plumbing would have less impact fire dangers than other aircraft in the same Class which lack this design feature.) Similarly, rescue opportunities for aircraft in a given weight "Class" might vary with the nature of the installed exit facilities provided. The utility of these classifications is thus subject to discriminating use until experience statistics will justify more accurate definition of rescue and fire fighting requirements based on actual impact fire hazard characteristics of individual aircraft and (as applicable) of individual models of the same aircraft. It should be clearly understood that it is not anticipated that the total fuel capacity of each aircraft will be involved in fire following each and every accident. The use of these classifications merely indicates the relative fire danger from fuel exposure and the total potential fuel capacities which might be involved. While the fuel capacity of an aircraft generally governs the potential magnitude of fire risk, it should be clearly understood that lubricating oils, flammable hydraulic fluids,

†U.S. gallons are used in this Table.

alcohol, combustible fabrics or cargoes, etc., might provide the initial fuel or contribute significantly to fire spread.

202. The chief purpose of providing such rescue and fire fighting equipment as specified herein is to save the lives of passengers and crew. It is most often necessary to effect complete control or extinguishment of fire to ensure such rescue. The recommendations advanced herein are promulgated upon this basic concept. Passenger and crew capacities are generally related to the gross weight of the aircraft (see paragraph 201) and thus are related to the other features governing extinguishing agent requirements.

203. The determination of the quantities of fire extinguishing agents required at an airport will be related to the heaviest "Class" of aircraft normally using the facility. (Illustration: An airport operating DC-3 aircraft with one or two DC-4 landings a day will normally be equipped on the DC-3 scale. Prudent operators will, however, provide auxiliary facilities for a possible DC-4 emergency.)

204. The number of recurrent operations per day will influence the assignment of personnel needed to man the equipment, but, basically, the type of protection provided will be in accordance with paragraph 203 above. This is formulated on the concept that the life safety of those aboard one aircraft are no less important than those on any other similar aircraft, regardless of the frequency of operations or exposures to accident. It is realized that the cost of providing the suggested scales of rescue and fire fighting facilities will be great and that, in the case of remote airports, the cost may be materially more than at those located within zones where public fire protection is afforded. The scale of facilities provided, therefore, may have to be related to the revenue produced by the air traffic and the overall requirements for fire protection in each situation. The economics of the protection must not ignore the life protection factors, the airline carrier investments at risk, and the loss of revenue resulting from declines in passenger patronage due to accident experience. Heavy traffic conditions may require an increase in the scale of facilities where parallel runways are provided and where runways are widely spaced and exceed 8,000 ft. in length.

205. In view of the lack of uniformity in the size and type of rescue and fire fighting equipment in use throughout the world, the most convenient means of specifying requirements is in terms of the minimum amounts and discharge rates of extinguishing agents required for initial rescue and fire fighting operations for each "Class" of aircraft (see paragraph 201 above). In addition, certain objective and functional specifications may be given for equipment design and operation which may apply to existing or future designs of vehicles.

206. In order to establish the types of extinguishing agents required for aircraft rescue and fire fighting, it is necessary to consider certain basic

principles concerning the various agents available for the purpose. These may be summarized as follows:

(a). Water, used as water spray or otherwise, is the best universally available cooling agent for the control of fire and for personnel protection from heat. The extinguishing ability of water and water spray, however, is poor on large gasoline based fires of the type usually encountered in accidents involving aircraft weighing over 15,000 lbs. gross weight (over 500 gallons (U.S.) of fuel capacity) because of its limitations in finalizing extinguishment. It is thus not recommended as the sole agent available for this type of fire fighting. Water spray is, nonetheless, so very useful 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, that its availability is recommended. This is usually entirely practical through the use of adjustable valves and nozzles on equipment designed essentially to dispense foam. The use of straight water streams discharged at high velocity is not recommended for aircraft rescue and fire fighting. Wetting agents added to water improve its extinguishing efficiency on flammable liquid based fires but care must be exercised to avoid freezing and to assure compatibility if foam is used as a supplementary agent.

(b). Foam used for aircraft rescue and fire fighting is an aggregation of small bubbles of lower specific gravity than oil or water and shows tenacious qualities for covering and clinging to vertical or horizontal surfaces. It cools hot surfaces by its high water retention ability and flows freely over a burning liquid surface to form a tough, air-excluding blanket that seals-off volatile flammable vapors from access to air or oxygen. Good quality foam is dense and long lasting, resisting disruption due to wind and draft or heat and flame attack and is capable of resealing in event of mechanical rupture of an established blanket. There are two kinds of foam:

(1). Chemical Foam—made 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 tough, fire resistant foam.

(2). Mechanical Foam (Air Foam)—made by the addition of a special foam stabilizer (a liquid) to water to make it capable of foaming in the presence of air which is incorporated by the mechanical action of jets in fixed foam maker or playpipe.

Mechanical foam (air foam) is more suitable for aircraft rescue and fire fighting because of advantages in speed of operation, reduced manpower requirements and ease of carrying the needed basic ingredient. The most serious limitation of foam for aircraft rescue and fire fighting is the time element involved in its application (usually best accomplished by the deflection of foam off the fuselage and working outwards to form a blanket over flammable liquid spills). To be effective for the primary mission of rescue, rapid discharge facilities must be available to permit application of large quantities in the shortest possible time. 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). Fog-foam used for aircraft rescue and fire fighting is the name applied to foam discharged at high pressures in water solution through specially designed nozzles. It has excellent cooling effects and measurably increases the extinguishing efficiency of plain water spray. With its high water content (which is reflected in its cooling ability), there is, however, a sacrifice in its smothering quality as compared with foam and, hence, in the permanency of the foam blanket formed by its application on flammable liquid spills. Quantity application of fog-foam on an aircraft fire at a high rate of discharge provides for effective extinguishment and unexcelled cooling within the limitations imposed on any single agent method now available.

(d). Carbon dioxide used for aircraft rescue and fire fighting provides a most rapid means of fire extinguishment on flammable liquids when dispensed adequately over the fire area in sufficient quantity at a sufficiently high rate of discharge. As an inert gas, its thorough penetration to otherwise inaccessible areas is particularly significant and its speed of action is tremendously important to the primary mission of rescue. The cooling effect of carbon dioxide is not always sufficient to reduce heated metal parts below the ignition temperatures of flammable liquid vapors liable to persist in the area. This introduces the hazard of reignition of such exposed flammable vapors upon diffusion of the inerting carbon dioxide gas. The permanency of extinguishment may also be affected by atmospheric conditions (particularly wind direction and velocity) but firemen's training has a great influence on this contingency.

(e). Dry chemical (gas expelled) used for aircraft rescue and fire fighting, like carbon dioxide, provides a most rapid means of fire extinguishment on flammable liquids when dispensed adequately

at a sufficiently high rate of discharge and in sufficient quantity. Its use as a medium for aircraft rescue and fire fighting has not proceeded beyond experimentation at this time (February, 1949) but its efficiency as an extinguishing agent on similar fires is well recognized. The principal action of dry chemical is the release of carbon dioxide and water vapor upon contact with flame. The cooling effect is negligible as compared with the bulk carbon dioxide method but the quantity of dry chemical required to extinguish identical fires is less because of the production of carbon dioxide and water vapor (by the decomposition of the dry chemical) at the base of the flame where it can be most effective. The hazard of reignition of exposed flammable vapors is present upon diffusion of the inerting carbon dioxide gas. The residue deposits of dry chemical are believed to have some beneficial effects on the extinguishment action but these deposits do introduce problems of compatability with certain foams requiring experimentation to assure that any subsequent foam application will not deteriorate because of chemical reactions. Reasonable compatability of foam and dry chemical has been secured experimentally to date but much depends on the acid and base properties liable to be encountered. The permanency of extinguishment may also be affected by atmospheric conditions (particularly wind direction and velocity) but firemen's training has a great influence on this contingency.

207. It should be noted from the information in paragraph 206 (above) that no single agent meets all the necessary qualifications for speedy and permanent aircraft fire extinguishment. It is therefore obvious that a combination of agents is desirable, especially for aircraft weighing over 15,000 lbs. gross weight (over 500 gals. of gasoline). *Experience criteria dictates the selection of carbon dioxide and foam (with option to fog-foam or water-fog) as the most effective means currently available for aircraft rescue and fire fighting.* This combination provides for rapid blanketing, effective cooling, and permanent extinguishment assuming adequacy of agent supply and discharge facilities.* The use of dry chemical in lieu of carbon dioxide may prove feasible but additional experimentation and practical use on a large scale are needed before final recommendations might be given. For aircraft weighing under 15,000 lbs. gross weight, the above combination is likewise recommended but recognition is given to the potential successful utilization of foam and fog-foam alone or by carbon dioxide alone by virtue of the limited fuel exposures liable to be involved.

*Experience criteria utilized was developed during the period 1941-1947 inclusive. It is specifically recognized that new equipment is being developed at a rapid rate and that these developments might alter the agent selection and utilization recommended in this Bulletin. Recommended Test Procedures for the evaluation of new equipment are being established by the Committee to permit prompt recognition of any such changes that may be dictated.

TABLE NO. 1

CRITERIA FOR THE MINIMUM AMOUNTS OF EXTINGUISHING AGENTS, MAXIMUM DISCHARGE PERIODS AND MINIMUM PERSONNEL REQUIREMENTS FOR AIRCRAFT RESCUE AND FIRE FIGHTING OPERATIONS GRADED ACCORDING TO AIRCRAFT WEIGHT CLASSIFICATIONS.

Aircraft Class by Gross Weight (See Par. 201)	Minimum Quantities Extinguishing Agents		Maximum Period of Discharges (Total Ports)		Minimum Number of Personnel Required*		Typical Civil Aircraft in Class (See also Appendix "D")
	Water in U.S. Gals. For Foam Production	Carbon Dioxide in Pounds	Water Min.**	CO_2 Min.	Full Time Manpower	Auxiliary Trained Manpower	
Class I Under 3,000 lbs.	300	300	4	3	1	2	Piper Cubs, Cessna 140, Navion, etc.
Class II 3,000-8,500	400	500	2½	2½	1	3	Widgeon, Cessna 190, AT-6, etc.
Class III 8,500-15,000	500	750	2½	2½	1	4	Beech D-18S, Mallard, Avro XIX, etc.
Class IV 15,000-26,000	750	1,200	2½	2½	3	5	DC-3, Beech Model 34, Lodestar, etc.
Class V 26,000-50,000	1,500	2,000	2½	2½	4	6	Convair Liner, Martin 202, CW-20E, etc.
Class VI 50,000-90,000	2,500	4,000	2½	2½	5	7	DC-4, Short S-45/H2, Hermes IV
Class VII 90,000-130,000	3,500	5,000	2½	2½	6	8	DC-6, Constellation, CW-32
Class VIII Over 130,000	4,500***	6,000***	2½	2½	7***	9***	Boeing 377 Short S-35, Brabazon I

*Does not include allowances for leave, sickness and other similar factors which must be taken into consideration by airport management (see par. 314 below).

**Discharge periods are calculated at rates of water dispensed, not rates of foam, but are based on use of foam.

***Projected estimates; subject to revision as aircraft in weight class are placed in civilian service.

208. The types and quantities of extinguishing media detailed in Table 1 are based on the finding indicated in paragraph 207 (above) and on research, large scale tests and actual experience studies in the United Kingdom and the United States as related to the particular requirements of civil aircraft operations (see footnote, page 7). The quantities recommended are the minimums to be immediately available for direct application.

209. 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 bulk application (see paragraph 206 above) 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; or (3) by cooling with water (this process liable to temporarily intensify flame spread until the application is sufficient to produce the degree of cooling required). (See also *NFPA Handbook of Fire Protection*, 10th Edition, pages 418-420.)

Section 300—Recommendations

301. Table No. 1 indicates the quantities of carbon dioxide and water (for conversion to foam) recommended as the minimum amounts for immediate application, graded according to aircraft weight "Classes" (see paragraph 201) and in accordance with the findings indicated in paragraphs 207 and 208. This criteria applies to all airports other than those where extremely low temperature conditions exist over extended periods of time preventing the utilization of these conventional agents.

302. The minimum amounts of water (for conversion to foam) and carbon dioxide specified in Table No. 1 are to be immediately available for application from properly designed and equipped aircraft rescue and fire fighting equipment (see paragraph 305, below) available at the airport, manned by thoroughly trained and equipped aircraft rescue and fire fighting crews (see paragraph 314 below). The minimum agent quantities specified in Table No. 1 presume the existence of additional water supply facilities (mobile or otherwise) and any special chemicals upon which dependence is placed for fire extinguishment to make possible continuing rescue and fire fighting operations for a reasonable period of time after the discharge of agents carried as the initial minimums.

303. The amount of water shown in Table No. 1 for each "Class" is the minimum considered necessary for fire extinguishment based on conversion to foam and when applied in conjunction with carbon dioxide (see par. 207 above). The gallonage is expressed in gallons of water (not in gallons of

foam) and the mechanical foam production contemplated is based upon an expansion ratio of from 5 to 1 to 10 to 1. When the water supply is used for other than foam production, the extinguishing efficiency or effectiveness must equal that of the foam method based on acceptable test procedures.*

304. The amount of carbon dioxide shown in Table No. 1 for each "Class" is the minimum considered necessary for fire extinguishment when applied in conjunction with foam (see paragraph 207 above). Other inert gases (or agents which produce inert gases when applied to fire, such as dry chemical) may be utilized following a determination of their extinguishing efficiency and effectiveness and assuring reasonable compatibility with foam. When other such agents are used, their extinguishing efficiency or effectiveness must equal that of comparable amounts of carbon dioxide based on acceptable test procedures.*

305. Aircraft rescue and fire fighting equipment must be mobile and the vehicles provided for conveying the extinguishing media quickly to the scene of the accident must be constructed to comply generally with the following objective functional specifications:

(a). The optimum carrying capacity of a vehicle and its gross weight will depend upon various chassis and body design features. In this respect, *vehicle capacity and gross weight must be compatible with and without prejudice to the performance characteristics specified in Par. 305(b), below.* This criteria will determine the suitability of the vehicle for the duties described. On the basis of current vehicle development, it is recommended that not over 1,000 gals. of water be carried on any single aircraft rescue and fire fighting unit (auxiliary tank trucks excluded) and that the gross vehicle weight not exceed approximately 40,000 lbs. (auxiliary tank trucks excluded). In this connection, it should be noted that with the larger type aircraft (particularly Class VI and over), it is desirable to have multiple units available to attack a fire from more than one point or quarter.

(b). Design and construction of the vehicle shall be suitable for carrying its full load at relatively high rates of speed over all types of roads, trails, open and rolling country under all reasonable conditions of weather and terrain on the movement area of the airport and in the immediate vicinity thereof. More specifically, the vehicle will have the following characteristics:

1. A cruising speed of at least 50 miles per hour on paved roads.
2. Acceleration shall be such that the vehicle, fully loaded, is able to achieve 50 miles per hour within 35 seconds in a distance of 1,400 feet without engine preheating with ambient temperatures above 45° F. (7° C.)

*Acceptable test procedures are under development by the Committee—see footnote page 7.

3. Braking should permit the vehicle to be brought to a stop in 20 ft. when travelling 20 miles per hour, fully loaded and manned, on dry pavement.

4. Detailed vehicle traction and flotation specifications cannot be issued on a blanket basis as they will vary with the terrain conditions existing or liable to exist at the individual airports at which the vehicle is in service. The importance of using proper tire sizes, treads and inflations cannot be overemphasized. Flotation and traction on soft soil is best obtained by the use of low tire inflations. It is recommended that ample tire sizes be chosen so that this reduced inflation can be maintained, regardless of the soil conditions, without sacrificing tire durability. The tire load and inflation tables in Appendix "A" were supplied through the courtesy of the Tire and Rim Association (U.S.A.) and are extended down to 25 psi inflation to serve as a guide in choosing adequate tire sizes. Inflations lower than 25 psi are not recommended since their use requires some provisions for preventing the tires from creeping on the rims. If the vehicle service requirements are such that inflations need not be as low as 25 psi, tire sizes can be reduced by the use of higher inflations and tire durability should be satisfactory providing there is adherence to the load-inflation tables. Great care must be used to avoid the danger of sidewall injury and pinching of tubes which may occur with underinflated tires.

5. Angles of approach and departure shall be not less than 30 degrees and center clearance not less than 15 degrees, except where only flat terrain exists within the normally accessible environs of the airport.

6. Vehicle motor horsepower requirements, transmission power ratios and chassis design will be governed by vehicle weight, the acceleration and speed requirements, and by the flotation specifications engineered for the terrain conditions at the airport being serviced. Normally, front and rear axle drive is desirable with positive four-wheel drive recommended for all difficult terrain where the need may be illustrated by actual test runs.

(c). 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.

(d). Overall vehicle dimensions should be within practical limits having regard to standard highway practices, width of gates and height and weight limitations of bridges. Vehicle length and height should take into consideration garaging facilities.

(e). 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 not enough for large aircraft fires; elevated turrets or horns having large discharge capacities are needed to quickly blanket the fire and knock down the bulk of the flames. Hand lines are used essentially for covering the rescue party, for maintaining fire control in the rescue entry area, and for spot cooling of the fuselage to avoid heat suffocation to trapped occupants.

(f). Accessory equipment desirable includes:

(1). Manual Cutting, Opening and Access Tools
- Large and small axes specially designed for piercing metallic fuselage skin surfaces (non-wedging)
- Bolt, bar and metal cutters
- Metal and wood cross cut and hack saws
- Rounded tip knives for cutting safety belts, parachute straps
- Vise and electrical wire cutting pliers
- Access ladders (height depending on aircraft utilizing airport)
- Screwdrivers and fastener tools
- Keys to aircraft compartments

(2). Manual Shifting Tools
- Crow bar and claw tool
- Grappling hook and cable (with tow hooks mounted on front and rear of mobile truck)
- Long handled shovels
- Pike pole
- Sledge hammer
- Plugs and crimping tools for flammable liquid lines and tanks

(3). Electrical or Mechanical Tools (May be mounted on separate Auxiliary Unit)*
- Electrical, circular metal cutting saw
- Electrical, push-pull metal cutting saw
- Electrical lighting plant with generator
- Portable public address system with batteries
- Power winch or crane

*See Appendix "B."

(4). First Aid Equipment (May be mounted on separate Auxiliary Unit)
First aid fire extinguishers
First aid medical kit
Asbestos and wool blankets
Stretchers
Resuscitator

306. The following fire fighters' personal equipment is recommended:

(a). Bunken 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). Firemen helmet with plastic full vision face shield and front and neck protective aprons.

307. Fire trailers and "Jeep" trucks (¼ ton) are valuable accessory units to supplement the equipment specified in paragraph 305 (above). Their main function is to reach accident sites quickly, particularly where terrain conditions make access difficult for larger units of equipment. Such trucks might carry small amounts of extinguishing agents for attacking incipient fires plus power tools, a lighting plant, access ladders, winches, a first aid kit and similar equipment. (See paragraph 305. (f). (3) and (4) and Appendix "B.")

308. Water tank trucks are important auxiliary units, particularly where water supplies on and around the airport are limited. Such tank trucks should be equipped with a pumping engine and hose for relaying water to major pieces of rescue and fire fighting equipments or for direct application on the fire. Foam supplies and combination foam, fog-foam, and water spray nozzles are recommended.

309. No attempt is made in these recommendations to detail water pump capacities, pump inlet and outlet plumbing, power take-offs, foam proportioners and controls, the location of elevated nozzles and their operations, hose reel location, hose sizes and length, cab and manpower carrying facilities and similar equipment details, although, they are all items requiring careful engineering and design. Basically such equipment will be related to the extinguishing media used and the production rates specified in Table No. 1 (above). Wherever possible, optimum benefits are achieved with mobile equipment by approaching an aircraft fire from a frontal or front quarter position on the windward side. This dictates that turrets and hand lines should be so located as to have their maximum effectiveness with the

vehicle in this position and they should be easily operatable to avoid waste of time. Ground sweep protection for the vehicle is desirable.

310. The provision of underground water service mains with flush type hydrants along aprons and in front of administration and service areas is recommended. 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.

311. All aircraft rescue and fire fighting vehicles should be painted red in accordance with "Army-Navy-Civil Uniform Requirements for the Marking of Vehicles Used on Landing Areas."* This requirement applies in the United States only, but international adoption is recommended.

312. *During all operational flight periods of transport category aircraft, the principal† aircraft rescue and fire fighting unit should be fully manned, equipped with two-way radio on airport control radio station frequency, and should normally be located where maximum practicable observation can be obtained of the flow of air traffic as it arrives and departs on the operational runway. At airports operating personal aircraft exclusively, this requirement for an alert unit and crew should be optional with aircraft operators utilizing the airport.* It must be emphasized that the entire purpose and function of the fire defense organization established by these recommendations will be defeated if the equipment specified is not available for immediate action the moment an accident occurs. Since all accidents cannot be anticipated, the need for an alert crew is obvious. Supplementary mobile equipment may be garaged at a central station providing a permanent assigned driver for each such unit will be immediately available in case of an emergency. This central 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 running distance to active runways is the shortest possible consistent with local regulations regarding clearances of structures.

(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.

313. Movement and utilization of aircraft rescue and fire control equipment and of other emergency fire equipment at the time of emergency

*See Technical Standard Order N4 (July 2, 1947) available from the Civil Aeronautics Administration, Washington 25, D. C., U.S.A.

†The "principal" unit is defined as the unit designated as the first major unit to be employed.

should be governed by the principles set forth in NFPA pamphlet "Suggested Standard Operating Procedures, Aircraft Rescue and Fire Fighting."*

314. Personnel recommendations are as follows:

(a). *Sufficient trained aircraft rescue and fire fighting personnel (Emergency Crew) should be available during all periods of flight operations to bring into immediate employment at least one-third of the total extinguishing media specified or a minimum of one unit of equipment, whichever is the greater. This contemplates that at airports operating Class IV or over aircraft, the principal† aircraft rescue and fire fighting unit will be fully manned with full-time personnel during all periods of flight operations and that each additional unit of equipment will have a full-time driver assigned. Trained auxiliary personnel should be available to complete vehicle manning requirements. Table No. 1 (above) may be used as a guide in the interpretation of these recommendations.*

(b). At airports which, from their nature and/or density or traffic, do not warrant the employment of full-time aircraft rescue and fire fighting personnel (Emergency Crew), it is recommended that at least one full-time employee be provided for the proper maintenance and operation of the mobile equipment provided for the purpose.

(c). All full-time or auxiliary trained personnel (Emergency Crew) 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. This involves particularly expert knowledge of:

1. The capabilities and limitations of their mobile and auxiliary aircraft rescue and fire fighting equipment and thorough familiarity with procedures recommended for their operation and for the accomplishment of their mission.

2. The physical features of the aircraft operating on the airport particularly as to the location of:
   Crew and passenger seats
   Entry and exit facilities and emergency exit equipment
   Forceable entry areas
   Fuel tanks, fuel shut-off controls, fuel line drainage points, fuel filler caps
   Battery locations and battery master switches
   Lubricating oil tanks and shut-off valves
   Hydraulic fluid tanks and shut-off valves

*Available from the Association.

†The "principal" unit is defined as that unit designated as the first major unit to be employed.

De-icer tanks
Baggage compartment areas
Fire extinguishing systems and controls
Fire extinguisher locations
Heater locations and controls

3. The behavior of fuel vapors and flammable liquids and their control and extinguishment under conditions encountered in aircraft accidents. Knowledge of aircraft fuel system construction is important in this connection.
4. The methods of preventing fire following aircraft accidents where fire does not initially occur.
5. Medical first aid and the proper manner of handling injured personnel to avoid infliction of additional suffering or injury in extricating trapped occupants from crashed aircraft.
6. Flight patterns and operational practices on the airport and airspace, including knowledge of ground flight obstructions and airport topography.

315. The utility of and requirements for aircraft rescue and fire fighting equipment should also take into consideration such local factors as:

a. Aircraft storage practices, quantity of aircraft stored, and the inherent hazards associated therewith.
b. Aircraft maintenance activities, facilities and inherent hazards associated therewith.
c. Installed fire protective equipment provided for aircraft hangars and aircraft repair and storage buildings.
d. Gasoline handling and storage practices and the inherent hazards associated therewith.
e. Frequency of adverse weather conditions which might effect the frequency of emergency landings and the radio and radar landing aids provided.
f. The availability of suitably organized and equipped public protective agencies available for assistance and aid to the airport fire defense organization.
g. Flight obstructions and hazards surrounding the airport.
h. The value of the real property investments on the airport.

APPENDIX "A"

Tires for Aircraft Rescue and Fire Fighting Equipment Load and Inflation Table

Adopted from Table TB-2C, "Tires for Trucks and Busses" A Tire and Rim Association Standard

Tire Size	Ply Rating	Tire Loads at Various Inflation Pressures											
		25	30	35	40	45	50	55	60	65	70	75	80
6.50-17	6	1000	1110	1215	1300	1400	**1500**						
6.50-18	6	1050	1170	1280	1375	1475	**1575**						
6.50-20	6	1130	1260	1380	1500	1600	**1700**						
*7.00-17	8	1115	1240	1360	1475	1575	1675	**1775**					
7.00-18	8	1165	1300	1420	1525	1650	1750	**1850**					
7.00-20	8	1260	1400	1535	1650	1775	1900	**2000**					
7.50-17	8	1260	1400	1535	1650	1775	1900	2000	**2100**				
7.50-18	8	1320	1470	1605	1750	1875	2000	2100	**2200**				
7.50-20	8	1420	1580	1725	1875	2000	2125	2250	**2375**				
8.25-18	10	1530	1700	1860	2000	2150	2300	2425	2550	**2675**			
8.25-20	10	1660	1850	2020	2175	2325	2475	2600	2750	**2900**			
9.00-18	10	1850	2060	2250	2440	2600	2775	2925	3075	**3225**			
9.00-20	10	1970	2200	2400	2600	2775	2950	3125	3300	**3450**			
10.00-18	12	2060	2300	2500	2720	2910	3100	3275	3450	3600	**3775**		
10.00-20	12	2190	2440	2660	2880	3090	3275	3475	3650	3825	**4000**		
10.00-22	12	2340	2610	2850	3080	3300	3500	3700	3900	4100	**4275**		
10.00-24	12	2490	2780	3030	3280	3510	3725	3950	4150	4350	**4550**		
11.00-20	12	2460	2740	3000	3240	3470	3700	3900	4100	4300	**4500**		
11.00-22	12	2600	2900	3160	3420	3670	3900	4125	4350	4550	**4750**		
11.00-24	12	2740	3050	3330	3600	3860	4100	4350	4575	4800	**5000**		
12.00-20	14	2780	3100	3380	3660	3920	4170	4420	4625	4850	5075	**5275**	
12.00-22	14	2940	3280	3580	3870	4140	4420	4670	4900	5150	5375	**5600**	
12.00-24	14	3120	3480	3800	4120	4400	4680	4960	5200	5450	5700	**5925**	
13.00-20	16	3300	3680	4020	4340	4650	4950	5240	5500	5775	6025	**6275**	
13.00-24	16	3700	4120	4500	4870	5220	5550	5880	6180	6475	6750	**7025**	
14.00-20	18	3880	4320	4720	5100	5470	5820	6160	6480	6780	7075	7350	**7650**
14.00-24	18	4320	4820	5260	5690	6100	6480	6870	7220	7560	7900	8225	**8525**
16.00-24	16	5675	6325	6925	7475	8000	8525	**9025**					
16.00-24	20	5675	6325	6925	7475	8000	8525	9025	9475	9950	**10375**		

*There is also a 7.00-17-6pr tire for Light Trucks with a maximum rating of 1,575 lbs. at 45 lbs. inflation.

NOTE: Bold face type denotes maximum recommended loads.

APPENDIX "A"

Tires for Light Aircraft Rescue and Fire Fighting Equipment
Load and Inflation Table
Tires Mounted on Tapered Bead Seat Rims
Adopted from Table LT-1A, "Tires for Light Trucks"
A Tire and Rim Association Standard

Tire Size	Ply Rating	Tire Loads at Various Inflation Pressures						
		25	30	35	40	45	50	55
6.00-16	6	810	900	985	1060	**1140**		
6.50-16	6	915	1020	1110	1200	**1290**		
7.00-15	6	980	1090	1190	1290	**1380**		
	8	980	1090	1190	1290	1380	1470	**1555**
7.00-16	6	1020	1135	1240	1340	**1440**		
	8	1020	1135	1240	1340	1440	1530	**1620**
7.50-16	6	1170	1300	1425	1540	**1650**		
	8	1170	1300	1425	1540	1650	1755	**1860**
8.25-16	8	1415	1580	1725	1865	**2000**		
	10	1415	1580	1725	1865	2000	2120	**2250**
9.00-16	8	1590	1775	1940	2100	**2250**		

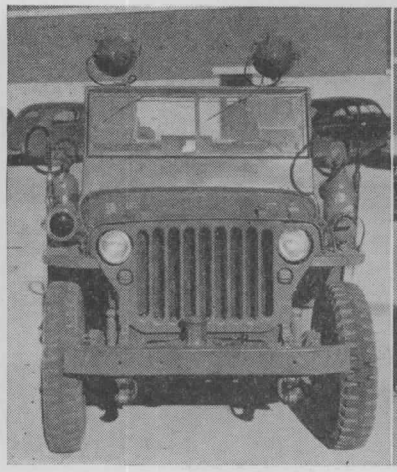
NOTE: Bold face type denotes maximum recommended loads.

APPENDIX "B"

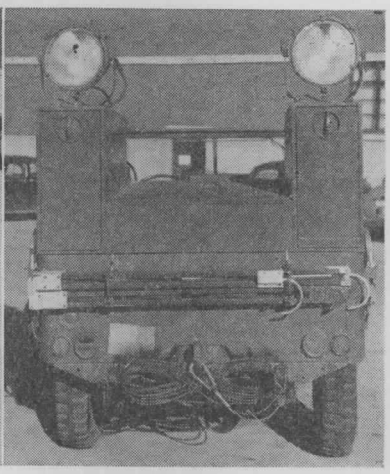
Recommended Specifications
for
Quarter Ton Auxiliary, Four Wheel Drive
Aircraft Rescue and Fire Fighting Unit

This auxiliary vehicle is recommended for any airport aircraft rescue and fire fighting organization. The basic requirement for this auxiliary is that it be capable of reaching any potential crash site on the movement area of the airport within 90 seconds under all normal operating conditions. It should be equipped with such extinguishing agents that it might be useful in holding an incipient fire in check pending the arrival of the major units of rescue and fire fighting equipment and, therefore, would be particularly useful if used to haul a fire fighting trailer (i.e. carbon dioxide or dry chemical cylinders or tanks, water tank with foam supplies and tank) but the specifications given below do not include such a trailer.

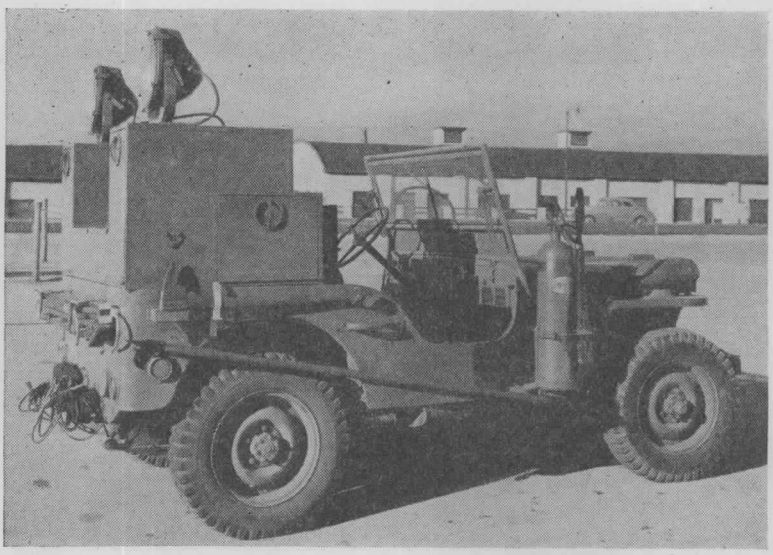
1. Truck, ¼ ton, 4 x 4, Willys-Overland "Jeep" or equivalent.
2. Generator, 3KW, 110 Volt, D.C. with power take-off or larger (depending upon electrical accessories used).
3. Floodlights, two 500 Watt.
4. Radio, for 2-way intercommunication with Airport Control Radio.
5. Siren, electric.



Front View Showing Winch



Rear View Showing Grappling Cable



Photographs of Quarter Ton Auxiliary Aircraft Rescue and Fire Fighting Unit
Courtesy U.S.A.F.