

NFPA No.

414



AIRCRAFT RESCUE— FIRE FIGHTING VEHICLES 1964



One Dollar

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National Fire Protection Association

International

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

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Standard for Aircraft Rescue and Fire Fighting Vehicles

NFPA No. 414 — 1964

1964 Edition of NFPA No. 414

This Standard for Aircraft Rescue and Fire Fighting Vehicles has been developed by the Sectional Committee on Aircraft Rescue and Fire Fighting through the following Subcommittee:

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This 1964 edition expands a 1963 text by the addition of Paragraphs 511, 512 and 513 in Part V, by changes in Paragraph 541, by the insertion of new Part VI on "Tank Vehicles," and by redesignating old Parts VI and VII as Parts VII and VIII respectively. It was submitted to the Association through the NFPA Committee on Aviation and adopted at the NFPA Annual Meeting, May 18-22, 1964.

Origin and Development of No. 414

In 1960 a tentative edition of present Parts I, II and III of this standard was adopted by the Association. In 1961, the Committee recommended adoption of a final edition, but at the NFPA Annual Meeting in that year, the report was returned to the sponsoring Committee for further study.

During the latter half of 1961 and early 1962, this standard was further processed and present Parts VII and VIII added. At the 1962 Annual Meeting, the revised draft was approved by the NFPA. Present Parts IV and V were added in 1963.

Attention is called to the companion publications of the Association dealing with Aircraft Rescue and Fire Fighting services particularly NFPA Nos. 402, 403, 406M, 412 and 420M. A listing of these publications and their brief titles is given on the inside back cover of this publication.

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Standard for Aircraft Rescue and Fire Fighting Vehicles

NFPA No. 414 — 1964

PART I — SCOPE AND PURPOSE

11. Scope.

111. This standard applies to aircraft rescue and fire fighting vehicles intended to carry rescue and fire fighting equipment for rescuing occupants and combating aircraft fires in disabled or burning aircraft on, or in the vicinity of, an airport. For the purpose of simplification, these vehicles will hereinafter be referred to simply as "vehicles." The basic NFPA recommendations on the use and provision of this equipment are contained in "Standard Operating Procedures, Aircraft Rescue and Fire Fighting" (NFPA No. 402), and "Suggestions for Aircraft Rescue and Fire Fighting Services at Airports and Heliports" (NFPA No. 403). Field testing procedures for aircraft rescue and fire fighting vehicles utilizing foam are given in the NFPA Standard for Evaluating Foam Fire Fighting Equipment on Aircraft Rescue and Fire Fighting Vehicles (NFPA No. 412).

NOTE: Where structural fire fighting capability is needed on aircraft rescue and fire fighting vehicles for the protection of airport property, the purchaser should so indicate by special provisions attached to the specifications.

It is essential that such additional features not be permitted to interfere with the basic capability of the vehicle to perform its primary aircraft rescue and fire fighting function. Where needed, it is considered preferable to have separate vehicles for structural fire fighting equipped with the needed complement of hose and tools since the amount of such equipment which may be appropriately carried on an aircraft rescue and fire fighting vehicle must be limited to conserve weight and space.

Vehicles designed to perform the dual function normally need to have the following added features to those detailed herein for aircraft rescue and fire fighting vehicles: pump suction inlets; a pump priming system; a 2½-inch gated inlet for supplying the pump and filling the water tank; 1½-inch and 2½-inch gated pump discharge valves; two lengths of suction hose with strainer and hydrant connections; compartments for 1½-inch and 2½-inch fire hose; and combination spray nozzles for each size of hose. It will be recognized that these are only part of the basic equipment for a standard fire department pumper; details regarding these vehicles will be found in the NFPA Specifications for Motor Fire Apparatus (No. 19).

Special attention is called to the fact that it may be desirable to provide pump suction facilities on certain aircraft rescue and fire fighting vehicles to permit refilling the water tank and supplying the pump(s) from water sources which may be available near the scene of an aircraft fire or emergency.

12. Purpose.

121. This standard is prepared as a guide to airport operators intending to purchase aircraft rescue and fire fighting equipment.

122. Parts II and III of this standard are intended to outline features and components which, when assembled, will produce an efficient and capable vehicle for both on-and-off-pavement performance. The features outlined therein affecting the vehicular capabilities of these vehicles are considered advisable for their proper operation on and off paved surfaces with particular emphasis on their off-pavement capability. This latter feature is particularly important to assure timely and effective response of these vehicles to aircraft accident sites across terrain which might halt or delay standard highway equipment. The omission of any of the features in Parts II or III should be done only with the complete knowledge of how it or they will affect the vehicle's performance capabilities.

123. Parts IV and V of this standard are intended to outline features and components of foam fire fighting vehicles and rescue vehicles in aircraft rescue and fire fighting service. The features outlined are considered advisable for the proper performance of these vehicles for the purpose for which they are designed. The omission of any of the features in Parts IV or V should be done only with the complete knowledge of how it or they will affect performance.

124. Part VI of this standard is intended to outline features and components of tank vehicles designed to serve as mobile water and foam liquid concentrate service vehicles for aircraft rescue and fire fighting service. The features outlined are considered advisable for the proper performance of these vehicles for the purposes for which they are designed. The omission of any of the features in Part VI should be done only with the complete knowledge of how it or they will affect performance.

125. The essential elements for the vehicles are included herein. Drafting of complete specifications for bidding purposes is the responsibility of the user exercising care against inclusion of provisions which may conflict with the recommendations set forth herein.

126. Three basic categories of vehicles are described herein in accordance with the NFPA Suggestions for Aircraft Rescue and

Fire Fighting Services at Airports and Heliports (NFPA No. 403), namely:

1261. MAJOR FIRE FIGHTING VEHICLES (Parts II and IV) with a gross weight of four (4) tons or more, and

1262. LIGHT RESCUE VEHICLES (Parts III and V) with a gross weight of under four (4) tons.

1263. TANK VEHICLES (Part VI).

Because of the broad range covered by the category Major Fire Fighting Vehicles (Part II), this category is divided into classes according to gross vehicle weight (see Paragraph 212). Certain recommendations in Part II (such as acceleration and tire sizes) are adjusted in recognition of differing needs of the vehicles in the various classes. Part IV applies to all Major Fire Fighting Vehicles designed to dispense foam as their principal fire suppression weapon. Part V applies to all Light Rescue Vehicles designed to dispense dry chemical or low pressure carbon dioxide as their fire suppression weapon. Part VI applies to all Tank Vehicles.

127. Part VII of this standard gives Definitions and Part VIII is a Questionnaire designed to secure information on design features of vehicles for aircraft rescue and fire fighting service.

13. Responsibility of Contractors (Suppliers).

131. The emergency nature of aircraft rescue and fire fighting services requires that a high level of competence, reliability, and experience be demanded of contractors building equipment for such service. Materials used in fabrication must be of superior character.

132. The contractor must assume complete responsibility for all component parts of the complete vehicle, even though major portions may be sub-contracted. This responsibility shall include design, construction, inspection, performance test, and servicing. The purchaser should ascertain that the contractor is capable of furnishing parts and technical assistance to the purchaser for the normal life of the vehicle (10 years).

NOTE: Responsibility for servicing shall not include those components supplied to the contractor by the customer, unless so specified in the contract.

133. The contractor shall also be responsible for assuring that the vehicular performance of the vehicle meets this standard

and thus qualify as a well-designed aircraft rescue and fire fighting vehicle. All major components shall have the manufacturer's rating for this type service and these ratings shall not be exceeded by actual imposed loads. A one-year warranty shall be supplied by the contractor. Bidders should be required to furnish with the bids a detailed description of the vehicles offered, and drawings showing general arrangement, weights, and dimensions. Data similar to that provided for in the Questionnaire contained in Part VIII should also be required.

14. Vehicular Design Principles.

141. The vehicle design shall provide for rapid acceleration and high speed; maximum mobility on and off pavements in all seasons and under all weather conditions; ease of operation; safety; reliability; and accessibility for repairs and maintenance.

142. All-wheel drive for off-pavement operation is essential and shall be achieved without sacrificing any of the attributes of high performance, high speed vehicles. Weight shall be distributed substantially equal over all wheels with maximum tire loads limited to provide the highest practicable level of performance on soft, slippery or rough terrain.

143. Special design consideration shall be given to the saving of weight wherever possible, insofar as it can be accomplished while retaining a large factor of safety on wearing and stressed members. This can be accomplished through the use of lightweight construction wherever possible.

144. Performance requirements outlined in this standard shall be met with the vehicle in an in-service condition.

PART II — MAJOR FIRE FIGHTING VEHICLES

21. General.

211. The category of major vehicles encompasses a gross vehicle weight range commencing at 4 tons (8,000 lbs.) and extending to over 45,000 lbs., and in some cases to over 60,000 lbs. Because the same performance cannot be expected of all vehicles within this range, it is necessary to classify vehicles into lesser weight ranges within which an equal level of performance is practicable.

212. Accordingly, the following weight ranges (lbs.) have been established in classes for the purposes of this specification:

Class	Vehicle Weight Range (Pounds)
1	8,000-15,000
2	15,000-20,000
3	20,000-25,000
4	25,000-30,000
5	30,000-35,000
6	35,000-40,000
7	40,000-45,000
8	45,000 and over

213. The weight of a vehicle for purposes of this classification is its gross weight, with all fire fighting and rescue equipment, full load of extinguishing agents, full load of fuel, and complete personnel complement, ready for service.

214. Because of the fact that definite differences in performance exist between classes, it is essential that specifications for purposes of bidding be drawn to limit the maximum gross weight.

NOTE: Variations in gross weight should be permitted because of differences in design and construction, provided the original performance recommendations as contracted for have been met.

22. Weights and Dimensions.

221. Weights.

2211. The gross vehicle weight rating of the chassis as furnished shall equal or exceed the actual gross weight of the fully loaded and equipped vehicle.

2212. Weight should be distributed as equally as possible

over the axles and tires under all conditions of loading. The variation in weight between any two tires or any one axle shall not exceed 5 per cent right and left, or 10 per cent between any two axles.

NOTE: Weight on individual tire shall be determined by weight scale measurement at the ground.

Weight variations between axles shall be based on the average loading of the axles and, between tires, shall be the average loading of the two tires of a given axle.

These recommendations favor the use of single tires and a drive to all wheels. The tires are also required to be of uniform size. Therefore, best performance and traction are possible only by equalizing the weight on individual tires.

Maintaining equalization of weight over the tires under conditions of light load is also essential for best performance, particularly since the load may be lightened so that the vehicle can traverse extremely soft ground.

The conditions of loading considered are those due to addition or discharge of the fire extinguishing medium such as water or chemicals.

2213. Center of gravity of the vehicle shall be kept as low as possible under all conditions of loading. The vehicle shall be capable of resting on a side slope equivalent to a 30 per cent grade without danger of capsizing.

NOTE: The maximum side slope on which a vehicle can rest without capsizing is an indication of its stability and location of center of gravity. Because of the combined effects of spring motion, tire deflection, speed and surface conditions, the ability to rest on a 30 per cent side slope should indicate the ability to operate on a side slope, up to 20 per cent, at slow speed.

A factor that cannot be measured by this test is the effect of movement of water in vehicle tanks while the truck is in motion on rough ground. Baffling of the water tank should mitigate the effect of such movement.

222. Dimensions.

2221. Under-clearances of the chassis shall be sufficient to permit the maximum mobility in soft ground and rough terrain which tire size, weight, and power make the vehicle potentially capable of traversing. The following are the minimum acceptable clearance dimensions and angles:

Angle of Approach	30 degrees
Angle of Departure	30 degrees
Interaxle Clearance Angle	12 degrees
Under-Chassis-Clearance Dimensions:	
Under 30,000 lbs. Gross Weight	12 inches
30,000 lbs. and over Gross Weight	14 inches

Under-chassis-clearance dimensions shall apply to all portions of the chassis except for tires and wheel-mounted brake drums provided that the drums shall not extend more than three inches from the tire line.

NOTE: Certain projections may extend below the minimum clearance provided they are hinged or otherwise constructed so that they will swing clear when striking an object. Generally, however, such projections should be avoided because, in spite of careful design, they are likely to be knocked off in service.

2222. Over-all height, length, and width of the vehicle shall be held to a minimum so as to provide greater maneuverability due to compactness and to facilitate movement on public highways.

NOTE: Over-all width should be checked with local jurisdiction.

2223. Chassis shall be so constructed and body and equipment so mounted that a driver of average height shall be able to see the ground 20 feet ahead when the driver is in his normal driving position without leaving or rising in his seat. He shall be able to see the ground immediately adjacent to the driver's side of the vehicle. It is recommended that mirrors, or other provisions, be made for vision on the opposite side of the vehicle.

NOTE: Best design dictates either a cab forward or cab-over-engine arrangement to insure that the driver is placed sufficiently far forward so that he can see the ground a short distance ahead of the vehicle.

23. Engine.

231. General Performance Recommendations and Arrangements:

2311. The vehicle shall be powered by means of an internal combustion engine(s), with a minimum cubic inch piston displacement as indicated in Paragraph 2313, capable of developing sufficient power under operating conditions to achieve the required rate of acceleration as specified in Paragraph 2312.

NOTE: Turbine-powered vehicles and "air-cushion" vehicles may be used when experience has been accumulated to permit evaluating the capabilities and limitations of vehicles of these types for this specialized service.

2312. The vehicle shall be consistently able, when fully

loaded, of accelerating from 0 to 50 miles per hour on dry level concrete pavement within the following maximum times:

Class	Gross Vehicle Weight (Pounds)	Time (Seconds)
1	8,000-15,000	30
2	15,000-20,000	30
3	20,000-25,000	35
4	25,000-30,000	40
5	30,000-35,000	45
6	35,000-40,000	50
7	40,000-45,000	55
8	45,000 and over	60

The above acceleration times shall be achieved in ambient temperatures varying from 0 degrees F to 100 degrees F and at elevations up to 2,000 feet above sea level unless a higher elevation is specified.

NOTE: The above acceleration requirements at elevations up to 2,000 feet above sea level are intended to ensure acceptable performance at the great majority of airports.

Airports above 2,000 feet should state the elevation at which the vehicle will operate in order to ensure the required performance.

2313. In addition to being capable of meeting the above acceleration requirements, the engine(s) shall also have the following minimum cubic inch piston displacement:

Class	Gross Vehicle Weight (Pounds)	Displacement (Cu. In.)
1	8,000-15,000	300
2	15,000-20,000	400
3	20,000-25,000	475
4	25,000-30,000	525
5	30,000-35,000	590
6	35,000-40,000	700
7	40,000-45,000	800
8	45,000 and over	900

2314. It is recommended that gasoline engines be used for aircraft rescue and fire fighting service due to their higher horsepower-to-weight ratio and greater acceleration capability.

NOTE: In some cases the acceleration time required can be met with engines with less displacement than specified above. Nevertheless, the minimum displacement is specified because of greater over-all performance obtained from larger displacement engines.

On the other hand, it may be that with certain types of engine design the required acceleration cannot be obtained even though engines meeting

the specified minimum displacement are used. In such cases, the acceleration time still stands as a minimum requirement.

The use of high compression or specially modified engines which require high octane or specially blended fuel, and requiring special maintenance, shall be avoided.

See Note following Paragraph 2311.

2315. Where the engine(s) is (are) used to power both the chassis and the fire fighting pumps, provision shall be made to ensure that the operation of the pump will not, under any circumstances, cause either:

- a. the engine(s) to stall, or
- b. more than a slight, and momentary reduction in engine speed and consequent drop in pump pressure.

The vehicle shall also be capable of full rated capacity while conducting a stipulated mud and sand test.

2316. The engine shall be equipped with a governor which shall be set at not more than the maximum permissible revolutions-per-minute recommended by the engine manufacturer under no-load condition.

2317. The provisions appearing in Sections 232, 233 and 234 contain recommendations for the engine and its accessories and systems which have proven desirable in vehicles for this type service.

232. Engine Cooling Systems.

2321. LIQUID COOLED ENGINES.

a. The cooling system should be of the closed, forced-feed type using a circulating pump. The radiator, cylinder block, cylinder head, fan and water pump shall be of ample capacity to permit continuous flow with full load operation of the engine at both stationary and maximum vehicle speed without boiling the coolant under ambient temperature conditions up to 110 degrees F. The cooling system shall be provided with an automatic thermostat for prompt engine warming.

b. Radiator shutters, when furnished for cold climates, shall be of the automatic type, and be designed to open automatically upon failure.

2322. AIR-COOLED ENGINES.

a. Air-cooled engines shall be so designed and installed as to permit the vehicle to stand still and pump for indefinite periods without overheating.

b. Air-cooled engine design and installation shall provide for sufficient rate of flow and distribution of air to hold cylinder head and oil temperatures within manufacturer's prescribed limits under all operating conditions. This shall include full power operation for prolonged periods with ambient temperatures up to 110 degrees F, at both stationary and maximum vehicle speed.

c. Cylinder head and oil temperature gages that clearly indicate maximum permissible operating temperature shall be mounted in the cab and elsewhere, as required, to be plainly visible to the driver.

233. Fuel System.

2331. For gasoline engines, a complete fuel system should include a mechanically driven fuel pump, auxiliary electric fuel pump, fuel strainer and necessary piping, including a flexible fuel line from the fuel pump to the tank line. All fuel lines shall be protected from damage, exhaust heat, and exposure to ground fire.

2332. An accessible strainer shall be provided for each fuel line and a drain shall be provided at the bottom of the fuel tank.

2333. Fuel tanks shall not be installed in such a manner as to permit gravity feed to the carburetor.

2334. Fuel tanks shall be provided with an Underwriters' Laboratories, Inc., Underwriters' Laboratories of Canada, or Factory Mutual Engineering Division approved flame arrester relief fitting on the filler opening.

2335. Fuel tank capacity shall be sufficient to provide for two (2) hours pumping at rated capacity.

234. Exhaust System.

2341. The exhaust system shall be of such size as to avoid undue back pressure and shall be located and constructed in such a manner that entrance of exhaust gases into the cab will be minimized under all conditions of operation. Exhaust pipe, muffler and tailpipe shall be of high-grade, rust-resistant materials.

2342. The tailpipe and muffler shall be protected from damage due to traversing rough terrain. Tailpipe shall be designed to discharge to the rear and shall not be directed toward the ground.

24. Vehicle Electrical System.

241. Each gasoline engine shall be equipped with a complete and separate battery starting system. Where greater engine reliability is desired, a complete dual ignition may be required.

242. The vehicle shall be provided with a complete electrical system of either the 12 or 24 volt type.

243. An alternator and rectifier, capable of delivering a minimum of 100 amperes, 12 volts or 50 amperes, 24 volts, shall be provided.

244. Two independent battery systems shall be provided, with a selector switch located in the cab. For 12 volt systems, there shall be two (2) 12 volt batteries, 150 ampere hour capacity each, at 20 hour rate. For 24 volt systems, there shall be two (2) 24 volt batteries, 100 ampere hour capacity each, or four (4) 12 volt batteries, 100 ampere hour capacity each, at 20 hour rate.

245. Provisions shall be provided to permit plugging into local electric power supplies to maintain battery charging.

246. An engine coolant preheating device shall be provided as an aid to rapid starting and high initial engine performance.

247. The electrical system shall be insulated, waterproofed and protected against exposure from ground fires.

NOTE: Radio suppression of the electrical system, sufficient to assure positive operation of radio equipment without interference to any other communications on the airport, shall be furnished when specified.

25. Vehicle Drive.

251. The drive shall provide for the transmission of power from the engine flywheel to the wheels of the vehicle with such multiplication of torque that the vehicle is capable of traveling at all speeds necessary for effective aircraft rescue and fire fighting service. With respect to Classes 3 through 8, the drive shall provide for the continuous transmission of power from the engine through a torque converter or fluid coupling and transmission. The transmission shall have the ability to shift from

any selected ratio to another in sequence, either forward or reverse, without interruption of power transmission.

NOTE: See Note under Paragraph 2311.

252. The entire drive train shall be designed with sufficient torque capacity to slip the wheels of the fully loaded and balanced vehicle on pavement having a coefficient of friction of 0.6. The following drive line components shall be certified by the component manufacturer to be suitable for use in the drive line of the complete vehicle considered as a complete vehicle: clutch and/or torque converter, transmission, transfer case, propeller shaft, differentials and axles.

253. The transmission shall have sufficient range of gears to provide a top speed in highest gear of 50 mph and enough reduction in lowest gear to produce the tractive effort needed to ascend a 50 per cent grade. Spacing of intermediate gears shall provide an adequate number of speeds for all operating conditions without excessive overlap.

254. Positive drive to each wheel is required to negotiate soft ground, unimproved surfaces, snow or ice. Positive wheel drive may be achieved by the use of torque proportioning or no-spin differentials, or by means of other automatic devices which will ensure that each wheel of the vehicle is driven independently of the other wheels.

255. The transfer case may be either separate or integral with the transmission. It shall incorporate a drive to the front and rear axles which is engaged at all times during the intended airport service and which will not allow the vehicle to stall as long as the tires of any axle have traction.

256. Front and rear axles shall have adequate capacity to carry the maximum imposed load under all intended operating conditions. The variations in axle tread shall not exceed 20 per cent of the tire sectional width at rated load. Front and rear axles shall be provided with automatic locking or no-spin differentials or other automatic devices which will lock out differential action whenever any one tire loses traction. When interaxle differentials are furnished with bogie axles, they shall be either automatic locking or no-spin type or be locked out at all times during the intended airport service.

257. It is recommended that front axles be equipped with steering drive ends of the constant velocity type or other provision be made to eliminate objectionable cyclical fluctuations

in angular velocity of the wheels when they are cramped in the steering position.

26. Other Chassis Components.

261. Clutch. When a clutch is used, the actuation pedal pressure to obtain release shall not exceed 50 pounds with adequate displacement for wear prior to normal adjustment.

262. Transmission. Where a fire fighting pump is driven from the chassis engine, provision shall be made in design of the power take-off to allow uninterrupted transmission of power to the pump even though the transmission gears are being shifted, clutch is released, or the transmission is placed in any of its speed ranges.

263. Suspension.

2631. The suspension system shall be designed to allow the vehicles, loaded or unloaded, to travel at high speeds over improved road surfaces, and at moderate speeds over rough, unimproved terrain. Special consideration shall be given to the need for cushioning road shocks, providing adequate wheel motion, and reducing unsprung weight.

2632. Design of the axles and suspension system shall be such that the total unsprung weight of the vehicle will not be greater than 20 per cent of the gross weight of the vehicle when fully loaded.

NOTE: Unsprung weight is that portion of the vehicle weight not carried by the chassis springs.

2633. Design of axles and suspension system shall also provide for an individual wheel motion above level ground of not less than 10 inches for vehicles under 30,000 lbs. gross weight, and 12 inches for vehicles 30,000 lbs. and over gross weight without raising any other wheel off the ground.

2634. Suspension design shall be such that at least two inches of deflection remain before bottoming of suspension on the axle stops or bumpers when the vehicle is fully loaded and on level ground.

2635. Double acting hydraulic shock absorbers shall be furnished on front axles. Front and rear axles shall be furnished with stops for bottoming to prevent damage to axles, propeller shafts, engine oil pan, or any other portions of the chassis which may be damaged by wheel motion beyond allowable amounts.

264. Wheels, Tires and Rims.

2641. Wheels shall be single rim type with tires of identical size and same tread design.

2642. Tires and inflation pressures shall be selected to provide effective performance on the terrain encountered in the intended airport service. For normal terrain conditions, a maximum inflation pressure of 45 pounds per square inch is recommended. For more extreme terrain conditions, lower inflation pressure down to 30 pounds per square inch may be desirable for greater off-pavement mobility. The following Table sets forth recommended maximum loads per tire for standard tire sizes at inflation pressures of 30 pounds per square inch and 45 pounds per square inch.

TIRE LOAD RATINGS

Tire Size	Recommended Load		Based on T & R A Table
	at 30 lb. Inflation	at 45 lb. Inflation	
9.00-16	1,950	2,475	LT-1B
8.25-20	2,390	3,030	EM-3D
9.00-20	2,840	3,590	"
10.00-20	3,200	4,050	"
11.00-20	3,540	4,480	"
12.00-20	4,020	5,080	"
12.00-24	4,520	5,720	"
14.00-20	5,620	7,100	"
14.00-24	6,270	7,920	"
16.00-25	8,200	10,400	"
18.00-25	10,670	13,520	"
18.00-33	12,640	16,000	"
21.00-25	13,640	17,280	"
21.00-29	14,820	18,770	"
24.00-25	16,860	21,340	"
20.5-25	9,590	12,170	WEM-1
23.5-25	12,440	15,760	"
26.5-25	15,530	19,700	"
26.5-29	17,090	21,650	"
29.5-25	19,160	24,210	"

NOTE: Adequate ply rating must be selected as determined by load and inflation to be used (refer T & R A Yearbook). T & R A refers to the Tire and Rim Association.

NOTE: For tire sizes not shown, current ratings may be obtained from the Tire and Rim Association, Inc. (2001 First National Tower, Akron 8, Ohio). The maximum loads in the Table are based on current Tire and Rim Association, Inc. ratings as shown in Tables LT-1B, EM-3D and WEM-1 of their 1961 Year Book.

2643. Actual inflation pressures of the tires with the vehicles in an in-service condition shall be as specified in the Table.

2644. If the vehicle is required to operate on the highway five or more miles beyond the immediate vicinity of the airport at sustained speeds above 30 miles per hour, inflation pressure should be increased to those levels recommended for highway service.

2645. An aggressive tire tread is recommended for general service. Tire manufacturers should be consulted for tread designs to meet special terrain conditions.

2646. Rim contours and sizes shall also be based on current practices of the Tire and Rim Association, Inc.

27. Controlling Mechanisms.

271. Brakes.

2711. Service brakes shall be of the all-wheel type. On vehicles less than 25,000 lbs. gross weight, service brakes may be of the hydraulic type with power booster or the air-mechanical type. On vehicles 25,000 lbs. or more gross weight, service brakes shall be of the air-over-hydraulic or air-mechanical type.

2712. If air-mechanical brakes are furnished, a brake chamber shall be provided for each wheel and shall be mounted so that no part of the brake chamber projects below the axle.

2713. Air brake systems shall include a compressor, release valve, brake control valve, treadle-type actuating pedal, air pressure gage, enclosed-type brake adjusters, low pressure warning, and all necessary connections.

2714. On vehicles less than 25,000 lbs. gross weight, and when supplied with air brakes, the air compressor shall be at least 7 cu. ft. capacity; on vehicles 25,000 lbs. or more gross weight, the air compressor shall be at least 12 cu. ft. capacity. Air compressors shall be lubricated and cooled by the engine lubrication and cooling system.

2715. Compressed air reservoirs will have a minimum capacity of 2,000 cu. in. and shall be equipped with drain and safety valves. Provision for quick build-up of pressure shall be furnished. Quick build-up of tank pressure from 5 lbs. to the pressure regulating valve setting shall be accomplished within 12 seconds.

2716. The service brakes shall be capable of holding the fully loaded vehicle on a 50 per cent grade, and capable of bringing the fully loaded vehicle to five (5) complete successive stops within 30 feet from a speed of 20 mph on dry, hard, approximately level road, free from loose material.

2717. The parking or emergency brake system shall be an entirely independent mechanical system or may be connected to the same brake shoes as the service brakes but through entirely separate mechanical means.

2718. The parking brakes shall be hand lever operated and shall be capable of holding the fully loaded vehicle on a 20 per cent grade.

272. Steering.

2721. All chassis shall be equipped with power assisted steering. The steering mechanism shall be so designed to permit manual steering sufficient to bring the vehicle to a safe stop in the event of failure of power assist.

2722. The power-assisted steering shall have sufficient capacity so that no more than 15 lbs. pull is required on the steering wheel in order to turn the steering wheel from lock to lock with the engine running.

28. Turning Diameter.

281. Wall-to-wall turning diameter of the fully loaded vehicle shall not be greater than three times its over-all length. In the event an 8 x 8 chassis is provided, the turning diameter shall not be greater than three-and-a-half times the over-all length.

PART III — LIGHT RESCUE VEHICLES

31. General.

311. The category of "light rescue vehicles" covers a vehicle with a gross weight of 7,999 pounds or less as indicated in Paragraph 1252 of Part I of this standard.

312. The weight of a vehicle for purposes of this classification is its gross weight, with all fire fighting and rescue equipment, full load of extinguishing agents, full load of fuel, complete personnel complement, ready for service.

32. Weights and Dimensions.

321. Weights.

3211. The gross vehicle weight rating of the chassis as furnished shall equal or exceed the actual gross weight of the fully loaded and equipped vehicle.

3212. The actual weight of the fully loaded and equipped vehicle should be distributed as equally as possible over the axles and tires. The variation in weight between any two tires of any one axle shall not exceed 10 per cent right and left nor shall any axle carry less than 40 per cent or more than 60 per cent.

NOTE: Weight on individual tire shall be determined by weight scale measurement at the ground.

This specification requires the use of single tires and a drive to all wheels. The tires are also required to be of uniform size. Therefore, best performance and traction are possible only by equalizing the weight on individual tires.

3213. Center of gravity of the vehicle shall be kept as low as possible under all conditions of loading. The vehicle shall be capable of resting on a side slope equivalent to a 30 per cent grade without danger of capsizing.

NOTE: The maximum side slope on which a vehicle can rest without capsizing is an indication of its stability and location of center of gravity.

Because of the combined effects of spring motion, tire deflection, speed and surface conditions, the ability to rest on a 30 per cent side slope should indicate the ability to operate on a side slope, up to 20 per cent at slow speed.

322. Dimensions.

3221. Under clearances of the chassis shall be sufficient to permit the maximum mobility in soft ground and rough terrain which tire sizes, weight, and power make the vehicle potentially capable of traversing. The following are the minimum acceptable clearance dimensions and angles:

Angle of Approach	30 degrees
Angle of Departure	30 degrees
Interaxle Clearance Angle	12 degrees
Minimum Ground Clearance	8 inches

Under-chassis-clearance dimensions shall apply to all portions of the chassis except for tires and brake drums.

3222. Over-all height, length, and width of the vehicle shall be held to an absolute minimum so as to provide maximum maneuverability due to compactness and to facilitate rapid movement on public highways.

3223. Chassis shall be so constructed and body and equipment so mounted that the vehicle driver shall be able to see the ground 20 feet ahead when a driver of average height is in his normal driving position without leaving or rising in his seat. He shall be able to see the ground immediately adjacent to the driver's side of the vehicle. It is recommended that truck-type mirrors, or other provisions, be made for vision to the opposite side of the vehicle.

33. Engine.

331. General Performance Recommendations and Arrangements.

3311. The vehicle shall be powered by means of an internal combustion engine capable of developing sufficient power under operating conditions to achieve the required performance characteristics.

NOTE: Turbine-powered vehicles and "air-cushion" vehicles may be used when experience has been accumulated to permit evaluating the capabilities and limitations of vehicles of these types for this specialized service.

3312. The vehicle shall be consistently able, when fully loaded, of accelerating from 0 to 50 miles per hour on dry level concrete pavement within 25 seconds. The above acceleration time shall be achieved in ambient temperatures varying from 0 degrees F to 100 degrees F and at elevations up to 2,000 feet above sea level, unless a higher elevation is specified.

NOTE: It is recommended that gasoline engines be used for aircraft rescue and fire fighting service due to their higher horsepower-to-weight ratio and greater acceleration capability. See Note under Paragraph 3311.

The requirement that the vehicle be capable of accelerating from 0 to 50 miles per hour within 25 seconds at elevations up to 2,000 feet above sea level is intended to ensure acceptable performance at the great majority of airports. Airports above 2,000 feet should state the elevation at which the vehicle will operate in order to ensure the same performance.

The use of high compression or specially modified engines which require high octane or specially blended fuel, and requiring special maintenance, shall be avoided.

3313. Where the engine is used to power both the chassis and the fire fighting pumps, provision shall be made to ensure that the operation of the pump will not, under any circumstances, cause either:

- a. the engine to stall, or
- b. more than a slight, and momentary reduction, in engine speed and consequent drop in pump pressure.

3314. The provisions appearing in Sections 332, 333 and 334 contain recommendations for the engine and its accessories and systems which have proven desirable in crash fire fighting vehicles.

332. Engine Cooling Systems.

3321. LIQUID COOLED ENGINES.

a. The cooling system should be of the closed, forced-feed type using a circulating pump. The radiator, cylinder block, cylinder head, fan and water pump shall be of ample capacity to permit continuous full load operation of the engine at both stationary and maximum vehicle speed without boiling the coolant under ambient temperature conditions up to 110 degrees F. The cooling system shall be provided with an automatic thermostat for prompt engine warming.

3322. AIR-COOLED ENGINES.

a. Air-cooled engines shall be so designed and installed as to permit the vehicle to stand still and pump for indefinite periods without overheating.

b. Air-cooled engine design and installation shall provide for sufficient rate of flow and distribution of air to hold cylinder head and oil temperature within manufacturer's prescribed limits under all operating conditions. This shall include full

power operation for prolonged periods with ambient temperatures up to 110 degrees F, at both stationary and maximum vehicle speed.

c. Cylinder head and oil temperature gages or warning lights that clearly indicate maximum permissible operating temperature shall be mounted in the cab and elsewhere, as required, to be plainly visible to the driver.

333. Fuel System.

3331. For gasoline engines, a complete fuel system should include an electric fuel pump located near the fuel tank to prevent vapor-lock, fuel strainer and necessary piping, including a flexible fuel line from the fuel pump to the tank line. All fuel lines shall be protected from damage, exhaust heat, and exposure to ground fire.

3332. A strainer shall be provided for each fuel line and a drain shall be provided at the bottom of the fuel tank.

3333. Fuel tanks shall not be installed in such a manner as to permit gravity feed to the carburetor.

3334. Fuel tanks shall be provided with an Underwriters' Laboratories, Inc., Underwriters' Laboratories of Canada, or Factory Mutual Engineering Division approved flame arrester relief fitting on the filler opening.

3335. Fuel tank capacity shall be sufficient for two hours' operation.

334. Exhaust System.

3341. The vehicle shall be furnished with an exhaust system, tailpipe, and muffler of such size as to avoid undue back pressure and shall be located and constructed in such a manner that entrance of exhaust gases into the cab will be minimized under all conditions of operation. Exhaust pipe, muffler and tailpipe shall be of high-grade, rust-resistant materials.

3342. The tailpipe and muffler shall be protected from damage due to traversing rough terrain. Tailpipe shall be designed to discharge to the rear and shall not be directed toward the ground.

34. Vehicle Electrical System.

341. The vehicle shall be provided with battery starting and a complete electrical system of the 12- or 24-volt type.

342. An alternator and rectifier, capable of delivering a minimum of 60 amps, 12 volts or equivalent power at 24 volts, shall be provided.

NOTE: Alternator capacity should be specified by the electrical load experienced at each airport.

343. A 70 ampere-hour, 12 volt battery or an equivalent in 24 volts shall be provided.

344. Provisions shall be provided to permit plugging into local electric power supplies to maintain battery charging.

345. The electrical system shall be insulated, splashproofed and protected against exposure from ground fires.

NOTE: Radio suppression of the electrical system, sufficient to ensure positive operation of radio equipment without interference to any other communications on the airport, shall be furnished when specified.

35. Vehicle Drive.

351. The drive shall provide for the transmission of power from the engine flywheel to all wheels of the vehicle with such multiplication of torque that the vehicle is capable of traveling at all speeds necessary for effective aircraft rescue and fire fighting service.

NOTE: See Note following Paragraph 3311 regarding turbine-powered and "air-cushion" vehicles.

352. The entire drive train shall be designed with sufficient torque capacity to slip the wheels of the fully loaded and balanced vehicle on pavement having a coefficient of friction of 0.6. The following drive line components shall be certified by the component manufacturer to be suitable for use in the drive line of the complete vehicle considered as a complete vehicle: clutch and/or torque converter, transmission, transfer case, propeller shaft, differentials and axles.

353. The transmission shall have sufficient range of gears to provide a top speed in highest gear of 60 miles per hour and enough reduction in lowest gear to produce the tractive effort needed to ascend a 50 per cent grade. Spacing of intermediate gears shall provide an adequate number of speeds for all operating conditions without excessive overlap.

354. It is recommended that front axles be equipped with steering drive ends of the constant velocity type or other provision be made to eliminate objectionable cyclical fluctuations

in angular velocity of the wheels when they are cramped in the steering position.

355. Rear axles shall be provided with automatic locking or no-spin differentials or other automatic locking devices which will lock out differential action whenever any one tire loses traction. It is recommended that the front axles be similarly equipped.

356. Transfer Case. The transfer case may be either gear or chain operated. If chain is employed, adequate provision shall be made for adjustment of the chain due to wear.

36. Other Chassis Components.

361. Suspension.

3611. The suspension system shall be designed to allow the vehicle, loaded or unloaded, to travel at high speeds over improved road surfaces, and at moderate speeds over rough, unimproved terrain. Special consideration shall be given to the need for cushioning road shocks, providing adequate wheel motion, and reducing unsprung weight.

3612. Design of the axles and suspension system shall be such that the total unsprung weight of the vehicle will not be greater than 15 per cent of the gross weight of the vehicle when fully loaded.

NOTE: Unsprung weight is that portion of the vehicle weight not carried by the chassis springs.

3613. Design of axles and suspension system shall provide for an individual wheel motion above level ground or not less than 8 inches without raising any other wheel off the ground.

3614. Spring design shall be such that at least one inch of spring deflection remains before bottoming of springs on the axle stops when the vehicle is fully loaded and on level ground.

3615. Double acting hydraulic shock absorbers shall be furnished on all axles. Front and rear axles shall be furnished with stops for bottoming to prevent damage to axles, propeller shafts, engine oil pan, or any other portions of the chassis which may be damaged by wheel motion beyond allowable amounts.

362. Wheels, Tires, and Rims.

3621. Wheels shall be single rim type with tires of identical size and same tread design.

3622. Tires and inflation pressures shall be selected to provide effective performance on the terrain encountered in the intended airport service. For normal terrain conditions, a maximum inflation pressure of 45 pounds per square inch is recommended. For more extreme terrain conditions, lower inflation pressure down to 30 pounds per square inch may be desirable for greater off-pavement mobility. The following Table sets forth recommended maximum loads per tire for standard tire sizes at inflation pressures of 30 pounds per square inch and 45 pounds per square inch.

TIRE LOAD RATINGS

Tire Size	Recommended Load		Based on T & R A Table
	at 30 lb. Inflation	at 45 lb. Inflation	
7.00-16	1,250	1,580	LT-1B
7.50-16	1,430	1,815	"
9.00-16	1,950	2,475	"

NOTE: Adequate ply rating must be selected as determined by load and inflation to be used (refer T & R A Yearbook). T & R A refers to the Tire and Rim Association.

NOTE: For tire sizes not shown, current ratings may be obtained from the Tire and Rim Association, Inc. (2001 First National Tower, Akron 8, Ohio). The maximum loads in this table are based on current Tire and Rim Association, Inc. ratings as shown in Table LT-1B of their 1961 Year Book.

3623. Actual inflation pressures of the tires with the vehicles in an in-service condition shall be as specified in the Table.

3624. If the vehicle is required to operate on the highway five or more miles beyond the immediate vicinity of the airport at sustained speeds above 30 miles per hour, inflation pressure should be increased to those levels recommended for highway service.

3625. An aggressive tire tread is recommended for general service. Tire manufacturers should be consulted for tread designs to meet special terrain conditions.

3626. Rim contours and sizes shall also be based on current practices of the Tire and Rim Association, Inc.

37. Controlling Mechanisms.

371. Brakes.

3711. Service brakes shall be of the all-wheel hydraulic type. Power booster shall be furnished when specified.

3712. The service brakes shall be capable of holding the fully loaded vehicle on a 50 per cent grade, and shall be capable of consistently bringing the fully loaded vehicle to a complete stop within 30 feet from a speed of 20 miles per hour on dry, hard, approximately level road, free from loose material.

3713. The parking or emergency brake system shall be an entirely independent mechanical system or may be connected to the same brake shoes as the service brakes but through entirely separate mechanical means.

3714. The parking brakes shall be hand lever operated and shall be capable of holding the fully loaded vehicle on a 20 per cent grade.

372. Steering.

3721. Power steering, if furnished, shall not prevent normal steering in the event of failure of power assist system.

373. Turning Clearance Diameter.

3731. Wall-to-wall turning clearance diameter of the fully loaded vehicle shall not be greater than $3\frac{1}{2}$ times its over-all length.

PART IV — FOAM FIRE FIGHTING VEHICLES

41. Cab.

411. ARRANGEMENT. The cab shall meet the ground visibility requirements of Paragraph 2223. It shall have seats for at least three men, including individually adjustable driver's seat and adequate space for the instruments, controls and equipment specified herein without hindering the crew. Wide opening doors shall be provided on each side of the cab with necessary steps and hand-grabs to permit rapid and safe entrance and exit from the cab. The windshield and side windows shall be constructed of shatter-proof plate glass. The windshield shall provide for wide and high visibility and shall be so designed, that with a standard man sitting in normal position he shall have a minimum vertical range of vision 15 degrees above the horizontal. His vision in the horizontal plane shall be at least 180 degrees. The cab shall be provided with wide gutters to prevent foam and water from dripping on the windshield and side windows. There shall be a quick-opening hatch in the roof providing access to the turret.

412. CONSTRUCTION. The cab shall be constructed in Classes 4 through 8 Vehicles (see Paragraph 212), of lightweight construction, of adequate strength to ensure the safety of the crew. The cab shall be rainproof and dripproof, and shall be fully insulated with a fire resistant insulating material at least one-half inch thick. The cab may be of the unitized rigid body and frame structure or it may be a separate unit flexibly mounted on the main vehicle frame.

413. INSTRUMENT AND WARNING LIGHTS. The minimum number of instruments and warning lights consistent with the safe, efficient operation of the vehicle and equipment shall be provided. Warning lights shall be used where practicable instead of instruments, and provision shall be made to readily test the condition of the bulb. All instruments and warning lights shall be displayed in a panel or panels in such a way that they will be most useful, convenient and visible to the driver. The panel or panels shall either be easily removable as units or hinged for back access by the employment of quick disconnect fittings for all electrical, air and hydraulic circuits. All instruments shall be illuminated by back-lighting. The following instruments and/or warning lights shall be provided:

Speedometer/Odometer	Pump pressure
Engine tachometer(s)	Water tank level
Fuel level	Foam liquid tank(s) level
Air pressure	Low air pressure warning
Engine(s) coolant temperature	Headlight beam indicator
Engine(s) oil pressure	Pump output indicators (applicable only when two pumps in parallel are furnished)
Engine(s) generator indicator	
Transmission(s) oil pressure*	
Transmission(s) oil temperature*	

*Applicable only when torque converters are furnished.

414. CONTROLS. The cab shall have all the necessary controls within easy reach of the driver for the full operation of the vehicle and of the pumping system. The following cab controls shall be provided:

Accelerator pedal	Groundsweep valve control
Brake pedal	Undertruck valve control
Clutch pedal**	Remote turret controls*
Parking brake lever	Starter switch(es)
Steering wheel, with self-cancelling directional signal control and horn	Light switches
Transmission range selector	Windshield wiper and washer controls
Pump control or selector	Heater-defroster controls
Foam liquid tank(s) valve control	Master electrical disconnect switch
Siren switch(es)	
Ignition switch(es)	

*Applicable only when remote turret is furnished.

**Applicable to Classes one (1) and two (2) vehicles ONLY.

415. EQUIPMENT. The following equipment shall be provided in or on the cab, as may be applicable:

Heater-defroster, with 200 BTU output per cubic foot of cab space, with blower capacity per minute equal to cab volume, with fresh air intake, and with defroster ducts to windshield	Siren
Driver's seat 3-way adjustable, bucket type, with seat belt	Horns
Crew seats with individual seat belts	2 or more windshield washers*
	2 or more windshield wipers*
	2 or more sun visors
	2 outside rear view mirrors
	2 door lights
	Cab dome light

*Appropriate for removing foam.

42. Body.

421. CONSTRUCTION. The body shall be constructed of metal alloy to provide the lightest weight consistent with the strength necessary for off-pavement operation over rough terrain. The body may be of the unitized with chassis rigid structure type or it may be flexibly mounted on the vehicle chassis. It shall also include front and rear fenders and running boards. Body panels are to be removable where necessary to provide access to the interior of the vehicle.

422. ACCESS DOORS. Access doors shall be provided for those areas of the interior of the vehicle which must be frequently inspected. In particular, access doors of sufficient size and number shall be provided for access to:

Both sides of each engine	Foam liquid metering device
The pump(s) and pump drive	Battery storage

Other areas requiring access for inspection or maintenance shall either be open, or have removable panels as specified in Paragraph 421.

423. COMPARTMENTS. Suitable compartments shall be provided for convenient storage of the equipment and tools furnished with the vehicle. Compartment doors shall be hinged and provided with chrome plated steel or anodized aluminum handles operable with heavy gloved hands. Compartments are to be weather-tight.

424. WORKING DECK. The working deck of the vehicle shall be adequately reinforced to permit the crew to perform their duties in the turret area, cab hatch area, water tank emergency fill area, foam liquid emergency fill area, and in other areas where access to auxiliary or installed equipment is necessary.

425. HAND RAILS. Hand rails or bulwarks are to be provided on the working deck and elsewhere as may be necessary for the safety and convenience of the crew. Rails and stanchions shall be constructed of chrome plated metal or anodized aluminum and shall be strongly braced. Hand rails on the upper deck should be at least 24 inches high when conditions permit or in accordance with local safety requirements.

426. STEPS AND WALKWAY. Steps or ladders shall be provided on each side or at the rear for access to the working deck. The

rear step may extend below the angle of departure if it is hinged to swing up. All steps shall be rigidly constructed and shall have a non-skid surface. Walkways on the upper deck shall also have a non-skid surface. The lowermost rear step shall be no more than 28 inches above the ground.

43. Pump(s) and Pump Drive.

431. Water Pump(s).

4311. The water pump(s) shall be constructed of corrosion resistant metal and shall be single or multiple stage centrifugal type, designed for dependable emergency service. It shall be carefully designed and built in accordance with good modern practice.

4312. When operating from the water tank, it shall be capable of discharging at a rate equal to or exceeding the amount established in Table 1 of NFPA No. 403, but not less than the total gpm requirements of all foam outlets discharging simultaneously at designed pressures.

432. Foam Generating Pump.

4321. A foam generating pump system may be used for primary foam generation providing that a suitable water pump is also installed to supply water and/or foam solution for handlines. The foam generating pump system when used shall be constructed of corrosion resistant materials and shall be designed to produce foam at a rate sufficient to supply the turret nozzles.

433. Pump(s) Drive.

4331. The pump(s) may be driven by either of the following methods: (a) Separate engine(s) drive; (b) Power take-off drive.

4332. SEPARATE ENGINE(S) DRIVE. An independent pump engine(s) shall be provided having sufficient power to meet the pump performance requirements as listed in Table 1 of NFPA No. 403, at not more than the engine manufacturer's recommended governed speed.

The engine(s) shall have the same voltage ignition and starting system as the chassis engine, air cleaner, replaceable element oil filter, full pressure lubricating system and overspeed govern-

ing device to prevent damage to engine if under power when water tank is exhausted. The engine shall be provided with a radiator of adequate capacity to cool the engine when operated continuously under full load up to a 110° F. ambient temperature.

The pump may be either mounted directly to the engine bell housing, or it may be mounted separately and drive through a friction clutch and propeller shaft. If mounted separately, the clutch shall be of the single or multiple disc friction type having a capacity equal to the engine torque.

4333. POWER TAKE-OFF DRIVE. If the pump(s) is powered by the same engine(s) which is used to propel the vehicle, it shall be driven by a power take-off which is not affected by changes in transmission ratios or the actuation of clutches in the vehicle drive, except insofar as these changes or actuations may affect engine speed. The overall design shall be such that the requirement of uninterrupted transmission of power set forth in Paragraph 262 is met.

Provision shall be made in the design of the drive system and/or controls to prevent damage to the drive or lurching of the vehicle when the transmission is shifted from neutral to either forward or reverse speed ranges while simultaneously pumping. The take-off drive(s) shall incorporate a friction clutch(es), controlled from the cab, with a torque capacity at least equal to the maximum torque which may be absorbed by the pump(s), and designed to withstand engagement of the pump(s) at all engine speeds and under all operating conditions when a fire fighting capability is required.

When a power take-off pump drive is used, there shall be sufficient engine power both to operate the pump(s) at the rate of discharge required by Paragraph 4312, and to propel the vehicle under all operating conditions when a fire fighting capability is required. The over-all design shall be such that the requirements of Paragraph 2315 shall also be met.

434. Manifolds and Connections.

4341. SUCTION. The suction system shall be designed for efficient flow at the pumping rates required by Paragraph 4312. The pump suction line(s) shall be of large diameter and shortest length consistent with the most suitable pump(s) location. There shall be a drain at the lowest point with a valve for draining all of the liquid from the pumping system when desired. Suction

lines and valves shall be constructed of lightweight, corrosion-resistant materials.

When two pumps are used, they shall be arranged in parallel with manifolding so that either or both may supply any discharge outlet at the required operating pressure. During single pump operation, total capacity may be reduced.

4342. **DISCHARGE.** The pump discharge system shall be provided with a minimum of two discharge gates with 2½-inch National Standard Thread* adapters and caps.

When two pumps are used in parallel, a discharge manifold shall be provided incorporating a pressure relief device and a check valve for each pump. The check valve shall function automatically and shall be sized and designed for minimum flow restrictions.

4343. **PIPING, COUPLINGS AND VALVES.** All piping, couplings and valves shall be sized for required flow with minimum restriction and pressure loss. Material for all piping, couplings and valves shall be selected to avoid corrosive and/or galvanic action.

Piping shall be securely mounted and provided with flexible couplings to minimize stress. Union or victaulic type couplings shall be provided where required to facilitate removal of piping.

All valves shall be ¼ turn ball type as selected for ease of operating and freedom from leakage.

All water system piping shall be tested for suction side of pump for leakage. All water and solution discharge piping shall be tested at 50 per cent above system operating pressure.

4344. **CHURN LINE.** A closed system churn line shall be provided from the pump discharge to a heat exchanger at the tank bottom, to prevent overheating of water in the pump while standing and pumping. The churn line valve shall be automatic or shall have a cab control.

4345. **PRESSURE REGULATOR.** The automatic pressure regulator shall maintain the desired working pressure at all rates of flow.

*See NFPA No. 194, Standard for Fire Hose Couplings.

44. Water Tank.

441. Capacity.

4411. A water tank shall have a capacity in agreement with Table 1, NFPA No. 403. The tank shall be constructed of glass-fiber, reinforced plastic or of metal, coated or lined with a suitable rubber, plastic or ceramic. The tank shall have longitudinal and transverse baffles to prevent undue water surge.

442. Construction.

4421. The construction and connections shall be made to prevent the possibility of galvanic corrosion of dissimilar metals.

4422. When dissimilar metals are used for pipe connections (piping) from the tanks, they should be electrically insulated by the use of non-conductive plastic pipe or hose.

4423. The tank shall be equipped with easily removable manhole covers over the sump and a removable top or panels to permit access within each baffle compartment of the tank. It shall have an anti-swirl baffle and a deep sump with drain valves, and two filler openings with caps. Filler openings shall be not less than 5 inches in diameter. The tank vent and overflow shall be provided of sufficient capacity to permit the tank to receive filling at the rate as specified for tank vehicles in Table 1 of NFPA No. 403. The water tank outlet and the suction piping shall be sized to permit a water flow of capacity as specified in Table 1 of NFPA No. 403.

4424. The tank shall be flexibly mounted unless attached to or supported by a rigid structure.

443. Tank Fill Connection.

4431. Two tank fill connections shall be provided, one on each side of the apparatus in a position where it can be easily reached from the ground. The connections shall have check valves or be so constructed that water will not be lost from the tank when connection or disconnection is made. The tank fills shall have National Standard Thread* swivel female hose connections and shall be sized to permit refilling on either side of the vehicle at a rate at least equal to the minimum discharge rate

*See NFPA No. 194, Standard for Fire Hose Couplings.

required in Paragraph 4312. All water fill openings shall be provided with strainers of $\frac{1}{4}$ -inch mesh.

45. Foam System.

451. Foam Liquid Concentrate Tank(s).

4511. The Foam Liquid Tank(s) should be sized in conformance with Table 1 of NFPA No. 403.

4512. Foam liquid concentrate tanks may be either rigid or flexible type.

Rigid tanks should be made of glass-fiber reinforced plastics. The plastics shall be resistant to attack by the foam liquid concentrate and shall not adversely affect the performance characteristics of the foam liquid concentrate after extended storage in the tank. Unplasticized reinforced plastics shall be required, such as polyesters, polyvinyl chloride or epoxies.

Flexible types shall be of nylon reinforced neoprene rubber.

4513. Rigid tanks shall be equipped with a removable manhole or a removable tank top to permit access within each baffled compartment of the tank.

4514. Rigid tank outlets should be located above the bottom of the sump and of adequate size to permit maximum flow. The outlets should be arranged so as to permit the use of the full capacity of the tank with the vehicle level and at least 75 per cent of the tank capacity with the vehicle inclined on a 20 per cent side slope or ascending or descending a 30 per cent grade. A large capacity drain connection should be installed flush with the bottom of the sump.

4515. Rigid foam liquid concentrate tanks shall be flexibly mounted unless attached to a rigid structure. Each tank shall be separate and distinct from the body and easily removable as a unit.

4516. A fill trough should be provided equipped with a stainless steel $\frac{1}{4}$ -inch mesh screen and can openers to permit emptying 5-gallon foam liquid concentrate cans into the storage tank at a rapid rate. The trough should be connected to the foam liquid storage tank with a fill line designed to introduce foam liquid concentrate near the bottom of the tank so as to minimize foaming within the storage tank.

4517. A hose connection should be provided on each side of the vehicle to permit the pumping of foam liquid concentrate into the storage tank or tanks. Positive check or automatic shutoff valves should be provided to prevent the loss of foam liquid. Where flexible tanks are used the supply system shall be designed so that the flexible tanks shall not be subject to excess pressure. The supply system should be capable of delivering foam liquid at a rate at least equal to or greater than the maximum discharge rate of the foam system.

4518. The tank(s) shall be adequately vented to permit rapid and complete filling without the buildup of excessive pressure and to permit emptying the tank at the maximum design flow rate without danger of collapse.

4519. All components of the foam system including the foam liquid tank, piping, fill troughs, screens, etc., should be made of materials resistant to corrosion by foam liquid concentrate and water. Where practical lightweight materials of adequate strength should be used.

452. Foam Liquid Concentrate Pump.

4521. On those vehicles using a pump discharge side proportioning system the foam liquid pump or pumps should be made of bronze or other materials resistant to corrosion by foam liquid concentrate.

4522. The foam liquid concentrate system should be so arranged that the entire piping system including the foam liquid concentrate pump or pumps can be readily flushed with clear water.

4523. The foam liquid concentrate pump or pumps shall be capable of delivering the required quantity of foam liquid at a pressure in excess of the water pump operating pressure regardless of the water flow rate or variations in engine speed.

4524. Where more than one engine is used to drive a water pump or pumps and these same engines are used to drive a foam liquid concentrate pump or pumps, the drive arrangement should be such that whenever power is available to a water pump, power will also be available to a foam liquid concentrate pump.

453. Foam Liquid Concentrate Piping.

4531. The foam liquid concentrate piping shall be of material resistant to corrosion by foam liquid concentrate. Care

should be taken to insure that combinations of dissimilar metals that produce galvanic corrosion are not selected or that such dissimilar metals are electrically insulated. Where plastic piping is used, it shall be fabricated from unplasticized resins unless the stipulated plasticizer has been shown not to adversely affect the performance characteristics of the foam liquid concentrate. The plastic pipe may be reinforced with glass fibers. Polyvinyl chloride, polyvinylidene chloride, epoxies and polyesters are among the acceptable classes of resins.

4532. The foam liquid concentrate piping shall be adequately sized to permit the maximum required flow rate.

454. Foam Liquid Proportioning System.

4541. The foam liquid proportioning system shall provide suitable control of the ratio of foam liquid concentrate to the quantity of water being discharged and will permit selection of foam liquid concentrate percentages from 3 to 8 per cent of the water flow rate.

4542. A maximum tolerance of plus or minus 5 per cent of the proportioning setting shall be permitted at the maximum flow rate.

For example: A proportioner set for 6 per cent should proportion between 5.7 per cent and 6.3 per cent.

The variation below the desired percentage shall not exceed 5 per cent at any flow rate.

455. Turret Nozzles.

4551. Airport Index 3, 4 & 5 Fire Fighting Vehicles (as set forth in NFPA No. 403) shall have one or two turret nozzles. Airport Index A, B, 1 & 2 Fire Fighting Vehicles (as set forth in NFPA No. 403) should have one turret nozzle.

4552. The total foam solution or water flow rates from the turret or pair of turrets shall be at least 75 per cent of the total minimum rate of discharge specified in Table 1 of NFPA No. 403.

4553. Turrets shall be capable of discharging foam, dispersed or fog foam, water and water spray in still air in a continuously variable pattern in accordance with the following table:

Type of Discharge	TURRET FLOW RATE					
	150-250 gpm		250-350 gpm		400 gpm & over	
	Minimum Range	Width	Minimum Range	Width	Minimum Range	Width
Foam	130 ft.	—	145 ft.	—	150 ft.	—
Dispersed or Fog-Foam	40 ft.	15 ft.	50 ft.	20 ft.	60 ft.	25 ft.
Water*	130 ft.	—	145 ft.	—	150 ft.	—
Water Spray	40 ft.	10 ft.	45 ft.	12 ft.	50 ft.	12 ft.

*If a foam pump generator system is used, the maximum water range will be reduced to approximately one-half the range given in the above table.

4554. Turret nozzles with liquid flow rates of 600 gpm or more should preferably be of the dual discharge type and arranged to permit selection of either 50 per cent or 100 per cent of the turret capacity. If these turrets are operable from within the cab, they should have power assist.

4555. Turrets may be hydraulically or manually powered. Where hydraulic or manual controls are provided in the cab, manual controls shall also be provided on the roof.

4556. Where hydraulic power is used the turret should be aimed by a direct connected control lever designed to operate with power assist. A decontrol shall be provided in the cab and on the roof to permit manual operation.

4557. Turrets should be capable of being depressed at least 15° and elevated at least 45°. Where a single turret is used on a vehicle it shall be capable of being rotated at least 100° to either side (total traverse at least 200°). Where two turrets are used on a vehicle the turrets shall be capable of being rotated at least 100° from the straight ahead position to the side and at least 60° towards the center of the vehicle (total traverse at least 160°).

4558. The foam discharged by the turret nozzles should have a minimum expansion of 8 and a minimum 25 per cent drainage time of 5 minutes. If a foam pump generating system is used, the foam discharged by the turret nozzles should have a minimum 12 expansion with a minimum 25 per cent drainage time of 20 minutes.

4559. Foam tests for expansion and drainage time to be determined in accordance with the methods described in NFPA Pamphlet No. 11.

456. Hand Line Reels and Nozzles.

4561. Trucks for airports in Indexes 1 through 5 (as set forth in NFPA No. 403) should have two hose reels. Trucks for airports in Indexes A, B (as set forth in NFPA No. 403), shall have at least a single hose reel and hand line. Each reel in Indexes 1 through 5 shall be mounted in a compartment and on a vertical hinge post permitting reel to swing out at an angle to the truck. A lock with a quick release shall be provided for locking in both the operating and the bed position and the top of the reel or reels shall be no more than $5\frac{1}{2}$ feet above the ground.

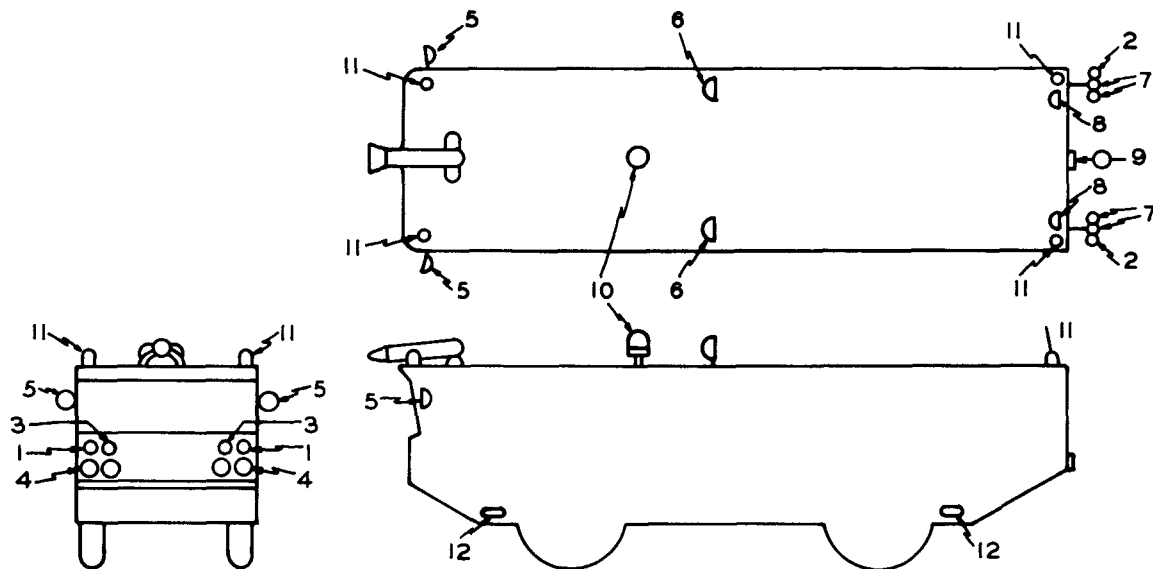
4562. Each reel shall have a capacity for and be equipped with a minimum of 150 feet of 1-inch or $1\frac{1}{4}$ -inch 800-lb. test rubber lined hose. Each reel shall be equipped with friction brakes with automatic actuation to prevent hose from unreeling when not desired.

4563. Flow to the reels should be controlled by manually operated quick opening ball type valves located so the hose can be charged in the bed position.

4564. Each hose shall be equipped with a shutoff type nozzle designed for selection of discharges of foam, water or water fog at a minimum rate of 60 gallons per minute. Each nozzle shall have a foam discharge pattern from a flat 15 ft. width and a 20 ft. range to a solid stream of foam with a minimum 50 ft. range; the resultant foam shall have a minimum expansion of 8 with a 25 per cent drainage time of at least five minutes, determined with the foam being discharged at the recommended operating pressure.

457. Ground Sweep and Under-Truck Nozzles.

4571. Trucks for airports in Indexes 1 through 5 (as set forth in NFPA No. 403) should have a ground sweep nozzle or nozzles capable of discharging at least 100 gpm at the recommended operating pressure in a flat pattern 12 ft. wide with a 25 ft. range. The resultant foam shall have a minimum expansion of 8 with a 25 per cent drainage time of 5 minutes. The ground sweep valve shall be controlled from the cab interior within easy reach of the



The diagram shows the lighting and reflectors recommended in this standard. The numerals have the following meanings: (1) Front direction lights (amber lens); (2) Rear direction lights (red lens); (3) Front parking and warning lights (red lens—flashing); (4) Dual headlights; (5) 6" Sealed beam spotlight (clear lens); (6) 6" Sealed beam equipment lights (clear lens); (7) Combination stop and taillights (red lens); (8) Rear equipment lights (clear lens); (9) Back-up lights (clear lens); (10) Rotating beacon flashing light; (11) Identification lights (red lens — flashing); (12) Side reflectors (amber).

driver and a crew man and shall also be controlled from a point outside the vehicle.

4572. Two or more under-truck nozzles shall be mounted under the truck and controlled from the cab. A sufficient number shall be provided so as to protect the bottom of the vehicle and the inner sides of the wheels and tires with foam solution discharged in a spray pattern.

458. Foam System.

4581. The quality of foam produced by foam liquid concentrates is influenced by the devices which proportion the liquid concentrate into water and by the devices which discharge the foam. It is recommended that the foam liquid concentrate used in aircraft fire and rescue vehicles be that supplied and/or recommended by the manufacturer of the foam discharge devices and proportioning equipment.

46. Lighting and Electrical Equipment.

461. Lighting.

4611. Lighting equipment shall include the following:

Two or more sealed-beam headlights with upper and lower driving beams. A foot controlled switch will be provided for beam selection.

Dual taillights and dual stoplights.

Turn signals, front and rear, conforming to S.A.E. Turn Signal Units, Type 1, Class A, and shall have self-cancelling control with a visual and audible indicator.

6-inch minimum chrome plated, sealed-beam spotlight on both left and right sides of the windshield, hand adjustable type, with controls for beam adjustment inside the truck cab.

Two chrome plated 6-inch minimum sealed-beam equipment pick-up lights with weatherproof switches.

Reflectors and marker and clearance lights shall be furnished and installed in conformance with the accompanying Figure.

Engine compartment lights, non-glare type, arranged to illuminate both sides of the engine with individual switches located in the engine compartment.

Two swivel mounted lights, 6-inch minimum with clear lens and individual switches, to be mounted on the top deck for equipment lighting.

At least one back-up light installed in the rear of the body. Light shall automatically light up when transmission is shifted into reverse.

A flashing red beacon or alternate red and white flashing lights shall be mounted on the top deck and visible 360° in horizontal plane. Mounting of beacon shall also provide good visibility from the air. A control switch shall be provided on the instrument panel in the cab for control of the beacon.

462. Siren.

4621. A warning siren shall be provided having a sound output of not less than 95 decibels at 100 feet directly ahead of the siren and not less than 90 decibels at 100 feet measured at 45 degrees on either side. The siren shall be mounted to permit maximum forward sound projection, but shall be protected from foam dripping from the turret, or water splashed up by the tires.

4622. The siren control switches shall be located for use both by the driver, and the officer.

NOTE 1: If desired, the driver's siren control shall be wired for selective control on the steering wheel horn button.

NOTE 2: If a combination public address type siren is desired, an electronic type having the above sound output shall be substituted.

463. Horn.

4631. An electric or air horn shall be provided.

4632. An electric horn shall be mounted at the front part of the vehicle with control by button or ring at steering wheel.

4633. An air operated horn shall be provided when specified with air operated brakes.

464. Radios.

4641. Provision shall be made for mounting two 2-way radios. Operation of the radios shall be from the cab. Radios shall be mounted permitting quick servicing or replacement.

4642. One radio shall be fixed frequency type operating on F.A.A. specified ground control frequency.

4643. One radio shall be two-way local control frequency.

47. Tools.

471. The following equipment shall be provided and properly mounted on the truck 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, $\frac{3}{4}$ -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 handline 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.

48. Miscellaneous.

481. Front Bumper. A heavy duty front bumper shall be mounted on the forward end of the vehicle and secured to the frame structure.

482. Towing Connections. Two large tow eyes will be capable of towing the vehicle and shall be mounted at the front of the truck and attached to the frame structure. A pintle tow hook or two tow eyes shall be mounted at the rear of the vehicle and attached to the frame structure.

483. Finish.

4831. The apparatus shall be finished with standard chrome yellow enamel. Retro-reflective striping (such as "Scotchlite") shall be applied to the front and rear of the vehicle and may be applied to the top and sides as required for quick night identification for rescue and fire fighting equipment.

4832. The surfaces shall be sanded and thoroughly cleaned to remove all oil, rust and dirt before application of primer and surfacer coats. Final color coats to be non-fading chrome yellow enamel.

4833. All lettering and striping shall be in black, unless otherwise specified.

PART V — RESCUE VEHICLES

51. Cab, Body, and Equipment

511. Cab

5111. The cab shall be chassis manufacturer's standard, meeting visibility requirements outlined in Paragraph 3223. The cab shall provide seating for at least two men, and seats shall be adjustable type for driving ease.

5112. The following items of equipment and controls are to be provided:

Heater and defroster, manufacturer's standard fresh air type.

Individual seat belts meeting SAE standards.

One (1) electric siren with flashing light having a sound output of not less than 95 decibels at 100 ft. directly ahead of the siren and not less than 90 decibels at 100 ft. measured at 45 degrees on either side.

One (1) traffic warning electric horn.

Two (2) windshield wipers, electric.

Two (2) windshield washers.

Two (2) sun visors.

Two (2) outside rearview mirrors.

One (1) interior dome light with individual switch.

Standard cab instrument panel with instruments and gauges.

For vehicle equipped with 300 pounds or more of dry chemical, a valve as required by Paragraph 5261 shall be provided and mounted convenient to the driver.

For vehicle equipped with low pressure carbon dioxide, the remote controls for the boom or nozzle required by Paragraph 5342 shall be provided convenient for the driver.

512. Body

5121. The body shall be constructed of metal alloy to provide the lightest weight consistent with the strength necessary for off-pavement operation over rough terrain. The body shall provide for mounting the dry chemical unit, or low pressure carbon dioxide unit, with a maximum of accessibility for hand lines and controls. Provision shall be made for easy access to service the dry chemical unit and replacement of the pressurizing cylinder. Rear fenders or wheel housings shall be provided. Fenders shall be securely attached to the body.

513. Compartments

5131. Suitable compartments shall be provided convenient for the storage of the tools and equipment recommended in Paragraph 541. Compartment doors shall be hinged and provided with chrome plated steel or anodized aluminum handles, operable with heavy gloved hands. Compartments are to be weather-tight.

52. Dry Chemical Components.

521. General.

5211. FLOW RATES. Flow rates of the dry chemical shall be such that they will conform with the requirements of Table 1 of NFPA No. 403.

5212. DRY CHEMICAL CHAMBER. Construction of the dry chemical chamber shall be in accordance with the latest ASME Code for Unfired Pressure Vessels and shall be so stamped.

NOTE: The nominal capacity of the dry chemical containers has generally been based upon the use of sodium bicarbonate based dry chemicals. When dry chemical compounds of different bases are substituted, a difference in the weights of the dry chemicals that can be placed in the same size container can vary considerably.

An example is the replacement of sodium bicarbonate base with potassium bicarbonate base dry chemicals. In such instances the difference in fresh fill capacity weights of the two dry chemicals for the same size container will vary as much as 10 per cent.

5213. PIPING AND VALVES. All piping and fittings shall conform to the appropriate ASME Code and shall be designed to withstand the working pressure of the system. The design of the piping and valving shall be such that it provides the desired flow of gas into the system and the minimum amount of restriction from the chemical chamber to the hose connection. When more than one hose line is provided, piping and fittings shall be so sized and designed that there will be equal flow to each line regardless of the number of lines placed in operation.

5214. PURGING PIPING AND HOSE. Provisions shall be made for the purging of all piping and hose of dry chemical after use without discharging the dry chemical remaining in the dry chemical chamber. Provisions shall also be made for the depressurization of the dry chemical chamber without the loss of the remainder of the dry chemical.

5215. FLUIDIZATION OF AGENT. The system shall be so designed as to insure fluidization of the dry chemical at the time

of operation. Where any design includes the movement of the chemical chamber to fluidize the contents, such design shall also include a manual operating feature.

5216. CHECK VALVE. A check valve shall be provided in the gas piping to prevent the extinguishing agent from being forced back into the propellant gas line.

5217. PRESSURE RELIEF. A means of pressure relief shall be provided for the dry chemical chamber and piping to prevent overpressurization in the event of a malfunction in the propellant gas regulator system or in the event the container is involved in a severe fire exposure.

5218. FILL OPENING. The fill opening in the dry chemical chamber shall be located so that it will be easily accessible for recharging and require a minimum amount of time and effort to open and close. The filling shall be accomplished without the removal of any of the extinguisher piping or any major component.

522. Propellants. The propelling agent shall be dry nitrogen or dry air.

5221. All propellant gas cylinders and valves shall be in accordance with ICC-3AA. Cylinders shall bear the ICC marking.

5222. The method of adequately pressurizing and propelling the dry chemical in the system shall provide a sufficient quantity of gas to expel the agent in its entirety as well as permitting the complete purging of all piping and hose lines after each use.

5223. The design of the propellant source shall be such that it will provide a quick and easy replacement after each use.

5224. A pressure gauge shall be provided which will at all times indicate the pressure on the propellant gas source.

5225. Cylinder valves, gauges, and piping shall be so arranged and/or guarded to preclude accidental mechanical injuries.

523. Pressure Regulation. Pressure regulation shall be so designed that it will automatically reduce the normal cylinder pressure and hold the propellant gas pressure at the designed operating pressure of the dry chemical chamber.

5231. All pressure regulating devices shall be sealed or pinned at the designed operating pressures after final adjustment by the system manufacturer.

5232. Pressure regulating devices shall be equipped with a spring loaded relief valve which will relieve any excess pressure that may develop in the regulator.

524. Hose. Hose shall be installed so that it is easily accessible. The system shall be furnished with one or two hoses.

5241. Provisions shall be made for the adequate storage of hose. It shall be easily removed from its storage position without kinking. Swivel connections may be provided at the nozzle and/or at the base of the hose, but these may be considered as a supplement to other arrangements which will avoid kinking.

5242. All hose shall be of a type and pressure rating adequate for the service intended.

5243. Each hose length shall be a minimum of 50 feet in length and the maximum length shall be compatible with the design of the system.

525. Nozzles.

5251. Hand hose nozzles shall be simple in operation and shall supply adequate dry chemical range and flow. The nozzle shall have a low discharge recoil characteristic. The operation shall be full open to closed position in one simple movement. The construction shall be of nonferrous metal or stainless steel.

526. Operational Design. Simplicity of actuation shall be given prime consideration in the design of any system. A maximum of two operations (exclusive of the nozzle) shall be required to fully charge the system.

5261. A quick acting valve for quick pressurizing the dry chemical system from the cab of the vehicle and at the unit shall be provided.

5262. Each hose outlet shall be equipped with a shutoff valve on the vehicle for closing the line.

527. Dry Chemical Type. For aircraft rescue and fire fighting purposes, dry chemical shall be of an approved foam compatible type (or, in the U.S.A., must meet the latest Military

Specification MIL-F-22287). It is recommended that the equipment manufacturer's dry chemical be used.

528. Maintenance. The manufacturer's operation and maintenance instructions for the dry chemical equipment shall be provided with each vehicle.

53. Low Pressure Carbon Dioxide Components.

531. General.

5311. Low pressure carbon dioxide may be used as a quick knockdown agent on the basis given in Table 1 of NFPA No. 403.

5312. Low pressure storage containers shall be designed to maintain the carbon dioxide supply at a nominal pressure of 300 psi corresponding to a temperature of approximately 0° F.

5313. The combined discharge capacity of hand lines and boom or bumper nozzles when used shall be sufficient to discharge the entire contents of the storage tank in not more than 2 minutes.

5314. A reserve supply of carbon dioxide should be readily available in order to permit immediate recharging of the truck mounted storage container after use.

532. Storage Container.

5321. The pressure container shall be made, tested, approved, equipped and marked in accordance with the current specifications of the American Society of Mechanical Engineers (ASME) Code for Unfired Pressure Vessels.

5322. In addition to the Code requirements, each pressure vessel shall be equipped with a liquid level gauge, a pressure gauge, and a high-low pressure supervisory alarm operated from the truck battery system. A special relief valve (in addition to the Code requirements) should be provided for controlled bleed off at a pressure below the setting of the main safety valve.

5323. The pressure vessel shall be thermally insulated with a suitable material to give an overall heat transfer coefficient of not more than 0.05 BTU per square foot per degree F. per hour. The insulation shall be protected with a suitable coating or cover to assure fire resistance, prevent water absorption, and protect against mechanical damage.

5324. The insulated pressure vessel shall be securely mounted to the vehicle chassis so as to prevent any possible shifting without transmitting excessive stress to the pressure vessel itself.

5325. A mechanical refrigeration system shall be provided of sufficient capacity to maintain 0° F. in the storage container with not more than 30 per cent running time when the ambient temperature is 70° F. The refrigeration system may be powered by an electric motor where the truck can normally be stationed at a point where electric power is available. The extension cord providing this power should be fitted with an adapter plug that will pull away automatically when the truck is driven away. The refrigeration system shall be automatically controlled to maintain a pressure differential in the storage tank of approximately 10 psi.

5326. In locations where the vehicle may be exposed to ambient temperatures below about -10° F. for substantial periods of time, a heating system should be provided to maintain the pressure in the storage container at near 300 psi.

533. Piping, Fittings and Valves.

5331. All pipe fittings and valves used to control and convey liquid carbon dioxide shall have a minimum bursting pressure of 1800 psi and shall be suitable for low temperature use.

5332. Pressure relief valves shall be connected to a separate outlet at the top of the storage container and directed so that the discharge cannot become a hazard to operating personnel. Safety relief valves shall also be provided for any pipe section in which liquid carbon dioxide can be trapped between closed valves.

5333. Liquid fill and pressure equalizing lines shall be piped so as to be readily accessible for recharging storage container.

5334. Discharge piping shall be adequately sized to permit the maximum required discharge rate while maintaining a pressure of at least 150 psi at the nozzles. Discharge valves shall be of the quick opening and closing type and may be remote pressure operated using vapor pressure from the storage tank.

5335. Piping and valves shall be arranged so that the minimum amount of piping is under continuous pressure. Piping under continuous pressure should preferably be welded and shall be tested to assure bubble tight connections.

534. Boom Discharge Nozzles.

5341. Where the vehicle mounted storage capacity is substantially more than 1,000 lbs., it may be desirable to use a high capacity discharge nozzle mounted on the front of the vehicle or on an overhead boom.

5342. Vehicle mounted nozzles when used shall be hydraulically controlled so as to permit remote directing of the discharge stream from within the cab. Remote control shall also be provided to conveniently start and stop the discharge as may be required from within the cab.

535. Hand Lines.

5351. Hose lines shall be constructed with wire braid reinforcement and shall have a bursting pressure in excess of 1800 psi. The inner liner shall be of a material that will remain flexible at -65° F. The outer cover over the wire braid shall consist of a cotton braid or protective covering of sufficient porosity to eliminate the formation of bubbles as a result of minor leakage through the inner liner.

5352. The hose shall be stored on a reel permanently connected to supply piping so that the line is ready for immediate use.

5353. The hose line shall be automatically charged when the discharge nozzle assembly is released from its holding device.

5354. The play pipe shall be provided with a quick opening squeeze type manual valve for conveniently starting and stopping the discharge.

5355. The discharge nozzle shall be of the type capable of giving reasonable projection under windy conditions and should have a discharge capacity of at least 300 pounds per minute.

5356. Special nozzles may be provided to permit total flooding of enclosed spaces through small openings.

54. Rescue Vehicle Accessory Equipment.

541. The following rescue equipment is recommended as a minimum to be carried on a light rescue vehicle. In the largest capacity units (1,000 pounds dry chemical) experience has shown that it will not be possible to carry any additional equipment and still keep within the G.V.W. recommended for such vehicles. Any additional equipment should be carried by other vehicles.

- One portable electric generator 3000 watt, 230 volt, 180 cycle, 3 phase. Unit shall be driven by a two- or four-stroke cycle gasoline engine, equipped with automatic choke, governor, self-contained gasoline supply and a recoil rope starter. The engine shall be of suitable size to deliver the wattage specified. It shall selectively, but not simultaneously, also deliver 1000 watts at 115 volts either D.C. or single phase A.C. for operation of lights, tools, etc. It shall be sufficiently light in weight to be carried by not more than two men.
- One portable saw 220 volt, 3 phase, 180 cycle A.C. with special aluminum metal cutting blade of minimum 10-inch diameter.
- Two floodlights 500 watts, 110 volts with stand.
- Two 50-foot lengths 14-3 conductor, type SO cable with twist type connectors to fit generator and floodlights.
- Two (2) 50-foot lengths of No. 12-4 conductor, Type SO cable with twist type connectors to fit generator and portable saw.
- One (1) electric lantern, weatherproof, 6-volt, hand type, sealed beam bulb, appropriate for one-hand operation, with battery and mounting bracket.
- One (1) axe, fireman's, non-wedging, 6-lb. pick head.
- Two (2) 30-lb. approved dry chemical hand extinguishers.
- One (1) shovel, short "D" handle, round point.
- One (1) 60-foot length of wire rope cable, $\frac{3}{4}$ -inch diameter, 38-strand, with choker hooks on each end.
- One (1) set of forcible entry tools in a canvas tool roll, with pockets and straps:
 - One (1) bolt cutter, 36".
 - One (1) bar, wrecking, offset, 36".
 - One (1) cold chisel, 1".
 - One (1) cutter, cable (AT-501C, Aircraft Tool Co.).
 - One (1) flashlight, 2-cell (explosion proof).
 - One (1) pair of shears, Tinner's, 3" jaw, 12" length.
 - One (1) roll of friction tape.
 - One (1) hacksaw, pistol grip, with 12 blades, assorted metal cutting.
 - One (1) hammer, cross peen, 4-lb. head.
 - One (1) hatchet, metal cutting, insulated handle.
 - One (1) knife, rescue (seat-belt-cutting), curved or V-blade.
 - One (1) pair of pliers, lineman's, side-cutting, 8".
 - One (1) screw driver, plain, 16".
 - Two (2) keys, Dzus fastener.
- One two-section aluminum alloy crash ladder with 14-foot extended length, and equipped to be used as a free stand "A" frame ladder. The ladder shall be mounted so as to be readily removable by a man standing on the ground.

PART VI — TANK VEHICLES

61. Cab

611. Arrangement. The cab shall meet the ground visibility requirements of Paragraph 2223. It shall have seats for at least three men, including individually adjustable driver's seat and adequate space for the instruments, controls and equipment specified herein without hindering the crew. Wide opening doors shall be provided on each side of the cab with necessary steps and hand-grabs to permit rapid and safe entrance and exit from the cab. The windshield and side windows shall be constructed of shatterproof plate glass. The windshield shall provide for wide and high visibility and shall be so designed, that with a standard man sitting in normal position he shall have a minimum vertical range of vision 15 degrees above the horizontal. His vision in the horizontal plane shall be at least 180 degrees.

612. Construction. The cab shall be constructed in Classes 4 through 8 Vehicles (see Paragraph 212), of lightweight construction, of adequate strength to ensure the safety of the crew. The cab shall be rainproof and dripproof, and shall be fully insulated with a fire resistant insulating material at least one-half inch thick. The cab may be of the unitized rigid body and frame structure, or it may be a separate unit flexibly mounted on the main vehicle frame.

613. Instrument and Warning Lights. The minimum number of instruments and warning lights consistent with the safe, efficient operation of the vehicle and equipment shall be provided. Warning lights shall be used where practicable instead of instruments, and provision shall be made to readily test the condition of the bulb. All instruments and warning lights shall be displayed in a panel or panels in such a way that they will be most useful, convenient and visible to the driver. The panel or panels shall either be easily removable as units or hinged for back access by the employment of quick disconnect fittings for all electrical, air and hydraulic circuits. All instruments shall be illuminated by back-lighting. The following instruments and/or warning lights shall be provided:

Speedometer/Odometer	Pump pressure
Engine tachometer(s)	Water tank level
Fuel level	Foam liquid tank(s) level**
Air pressure	Low air pressure warning
Engine(s) coolant temperature	Headlight beam indicator
Engine(s) oil pressure	Pump output indicators (applicable only when two pumps in parallel are furnished)
Engine(s) generator indicator	
Transmission(s) oil pressure*	
Transmission(s) oil temperature*	

*Applicable only when torque converters are furnished.

**Applicable only when vehicle carries foam liquid.

614. Controls. The cab shall have all the necessary controls within easy reach of the driver for the full operation of the vehicle. The following cab controls shall be provided:

Accelerator pedal	Siren switch(es)
Brake pedal	Ignition switch(es)
Clutch Pedal*	Starter switch(es)
Parking brake lever	Light switches
Steering wheel, with self-cancelling directional signal control and horn button or ring	Windshield wiper and washer controls
Transmission range selector	Heater-defroster controls
Pump control or selector	Master electrical disconnect switch

*Applicable to Classes one (1) and two (2) vehicles ONLY.

615. Equipment. The following equipment shall be provided in or on the cab, as may be applicable:

Heater-defroster, with 200 Btu output per cubic foot of cab space, with blower capacity per minute equal to cab volume, with fresh air intake, and with defroster ducts to windshield	Siren (see Paragraph 662)
Driver's seat 3-way adjustable, bucket type, with seat belt	Horns
Individual seat belts meeting SAE standards	2 or more windshield washers*
	2 or more windshield wipers*
	2 or more sun visors
	2 outside rearview mirrors
	2 door lights
	Cab dome light

*Appropriate for removing foam.

62. Body

621. Construction. The body shall be constructed of metal alloy to provide the lightest weight consistent with the strength necessary for off-pavement operation over rough terrain. The

body may be of the unitized-with-chassis rigid structure type or it may be flexibly mounted on the vehicle chassis. It shall also include front and rear fenders and running boards and/or wheel housings. Body panels are to be removable where necessary to provide access to the interior of the vehicle.

622. Access Doors. Access doors shall be provided for those areas of the interior of the vehicle which must be frequently inspected. In particular, access doors of sufficient size and number shall be provided for access to:

Both sides of each engine

Battery storage

The pump(s) and pump drive

Other areas requiring access for inspection or maintenance shall either be open, or have removable panels as specified in Paragraph 621.

623. Compartments. Suitable compartments shall be provided for convenient storage of the equipment and tools furnished with the vehicle. Compartment doors shall be hinged and provided with chrome plated steel or anodized aluminum handles operable with heavy gloved hands. Compartments are to be weather-tight.

624. Working Deck. The working deck of the vehicle shall be adequately reinforced to permit the crew to perform their duties in the water tank emergency fill area, and in other areas where access to auxiliary or installed equipment is necessary.

625. Hand Rails. Hand rails or bulwarks are to be provided on the working deck and elsewhere as may be necessary for the safety and convenience of the crew. Rails and stanchions shall be constructed of chrome plated metal or anodized aluminum and shall be strongly braced.

626. Steps and Walkway. Steps or ladders shall be provided on each side or at the rear for access to the working deck. The rear step may extend below the angle of departure if it is hinged to swing up. All steps shall be rigidly constructed and shall have a nonskid surface. Walkways on the upper deck shall also have a nonskid surface. The lowermost rear step shall be no more than 28 inches above the ground.

627. Hose Storage

6271. A compartment shall be provided on each side of the body, sized to permit storage of not less than 100 feet of 2½-inch double jacketed hose in each compartment. Compartments shall be readily accessible.

6272. Compartment space shall be provided, easily accessible, for storage of 15 feet of 4½-inch double jacketed suction hose, coupled.

6273. When applicable (see Section 65), compartment space shall be provided for storage of 100 feet of 1½-inch double jacketed hose for foam liquid concentrate transfer. Compartment shall be easily accessible.

63. Water Pump and Pump Drive

631. Water Pump

6311. The water pump shall be constructed of corrosion-resistant metal and shall be single or multiple stage centrifugal type, designed for dependable emergency service. It shall be carefully designed and built in accordance with good modern practice.

6312. When operating from the water tank, it shall be capable of transferring into the primary vehicle at a rate equal to or exceeding the amount established in Table 1, Line (i) of NFPA No. 403.

632. Pump Drive

6321. **POWER TAKE-OFF DRIVE.** The pump shall be driven by a power take-off with a torque capacity rating equal to the requirements for maximum discharge as specified for the pump.

633. Manifolds and Connections

6331. **SUCTION.** The suction system shall be designed for efficient flow at the pumping rates required by Paragraph 6312. The pump suction line shall be of large diameter and shortest length consistent with the most suitable pump location. There shall be a drain at the lowest point with a valve for draining all of the liquid from the pumping system when desired. Suction lines and valves shall be constructed of lightweight, corrosion-

resistant materials. When two pumps are used, they shall be arranged in parallel with manifolding so that either or both may supply any discharge outlet at the required operating pressure. During single pump operation, total capacity may be reduced.

6332. **DISCHARGE.** The pump discharge system shall be provided with a minimum of two discharge gates, one each side of the body, located in a position where they can be easily reached from the ground. When two pumps are used in parallel, a discharge manifold shall be provided incorporating a pressure relief device and a check valve for each pump. The check valve shall function automatically and shall be sized and designed for minimum flow restrictions.

6333. **PIPING, COUPLINGS AND VALVES.** All piping, couplings and valves shall be sized for required flow with minimum restriction and pressure loss. Material for all piping, couplings and valves shall be selected to avoid corrosive and/or galvanic action. Piping shall be securely mounted and provided with flexible couplings to minimize stress. Union or victaulic type couplings shall be provided where required to facilitate removal of piping. All discharge valves shall be one quarter turn locking ball type as selected for ease of operating and freedom from leakage. All water system piping on the suction side of the pump shall be tested for leakage. All water discharge piping shall be tested at 100 psi above system operating pressure.

6334. **PRESSURE REGULATOR.** The automatic pressure regulator shall maintain the desired working pressure at all rates of flow.

64. Water Tank

641. Capacity

6411. A water tank shall have a capacity in agreement with Table 1, NFPA No. 403. The tank shall be constructed of glass-fiber, reinforced plastic or of metal, coated or lined with a suitable rubber, plastic or ceramic. The tank shall have longitudinal and transverse baffles to prevent undue water surge.

642. Construction

6421. The construction and connections shall be made to prevent the possibility of galvanic corrosion of dissimilar metals.

6422. When dissimilar metals are used for pipe connections (piping) from the tanks, they should be electrically insulated by the use of nonconductive plastic pipe or hose.

6423. The tank shall be equipped with easily removable manhole covers over the sump and a removable top or panels to permit access within each baffle compartment of the tank. It shall have an anti-swirl baffle and a deep sump with drain valves, and two filler openings with caps. Filler openings shall be not less than 5 inches in diameter. The tank vent and overflow shall be provided of sufficient capacity to permit the tank to receive filling at the rate as specified in Table 1 of NFPA No. 403. The water tank outlet and the suction piping shall be sized to permit a water flow of capacity as specified in Table 1 of NFPA No. 403.

6424. The tank shall be flexibly mounted unless attached to or supported by a rigid structure.

643. Tank Fill Connections

6431. A minimum of two 2½-inch tank fill connections shall be provided, one each side of the body, and one 4½-inch fill connection shall be provided, each in a position where the connections can be easily reached from the ground. The connections shall be provided with check valves or so constructed that water will not be lost from the tank when connection or disconnection is made. The 2½-inch tank fills shall have National Standard Thread,* swivel, female hose connections. The 4½-inch tank fill shall have male National Standard Threads. All water fill openings shall be provided with strainers of ¼-inch mesh and blind caps. If other than National Standard Threads are to be used, the thread shall be specified.

65. Foam Liquid Concentrate System

NOTE: This system only applicable when it is desired to carry foam liquid concentrate in a tank or tanks on the tank vehicle for transfer to the foam fire fighting vehicle.

651. Foam Liquid Concentrate Tank

6511. The foam liquid tank should be sized in conformance with Table 1 of NFPA No. 403.

6512. Foam liquid concentrate tanks may be either rigid or flexible type. Rigid tanks should be made of glass-fiber rein-

*See NFPA No. 194, Standard for Fire Hose Couplings.